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OECD Reviews of Innovation Policy: Norway 2017

BETTER POLICIES FOR BETTER LIVES

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Foreword

The OECD Review of Norway's Innovation Policy is part of a series of OECD country reviews of innovation policy (www.oecd.org/sti/innovation/reviews). It was requested by the authorities of Norway, represented by the Ministry of Education and Research, and was carried out by the OECD Directorate for Science, Technology and Innovation under the auspices of the Committee for Scientific and Technological Policy (CSTP).

The review aims to provide a knowledge base for the Norwegian government when implementing and revisiting its Long-term plan for research and higher education in 2018. In addition, as for all Innovation Policy Reviews, its purpose is to obtain a comprehensive understanding of the key elements, relationships and dynamics that drive Norway's innovation system and the opportunities to enhance it through government policy. More specifically, the review:

- provides an independent and comparative assessment of the overall performance of the Norwegian innovation system
- recommends where improvements can be made in the system
- formulates recommendations on how government policies can contribute to such improvements, drawing on the experience of OECD and non-OECD countries and evidence on innovation processes, systems and policies.

The review is relevant to a wide range of stakeholders in Norway, including government officials, entrepreneurs and researchers, as well as the general public. It aims to provide a comprehensive presentation of the Norwegian innovation system and policy to a global audience through the OECD communication channels.

An informal note containing a preliminary assessment and areas for improvement was presented for a peer review to the Working Party for Innovation and Technology Policy (TIP) of the CSTP in December 2016. A draft overall assessment and recommendations was presented at a stakeholder workshop organised by the Ministry of Education and Research of Norway (MER) held at the premises of the Research Council of Norway in March 2017 and chaired by Kari Balke Øiseth, Director General (MER), in presence of the State Secretary Bjørn Haugstad (MER).

The review was led by Gernot Hutschenreiter, Head, Country Innovation Policy Reviews Unit (Directorate for Science, Technology and Innovation, OECD). The review report was drafted by Philippe Larrue (Directorate for Science, Technology and Innovation, OECD), who acted as the project manager of the review, and Giulia Ajmone Marsan (Directorate for Science, Technology and Innovation, OECD), with contributions from Michael Stampfer (consultant to the OECD; Managing Director of the Vienna Science and Technology Fund, Austria), Elvira Uyarra (consultant to the OECD; Senior lecturer at Manchester Business School, Innovation Management and Policy division, United Kingdom) and Sylvia Schwaag Serger (consultant to the OECD; Executive

Director International Strategy and Networks, Vinnova; and Adjunct Professor in Research Policy, School of Economics, Lund University, Sweden), with valuable support from Johannes Weber, Blandine Serve, Chrystyna Harpluk and Yana Vaziakova (all from the Directorate for Science, Technology and Innovation, OECD) under the supervision of and with contributions from Gernot Hutschenreiter.

The review draws on the results of a series of interviews with a wide range of major stakeholders of the Norwegian innovation system during fact-finding missions to Norway in September 2016 and January 2017 as well as specific missions to inform two case studies, respectively on seas and oceans in January 2017 and health and healthcare R&D in February 2017. A background report has been drafted under the responsibility of the MER, with contributions from a reference group with representatives also from the Ministry of Trade, Industry and Fisheries and the Research Council of Norway. Additional contributions have been made by Espen Solberg from the Nordic Institute for Studies in Innovation, Research and Education (NIFU). This report provided background in the preparation for the OECD fact-finding mission and a valuable source of information for the review.

This review has benefited from comments and additional information received from stakeholders in Norway, including during the above-mentioned stakeholder workshop held in March 2017.

The authors owe much to the support and co-operation of the Norwegian government officials. The OECD Review Team is especially grateful to Geir Arnulf (MER) and his team, including in particular Anne Karine Nymoen and Sigve Berge Hofland. The staff of the Research Council of Norway was also very helpful to the successful delivery of this Review, in particular Randi Søgnen and Christina I.M. Abildgaard. Many of the stakeholders the OECD review team met with during the fact-finding mission and at the stakeholder workshop provided valuable information and data and were instrumental for the preparation of this report (see the list of people interviewed in Annex C).

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Acronyms and abbreviations

BERD	Business enterprise expenditure on research and development
CoE	Centre of excellence
DFU	Inter-ministerial Committee on Research Policy *Departementenes forskningsutvalg*
EPO	European Patent Office
ERC	European Research Council
EU	European Union
FP	Framework Programme
FRIPRO	Norwegian Scheme for Independent Research Projects
FTE	Full-time equivalent
GBAORD	Government allocation to R&D
GCE	Global centres of expertise
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and expenditure
GOVERD	Government expenditure on research and development
HE	Higher education
HEI	Higher education institution
HERD	Higher education expenditure on research and development
ICT	Information and communication technology
IN	Innovation Norway
IUS	Innovation Union Scoreboard
KMD	Ministry of Local Government and Modernisation
LTP	Long-Term Plan for Research and Higher Education
MAROFF	Maritime activities and offshore operations
MER	Ministry of Education and Research
MHCS	Ministry of Health and Care Services
MSCA	Marie Skłodowska-Curie actions
MTIF	Ministry of Trade, Industries and Fisheries
NMBU	Norwegian University of Life Sciences
NOK	Norwegian krone (currency)
NOKUT	Norwegian Agency for Quality Assurance in Education

NTNF	Norwegian Council for Scientific and Industrial Research
NTNU	Norwegian University of Science and Technology
O&G	Oil and gas
OFU	Public Research and Development contracts *Offentlige Forsknings- og Utviklingskontrakter*
PA	Performance agreement
PBF	Performance-based financing
PhD	Doctor of Philosophy
PIAAC	Adult Skills Programme for International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
PRI	Public research institute
R&D	Research and development
RCN	Research Council of Norway
REF	Research Excellence Framework
RFU	Cabinet Research Committee
RTO	Research and technology organisation
SFF	Centres of Excellence Programme *Sentre for fremragende forskning*
SFI	Centres for research-based innovation
Siva	Industrial Development Corporation of Norway
SJR	Scimago Journal Rank
SME	Small and medium-sized enterprise
STEM	Science, technology, engineering and mathematics
STI	Science, technology and innovation
TTO	Technology transfer office
TVET	Technical and vocational education and training
UC	University College
UiT	Artic University of Norway
VRI	Programme for Regional R&D and innovation
VTT	Technical Research Centre of Finland

Executive summary

Norway has experienced a remarkable transformation based on research and innovation, but is now facing a "triple transition imperative"

In the past century, Norway has experienced a remarkable transformation which has reshaped the country into one of the richest in Europe. Norway has demonstrated its ability to seize the initiative where opportunities arise, supporting the development of successful clusters in resource-based sectors, in particular in oil and gas (O&G), shipbuilding, fisheries and aquaculture. The revenues generated from these sectors became a driving force in the growth and technological upgrading of these sectors and helped to establish a virtuous circle for building strong, interlinked research and innovation capabilities.

However, Norway is now increasingly facing a "triple transition imperative". The first transition relates to a shift towards a more diversified and robust economy. A strong research and innovation system will be needed to transform the economy, which is still highly dependent on O&G. The second transition involves moving towards a more competitive, effective and efficient innovation system, with sufficient incentives and checks and balances for better performance in research and innovation. The higher education sector lags behind those of the other Nordic countries in a number of key research performance indicators, despite a high level of public expenditure. Finally, these structural transformations must be achieved while supporting research and innovation that can confront an array of societal challenges.

Reflecting the need for this triple transition, in 2014 the Norwegian government launched a comprehensive strategic plan to enhance the contribution of the research and higher education system to these challenges. The Long-Term Plan for Research and Higher Education 2015-2024 is built around three overarching government objectives for science, technology and innovation policy: developing research communities of outstanding quality; enhancing competitiveness and innovation; and tackling major societal challenges. This Review is intended to help inform the revision of the Long-Term Plan in 2018.

Developing excellent academic communities

Norway has long faced concerns over the insufficient excellence of research and the quality of higher education. Although it ranks among the countries with the highest scientific performance, it falls below the top-performing countries and lacks world-class research groups. However, the fragmentation and lack of critical mass in the dominant higher education institutions, both within the organisations and in the overall higher education sector, impede the emergence of more "peaks of excellence". The significant effort expended by Norway on mergers between universities has not yet borne fruit. Moreover, these structural changes have jeopardised the dual university system involving universities and university colleges. The institutional performance agreements currently being tested in some universities will be instrumental not only in driving universities towards better performance, but also in preserving the distinct profiles of the different types of institutions. Norwegian public authorities should also pursue their effort to create a culture of competition and adequate competitive mechanisms among higher education instititions, including through changes to the performance-based budgeting system used to allocate its generous block grants.

Finally, the universities themselves, which have reached a significant level of autonomy, have an important role to play in enhancing research quality. The recruitment, career management, priority-setting and budget allocation processes only imperfectly allow selection mechanisms to operate at the level of departments, research groups and individual researchers. Most universities have yet to transform new opportunities – notably the implementation of the tenure-track system – into action. They will also need to use part of their internal block funding in order to strategically create critical mass and attract top talent to their best departments.

Enhancing competitiveness and innovation

Norway's innovation performance is mixed. While this is partly attributable to the structure of the Norwegian economy, Norway can build upon the success of large Norwegian industrial clusters, interlinked with strong scientific communities in related fields. The Norwegian industry also benefits from a well-developed system of R&D support, although it seems better suited to support existing strengths than new sectors and new areas for diversification. More efforts towards greater selectivity and co-ordination of innovation policy will help in this respect. The Long-Term Plan has set ambitious goals in terms of improving Norway's competitiveness, but a more co-ordinated commitment to the priority areas will require better cross-ministry and cross-agency co-ordination.

Although still immature and fragmented, a fairly well-developed system of commercialisation has emerged as a result of several initiatives, with signs of development towards greater collaboration, critical mass and professionalisation. The third mission of universities is also increasingly acknowledged and supported in institutions. However, Norway needs a dedicated third-stream policy and funding.

The Norwegian innovation system is also characterised by a strong research institute sector, even though it is heterogeneous and fragmented. These institutions are key R&D performers in the Norwegian system in cooperation with industry and play a key role in the internationalisation of research and innovation in Norway. Research institutes are supported by the Research Council of Norway (RCN), which manages the allocation of their core funding, develops the strategy for the sector and undertakes periodic evaluation of the centres. However, the low share of base funding, the unequal roll-out of the performance-based system of the allocation of core funding across institutes has limited the RCN's capacity to steer the institutes towards specific policy goals, and in particular, to prepare for the major transition ahead.

Tackling major societal challenges

Norway has a strong tradition of investing in research areas regarded as relevant for societal challenges and is among the European countries that have taken up the challenge to address the "grand" societal challenges with elaborate instruments at the national level. Norway's efforts to tackle societal challenges is focused on the development of the basic knowledge base underpinning societal challenges, with too little attention on the framework conditions for innovation and systemic change, at the detriment of other areas, for instance in social sciences, from which ground-breaking solutions to societal challenges might arise. Policies should be implemented not only at the level of individual areas, but also at the systemic level. Norway has much to gain from systematic policy experimentation and learning with a focus on disseminating, scaling up and incentivising the wider implementation of successful initiatives and approaches.

The Long-Term Plan assigns a prominent place to societal challenges. However, it stops short of proposing the systemic new policy approach and instruments that such bold ambitions call for. Moreover, the plan has so far mobilised little new funding for this purpose, and there has been little change in the origin and destination of the limited funds. The revision of the plan should focus on "translational", systemic issues focusing on turning good research into practical solutions, as well as on acknowledging the importance of user- and demand-driven innovation.

Improving the governance of the national system of innovation

Norway has a stable and functional, but highly sectorised, policy framework that strongly shapes science, technology and innovation policy. Where this framework, governed by the so-called "sector principle", may have been advantageous in the past to sequester research in various fields throughout the policy spectrum, Norway's imperative for an economic transition has increased the need for horizontal, interministerial co-ordination and a more active and integrated setting of strategic priorities. Some interministerial co-ordination processes, including in the context of the preparation and implementation of the Long-Term Plan, "soften" the practice of the sector principle.

While government actors can co-ordinate specific operational issues to ensure continuous incremental progress under the current setting, broader strategic issues are not as well covered, including long-term options with alternative paths, possible directions of which priorities to choose, or larger initiatives combining funding with regulatory issues and cross-policy approaches. The absence of a top-level referee or central priority-setting mechanism at the top government level shifts the task of co-ordination to the agency level, which puts the RCN under pressure. This model of co-ordination may also leave only limited room for policy innovation and cross-cutting activities.

The "21-Forums" could be instrumental in supporting this co-ordinated work if they are constituted as permanent advisory bodies, adopt a broader and more visionary perspective, and have the capacity to monitor the implementation of their proposed strategy in close co-operation with the public authorities. In certain key areas relevant to societal challenges, for instance, the "21-Forums" set up already provides a valuable complement to the Long-Term Plan in bringing together stakeholders to agree upon, co-ordinate and advance efforts to strengthen prioritised sectors and areas.

Although it contains only a few concrete actions and does not set "hard" priorities, the LTP is a significant first step to improve Norway's capacity for priority setting and horizontal co-ordination in the context of highly sectorial policy that is expected to advance further in its 2018 (and subsequent) revision. Its four-year cycle offers the Ministry of Education and Research and other ministries the opportunity to add more concrete structural and programme-style policy activities to the plan from 2018 onwards, without changing the plan's general orientation.

Chapter 1.

Overall assessment and recommendations

This chapter presents an overall assessment of Norway's innovation system and policy, reflecting the key findings of the review. It identifies strengths and weaknesses and key issues for innovation policy, and develops specific policy recommendations for improving Norway's performance in science, technology and innovation.

Introduction

In the past century, Norway has experienced a remarkable transformation, which has reshaped the country into one of the richest in Europe. Its economy had long been dominated by agriculture, forestry, fisheries, mining and shipping, which resulted in the gradual growth of supplier firms and generated opportunities for smaller scale industrial development, for example in shipbuilding. In the first decades of the 20th century, extensive investment was made in hydropower for energy-intensive basic industries like aluminium smelters. A small number of academic innovators contributed to this development from the beginning.

From the late 1960s on, the offshore oil and gas (O&G) sector was developed by state-owned companies and other domestic and foreign companies that were awarded concessions for the exploitation of the Norwegian Continental Shelf. These concessions were coupled with specific tax and regulation instruments, notably the requirement to invest in Norwegian technological capacity. In places like Bergen, Stavanger and Trondheim, specific technological and engineering clusters emerged as a result of this voluntary policy, notably in shipbuilding and O&G.

Research and innovation began to play a more prominent role in the last third of the 20th century, with the emergence of knowledge producers and the pervasive economic and social influence of information and communication technologies (ICT). Some service companies with strong ICT competencies became important nodes in the large industry networks, especially in O&G.

Norway was able to seize the initiative where opportunities arose, and pursued an active industrial policy in the post-war era. This led to the development of successful clusters in resource-based sectors, in O&G, shipbuilding and also fisheries and aquaculture, which were supported by technology and engineering service companies and maintained a close relationship with universities and specialised research institutes. The revenues this generated became a driving force in the growth and technological upgrading of these sectors and helped to establish a virtuous circle for building strong, interlinked research and innovation capabilities.

Concerns have nevertheless been raised about persistent challenges. Several studies and evaluations, including some conducted by the OECD, have noted the limited cost-effectiveness of the research and higher education (HE) system in Norway. On the research side, the system produces “good, but not excellent,” science – at a high price; on the education side, the HE pipeline has a high rate of student dropouts and overly long periods of academic studies. The performance of the HE sector, which lags behind those of the other Nordic countries on a number of key indicators, is not commensurate with the annual level of public expenditure, which is well above the OECD average.

A strong research and innovation system will be needed to transform the economy, which is still highly dependent on O&G. Despite long-standing efforts and significant success in diversifying the economy, around 7.5% of total employment in Norway was still linked to the oil industry in 2015, and the value added in oil and gas extraction (including services) accounted for 17.5% of Norway’s total value added in 2015 (compared to 13.7% in 2013).While the macroeconomic performance of the country is in many respects above the OECD average, the slowdown of the oil economy has revealed the risks of the country’s dependence on oil and gas. Finally, climate change is a significant challenge for Norway, as a key O&G exporter and given its relatively high and increasing CO_2 emissions.

Against a backdrop of increasing research and innovation-based global competition and mounting societal challenges, Norway is facing a “triple transition imperative”. While it is clear from the most recent projections that oil and gas-related activities will decrease significantly, all the while remaining important in the Norwegian economy for many years, the first transition relates to a shift towards a more diversified and robust economy. Although the drop in the price of oil has made this imperative more acute, there is broad consensus among policy makers and stakeholders in Norway’s system of innovation that the long-term need for transition will persist, even if the price of oil rises again.

Table 1.1. **SWOT (strengths, weaknesses, opportunities, threats) analysis of the Norwegian research and innovation system**

Strengths	Weaknesses
– Abundant and prudently managed natural resources – Good economic performance, above the European Union (EU) average – Several academic strongholds in specialised economic areas, such as fisheries, aquaculture and O&G – A well-equipped higher education institution (HEI) system that allows for planning and building of scientific infrastructure Continuous operational science, technology and innovation (STI) co-ordination on the government level – A rather simple institutional landscape, with strong funding actors, including the Research Council of Norway (RCN) as a central actor (but with numerous roles and instruments) – A diversified public research institutes (PRI) sector with good technological performance, well-connected to industry – International attractiveness, inflow of talent from abroad – Strong EU programmes related information, networking and advocacy infrastructure – Extensive programme evaluation, well-developed evaluation practices – Strong tradition of consensus-based decision making – Continuous incremental innovation in the public sector	– A satisfactory but less than excellent research performance, with only few “peaks of excellence” in the university system – Less return than expected from the performance-based funding and governance reform of universities in the research area – Limited fully-fledged tenure track and strategic recruitment; high average age of university professors – Persistent deficiencies in higher education in the fields of science, technology, engineering and mathematics (STEM) despite progress – High number of tertiary student dropouts and overly long academic studies – Low outward mobility in research: young researchers with little international mobility – Low levels of applications and participation in the European Union Framework Programme. – Industrial specialisation in sectors with low research and development (R&D) intensity – Limited research-industry relationships, except in O&G and aquaculture – Current setting in the Norwegian STI policy system limits effectiveness of policy advice and ability to promote structural change – Lack of a dedicated actor for renewal in the public sector (including upscaling successful solutions and approaches) – Insufficient strategic focus on key fields like health
Opportunities	**Threats**
– Evidence that diversification from O&G is already under way (e.g. in deep-water energy, mining, offshore fish farming) and industrial upgrading – Putting in place an environment (including public support instruments) conducive to the emergence of new activities/sectors – Potential that public procurement for innovation can support diversification, on the basis of existing instruments at RCN – Revision of the Long-Term Plan (wider scope integrating higher education; more precise investment and action plans, (including outside the remit of the Ministry of Research) – Reconcile Norway’s egalitarian culture with the advantages of greater excellence and competition	– Little pressure for change, given the generous benefits offered by the system and the generally high level of satisfaction with it – Strong reliance on past performance, limited ability to invest in new areas – Weak strategic basis of many public research institutes (PRIs), small institutes, low basic funding – Reluctance to embrace structural change – Reduction of diversity in the system as a result of the harmonisation of universities and university colleges that may negatively affect overall performance

The second transition thus involves moving towards a more competitive, effective and efficient innovation system, with sufficient incentives and checks and balances for better performance in research and innovation.

Finally, these structural transformations must be achieved while supporting research and innovation that can confront an array of societal challenges (climate change, food security, ageing, health and so on). Several of the challenges related to the transition to a sustainable economy already affect key sectors of the Norwegian economy. Fisheries, for example, are vulnerable to the effects of climate change and food security, and the oil and gas industry is also subject to increasing environmental pressures.

Reflecting the need for this triple transition, the Norwegian government recently launched a comprehensive strategic plan to enhance the contribution of the research and HE system to these challenges. The Long-Term Plan for Research and Higher Education 2015-2024 (referred to in this report as the LTP), submitted to the Storting in 2014, is built around three overarching government objectives for science, technology and innovation (STI) policy: developing research communities of outstanding quality; enhanced competitiveness and innovation; and tackling major societal challenges. The LTP also includes six broad priority areas within a ten-year perspective, and proposals for longer term goals, as well as a few specific actions with budget commitments for the first four years (see Annex B).

The LTP will be revisited in 2018, not only to renew the budget commitments for the following four years but also to revise some of its limitations as an institutional arrangement for priority-setting, multi-year investment and interministerial co-ordination. This Review is intended to help inform this revision process.

Developing excellent academic communities

Norway has a comparatively young but sizeable public research sector consisting of public research institutes (PRIs), universities, university colleges and hospitals.[1] The country has faced long-standing concerns over the insufficient excellence of research and the quality of higher education. These concerns were recently highlighted both in the LTP and by the Productivity Commission report “At a Turning Point: From a Resource-Based Economy to a Knowledge Economy”, published in 2016.

Previous attempts to address this issue have yielded mixed results. They have been hampered by some distinct features deeply entrenched in the Norwegian system of research and innovation at the level of the government and higher education institutions (HEIs). In particular, the “consensus principle”, an important feature of Norwegian political culture, has tended to temper some of these initiatives, and the “sector principle,” which gives individual Norwegian ministries a high degree of autonomy in their respective fields, has restricted horizontal co-ordination.

At this stage, an adapted research policy approach needs to be considered, one partly aimed at achieving critical mass in the highest-performing sector of the research system, while still ensuring sufficient relevance for competitiveness and societal challenges. Excellence and relevance are not contradictory goals in this respect. Many examples show how important top-class research is in achieving relevant objectives and new solutions for different challenges in the medium and long term, and several instruments attempt to foster both excellence and relevance.

Good, but less than excellent, research in higher education institutions

Overall, the higher education expenditure on research and development (HERD) ranks at the medium level, at 0.59% of GDP, while the share of researchers (in FTE) is high, approximately 35% of the national total (2015). The first indicator is below, and the second comparable to other successful smaller European countries.

Starting at a very low level in the 1980s, Norway's HEI research output has been on a steadily upward trend. Norway is ranked far above the world average, but below Switzerland, Denmark and Sweden in terms of the number of scientific articles published per inhabitant. While several indicators suggest that Norway is doing well, the performance and impact of its public research system is not outstanding in areas sustaining the competitiveness objective or aiming to tackle societal challenges. Various indicators show that Norway performs less well in terms of quality measures and lacks world-class environments. Its share of the top 10% most cited publications lags well behind that of the leading countries, including Denmark, Netherlands, Sweden and Switzerland. Other indicators, like Norway's low success rates at the European Research Council (ERC) and in publications in top journals, also indicate that the number of its world-class researchers and environments is still too low.

Nevertheless, Norway needs more top-performing groups and is well-equipped to support them. International experience suggests that highly rated research groups and leading scientists are critical for establishing technology clusters in a context of growing technological complexity. Examples in Norway include fields like oil and gas or marine biology, each of which faces great opportunities in future. Encouraging "peaks of excellence" will also be a critical step in taking advantage of these opportunities and helping to start new avenues for development, for example in the digital economy.

Efforts to strengthen competitive mechanisms among higher education institutions

The fragmentation and lack of critical mass in the dominant HEIs, both within the organisations and in the overall HE sector, impede the emergence of more "peaks of excellence". Norway has a considerable number of universities and university colleges, with a few traditional centres of research and higher education, including Oslo, Trondheim, Bergen and a large number of smaller regionally distributed HEIs created in the post-war era. The number of HEIs has significantly fallen in recent years, mainly due to mergers in the overpopulated University College (UC) sector. However, the significant effort expended on mergers between universities, including university colleges, has not yet borne fruit.

Various recent assessments and white papers, including the LTP, suggest that the lack of critical mass is partly the result of the clear preference of Norway's government and of universities to distribute funds equitably among HE institutions (an effect that has been reinforced by the lack of internal priority setting). These sources indicate that Norway does not favour a culture of competition or set adequate competitive mechanisms among HEIs. The structural change initiated by the government is to some extent also driven by this approach: the intent of the latest wave of mergers seems to be to level out the university colleges, which have traditionally been weaker in research, rather than to enhance excellence in leading universities.

In addition, the MER has used a performance-based funding element as part of the HEI block funding since 2002, and the Research Council of Norway (RCN) has introduced several competitive programmes to enhance research quality. The Centres of

Excellence programme (Sentre for fremragende forskning, or SFF) scheme was set up to finance the best research groups for periods of up to ten years and helped significantly to raise the level of quality in Norwegian research. The FRIPRO Toppforsk scheme also provides financing for a four-to-five-year period for research projects that have the potential of attaining the highest international standards. However, there is still room to increase the share of large, risky and more fundamental projects in the overall Norwegian (i.e. RCN) funding portfolio, as indicated by the Productivity Commission report and the recent RCN Spending Review. Competing for large external grants makes it possible to bypass internal distribution channels.

Opportunities to reinforce competitive mechanisms within higher education institutions

The LTP and the evaluations of Norway's top research performers also attribute its lacklustre scientific performance to the lack of competitive mechanisms within HEIs themselves. The recruitment, career management, priority-setting and budget allocation processes only imperfectly allow selection mechanisms to operate at the level of departments, research groups and individual researchers. The universities themselves, which have reached a significant level of autonomy, have an important role to play in enhancing research quality. The universities appear now to have a legal and structural framework that should allow the stronger HEIs to enhance their performance and achieve critical mass. Recent reforms of HE governance structures and of career paths are a step in the right direction and could now in principle be fully embraced by the HEIs. However, the results have not yet reached a satisfactory level.

For research staff, one key incentive is the career path. So far, Norway has no real tenure track system of the kind that is in place, for example, in the United States. Recruitment is described as often being based on routinely programmed promotions related to the time spent in the organisation, with little long-term strategic planning. Positions for professors are advertised internationally and promotions are merit-based and peer-reviewed. However, further efforts could be made to search for the best talent worldwide, recruiting potential applicants early on and putting them on an evaluation-based track to full professor.

It has been noted that the lack of a strategic approach underpinning human resource policies has limited the number of lifelong positions for younger top talent, due both to the small number of permanent senior positions and to how appointments are carried out. Recruitment processes appear to often satisfy local ambitions, with incumbents building their own small research fiefdoms. This does not take full advantage of the number of talented international researchers – actually and potentially – coming to Norway at all levels, from PhD students to full professors.

Change will therefore also have to come from within organisations, as external incentives and support programmes can be only part of the solution. The conditions are now conducive to such changes: universities are well funded and enjoy a high degree of autonomy; the position of university boards and rectors has been recently reinforced; new incentives for world-class recruitment have been set up; and the conditions for a tenure-track system have been put in place.

A tenure-track system, which is in principle now possible in Norway, allows for active recruitment of younger talent, mostly from outside and for the promotion of researchers to the status of full professor after a number of evaluations.

Most universities have yet to transform these opportunities into action. They will need to use part of their internal block funding in order to strategically create critical mass and attract top talent to their best departments. This will also mean shutting down departments whose performance is underperforming. The government can only carry out such changes by setting the right framework conditions, taking further legal steps and providing adequate incentives and “nudges”. Another key condition for success would be to strengthen the HEIs’ strategic leadership and to further incentivise HEIs to recruit and promote top people from abroad as well as from within the system.

The creation of critical mass through mergers, while preserving the dual university system

As in many other countries, the Norwegian HE system went through a major period of expansion in the post-war era. Increasing numbers of students and regional ambitions under specific geographic conditions resulted in a population of more than 100 HEIs with their own regulations and missions. Many new university colleges were based on regional upper-secondary schools that were “upgraded” to the tertiary level. Confronted with this proliferation, Norway’s HE policy responded with two interrelated policy measures: on the one hand, HEI mergers have been encouraged; on the other hand, the main structural differences between universities and university colleges were gradually eroded.

Mergers typically aim to reduce the number of HEIs and decrease the fragmentation of the system, in order to enhance research and educational quality through critical mass. They have been carried out in successive waves in recent years, mainly among university colleges or between colleges and larger universities. These reforms combined successive or overlapping voluntary and mandatory measures, top down and bottom up, state control and stakeholder involvement, egalitarian and leadership visions. Although some consolidation initiatives have been watered down due to the consensus principle, and to successful – often regional – resistance, the number of university colleges has been significantly reduced in the past decade. Some new players have been created, while a few universities were merged into larger entities. The incremental, long-term Norwegian approach contrasts, for example, with Denmark’s “big bang” university merger process.

In a white paper released in 2015, the government announced a new series of structural reforms in the HE sector. While in the past, reforms were usually voluntary and took a long time to take effect, the most recent mergers were strongly promoted and incentivised by the state. The Ministry of Education and Research invited all higher education institutions to discuss the issues, asking them to draw up expressions of interest in possible mergers. This resulted in several mergers, reducing the number of public HEI from 33 to 21 as of January 2017. This also shows that the step-wise, negotiation-based approach of Norwegian science, technology and industry (STI) policy can be quite effective. The reduction in the number of HEI was emphasised as a necessary means of increasing the quality of research and of teaching and learning. However, a closer look at this document reveals that it does not primarily target the larger universities or address issues of quality but serves mainly as a justification for the ongoing wave of mergers in the university college sector. It will be a while before these mergers bear fruit, since the research capacity of university colleges is far below that of universities and may ultimately result in levelling rather than raising the level of quality. However, it is too early to assess whether the recent mergers will have the desired effect on the quality of research and teaching, especially since some of them have not even been completed. One additional instrument for enhancing quality and differentiation is the individualised performance agreements, which are now in the pilot phase but will be rolled out in the coming years.

The recent trajectory of Norwegian HE policy, together with other factors, has reduced the differences between the respective missions of universities and university colleges. Both are governed by the same laws, which give them the same internal structure, tasks and prerogatives. Nearly all HEIs can grant PhDs and conduct research. The colleges were incentivised regarding both their performance and their ambitions. A number of university colleges aim to become full-scale universities, often through mergers. This should lead to a much smaller number of university colleges but a large number of universities.

International experience suggests that Norway should retain some stratification in its HE system, for two reasons. First, regionally anchored university colleges can be successful, as the Swiss, German and Austrian examples show. Second, Denmark, Germany, the Netherlands and Switzerland have in different ways shown the advantage of cultivating a few top universities able to compete in the top European or even global academic circles.

An adequate funding model to increase research quality

Norwegian HEIs are well funded. The share of block grants is high by international standards, and the same is true for the share of all public funding sources compared to the HEIs' overall budgets. The larger universities are well endowed by European standards, but budget increases are needed before a few top universities can become major European HE players at the level of the best-performing Belgian, Danish, Dutch, German and Swiss institutions.

Universities and university colleges receive part of their block funding through a performance-based budgeting system. Around 70% of the block funding is based on historical levels, while 30% of the HE funding comes through a performance-based financing (PBF) stream, mainly following an *ex post*, output-oriented approach. Two different sets of performance criteria co-exist; from 2017 onwards, the following adapted formula will be in place:

- A dominating "open budget" PBF element, where overall funding for the HE system can increase if the universities or university colleges are successful. This element concerns the HE education component in four sub-categories: The main bulk of PBF funding is measured against reported student performance (completed study credit points). This makes up for 64% of the overall 30% PBF HE block funding share. Another 15% of the overall PBF is tied to graduation rates and 5% to PhD graduates (formerly part of the "fixed-limit budget"), while 1.2% forms an incentive for student exchange. So around 85% of all PBF are in this open category; PhD graduates have been recently shifted from the "fixed-limit budget" to this category.
- A much smaller "fixed-limit budget" element for the more research-related components, where the overall amount for the HE system is fixed with a ceiling, allowing only for reallocations between HEIs. From 2017 onwards, this element accounts for a little more than 15% of the overall PBF HE block funding. This component now includes four smaller indicators – each between 2.8% and 5% – the publication credits, the funding from RCN, funding from EU and other public sources and the contract research indicator (*Bidrags og oppdragsfinansiert aktivitet*, or BOA) for private revenue, including contract research.

These recent changes were introduced on the basis of recommendations by an expert committee to fine-tune the Norwegian PBF component in HE funding. On this basis, the government adapted some elements and included revisions in its 2016 and 2017 budget proposal. The main changes include the new indicator for completed degrees, to reduce the length of time students spend on their studies. As described, greater incentives for success in the European Union Framework Programmes (EU FP) and for contract research have also been added.

Performance-based funding can come in various forms, from *ex post* peer evaluations with a strong reallocating effect (along the lines of the Research Excellence Framework, or REF, in the United Kingdom) to performance contracts mainly negotiating extra budgets for additional achievements. Norway has chosen a third path, widely applied internationally, making a certain fraction of the block grants conditional upon indicators measuring past output. Both appear to have some advantages, but it is unclear whether the research component of the performance-based funding helps create critical mass and superior performance. The teaching component will also be difficult to handle in the future, as there are still not many competitive funding elements in place in addition to PBF. Some steps, however, are planned for the coming years to introduce more competitive elements into the Norwegian HE teaching realm, based on a white paper presented to Parliament spring 2017.

There is no golden rule for university funding, either for the different forms of block grants or for the proportion of block funding and competitive funding. However, Norway's high share of block funding in its current form might have led to internal distribution patterns without strong quality signals. One option would be to combine quality-enhancing indicators with a broad discussion process and incentives for new recruitments and career standards, as well as to strengthen HE leadership.

Based on the recommendations from an expert committee, the ministry is also piloting institutional performance agreements (PAs) with a sample of five state-owned higher education institutions. The overall goal is to increase quality in education and research, and the instrument may possibly be included as an element in the funding system. PAs are expected to contribute to the achievement of the two big HE sector goals, excellence and differentiation. Until 2019, the government plans to introduce PAs across the whole HE sector.

The goal of the PAs is also to establish clearer institutional profiles and better division of labour between the institutions, with individual performance goals for each HEI. PAs are therefore also a potential response to concerns regarding the loss of diversity in the HE system, as long as they are concise, coupled to indicators and action-oriented. The pilot universities are asked to include in their performance contracts a "local development strategy" that describes how they will contribute to the economic development of their area. In addition to driving universities towards higher performance, these contracts are meant to help preserve the regional profile and particularity of universities.

Recommendations: Developing excellent academic communities

- Continue to focus on excellence and critical mass in the higher education (HE) sector. This effort need not only come from the top, a common vision, financial incentives and policy experiments will have to be developed, involving a joint, structured action like the Long-Term Plan process. In particular, the government should:
  - introduce a next step in the performance-based part of HE funding, to incentivise high-quality research and education
  - prioritise top-class recruiting and career models
  - further increase, in co-operation with other stakeholders, the capacity of HE leadership to reallocate resources towards excellence
  - discuss options to develop a few universities as top European players.
- Rapidly install a fully-fledged tenure track system in the HE sector and support its implementation in HEIs. The Norwegian HE system needs to roll out an internationally competitive career development model, and while it is already possible in principle, ways must be found to establish it as the standard way of hiring and developing talent.
- Further promote HE mergers, mainly among university colleges, without abandoning a functionally binary system. The number of smaller HEIs could still be reduced. However, merger issues and development ambitions of university colleges should not inadvertently lead to an increase in the number of universities. In the current legal framework, Norway should take care to maintain a functional stratification between regional or applied HEIs and highly visible, research-intensive universities able to compete at the highest levels in the European league.
- Continue funding centres of excellence (CoEs) as an effective external driver of change for the public research sector. CoEs cannot substitute for internal priority setting and structural reforms, but they can play a strong supportive and enabling role.

Enhancing competitiveness and innovation

The success of the transition of Norway’s economy will, in the end, be assessed in the light of structural changes in the industry and service sectors. The Long-Term Plan has set ambitious goals in terms of industrial renewal and improvement of Norway’s competitiveness. It relies principally on the two other pillars of the plan, i.e. innovation resulting from excellent research, as well as economic development based on major societal challenges. The plan’s three overarching priorities are intended to reinforce each other systemically, with innovation as a common thread between them.

Norway’s innovation performance is mixed. The EU’s 2016 Innovation Union Scoreboard (IUS) classifies Norway as a moderate innovator and ranks it below the EU average. Norway performs well in terms of its research system in the IUS, but scores particularly low on indicators related to high-technology industries and innovation activities and expenditure, particularly in small and medium enterprises (SMEs). However, data from the most recent Norwegian innovation survey (conducted separately for the first time, rather than combined with R&D surveys) show strongly improved performance in these indicators, including considerably higher reported innovation activities by Norwegian firms. Using these figures for the relevant indicators in the IUS, the position of Norway would improve from 16th place to 13th in the IUS ranking.

A specialisation in sectors with lower R&D intensity

Like many other countries, Norway has set ambitious targets for levels of R&D expenditures, which, as an input in research innovation processes, will translate into improvement of innovation and economic performance. As early as 2005, Norway adopted the general target of increasing total R&D expenditure to 3% of GDP by 2010, with 1% from public R&D expenditure, in line with the original EU Lisbon strategy. The level of R&D expenditure remained stable, oscillating between 1.4% and 1.7%, no more than in the previous 20 years, and the target was not met. The Long-Term Plan reiterated these R&D intensity targets, starting from the same level (1.71% of GDP in 2014), while specifying that the 1% target should be reached in 2019/2020 and the 3% target in 2030. While the 1% public R&D expenditures' target was reached in 2016, there is broad agreement that reaching the overall 3% target would require a substantial restructuring of Norway's industry. R&D figures for 2015 indicate a considerable real increase in Norway's total R&D expenditure, of 12% from 2014, or from 1.72% to 1.93% of GDP.

Business R&D, which accounted for 54% of total R&D expenditures in 2015, is low, especially compared with figures of approximately 70% in other Nordic countries and 60% on average in the EU. This is partly attributable to the structure of the Norwegian economy, and its large share of commodity-based activity and related low share of industries with high R&D intensity, as well as the relatively large share of smaller sized companies. Moreover, Norway's high-tech industries have lower R&D intensity than the OECD average. In contrast, sectors such as fishing and aquaculture, typically classified as low-technology, have a higher R&D intensity in Norway.

Despite this relatively low business R&D intensity by international standards, Norway has recorded the highest growth in business sector expenditure on R&D (BERD), particularly due to increasing R&D in the service sector. There is also a good match between the scientific specialisations and the large Norwegian industrial clusters, in particular fisheries and aquaculture, the maritime sector, marine biology and environmental technologies. With the relevant incentives and adequate guidance, the strong positions established in these sectors could be used as a stepping stone to broaden and diversify the national economy. Recent developments in "smart" maritime activities, ocean mining and ocean fish farming, drawing on the accumulated technological expertise of the oil and gas sector, are some examples where this is already occurring.

Efforts to internationalise Norwegian research and innovation will help in this respect, together with increased mobility across economic and institutional sectors and opportunities for diversification in the service sector, including in the public sector. The growing opportunities for economic diversification within the service sector, including public sector services, will have to be carefully scrutinised.

Diversified and effective public support for business innovation

Norway is among the OECD countries with the highest share of government-financed gross domestic expenditure on research and development (GERD). Public funding to support business innovation has risen substantially in recent years, in particular through the Skattefunn R&D tax incentives and RCN programmes. RCN and Innovation Norway offer a comprehensive portfolio of financial support schemes and technical services to support business innovation. Some of these are technology- or industry-neutral, while others are linked to specific industries, covering the needs of industry along the innovation life cycle and covering the research spectrum from curiosity-driven to more user-driven R&D. Geographically, funding through the RCN and Skattefunn tends to concentrate in geographical areas with well-developed research infrastructure and a strong concentration of industrial R&D, respectively. Innovation Norway funding is distributed more widely across the regions, including in peripheral areas and those more likely to be affected by the decline in the oil and gas industry.

Norwegian industry therefore benefits from a well-developed system of R&D support. It could be argued, however, that Norway's comprehensive policy mix is better suited to support existing strengths than new sectors and new areas for diversification. The government has taken some actions, using in particular RCN strategic programmes and funding schemes, that encourage the transfer of knowledge across sectors. Finally, more use could be made of demand-side tools such as public procurement, building on the experience of the Public Research and Development contracts (or OFU, standing for *Offentlige forsknings- og utviklingskontrakter*).

Instruments undergo rigorous periodical evaluations. Evaluations of R&D and innovation support instruments generally show promising results, although most of the evaluations focus on individual instruments and few evaluations take a system perspective. In a recent evaluation of innovation support instruments, including the tax incentive scheme Skattefunn, Innovation Norway and the RCN found positive effects in sales, valued added, employment and R&D expenditure compared to a control group.

Since 2014, a comprehensive innovation cluster support programme has been in place in Norway, which adopts a cluster life cycle approach, adapted to the different stages of development of supported clusters. Some pro-active attempts are under way to promote cross-cluster collaborations, but these still need to be confirmed and scaled up. Besides the cluster programme, programmes such as the Ten-Year Programme for Regional R&D and innovation (Virkemidler for regional Forskning og Utviklingsarbeid og innovasjon, or VRI), introduced in 2007, have supported the development of 15 regional innovation initiatives across Norway and reinforced the position of regional authorities in the formulation of regional policy and setting of regional priorities based on the regions' strengths and challenges.

A shifting balance of instruments

Since its inception, innovation policy in Norway, as in many other advanced countries, has gone through a number of stages, alternating targeted measures with more neutral approaches where the emphasis is placed on areas such as recruitment of researchers, basic research and framework conditions for innovation. A budget breakdown by programmes and schemes indicates that the biggest funding category (18% of RCN funding) covers large-scale programmes, currently focusing on eight areas, such as ICT, bio- and nanotechnology, followed by non-selective user-led programmes (14% of the funding of RCN and around half of the RCN funding received by businesses), in addition to industry use of Skattefunn. This breakdown calls into question the recent efforts towards greater selectivity. Still, there is evidence of efforts towards greater signalling and steering of neutral programmes around key priorities, including those of the LTP. In addition, and in order to balance the goals of strategic prioritisation and diversity, the RCN is reorienting some of the thematic programmes to support knowledge transfer across sectors and themes.

Innovation Norway is also increasing selectivity and strategic thinking. The initiative, as part of the "Dream Commitment" activity, is seeking to reorient its activities towards opportunities seen as relevant for the Norwegian economy. This shift towards encouraging greater selectivity is driving efforts to modify existing tools, such as clusters and other instruments (loans, financial support) to promote greater connectivity across industries to support the opportunities that have been identified.

Framework conditions for entrepreneurship and venture creation

Setting up the right conditions for entrepreneurship and creating new companies, particularly in pioneering activities, is of key importance for the long-term growth and diversification of the Norwegian economy. Analyses undertaken by the Productivity Commission and the OECD suggest that Norway is well placed to manage such restructuring, in terms of its institutions and regulatory conditions.

Ranked 6th out of 190 countries, Norway scores very well in the latest World Bank *Doing Business* report (2017). According to this metric, Norway performs better than the OECD average, ahead of countries like Sweden, Finland or Germany and the United Kingdom, but behind Denmark, (in particular with respect to the ease of starting a new business).

However, Norway has been slower to reduce barriers for business than the average OECD country, including barriers to entrepreneurship. The government recently implemented a series of reforms to reduce red tape, including, for example, simplified tax rules for business partnerships.

The number of start-ups is low compared to other countries, although they seem to be larger and their survival rate higher. At the same time, its percentage of fast-growing businesses is low, and few of them grow to become major employers. Recent efforts to address these shortcomings include increasing funds for seed capital to start-ups, start-up grants and financing of young companies through the FORNY programme, dedicated to the commercialisation of R&D results.

Improving knowledge transfer to reward excellent research

Legislation in the early 2000s in Norway gave universities a mandate to develop the incentives and framework conditions for commercialisation of academic research. The last decade has witnessed sustained efforts towards developing a commercialisation infrastructure, particularly the establishment of technology transfer offices, science parks and incubators. As a result, a fairly well-developed system of commercialisation has emerged. Arguably, the system is still immature and fragmented, but there are signs of development towards greater collaboration and critical mass, greater professionalisation and better systems for project selection.

The third mission of universities is increasingly acknowledged and supported in universities and colleges. However, Norway has no dedicated third-stream policy and funding, and commercialisation indicators such as patents, licenses and spin-offs are not included in the performance-based funding system for universities.[2] Unlike, for example, the United Kingdom, which has a well-established system of third-stream funding of universities, Norway does not have a comprehensive mechanism for reporting the knowledge-exchange activity of its universities, beyond narrow metrics such as patents and licenses. Although commercialisation has been among the priorities in MER’s governance of the HEIs, the ministry has not yet set any incentives for commercialisation besides the support programme such as FORNY.

Industry funding, which currently stands at 3.1% of higher education expenditure for R&D (HERD), is moderate by international standards. A relatively small percentage of HEIs’ staff reports research collaboration with industry. However, collaboration is extensive with the public sector and with health trusts.

Commercialisation activities are particularly strong in certain universities, such as the University of Oslo (UiO) and the Norwegian University of Science and Technology (NTNU), which have strong ties to industry and the public sector. Knowledge transfer is an integral part of its activities, with significant investment in infrastructure for commercialisation of research and entrepreneurship education. Universities and colleges play an important yet differentiated role in supporting commercialisation and knowledge exchange in their regions. Colleges are likely to play an important part in offering industry-oriented continuing education, which is important for Norway's economic transition.

The contribution of public research institutes to competitiveness and innovation

Distinct features of Norway's research institute sector

One of the defining features of the Norwegian innovation system is the strong research institute sector. Key R&D performers in the Norwegian system, the research institutes accounted for around 24% of R&D in the country in 2013, only slightly less than the university and the college sector. Most of the R&D performed by the institutes can be categorised as applied research, covering a range of disciplines, of which engineering and technology and natural sciences are the most important. The share of applied R&D activity undertaken by the research institutes in Norway is higher than that of comparable structures in other countries such as Denmark and Sweden. Research institutes also make a significant contribution to the volume and impact (in terms of number of citations) of scientific production.

Norway's research institutes, particularly the technical-industrial institutes, have a long history of supporting innovation in industry. Its marine and agricultural institutes were established in the nineteenth century. However, the main growth in the sector occurred during the post-World War II period. The SINTEF, now the largest Norwegian research institute, was established in 1950 by the Norwegian Institute of Technology (Norges Tekniske Høgskole, or NTH, now part of the Norwegian University of Science and Technology, or NTNU).

Compared to other countries, the institute sector in Norway is large in terms of number of institutes (over a hundred) but also more heterogeneous and fragmented in terms of the size of the average institute, ranging from large, cross-disciplinary organisations with several hundred employees, such as SINTEF, to small, specialised institutes with a few employees. Most of the institutes operate as autonomous entities at arm's length from the government, constituted as foundations or non-profit organisations.

Forty-four research institutes currently receive public funding from the state through the common block-funding system. These are divided into four arenas (technical-industrial institutes, primary industry institutes, environmental and social sciences). The fragmentation and relatively small size of many institutes is a constraint in terms of competing in international areas and developing quality and competence. A number of voluntary mergers have been undertaken in recent years to build critical mass in PRIs, in some cases involving the merging of two or more institutes, and in other cases merging with HEIs. Restructuring is ongoing and likely to increase in the future. In addition to encouraging formal mergers of institutes, there is scope for generating greater synergies between them. Few of the RCN funding instruments specify collaboration between PRIs as a criterion.

In addition to these institutes that receive core funding, some "government laboratories", such as the Institute of Marine Research (Havforskningsinstituttet) are also financed by the government, but through other channels. Norway could benefit from broadening its PRI strategy and policy to this category of research institute, as well as to other types of institutes.

The funding of research institutes

The average percentage of the non-competitive base funding of Norwegian research institutes is relatively low, at around 11% (ranging from 6% to 15%), compared with organisations such as Finland's VTT Technical Research Centre, the Netherlands' Organisation for Applied Scientific Research, TNO, and Germany's Fraunhofer (around 30%), although the share is similar to that of the Danish GTS and Swedish RISE institutes, which receive around 10%.

RCN is in charge of the management of the block funding of research institutes, within the framework of guidelines defined by MER and following decisions by relevant funding ministries (for instance regarding the funding levels). Since 2009, the block funding of the research institutes has included a mechanism for performance-based redistribution, intended to stimulate competence building, scientific quality and collaboration. As of 2017, the performance indicators used for PRIs, as well as for higher education and regional health authorities, have been further harmonised. This performance-based system of core funding allocation has not, however, been fully rolled out across all categories of institutes. Where different ministries contribute to the core funding of the institutes, they have been reluctant in some instances to transfer their core funding to the performance-based part of their funding arrangements.

Fully harmonising performance-based funding would contribute to the objective of improving the research quality of institutes. While the current levels of direct R&D allocations in selected institutes provide them greater financial stability and resources for capacity building, it also reduces competition in the sector, rather than rewarding the institutes with the best performance.

Although the performance-based component of the core funding is a relatively small percentage of the total, evaluations have shown that it has an influence on the research institutes' priorities and strategies. However, some institutes see the performance-based system as placing conflicting demands upon the research institutes, in terms of their contribution to excellent research and innovation. For instance, the emphasis on publication may reduce engagement in innovation and commercialisation activities, such as patent, spin-off and licensing activities.

The institutes play a key role in the internationalisation of research and innovation in Norway, notably in terms of their participation in the EU Framework Programme (FP) projects and by integrating Norwegian firms into global networks. The institute sector has the highest engagement and the largest share of EU research funding, and some of the institutes do very well in the FP. Overall, the TI institutes absorb 64% of the total EU revenues for all institutes. SINTEF Foundation is the largest single actor participating in EU programmes. Financial mechanisms such as the STIM-EU scheme have been set up to boost internationalisation, somewhat offsetting the additional costs incurred by the institutes in their FP participation through an increase of the block funding proportional to the amount of EU funding received.

Research institutes' role in the transition

PRIs play an important role in the competitiveness of Norwegian industry. Surveys of innovation have shown that the research institutes are industry's most important R&D partners. Collaboration with institutes has been demonstrated to add to turnover and productivity gains as well as capacity building.

While the close interaction between industry and research institutes can be seen as a success, it is not clear how well placed the research institutes are to contribute to Norway's transition from an economy based on oil. An evaluation of the technical-industrial institutes revealed that their activities focus more on well-honed methods and activities (exploitation) than on exploring new markets and technological opportunities.

The combination of a competitive funding system around collaborative projects, the low innovation intensity of Norwegian firms and the relatively low base funding of institutes suggests that the system may be locking in existing relationships between incumbent industries and leading research institutes, rather than opening up opportunities for renewal and competence development in new and relevant areas. This systemic co-dependency may also make it difficult to build up internal R&D capacity in firms.

Norwegian research institutes have traditionally maintained close connections with the university sector. They co-operate on joint projects, co-publications, doctoral projects and joint affiliations, and contribute in other formal and informal ways. To some degree, there is increasing overlap and competition between the two sectors: HEIs are becoming more involved in contract research in real terms (although the HERD financed by industry as a share of total HERD has decreased almost constantly since the 1990s), and institutes are increasingly expected to deliver doctoral training. Good examples of collaborative work between universities and research institutes can be found, and there is no evidence that this overlap is significant and problematic at present. However, funding mechanisms, and particularly the harmonised system performance indicators coming into force in 2017, may encourage further overlap of the roles of research institutes and universities, rather than complementing each other.

RCN also fulfils other missions, such as the development of a strategy for the sector and the periodic evaluation of the centres. However, the low share of base funding, as well as the multiple ownership and independent legal status of the institutes, has limited the RCN's capacity to steer the institutes towards particular policy goals, and in particular, to prepare for the major transition ahead. Instead, the RCN and its principals have taken a piecemeal approach to such guidance, in the form of specific activities and sources of funding, for instance with the STIM-EU or additional PhD funding for some of the institutes. It is questionable whether these efforts are sufficient to support capacity building in the institute sector.

The Long-Term Plan's support of the innovation-based transition

The LTP emphasises the need to diversify and increase the absorptive capacity of industry, to prepare for the transition to a low-emission society. Clear long-term priorities for government support are required.

Since the early 2000s, policy efforts to support R&D have identified a number of key priorities. These have remained more or less stable, and the LTP does not represent a break with the past. Priorities are consensus-based and uncontroversial, reflecting the composition of the Norwegian economy. They reflect the strategic advantages of Norway around natural resources and strong industrial clusters. As such, they could be considered rather conservative, raising questions as to whether they are ambitious enough to support Norway's transition from an oil economy.

While the Norwegian policy mix for R&D is comprehensive, more efforts towards greater selectivity and co-ordination are needed. As the LTP notes, this requires that the agencies involved (RCN, Innovation Norway and the Industrial Development Corporation of Norway, or Siva) adopt a "co-ordinated and cohesive commitment to prioritised areas".

There is strong overlap between the research priorities identified in the LTP and the opportunity areas identified by Innovation Norway's "Dream Commitment" strategy (e.g. bio-economy, ocean space, clean energy). However, a more co-ordinated commitment to the priority areas requires better cross-ministry and cross-agency co-ordination. The "21-Forums" (see below), could be instrumental in supporting this co-ordinated work if they are constituted as permanent advisory bodies, and monitor the implementation of their proposed strategy in close co-operation with the public authorities. The proposed attention to collaboration arenas for co-ordination and implementation included in the follow-up plan of the LTP will require greater examination of potential missing linkages in the innovation system, as well as co-ordination failures.

The LTP does not address the spatial dimension of economic transition and diversification. The decline of the oil industry and related activities is expected to have an uneven impact on the regions. At the same time, economic diversification through spin-offs, product diversification and mobility is likely to be supported by dynamic regional ecosystems.

To support the innovation-based diversification of Norway's industry effectively, the LTP will need to involve stronger forms of priority setting, including in emerging areas, in addition to formal horizontal co-ordination mechanisms.

Recommendations: Enhancing competitiveness and innovation

Innovation policy

- Strengthen targeting and reorientation of innovation support funding, towards identified priorities. For instance, cluster policies could be amended to increase their selectivity.
- Develop a holistic system of enterprise support that focuses both on R&D of established firms and renewal through start-up development.
- Reinforce collaboration across agencies and ministries around key priorities and opportunity-driven innovation policies.

Public research institutes

- Increase the block funding for the institutes showing good performance and a low share of block funding. These additional funds should be linked to the institutes that demonstrate their ability to contribute to the industrial transition. A more strategic approach based on dialogue (including in the context of possible mergers) and the use of performance agreements (e.g. using indicators associated with knowledge transfer and industrial diversification activities) would help advance this agenda.
- Ensure that the funds distributed directly by ministries to the research institutes are related to strategic projects, in line with the government's defined priorities.
- Continue the structural reform of research institutes, including mergers across institutes and with universities, to increase critical mass and international competitiveness.

Recommendations: Enhancing competitiveness and innovation (*continued*)

- Encourage collaboration across institutes, stipulating that collaboration across institutes will be a criterion assessed in funding programmes.
- Encourage knowledge-transfer activities of research institutes. Consider additional funding streams, including dedicated commercialisation funds, and/or the inclusion of knowledge-transfer indicators, in the performance-based funding system (including, but not limited to, commercialisation).
- Reduce the mutual dependencies between RCN and the PRI sector. Increase block funding for PRIs and link it to incentives to start mergers and employ longer term planning and research cycles.

Knowledge transfer

- Provide more diversified support to the "third mission" in universities, in addition to increasing the budget of the FORNY programme, as suggested by the LTP. This should include a broader range of technology transfer mechanisms than commercialisation activities.
- Increase incentives for external engagement of academics with industry, and also broader stakeholders such as hospitals and the public and voluntary sector. Improve data collection on third-mission activities.

Tackling major societal challenges

Societal challenges already have concrete economic and social implications, which call for action. For instance, health security and climate change requirements have affected fisheries. The ageing of the population translates into increasing public expenditures for pensions, healthcare and the elderly.

Norway is among the European countries that have taken up the challenge to address the "grand" societal challenges with elaborate instruments at the national level, rather than only at subnational or European levels. Since the mid-1980s, important government documents on future research policy orientations presented regularly to the Storting as white papers (the *Stortingsmeldinger*) have had dedicated priority areas focusing on societal challenges.

The Long-Term Plan also assigns a prominent place to societal challenges, not only as one of the three overarching priorities, but also in the four thematic priorities that incorporate many of these challenges. The Long-Term Plan also includes the new insight that finding new solutions to address societal challenges is not only important for overcoming future threats for society but for providing important opportunities for economic development. However, it stops short of proposing the systemic new policy approach and instruments that such bold ambitions call for.

The "21-Forums" are set up in certain key areas relevant to societal challenges. They provide a valuable complement to the LTP in bringing together stakeholders within thematic areas to agree upon, co-ordinate and advance efforts to strengthen prioritised sectors and areas. They are, however, at the same time, strongly sector-driven and consensus-oriented processes, often lacking a broader and more visionary or forward-looking perspective. They have not demonstrated the ability to accommodate and drive the transformative (and often disruptive) change that is likely to be necessary to address the grand challenges our societies face today.

A disproportionate focus on developing the knowledge base in addressing societal challenges

Norway has a strong tradition of investing in research areas regarded as relevant for societal challenges. Health, for instance, is by far the largest thematic research area in terms of R&D expenditure, ahead of petroleum. Significant investments have resulted in strong scientific performance, as measured by citation impact (for example in marine technology, global and planetary change). The fact that RCN, the main research funder, has set up a division dedicated to "society and health" is an important indication of the importance assigned to societal challenges in the research system.

The focus on societal challenges was open to criticism in the recent report of the Productivity Commission. This argued that excessive consideration of societal challenges as a criterion for allocating public research funding has undermined research excellence in Norway. The commission argues that as a result, too few research groups or institutions score high on research excellence, negatively affecting their total relevance and impact. However, an evaluation of the engineering sciences commissioned by the RCN in 2015 showed that research groups or institutions that scored high on research excellence also scored high in societal relevance and impact, calling into question the premise that excellence and relevance are mutually exclusive

Norway's focus on the development of the basic knowledge base underpinning societal challenges has two main limitations. First, inadequate investment has been made in other elements that could ensure the changes in socio-technical regimes that are necessary for systemic change. Overall, the tendency has been to address problems by designing a research and innovation programme, with too little focus on the framework conditions for innovation and systemic change, and on regulatory barriers that might hold change back. This attention to societal challenges is a recent phenomenon, but it has been widely documented that this linear approach is not well suited to tackling societal challenges. What was considered adequate in earlier decades for supporting the traditional "mission-oriented" research, and also, more recently, innovation for competitive purposes, has been called into question by the systemic and cross-sectoral dimension of societal challenges (including the fact that they transcend sectors and disciplines). An in-depth examination of research and innovation in health also revealed significant co-ordination and governance challenges. Systemic change is needed to promote better, more economically sustainable healthcare and for a thriving health industry. Second, most funding has been focused on areas often associated with societal challenges (climate, energy, medicine, biotech), but ground-breaking solutions to societal challenges might arise in other areas. For example, better health and healthcare are typically not the result of medical breakthroughs, but of organisational and behavioural changes that rely heavily on social sciences rather than technical solutions.

A specific action framework is needed to support transformative, systemic change

Policies should be implemented not only at the level of individual areas but also at the systemic level. The former, often referred to as the "niche level", requires measures to support experimentation and learning in a given area, most often with a strong involvement from users and a wide array of stakeholders. At the system level, where these niches compete and are combined, large-scale transformations require an interdisciplinary and intersectoral interaction framework, in the form of wide-ranging strategies, roadmaps and platforms.

While incremental innovation in niche areas appears to be accepted and facilitated in Norway, transformative change at the systemic level may require new instruments, organisation and co-ordination. Solutions for societal challenges often require a multidisciplinary approach. Furthermore, they require translational activities in which different solutions are first developed in close co-operation with users and then tested in different contexts. Much bottom-up experimentation and incremental innovation is under way, for example, in municipalities and in education, healthcare and in the provision of public services, one of the great strengths of the Norwegian public sector. However, there is little systematic policy experimentation and learning with a focus on disseminating, scaling up and incentivising the wider implementation of successful initiatives and approaches. Incentives, mechanisms and structures for scaling good practices are often lacking in the public sector, an area that merits closer scrutiny.

Public sector innovations are key to tackle the "grand challenges"

The Ministry of Local Government and Modernisation has the formal responsibility for innovation in the public sector. The Agency for Public Management and e-Government (Difi), under the Ministry of Local Government and Modernisation, appears to have some responsibilities in this respect. However, its main focus is digitisation, which, while important, relatively neglects other factors driving innovation in the public sector. Organisational issues, regulatory changes (for example regarding public procurement), incentives and disincentives for innovation and the diffusion of innovation, experimentation and learning, public-private partnerships, leadership and other aspects are also crucial for increasing the efficiency and effectiveness of the public sector.

A further challenge is that social innovations in areas such as integration, healthcare, green growth, social mobility and cohesion are often interrelated and require systemic change and horizontal policy co-ordination. There is thus a need for a co-ordinating function for innovation in the public sector or an architecture for ensuring structured learning and driving systemic change (see, for example, the experience of Mindlab in Denmark, the Government Policy Analysis Unit of the Prime Minister's Office in Finland or the United Kingdom's Prime Minister's Delivery Unit).

The Long-Term Plan has not yet provided a new policy approach to address societal challenges

The LTP singles out societal challenges as one of the core priority themes and acknowledges their specificity, calling for actors and ministries to work across sectoral divides. However, it falls short of providing a road map or a tool box for the task.

In general, the plan approaches this task in a rather conventional way. The range of issues identified is relatively narrow (health, education, climate change, ageing) and the main strategy proposed is still a science-push approach. Other important societal challenges, such as social cohesion, integration, security and safety (in a broader sense) get scant attention. Regulatory changes, leadership and change management – essential in handling the kind of disruptive transitions that might be required – are not discussed.

Moreover, the LTP has so far mobilised little new funding for this purpose, and there has been little change in the origin and destination of the limited funds. Although the LTP aims to provide an overarching, interministerial framework for research and higher education, most of its research funding comes from the Ministry for Education and

Research (MER) and the Ministry of Trade, Industries and Fisheries (MTIF). Some ministries allocate little funding to research and innovation, even though their portfolio is associated with important societal challenges. The Ministry of Justice, for example, has a large budget for fighting crime and policing, but only limited funds for knowledge creation and innovation in these arenas.

Furthermore, the formulation of the LTP does not appear to have included a systematic process for identifying the "challenges within the societal challenges", that is, a foresight process or stakeholder consultation that could identify bottlenecks and institutional or systemic failures, as well as potential conflicts and resistance to change that might stand in the way of developing solutions.

The revision of the LTP should focus on "translational", systemic issues focusing on turning good research into practical solutions, but also on acknowledging the importance of user and demand-driven innovation. Greater emphasis on the demand side for innovation will be needed, focusing on experimentation, learning and orchestrating systemic change. This will require mechanisms and structures for horizontal policy co-ordination and governance, for addressing framework conditions for innovation (including the regulatory aspects), organisational issues, public procurement, policy labs, demonstration and testing facilities and upscaling of successful solutions.

Further work is needed to assess whether the higher education system can not only meet the need for translational capacities but also cultivate the interdisciplinary and multidisciplinary skill sets and approaches that are often necessary to tackle societal challenges. The LTP does not address the critical long-term question of building the competence and skill base needed to address its priorities. Failing to address the mismatch between LTP priorities and the education services provided by the tertiary education and Technical and Vocational and Educational Training (TVET) system could have adverse consequences. This particularly affects the priority of tackling social challenges, which will require questioning established structures and capabilities, redefining learning outcomes and strengthening systems and structures for lifelong learning.

The renewal of the public sector is one of six key pillars of the LTP, and social innovation is cited as a clear priority for ensuring an adequate, effective and efficient public sector. The LTP places great emphasis on healthcare, education and social services, but little on other areas, some of which urgently require systematic renewal and innovation. These include policing and security, labour market services and integration.

"21-Forum" processes complement the Long-Term Plan, but do not take systemic change far enough

The "21-Forum" processes are actor-driven strategy initiatives commissioned by the government or a ministry to promote research-based value creation and development. Based on broad interactions between industry, research and other actors, these platforms, which have developed sectoral R&D strategies, serve as advisory bodies and stakeholder forums.[3] In a few cases, such as OG21 (oil and gas), these initiatives function as a permanent advisory body that advises the government on implementing the strategic recommendations. The permanent 21-Forum revise their strategy documents at regular intervals, whereas the non-permanent 21-Forum have been finalised with the launching of their main strategic document.

These initiatives represent a significant effort towards mobilising stakeholders beyond public R&D funding. However, they do not offer a holistic approach to addressing societal challenges (e.g. health), since they are limited by sectorial boundaries. According to an evaluation that the Norwegian Board of Technology (*Teknologirådet*) and the RCN conducted in 2015, the "21-Forum" focus primarily on co-ordinating activities, supporting political priorities and on creating consensus among the participants in their respective areas. The forums tend to promote dialogue between actors within, rather than across, sectors or areas. The evaluation concludes that the "21 processes" are expected to co-ordinate and optimise – not to question – the direction of adopted (existing) policies. They could have benefited from involving more actors who could have contributed outside perspectives and anchored the initiative in a broader societal context. Furthermore, they often lack a forward-looking vision or perspective, and many could have a stronger international perspective and context.

In common with other initiatives in Norway, "21-Forum" adopt a strongly consensus-based approach. They could benefit from a broader and more visionary perspective and the ability to accommodate and drive the transformative (and often disruptive) change likely to be necessary to address the challenges our societies face today.

Recommendations: Tackling major societal challenges

- Devise broad integrated programmes that prioritise addressing societal challenges. These programmes should include features that directly take account of the specificities of societal challenges. They should:
  - be based on inclusive processes that engage a broad array of stakeholders, including users, concerned parties and experts, entrepreneurs, local public authorities (and even, for example, artists and immigrants)
  - launch studies and initiatives to examine regulatory frameworks, legislation and standards that could facilitate the widespread implementation of solutions to tackle societal challenges
  - promote interdisciplinary and multidisciplinary research
  - access a wide range of instruments, from specific research and innovation projects (including social innovation) to experimentation and public procurement
  - include foresight exercises and agree on strategies/visions that transcend sectoral boundaries and include education, innovation and upscaling.
- Align the higher education and technical and vocational and educational training (TVET) system with the competence and skill base needed to address societal challenges.
- Invest in translational activities and establish structures for experimentation (including radical/disruptive innovations), as well as for learning and upscaling solutions. This could take the form of policy labs, experimental regulation-free zones, and also assigning selected actors (agencies, ministries, commissions) the responsibility for broader implementation.
- Strengthen public procurement for innovation, aiming to address societal challenges and considering other forms of support to demand relevant solutions.
- Address governance issues to improve co-ordination across ministries and policy domains of efforts towards solving societal challenges (for example in healthcare innovation).

Improving the governance of Norwegian national system of innovation

The triple transition imperative requires Norway to improve its capacity for priority setting and horizontal co-ordination in the context of highly sectorial policy. Although it falls short of fully achieving initial expectations, the LTP is a significant first step in this direction and is expected to advance further in its 2018 (and subsequent) revisions.

A highly sectoral governance structure

Norway has a stable and functional policy framework that strongly shapes science, technology and innovation (STI) policy. The Norwegian set-up requires that ministries independently formulate and execute policy measures in this regard. This so-called "sector principle" gives no less than 15 ministries strong prerogatives in all research and innovation matters in their respective policy areas. The principle is observed in many countries – without necessarily being conceptualised or explicitly acknowledged in most cases – but it appears particularly strong in Norway. In the past, it may have been advantageous to sequester research in various fields throughout the policy spectrum, but Norway's imperative for an economic transition has increased the need for horizontal, cross-silo co-ordination and a more active and integrated setting of strategic priorities. This approach can help support the transformation of the system that is needed to address societal challenges and to encourage emerging areas.

The Ministry for Education and Research (MER) has by far the largest budget and is well positioned to lead the co-ordination effort within the confines of the sector principle. Of the other ministries, the Ministry of Trade, Industries and Fisheries (MTIF) and the Ministry for Health and Care Services stand out, the first being responsible for industry-oriented research and innovation policy and the second for health research funding. Health research is a world of its own, with competitive funds deployed mainly through distinct allocation mechanisms outside the RCN. The three ministries account for more than 75% of government allocations for R&D.

Norway's sectoral approach is paired with a strongly consensus-oriented policy-making style. As has been demonstrated in the past, this combination allows for constant improvements. Norway has a good track record of making most of the opportunities it encounters. Its hydropower, raw materials, fishing/fish farming and oil and gas industries grew out of a combination of smart regulations, bold investments and clustered technological expertise. Some of its dominant sectors grew from modest incremental steps long ago, after acquiring foreign technology or hands-on experience. Part of the next wave of innovation, e.g. in raw materials from the seabed, could evolve in the same way. However, a number of new opportunities will be linked to cross-sectorial innovation, to fields with societal issues like health, and to new challenges, for example the digital economy and fully digitised "Industry 4.0", which would benefit from an approach that transcends conventional silos and boundaries.

Limited orientation and priority setting at the highest levels of policy making

Norway's governance structure does not favour co-ordination and agenda setting. Since World War II, and particularly in recent decades, some institutional arrangements of this kind have been set up, but they only allowed for weak co-ordination and have since been abandoned. At least since the 1970s, the Cabinet Research Committee (RFU) was used as a co-ordinating forum within the government for policy and budget questions. Without the formal powers to counterbalance the strong sectorial interests, it was abolished in 2014 in favour of more intensive Cabinet discussions.

Most key policy decisions, including budgeting and priority setting, are taken at the (sector) ministerial level, but some interministerial co-ordination processes "soften" the practice of the sector principle. The first main instrument is an extensive weekly Cabinet meeting dedicated to the discussion of substantial ministry initiatives and white paper drafts. The second is a well-structured annual process to draw up the national budget, with two large budget conferences and negotiation rounds in between. These negotiations address both the overall ministry budgets and, depending on the year, smaller "common pots", respectively for research and for innovation. An interministerial negotiation process leads to a commonly agreed upon distribution process across ministries. With respect to the research pot, the MER has a distinct but soft co-ordination function, including the civil service research committee (departementenes forskningsutvalg or DFU) for day-to-day government research policy co-ordination and a considerable role in the "common pot" distribution.

In this setting, government actors can co-ordinate specific operational issues to ensure continuous incremental progress. This is coupled with agenda-setting mechanisms like the high-level meetings around and after the formulation of the LTP, dealing with such topics as top-tier research or entrepreneurship. Some actors have objected that these initiatives are no substitute for a holistic innovation policy. Funding programmes (mainly by RCN) and individual budget items tend to be the unit of analysis and negotiation. This often replaces the discussion of whole portfolios and strategic approaches in the interaction between the many principals and the agent. Steering by ministries appears to be operational rather than strategic. In addition, the sector principle negatively affects Norway's ability to mobilise other resources from various sectors to provide for successful cross-departmental policy delivery, for example in health, transport or other public sector innovations.

Broader strategic issues are not as well covered, including long-term options with alternative paths, possible directions of which priorities to choose, or larger initiatives combining funding with regulatory issues and cross-policy approaches.

Norway has no provision for long-term foresight, and optimising the existing sectors dominates policy discourse. In recent decades, thematic priorities have been remarkably stable, and the number of such priorities running in parallel has been large relative to the size of the country. While this configuration can have its advantages, an explicit foresight mechanism could help define desirable policy orientations.

Alternatives to the status quo do not originate only in *ad hoc* and sometimes one-off events like evaluations, spending reviews and productivity commission reports. Compared with other countries, Norway has fewer independent voices and organisational settings that come forward with strategic advice pro-actively. Elsewhere, high-level advisory and planning bodies are often used. Norway should find its own way to incorporate such a function into its STI system. The country has no high-level advisory body acting as a kind of referee, and before the LTP was launched, only the traditional white papers on research existed as formal and integrated cross-government STI strategies; however, with a different scope and with no multiannual financial commitments. Policy co-ordination generally follows the "consensus principle", depending on lengthy negotiations to reach common ground.

A more structured approach might be worth considering. Policy areas like health and other public sector innovation policies are not particularly well suited to Norway's current approach for developing a policy field. The cross-sectorial dimension of these area calls for more dedicated and co-ordinated policy action. New developments in the digital economy have been overturning established business models and transforming whole sectors. Given its abundant financial resources and regulatory know-how, Norway could become a good proving ground for experimentation in such new technology-based business models.

The Norwegian model also has considerable strengths, since it allows for long-term sectorial activities and actor mobilisation once consensus has been achieved. The various "21" thematic strategies, and to a lesser extent some government R&D strategies, e.g. for enabling technologies, play an important role in this context, as they constitute stable platforms for mid-term developmental paths, including funding instruments and some interministerial co-ordination. RCN plays a strong role in many of these sectorial strategies. The resources available allow Norway to follow a number of priorities and developmental paths simultaneously. This is an advantage as long as these resources continue to flow and policy arrangements allow informed, forward-looking and tough decisions on given options.

A costly research policy co-ordination model at lower levels

The absence of a top-level referee or central priority-setting mechanism at the top government level shifts the task of co-ordination to the "ground floor", i.e. the agency level. This puts RCN under pressure to fulfil a wide range of demands from the different ministries and assigns a number of roles to a single agency that do not necessarily amount to the broad remit of RCN as intended. The Council is a unique public body, combining funding tasks for academic and applied research and research-based innovation activities with the government STI advisory function and the role of the main commissioner of evaluations, among other tasks.

In this setting, RCN has to work hard to co-ordinate operational STI policy issues. If Norway is to introduce disruptive, new and step-change initiatives, an appropriate actor and voice is needed. The role of RCN as a "policy advisor from below" does not resolve this issue, given its position in the system and its linkages with its many "principals". RCN, which is not an independent or high-level body, strives to balance the demands of the various ministries and to obtain sufficient funding without too much earmarking. The task of giving strategic advice to the government is necessarily subordinated to this and may be influenced by RCN's immediate needs. As a whole, the structure of Norway's STI policy governance implies that research policy is guided not *ex ante* by strategic decision making, but is the *ex post* result of the balance between the different elements of the system. Elements of stronger forward planning are more typical *within* the individual priorities, as some of the "21" strategies show, rather than at the higher, overall, level.

RCN is limited not only in its ability to devise an integrated strategy but also to implement it. Although its wide scope puts it in a strong position in the research and innovation system, it has no autonomous central budget and cannot reallocate resources from different ministries for any set of priorities that might be agreed upon. RCN programmes have "ministry-earmarked" budgets, many of which are ordered by a single ministry. The number of principals and the number of funding activities put RCN in a difficult position. Although the MER and MITF account for half of the Council's funds, the imperative for RCN is to co-ordinate the requests from the 15 principals, which are conveyed through annual allocation letters (*tildelingsbrev*). This makes for a complex annual budgeting process. All the sectorial interests and the requirements of the consensus principle must be integrated every year into the RCN portfolio. There have been recent efforts to harmonise the allocation letters, partly in relation to references to the Long-Term Plan priorities.

RCN thus mainly relies upon soft co-ordination mechanisms, which ultimately results in time-consuming bilateral negotiations. Evidence shows that the (numerous) RCN staff devote much time to creating and sharing strategic intelligence and similar activities, and in co-ordination groups and public meetings. Despite its apparent simplicity, this apparatus has to deal with a lot of complexity to preserve the highly valued stability and consensus of the Norwegian policy system. The extent of the co-ordination workload is at odds with Norway's aim to adopt New Public Management and management by objectives. Both the ministries and the RCN apparently strive for detailed, operational instructions, a play-safe approach implied by the sectorial and the consensus principles.

The RCN runs around 100 instruments (including more than 30 major programmes), a large portfolio for a small country and a single council. The number of instruments has decreased considerably in recent years, but is still sizeable. This process of compartmentalisation can be an advantage in policy fields with favourable regulations, strong actor settings and clusters like oil and gas. Other activities, like healthcare, for example, seem to fare less well under these conditions. Moreover, this system makes it difficult to discuss overarching strategic questions (for example, oil and gas vs. climate and environment).

More fundamentally, this extensive model of co-ordination may leave only limited room for policy innovations, unconventional approaches and cross-cutting activities. Policy makers are possibly overly preoccupied with establishing consensus, and fine-tuning and funding activities.

The RCN has not only to balance a broad funding instrument portfolio but must harmonise it with its other roles, including government advisor, evaluation co-ordinator or the remarkably extensive interface with the Norwegian PRI sector, it must apparently devote more attention to juggling all these functions and programmes rather than building portfolios or helping whole sectors grow.

An interesting case is the public research institutes (PRI) sector. The RCN distributes their comparatively modest block funds, checks the performance criteria of this funding stream and has a strategic responsibility for this large sector. Its functions include performance discussions plus a *de facto* decision-making power through which PRIs can obtain block funds. Nevertheless, the RCN still has the right to decide on some of the PRI board memberships. RCN funds the PRIs through various competitive programmes, as well as indirectly through industry subsidies that are used to pay for contracts with PRIs. As a result, the PRI sector is the ultimate beneficiary of nearly half of the RCN's overall spending budget.

In theory, the RCN thus has considerable leeway to steer the large but rather fragmented PRI sector, but it apparently does not exercise that authority. On the contrary, different and legally independent institute populations are affiliated with different ministries, and many PRIs depend on all kinds of RCN programmes to survive financially. RCN assumes the workload and the responsibilities, but it cannot help lift the PRI sector to the next level: first, RCN has many tools, but cannot help restructure a small sector that has to deal with short planning cycles, due to the low degree of basic funding. Second, the constant needs of many small (and a few larger) PRIs might have some feedback on how the RCN programmes and its other actions are decided on. The PRI sector accounts for nearly 50% of all RCN funding and requires constant attention to its short- and medium-term needs in a given setting. It could therefore be beneficial from a governance perspective to review how the PRIs could obtain more basic funding (like most of their counterparts abroad) and to give them incentives to formulate long-term planning cycles. This could be accompanied by stronger incentives for the PRIs to merge, as the university colleges did.

The Long-Term Plan as a co-ordination and steering mechanism

The LTP is an attempt to encourage a more strategic and co-ordinated policy approach. It can be traced back to the previous (a coalition including the Social Democratic Party, the Socialist Left Party and the Centre Party) government, which tried to build stronger consensus around long-term planning in Norwegian research policy. The MER, in its 2013 white paper "Long-term perspectives: knowledge provides opportunity," launched the idea of taking a ten-year perspective on research and higher education priorities. The successor government (a coalition including the Conservative Party and the Progress Party) followed up on some of these ideas and presented a "Long-Term Plan for Research and Higher Education 2015-2024" in October 2014.

The MER, which led the process, managed in a remarkably short time to accomplish the first such exercise in Norwegian STI policy, involving a wide array of stakeholders.

Against the backdrop of an institutional setting that enshrines the sectorial and consensus principles, the main expected added value of the LTP lies in its long-term perspective, its authoritative status, its interministerial scope and strategic approach. In each of these four dimensions, it has achieved noticeable progress, but several limitations persist.

Despite its original intent and formal title, the LTP is not a ten-year planning document. It has a ten-year perspective for designing longer term avenues, but is in practice conceived on a four-year rolling basis, with the first revision of the plan to come in 2018.

Although the LTP was presented to the Storting, like any white paper, it is not a binding multiannual research bill of the kind Sweden and Switzerland have put in place. Formally, it is a government strategy document. It does not enforce priorities or set radically new forms of government co-ordination. Its implementation still involves voluntary common negotiation and planning procedures.

The wide scope of the consultations during its development phase has resulted in the formulation of a single common, interministerial document, accepted across the government, covering such topics as upstream research, business innovation support and competitiveness. However, when it comes to concrete financial commitments and actions, the LTP does not have the same status in the different policy fields. While all ministries have contributed thematic or structural priorities to the plan, only some of MER's actions and programmes have earmarked budgets. Under this "asymmetric budgeting" process, the closer the actions to MER's core policy field, the firmer are the commitments. The only three concrete funding activities involve the field of research (junior university positions, appropriations to research infrastructure, etc.). In other areas, actions are more broadly defined and do not benefit from any financial commitment. The strongest limitation of its horizontal scope belies its very title, the "Long-Term Plan for Research and Higher Education". The fact that higher education issues are not covered in detail has raised some criticism. MER launched a white paper dedicated to HE policy issues in January 2017, which many see as compensation for the missed opportunity of the Plan.

The LTP initiative is a strategic initiative by nature. The plan establishes six priorities, building on ideas, proposals and plans from different ministries, agencies and stakeholders. However, these are wide-ranging priority areas. Despite the original intent, the approach of the LTP appears to be agglutinative rather than selective. Moreover, the topics covered in the LTP nearly all represent established thematic or structured priorities. Some even date back decades, either because of the long trajectories and path dependencies of sectors like oil and gas and marine/fish farming, or because of the slow progress and areas of conflict, like governance and high-level research issues in the HE sector. The design of the priorities seems to reflect a somewhat weak strategic approach. While the four first priorities are thematic, the last two are horizontal, with a clear correspondence with the two overarching objectives, "enhanced competitiveness and innovation" and "developing research communities of outstanding quality". This structure does not favour a matrix in which research and innovation policies cut across the four thematic priorities.

However, the plan has succeeded in establishing a new approach that makes prioritisation politically more acceptable and in increasing commitment for some priorities across the whole government. It is a step in the direction of more ambitious quantitative goals, like the 3% research intensity goal envisioned for 2030. The LTP had some effects on horizontal co-ordination, including the high-level meetings chaired by the prime minister, Cabinet discussions on STI issues, the establishment of some interdepartmental steering groups at administrative and political level, alignment work in RCN and other soft co-ordination questions. The discussion and drafting of the LTP have already contributed to closer government co-operation, since it was a government-wide activity.

The LTP has also made a first step away from the "ground-floor" co-ordination model. The government seems willing to do more co-ordination work at its level. However, this structuring effect seems still superficial at this stage, even with respect to the operation of the RCN, the key LTP implementation body. Its Research Strategy for Innovation and Sustainability 2015-2020, launched in 2015 after the LTP, lists many goals and activities in lofty language and appears to be an effort to harmonise the LTP structure with the RCN's many ongoing activities. The strategy mentions the LTP only once, stating that the RCN "will help to follow (it) up".

Science, technology and innovation governance at the crossroads – options for the revision of the Long-Term Plan

While the plan is well articulated, it is long and not as precise as it might be. It intentionally contains only few concrete action points and does not set "hard" priorities, apart from the few initiatives announced for the period 2014-18. Most of these initiatives were already in the policy pipeline, and the LTP only conveys and concretises them. In a sense, the LTP is a mirror of Norwegian STI policy making, reflecting both its strengths and weaknesses.

The LTP assimilated many strategies, interests, viewpoints and policy options in an attempt to include every major actor. Getting beyond the strong sector principle and the current "ground-floor" co-ordination model will necessarily mean persuading all major Norwegian policy actors to take this step simultaneously, under the consensus principle. In this first edition of the LTP, the long and not very precise text of the document could help to initiate new policy practices. All the parties involved can assemble around the LTP to take the next step together. This might work out even better with the next LTP, because many government organisations, such as sector ministries or funding organisations, consider the plan a useful tool for streamlining and co-ordinating thematic priorities.

The LTP's strongest asset is the revolving nature of the planning process. Its four-year cycle offers the opportunity to start a next planning stage soon, since the ten-year plan has to be reworked every four years. This gives the MER and other ministries the opportunity to add more concrete structural and programme-style policy activities to the LTP from 2018 onwards, without changing the plan's general orientation. A gradual adjustment over the next LTP periods would allow more policy actors to work on this policy-negotiating instrument, without giving up the sectorial and the consensus principles.

Recommendation: Improving the governance of Norwegian national system of innovation

- Use the LTP process and its regular revisions to gradually enhance the level of multiannual financial commitment and STI priority setting

  The LTP has a ten-year perspective for its main priorities and a four-year perspective for concrete programmatic action. It is thus well suited to align sectorial interests periodically and to reach consensus on the next wave of STI priorities at government level. Its revision every four years also allows for a gradual enhancement of multiannual financial commitment in these priorities, including in emerging areas. The next four-year perspective, from 2018 onwards, might include additional and bolder policy actions, programmes and initiatives from other ministries, as well as MER.

- Build upon the LTP process and institutional infrastructure to improve strategic and operational interministerial co-ordination

  Norway's STI policy needs advisory and planning capacities at the top government level to help develop long-term views, alternative paths and strategic options. If a high-level advisory council is not considered a viable option, this role should go to a specific adapted instrument or body. This might be serviced by or linked to a permanent inter-ministerial group tasked with monitoring the progress of the LTP and preparing the next revision. This could replace the RCN's central role, while enlisting the support of the RCN, which should retain its advisory role given its unique relationship with the research actors and its privileged access to relevant data. In each current LTP thematic priority, the interdepartmental groups mobilised for the budget conference could also be made permanent.

- Prepare the ground for long-term foresight activity

  Norwegian STI policy and future revisions of the LTP should be informed by dedicated foresight initiatives. These should help to gradually identify and discuss long-term STI options for Norway.

- Provide RCN with a more independent budget to run inter-ministerial strategic programmes

  RCN follows the sector principle and receives earmarked funds from 15 ministries. The decommissioned Fund for Research and Innovation (FFN), although it was formally not an independent budget and showed its limitations in some regards, seemed to have provided RCN with some room for manoeuvre to introduce new, cross-sectorial activities. In the future, the RCN should be granted more independent budgetary authority.

- Incentivise RCN to further reduce the number of funding programmes

  RCN should run a less fine-structured and (over-)determined funding portfolio.

Notes

1. Although usually accounted for in the public research sector in Norway, hospitals are presented as a distinct category here.
2. A new indicator taking into account external income (contract research and grants other than those supported by the RCN and EC programmes) was introduced in 2017.
3. Starting from 2001, the "21-Forums" have been: OG21 (oil and gas), Energi21 (energy), Klima21 (climate), Maritim21 (maritime), Hav21 (marine), Bygg21 (construction), HelseOmsorg21 (health and care), Skog22 (forestry). A recent white paper on industry (Meld. St. 27 (2016–2017)) announced that a new 21-Forum for digitalisation of trade and industry as well as for the processing industry will be initiated.

Chapter 2.

Macroeconomic and innovation performance in Norway

This chapter discusses macroeconomic and framework conditions in Norway and the state of innovation capabilities and performance outcomes of the Norwegian innovation system. The first part presents macroeconomic and social developments and highlights salient features of the Norwegian economy, patterns of structural change and entrepreneurship. The second part looks at the current state of indicators of innovation inputs and outputs. It also compares Norway's innovation capacities to other relevant OECD countries in order to highlight qualitative and quantitative characteristics of Norway's innovation system.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Macroeconomic trends, well-being and framework conditions in Norway

Impressive economic and social development in recent decades

Norway's economic development has been transformed dramatically since the discovery of offshore oil and gas in the late 1960s. The offshore oil and gas (O&G) sector was developed by state-owned companies and other domestic and foreign companies that were awarded concessions for the exploitation of the Norwegian Continental Shelf. These concessions were coupled with specific tax and regulation instruments to favour long-term technological development, notably the requirement to invest in Norway's technological capacity. In places like Bergen, Stavanger and Trondheim, specific technological and engineering clusters emerged as a result of this policy, notably in shipbuilding and oil and gas. This sector has since then remained prominent in the national economy. It accounted for nearly a quarter of Norway's GDP over the 2000s (MER, 2016), starting from nothing in 1970 and oscillating between 10% and 15% in the 1990s (Engen, 2009).

Apart from the O&G sector, the Norwegian economy had long been dominated by agriculture, forestry, fisheries, mining and shipping, which resulted in the gradual growth of supplier firms and generated opportunities for smaller scale industrial development, for example in shipbuilding. In the first decades of the 20th century, extensive investment was made in hydropower for energy-intensive basic industries like aluminium smelters. A small number of academic innovators contributed to this development from the beginning.

Research and innovation began to play a more prominent role in the last third of the 20th century, with the emergence of knowledge producers and the pervasive economic and social influence of information and communication technologies (ICT). Some service companies with strong ICT competencies became important nodes in the large industrial network, especially in oil and gas.

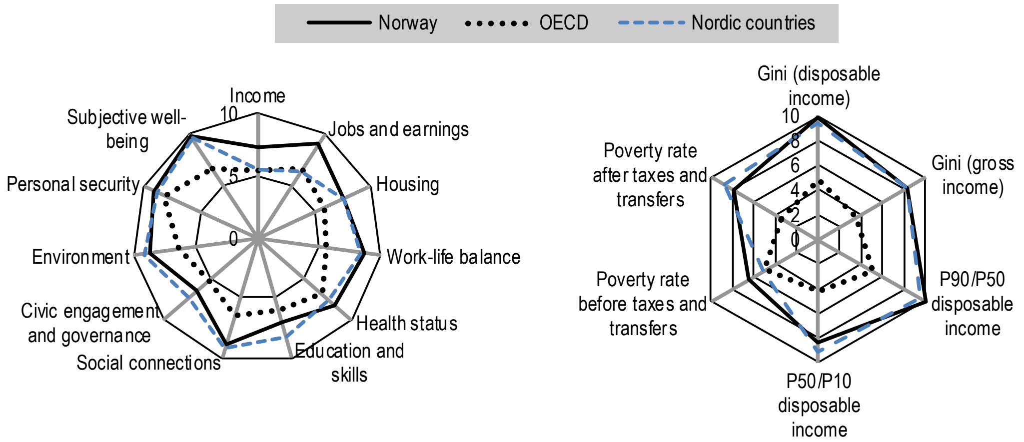
Norway was able to seize the initiative where opportunities arose, and pursued an active industrial policy in the post-war era. This led to the development of successful clusters in resource-based sectors, predominantly in oil and gas, shipbuilding and also fisheries and aquaculture. These were supported by technology and engineering service companies that maintained a close relationship with universities and specialised research institutes. The revenues generated by these industry clusters became a driving force in the growth and technological upgrading of these sectors and helped to establish a virtuous circle for building strong, interlinked research and innovation capabilities.

Smart management of the country's natural resources, with the help of Norway's sovereign fund, has helped Norway achieve standards of living that are among the highest in the world. It consistently ranks at the very top of countries in terms of human development index-related indicators (Figure 2.1, Panel B). It scores well in the OECD Better Life Index (Figure 2.1, Panel A) surpassing the OECD average in every dimension. In respect to education and skills dimensions, however, Norway ranks below other innovation-intensive OECD countries.

Despite these impressive achievements, the drop in oil prices suggests that it should prepare for an economic transition in the near future. Innovation will play a key role in this transformation, as well as integrating the highly skilled workforce from the oil and gas sector into emerging industries.

Figure 2.1. **Norway scores well in measures of well-being**

Panel A. Better Life Index Panel B. Inequality index



Note: Indicators are normalised by re-scaling from 0 (worst) to 10 (best). Each well-being dimension is measured using 1 to 3 indicators from the OECD Better Life Indicator set with equal weights. Nordic is a simple average of Denmark, Finland and Sweden.

Sources: OECD (2016a), *OECD Economic Surveys: Norway 2016*, http://dx.doi.org/10.1787/eco_surveys-nor-2016-en based on OECD (2015a), "Better Life Index 2015", *OECD Social and Welfare Statistics*, http://dx.doi.org/10.1787/data-00823-en; OECD (2015d), "Income distribution", *OECD Social and Welfare Statistics*, http://dx.doi.org/10.1787/data-00654-en.

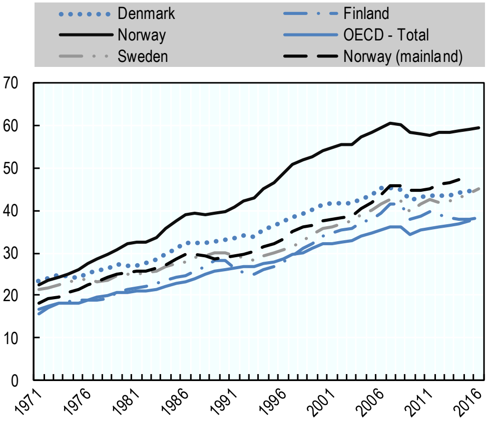
Macroeconomic trends

Norway has the second-highest GDP per capita in the OECD, after Luxembourg, with USD 63 000 PPP per head in 2016. GDP growth slowed from 1.9% in 2014 to 1% in 2016, mainly as a result of the impact of falling oil prices. Norway's GDP levels remain among the highest in the OECD, even when considering only the mainland economy (i.e. without the oil and gas revenues) (Figure 2.2). The oil economy accounts for a significant portion of the economic growth in recent decades, but the mainland economy has meanwhile showed strong productivity growth (Table 2.1). An estimated 230 000 workers are linked to the oil industry (8.7% of total employment). Supplies for the oil industry accounted for 14% of value added in mainland manufacturing industries in 2013; for service industries the share was 9%. Labour productivity has declined, (Table 2.1) although less than in comparable OECD countries, and the drop is attributable chiefly to the slump in oil prices rather than in mainland economic activities.

The Norwegian economy's drop in productivity since 2005 was heavily influenced by the petroleum sector, partly because the remaining oil resources are less easily accessible. Productivity in the mainland economy has continued to increase, though at a slower pace.

Norway's economic structure (Figure 2.3) is likely to progressively diversify and move away from petroleum-related activities (OECD, 2016a). As illustrated in Figure 2.3, its economy is now dominated by a wide range of service sectors, following the trend in most other OECD countries. While mainland exports of goods are primarily towards Europe (67% of mainland exports of goods), exports of services have become increasingly global (50% towards Europe and 50% to markets outside Europe).

Figure 2.2. **Norway's GDP per capita is high**



Sources: OECD (2017a), *National Accounts Database*, http://dx.doi.org/10.1787/na-data-en (accessed 24 April 2017); OECD (2016a), *OECD Economic Surveys: Norway 2016*, http://dx.doi.org/10.1787/eco_surveys-nor-2016-en.

Table 2.1. **Norway's growth performance indicators**

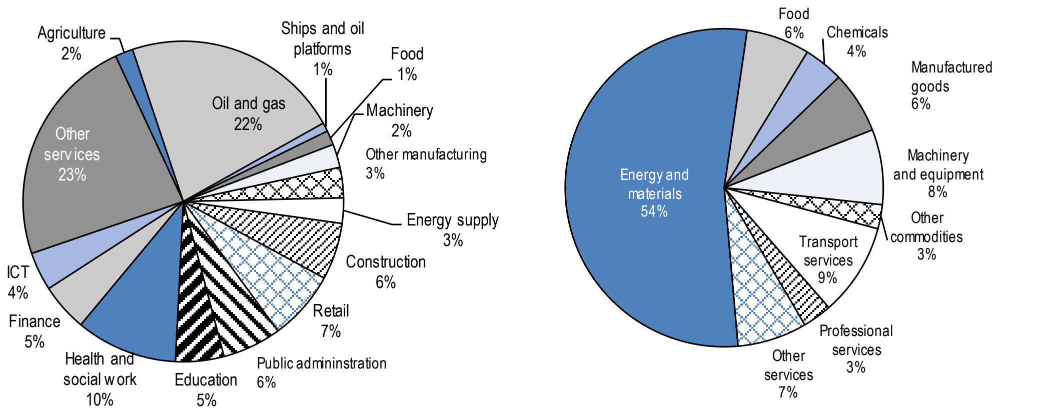
Average annual growth rates (%)		2003-09	2009-15
GDP per capita		2.4	0.9
Labour utilisation		0.8	-0.6
of which:	Labour force participation rate	0.3	-0.4
	Employment rate	0.2	-0.2
Labour productivity		1.3	1.2
of which:	Capital deepening	-0.5	-0.4
	Total factor productivity	1.9	1.6

Source: OECD (2017b), *Economic Policy Reforms 2017: Going for Growth*, http://dx.doi.org/10.1787/growth-2017-en.

Figure 2.3. **Norway's economic structure**

Panel A. Value added by sector as % of GDP

Panel B. Exports by type of commodity and service



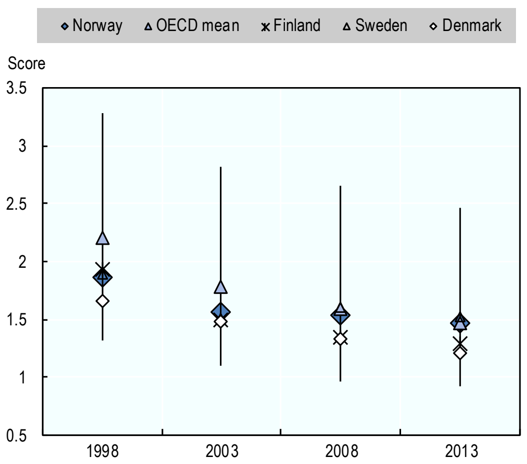
Source: OECD (2016a), *OECD Economic Surveys: Norway 2016*, http://dx.doi.org/10.1787/eco_surveys-nor-2016-en.

Trends in entrepreneurship

Given the challenge in cost-competitiveness faced by Norwegian companies (especially in the mainland economy), it is essential that policy makers provide very good framework conditions for entrepreneurship and innovation. Norway's corporate tax rate does not compare favourably with that of other OECD countries. The OECD product market regulation measure suggests that Norway compares relatively well with other countries, but that it has been cutting barriers to business more slowly than elsewhere (Figure 2.4). According to this index, Norway ranks at the OECD mean with respect to the restrictiveness of economy-wide procedures, protection of incumbents and barriers to trade and investment. Norway is below the mean when considering the administrative burden on start-ups. The government is aware of these problems and is moving forward to address the issues.

Self-employment is an indicator that helps illuminate the extent of entrepreneurship within a country. The self-employment rate in Norway is very low by comparison with other countries (Figure 2.5). Surprisingly, there are even fewer self-employed women than males, despite Norway's relatively low gender gap in other measures. However, cross-country comparisons of self-employment are complicated in two ways. Self-employment status is sometimes favoured by tax and social security provisions, or other regulatory practices, which differ across countries. Secondly, individuals who own all or part of a small firm may well be recorded as employees of the firm rather than as entrepreneurs.[1]

Figure 2.4. **Norway is losing ground on the OECD's product market regulation index**

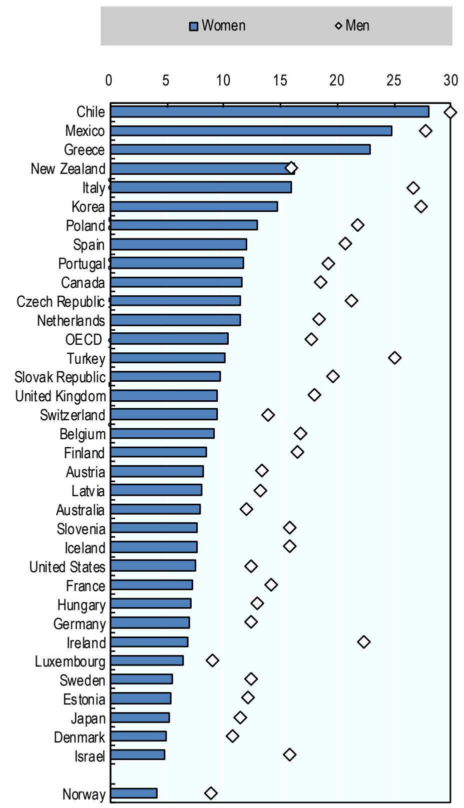


Notes: Scores potentially range from 0 to 6 and increase with restrictiveness. The OECD mean is depicted on a line connecting the minimum and maximum values within the OECD.

Source: OECD (2015b), "Economy-wide regulation", *OECD Product Market Regulation Statistics* http://dx.doi.org/10.1787/pmr-data-en.

Figure 2.5. **Self-employment by gender**

Percentage of total employment, 2014 or latest available year



Source: OECD (2016b), *Entrepreneurship at a Glance 2016*, http://dx.doi.org/10.1787/entrepreneur_aag-2016-en.

Entrepreneurial activities and the formation of innovative ventures are also influenced by educational background. In that regard, the specific subject of study appears more influential on the entrepreneurship rates than on the level of education reached (OECD, 2014a). Entrepreneurship rates are highest among those who study dentistry, veterinary science and hairdressing, and the lowest among PhDs (though this last observation is undifferentiated across subjects). Among those studying at the master's level, entrepreneurship is higher among engineers and architects than among those studying business and administration, while the latter in turn have rates higher than among scientists (including computer scientists) and mathematicians. Although it is difficult to clearly distinguish between subjects that are conducive to research, innovation and entrepreneurship from the others, it should be noted that relatively few recent graduates in Norway have specialised in science and engineering relative to health, education and social sciences, which may also contribute to lowering the entrepreneurship rate.

Equally important to entrepreneurship and the growth of new firms is access to finance. Bank loans may be appropriate if a business has physical collateral to post as security, but may be less relevant for start-ups where knowledge-based capital is more important. In these cases, start-up finance, i.e. seed money beyond the entrepreneur's own resources, or that of family and friends, is sometimes provided by venture capital investors. A report on private equity funds by the Norwegian Venture Capital Association shows that almost no private equity investment is seed money for completely new start-ups (NVCA, 2012). Instead, between one-quarter and one-third of private equity investment is in the venture stage, when successful start-ups are looking to expand, the rest – twice as much – being buy-out finance.

Venture capital investment in Norway as a percentage of GDP is lower than in other innovation-intensive countries such as Israel, the United States, Canada or Sweden (Figure 2.6). However, in interpreting this figure, Norway's high GDP must be factored in. In absolute figures, venture capital investment in Norway is comparable to that of Denmark, Finland or Belgium, but lower than in other small advanced economies, such as Switzerland. Venture capital investment is relatively equally balanced between early- and later stage capital support and decreased over the period 2007-2014, a trend common in many other OECD countries (Figure 2.6).

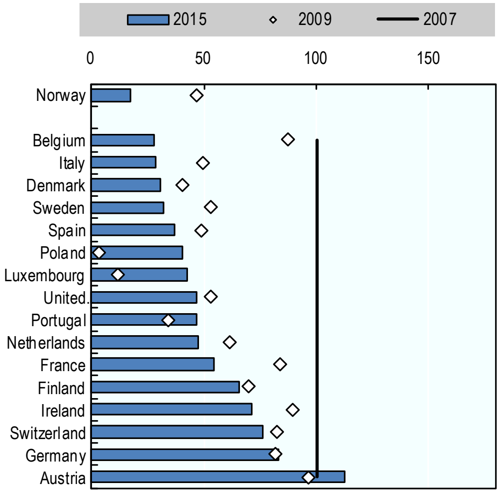
Employment created by enterprise start-ups, and the loss of jobs consequent on their failure, provides an indication of how enterprise contributes to overall employment changes in the economy, and in particular, start-ups' important contribution to employment growth. Employment creation is particularly dynamic in the services sector. At the level of the economy as a whole, net creation was positive, at over 1% of total employment, driven by the net creation of employment from enterprise start-ups in the service sector (Figure 2.7). New small and medium enterprises (SMEs), as in other countries but to a lesser extent, contribute disproportionately to job creation (Figure 2.8).

Access to the Internet and ICT

Information and communications technology (ICT) infrastructure, especially high-bandwidth connectivity – affects innovation and broader business outcomes in a variety of ways. For instance, Internet usage is associated with superior performance in small firms. ICT infrastructure facilitates innovation by enabling the circulation of data and information, whether or not publicly or privately generated and funded. ICT infrastructure also facilitates the data-driven delivery of key public services, from the management of smart electricity grids and transport systems to efficiency-enhancing patient data in healthcare.

Figure 2.6. **Trends in venture capital investment**

Index 2007=100



Source: OECD (2016b), *Entrepreneurship at a Glance 2016*, http://dx.doi.org/10.1787/entrepreneur_aag-2016-en.

Table 2.2. **Education field of entrepreneurs at start-up, 2011**

Education field	All entrepreneurs
General programmes	24%
Humanities and arts	4%
Teacher training, social science, law	7%
Business and administration	18%
Natural sciences, vocational and technical subjects	36%
Health, welfare and sport	6%
Primary industries	2%
Transport and communications and other services	5%

Source: OECD (2016a), *OECD Economic Surveys: Norway 2016*, http://dx.doi.org/10.1787/eco_surveys-nor-2016-en.

Access to broadband communication networks and the services provided over them support existing economic and social activities and hold potential for innovation. According to Figure 2.9, fixed broadband penetration in Norway is significantly above the OECD average, below only Switzerland, Denmark, the Netherlands, France and Korea. Mobile broadband penetration is lower but still above the OECD average. Norway is also a leader in terms of M2M subscriptions and the number of devices used for online access at home. Indicators of online usage among young people are also very strong. In Norway, children obtain access to the Internet earlier than in most OECD countries, and in 2012, the availability of Internet connections in schools is the third highest after Denmark and Australia. According to 2014 data, the share of individuals using the Internet to interact with public authorities was also very high: more than 80%, the third-highest share after Iceland and Denmark.

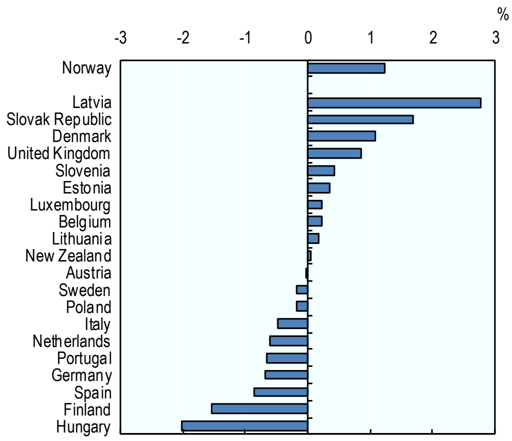
Innovation performance in Norway

Innovation inputs

The ability to mobilise resources for innovation differs markedly across countries. Innovation-intensive countries devote considerable financial resources investing in R&D, skills for innovation and science and technology. The assessment of the innovation performance of a country should take into account a wide range of indicators, including R&D expenditure, educational and skills characteristics across the population over time and across sectors (notably government, business and higher education).

Figure 2.7. **Net employment creation due to employer enterprise births and deaths, total business economy**

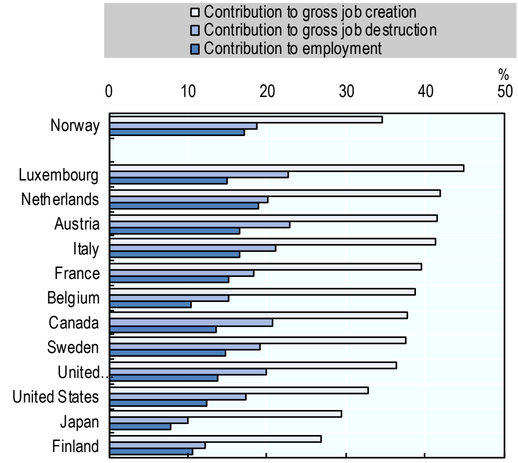
Percentage of total employment in employer enterprises (2013)



Source: OECD (2016b), *Entrepreneurship at a Glance 2016*, http://dx.doi.org/10.1787/entrepreneur_aag-2016-en.

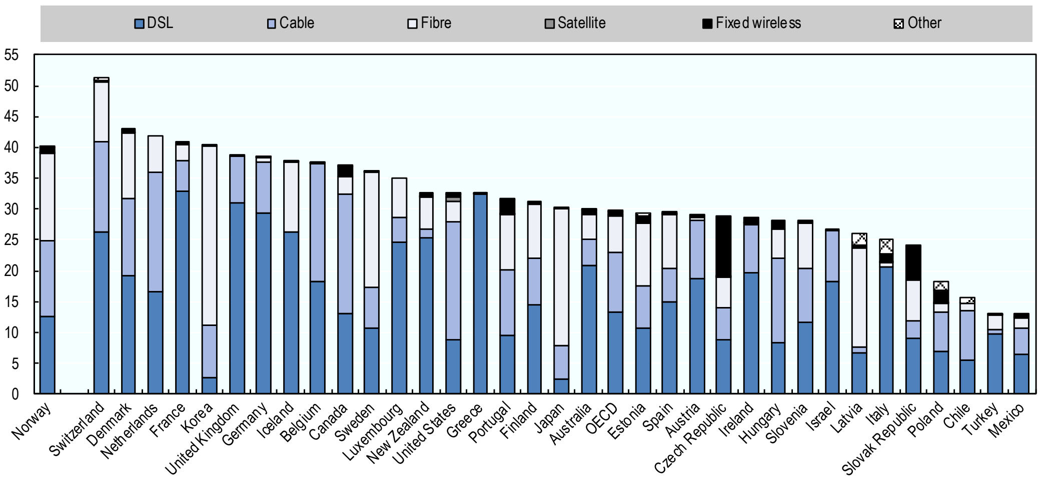
Figure 2.8. **Young SMEs contribution to job creation in each country, 2001-2011**

Share of total employment/job creation/job destruction



Source: Criscuolo, C., P.N. Gal and C. Menon (2014a), "The dynamics of employment growth: New evidence from 18 countries", http://dx.doi.org/10.1787/5jz417hj6hg6-en.

Figure 2.9. **Fixed broadband subscriptions per 100 inhabitants, by technology, 2016**



Source: OECD (2017c), Broadband Portal, www.oecd.org/sti/broadband/oecdbroadbandportal.htm (accessed 24 April 2017).

R&D expenditures

Gross domestic expenditures on R&D (GERD) in Norway increased considerably over the last decade from 3.2 in 2005 to USD 6.2 billion PPP in 2015. The 2015 figure was NOK 60 billion. GERD in Norway is comparable to Finland's (USD 6.7 billion PPP in 2015) but lower than other Nordic countries like Denmark (USD 8.2 billion PPP in 2015) and Sweden (USD 15.3 billion PPP in 2015). Business expenditure on R&D (BERD) increased from USD 1.7 billion PPP in 2005 to USD 3.3 billion PPP in 2015. Government expenditure on R&D (GOVERD) and higher education expenditure on R&D (HERD) also increased, but at a slower pace, and in 2015, accounted respectively for USD 0.8 billion and USD 1.8 billion (Figure 2.10).

The share of GERD accounted for by the business sector was 54% in 2015, a figure around the OECD median and below the OECD average (69%). Other comparable Nordic countries exhibit shares closer to the OECD average: 64% in Denmark, 66% in Finland and 69% in Sweden.

BERD intensity (BERD as a % of GDP) in Norway has increased in the last decade (from 0.79% in 2005 to 1.05 % in 2015). However, it remains below the OECD average (1.09% in 2015) and the shares in other Nordic countries (around 2%). Figure 2.11 shows that BERD per capita is USD 690 PPP, whereas the OECD median is USD 554 PPP per capita. It must be noted, however, that this share is in line with that of other natural resources-based OECD economies, like Canada, New Zealand or Australia.

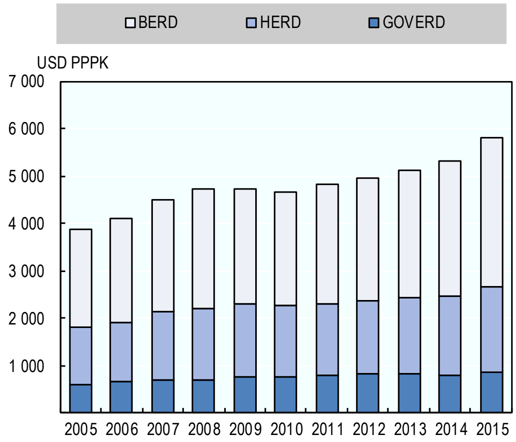
The higher education sector has had the highest increase in R&D expenditure since 2003, with average annual growth of 3.4%. Universities (including university hospitals) account for more than 80% of the HEI sector's total R&D expenditure in 2015. The rest is conducted by university colleges and specialised university colleges. Instead, HERD intensity in 2015 was at 0.6% of GDP, higher than the OECD average of 0.5%. GOVERD intensity was 0.3% in 2015, similar to the OECD average of 0.2% (Figure 2.11). The Norwegian GOVERD per capita indicates USD 192 per capita for 2015, higher than the OECD median and Nordic selected countries.

Like other countries, Norway has set ambitious targets for levels of R&D expenditure. A target of increasing R&D investments to 3% of GDP was introduced in 2005, in line with the EU Lisbon strategy, and was reclassified in 2009 as a long-term objective rather than as a target (Solberg, 2016). The LTP has restated the 3% goal to be reached by 2030. In addition, the LTP has specified that government allocations to R&D (GBAORD) should reach 1% by 2019-2020. While the target of 1% public R&D expenditures was reached in 2016, the consensus is that reaching the overall 3% target with two-thirds of business spending would require a substantial restructuring of the structure of Norway's industry.

It should be noted that the relatively low level of business R&D in Norway is linked to the country's industrial structure. For international comparison, the impact of differences in industrial structure, expressed as R&D intensity, varies considerably across sectors. BERD intensity adjusted for industrial structure is a weighted average of the R&D intensities of a country's industrial sectors, using the OECD industrial structure's sector value-added shares as weights instead of the actual shares used in the unadjusted measure of R&D intensity. Even with the adjusted structure, Norway remains at the level of the OECD median.

Business R&D expenditures in Norway tend to be higher in natural resources-based industries, whereas non-natural resources-based manufacturing, including high-technology manufacturing, have lower shares. The share of business R&D in services is above the OECD median, especially for knowledge-intensive services (OECD, 2015c).

Figure 2.10. **Evolution of GERD performance in Norway, constant prices**

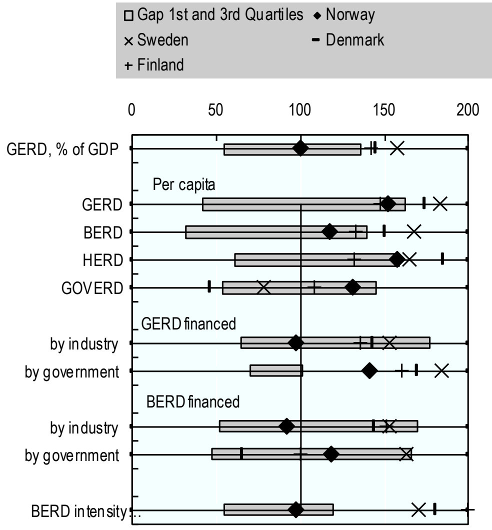


Notes: Values for 2015 are provisional. In 2007, change in compilation methods for health institutions. This affects both the higher education sector (university hospitals) and the government sector (other hospitals).

Source: OECD (2017d) *Main Science and Technology Indicators Database*, www.oecd.org/sti/msti (accessed 12 April 2017).

Figure 2.11. **R&D performance and funding, OECD and selected countries**

Index of performance relative to the median values in the OECD area (Index median = 100)



Notes: 2015 or latest available data. All indicators are presented in indices and reported on a common scale from 0 to 200 to make them comparable (0 being the lowest OECD values and 200 the highest). The median OECD value is represented by the bar at 100.

Sources: OECD (2017d), *Main Science and Technology Indicators Database*, www.oecd.org/sti/msti; *OECD Historical Population Data and Projections Database*, http://dx.doi.org/10.1787/d434f82b-en

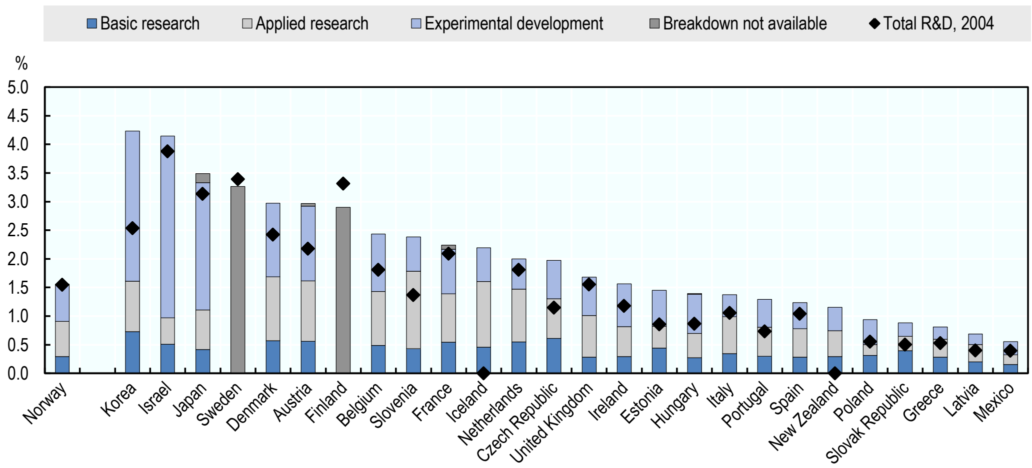
GERD in Norway shows a relatively balanced distribution between applied and experimental research, while the share of basic research is markedly lower (Figure 2.12). This distribution is commensurate with that of other OECD countries, but significantly different from the distributions in Israel, Korea, Japan, Denmark or the United States, where experimental development in GERD accounts for the largest share. While Norway's share of is perceptibly lower than that of other Nordic countries, it is noteworthy that its high GDP by comparison with other countries creates a bias towards a low GERD intensity.

R&D personnel

R&D personnel include researchers and other support staff, such as technicians and managers. The evolution of the number of R&D personnel over time provides a perspective on the changing nature of R&D activities. R&D expenditure and R&D personnel generally follow similar trends, for the simple reason that for the most part, R&D expenditure consists of the salaries of research personnel.

Figure 2.12. **Gross domestic expenditure on R&D by type**

2013 or latest data available, as a percentage of GDP



Notes: For Ireland, data for total GERD refer to 2012. For Switzerland, data for total GERD refer to 2004 and 2012.

Source: OECD, *Main Science and Technology Indicators Database*, www.oecd.org/sti/msti.htm, and OECD, *Research and Development Statistics Database*, www.oecd.org/sti/rds (accessed 2 June 2017).

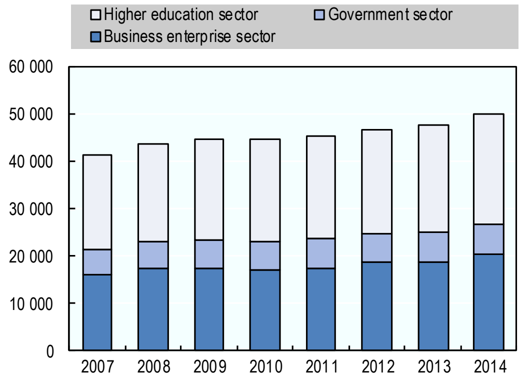
Between 2007 and 2014, with the deterioration of the economic conditions in many European countries and thanks to the high standards of working conditions in Norway, the number of international researchers in the public research system has increased considerably, by 50%. Foreign researchers accounted for around 60% of the total increase in the period and the share with a foreign nationality rose from 15% to 20%. Overall, while the number of researchers increased across all sectors between 2007 and 2014, the relative shares of researchers in the higher education, government and business enterprise sectors remained relatively stable (Figure 2.13). R&D personnel per thousand employment is above the OECD and the EU average but behind other advanced Nordic countries, especially in terms of researchers. Norway has achieved very good results in terms of the participation of women in science and research compared to other OECD countries. (Figure 2.14).

Skills for science, technology and innovation

Skilled people generate knowledge that can be used to create and introduce an innovation. Carlino and Hunt (2009) found that an educated workforce is the decisive factor in the inventive output of American cities; a 10% increase in the share of the workforce with at least a college degree raises quality-adjusted patenting per capita by about 10%. Data on Spanish regions also found a positive relationship between human capital and number of patent applications (Gumbau-Albert and Maudos, 2009).

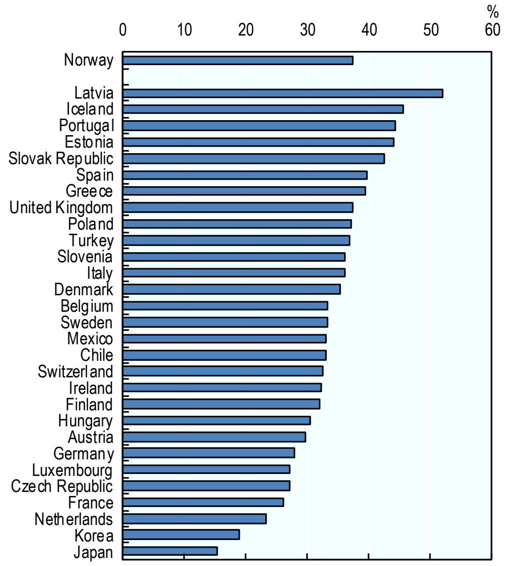
The percentage of people in Norway with tertiary education is high: 43% in the age group of 25-64 year-olds in 2015, considerably higher than the OECD average of 35% (OECD, 2016c). This positive achievement has been made possible thanks to an education system free of tuition fees and a high investment in higher education, above the OECD average country. However, although many students are attracted to higher education programmes, only 62% of students complete their postgraduate master’s degree within three years of study (MER, 2016).

Figure 2.13. **Number of researchers by sectors of employment in Norway, 2007-14 (headcounts)**



Source: OECD (2017d), *Main Science and Technology Indicators Database*, www.oecd.org/sti/msti.htm (accessed 13 April 2017).

Figure 2.14. **Share of female researchers, 2014 or latest year available, as a percentage of total (headcounts)**



Source: OECD (2017d), *Main Science and Technology Indicators Database*, www.oecd.org/sti/msti.htm (accessed 21 April 2017).

Norway has more PhDs than the EU average relative to population size. However, with 27 PhD graduates per 100 000 people, in 2016, Norway lags behind advanced innovation countries like other Nordic countries (33 on average) or Switzerland (47). In the age group 25-34, Norway is even further behind, and below the European median. The number of PhDs has increased in the last 20 years, and in 2013, was twice what it was in 2003. This increase can be mainly linked to a considerable increase in female as well as foreign PhD students.

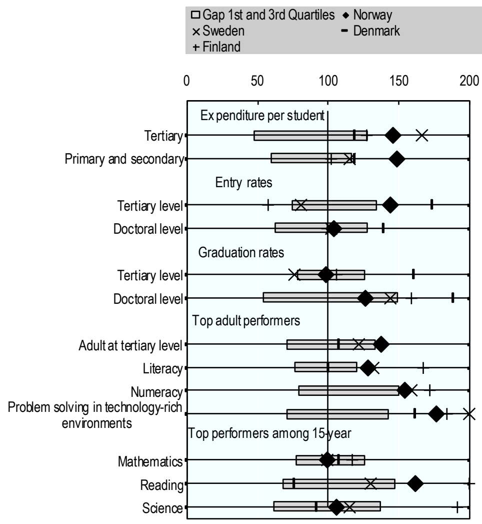
The OECD Survey of Adult Skills Programme for International Assessment of Adult Competencies (PIAAC) shows that on average, adults in Norway are more proficient in literacy, numeracy and problem-solving in technology-rich environments than the average across all participating countries (OECD, 2014a) (Figure 2.15). However, around 10% of 20-34 year-old tertiary graduates in Norway attain only low levels of literacy. Even if Norway scores better than the OECD average in the PIAAC survey, this share is still worrying. The PIAAC survey also identifies issues with respect to the usage of migrants' skills. The survey shows that over-qualification is relatively widespread among the foreign-born population in Norway (OECD, 2014a). This group is 2.5 times more likely to be over-qualified for their job than native- born Norwegians. This rate is higher than in comparable countries such as Austria, Sweden or Germany, and indicates that migrants could potentially contribute a stock of untapped skills.

Despite the overall positive development in the educational level of Norwegians, student skills in primary and secondary education are not outstanding, despite a high level of spending. Norway ranks in the middle on the OECD Programme for International Student Achievement (PISA) test (Figure 2.15), while spending per student on a PPP basis ranks the third-highest in the OECD. Completion rates are weak in many vocation training and upper-secondary education courses.

In addition, there are concerns that the Norwegian system is not fully able to produce skills that are in demand from industry, and which will be even in greater demand as Norway's industrial diversification process and economic transition further develops. Graduates in Norway are concentrated in the fields of the health sciences, social sciences and humanities. Instead, in the natural sciences, agricultural sciences and engineering and technology, its shares are below the OECD median. In particular, the shares of engineering and technology are among the lowest in OECD countries. Graduates at the doctoral level as a percentage of all graduates in the sciences and engineering, manufacturing and construction are also below the OECD average (Figure 2.16).

Figure 2.15. **Education funding and overview, OECD and selected countries**

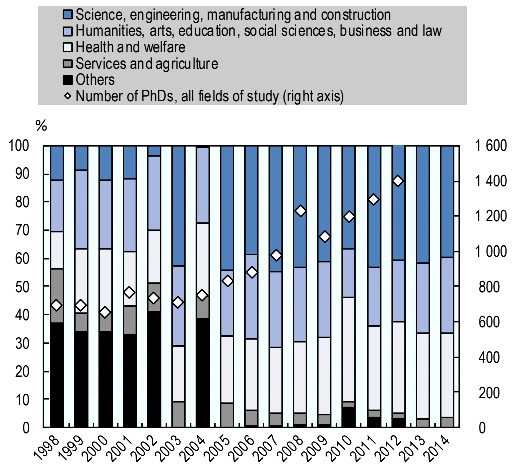
Index of performance relative to the median values in the OECD area (Index median = 100)



Note: 2015 or latest available data. All indicators are presented in indices and reported on a common scale from 0 to 200 to make them comparable (0 being the lowest OECD values and 200 the highest). The median OECD value is represented by the bar at 100.

Sources: OECD (2016c), *Education at a Glance 2016: OECD Indicators*, http://dx.doi.org/10.1787/eag-2016-en; OECD (2016d), *Skills Matter: Further Results from the Survey of Adult Skills*, http://dx.doi.org/10.1787/9789264258051-en; OECD (2016e), *PISA 2015 Results (Vol. II): Policies and Practices for Successful Schools*, http://dx.doi.org/10.1787/9789264267510-en.

Figure 2.16. **Evolution of graduation at doctoral level by field**



Source: OECD (2016c), *Education at a Glance 2016: OECD Indicators*, http://dx.doi.org/10.1787/eag-2016-en and *OECD Education and Skills Database*, http://stats.oecd.org/Index.aspx?DataSetCode=EAG_GRAD_ENTR_FIELD (accessed 21 April 2017).

Innovation output

Innovation output is difficult to measure for a number of reasons. The indicators available only partly cover various forms of innovation. For example, does basic education play a role in shaping the skills of future innovators and entrepreneurs? The activities of entrepreneurs and their impact on innovation are not easy to measure. Furthermore, entrepreneurial activity consists not only of launching new ideas in the market, but applying new business processes. Other indicators that are generally available and commonly used to measure the impact of innovation input include patent data and scientific publications.

Scientific publications

Norway has seen a substantial increase in the number of its scientific publications in the past decade, and is now included in the group of publication-intensive countries (Figure 2.17). Its output is on a par with Finland's but below that of Denmark, Sweden and Switzerland. Its relative citation impact is also in the upper third of OECD countries, but behind top performers such as the Netherlands, Denmark and Switzerland (Figure 2.18).

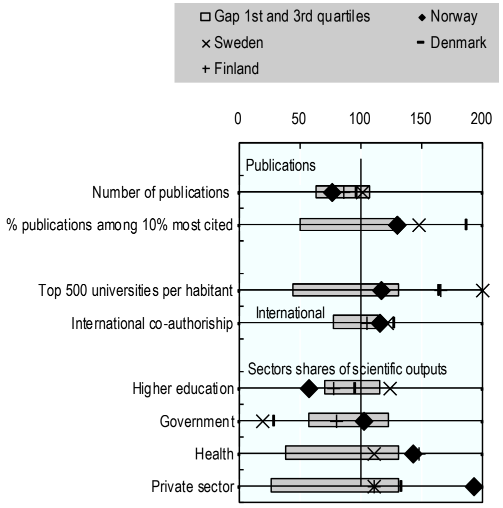
Norway has improved its relative citation impact, which was around the global average in the 1990s, consistently scoring above the average in the period 2000-10. Clinical medicine, physics and materials, earth and environmental sciences and health sciences have high relative citation impact, while biomedical sciences and particularly chemistry have rather low citation impact. This is also the case for several engineering disciplines, including energy sciences and technology. The relative citation impact is highest in the themes of climate change and the environment, but also fairly high in the themes of marine biology and fisheries and aquaculture, and the technological themes of nano- and biotechnology.

In terms of publications per capita, Norway ranks fifth after Switzerland, Sweden, Denmark and Iceland. Comparator countries like Finland or Netherlands come next, while Austria and Ireland lag behind. Quality indicators also place Norway on a high, though not top-ranking position. The relative citation index, for instance, puts Netherlands, Belgium and the United Kingdom in a better position.

International co-operation is crucial for increasing quality in science and innovation. It is even more important for small countries like Norway, which, for instance, represents less than 1% of the world's scientific output. International co-operation in science has continued to increase: around one-third of the Norwegian publications had a co-author from abroad in 1995 (Web of Science data), whereas this percentage increased to 60% in 2014. Norway today has a level of international co-authorship in scientific publications comparable to that of other small countries, for example, Ireland, Finland, New Zealand and the Netherlands, but lower than Switzerland or Sweden (Figure 2.19). The main co-authorships partners of Norway's researchers are located in the United States, the United Kingdom, Sweden and Germany (RCN, 2015a).

Figure 2.17. **Scientific outputs, international comparison, OECD and selected countries**

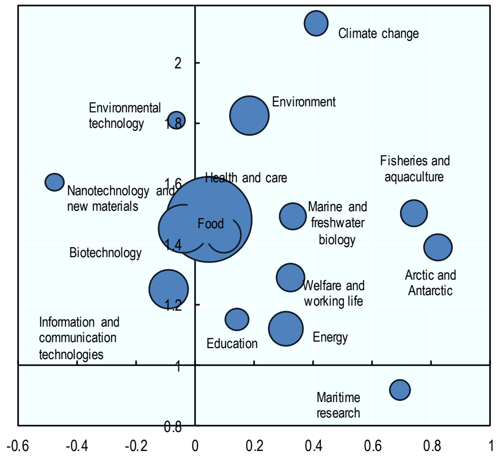
Index of performance relative to the median values in the OECD area (Index median = 100)



Note: 2016 or latest year available. All indicators are presented in indices and reported on a common scale from 0 to 200 to make them comparable (0 being the lowest OECD values and 200 the highest). The median OECD value is represented by the bar at 100.

Sources: OECD (2015c), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en; ARWU (2016), Ranking of university 2016, www.shanghairanking.com/ARWU-Statistics-2016.html#2 (accessed 20 April 2017); OECD and SCImago Research Group (CSIC) (2016), *Compendium of Bibliometric Science Indicators,* http://oe.cd/scientometrics.

Figure 2.18. **Relative specialisation and relative citation impact**



Notes: The *x* axis shows a relative specialisation index, where a positive number means that the theme accounts for a larger number of Norwegian publications than the world average. The size is proportional to the number of (fractionalised) publication, and citations are calculated using the full counts.

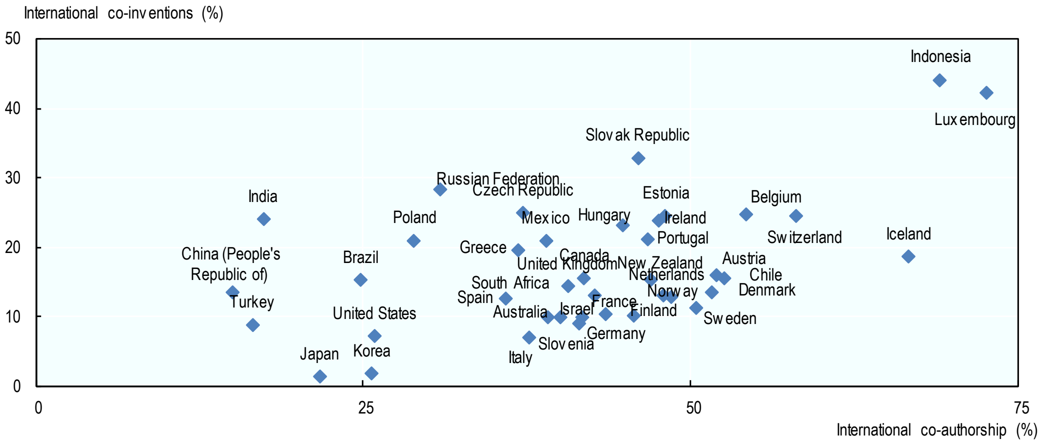
Source: ScienceMetrix (2014), *Bibliometric Study in Support of Norway's Strategy for International Research Collaboration: Final Report.*

Norwegian higher education institutions represent a significantly lower share of the most cited documents than it is the case in most comparator countries. The health sector accounts for a large share of the "best" publications in international comparison. Joint analysis of excellence and leadership information can provide further insights into the source of a country's highly cited publications. In the United States, for example, 17% of publications are among the 10% top cited, of which 14% had a US-based leading author, while only 3% are led by authors with affiliations abroad(Figure 2.20). Accordingly, the United States has the largest share of top-cited publications led by domestic authors, followed by the Netherlands and the United Kingdom. Other countries with higher overall excellence rates display lower levels of leading excellence because of the higher importance of collaborative articles led by authors from other countries. The institute sector covers both privately and publicly funded research institutes, including SINTEF (*Stiftelsen for industriell og teknisk forskning*), which is the largest research institute in

Norway and one of the biggest in Europe. The institute sector performs a relatively high percentage of R&D compared to other countries.

Figure 2.19. **International collaboration in science and innovation, 2003-12**

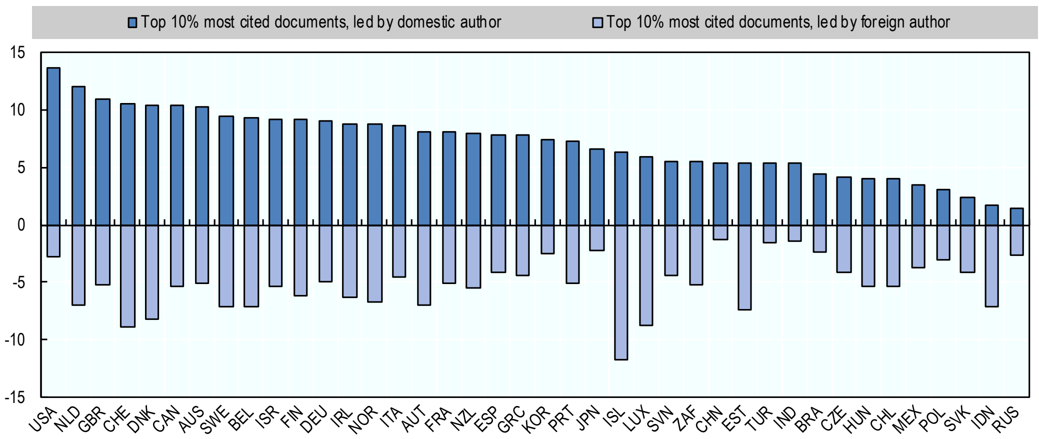
As a percentage of scientific publications and IP5 patent families



Source: OECD (2015c), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en.

Figure 2.20. **Top 10% most cited documents and scientific leading authorship, 2003-12**

As a percentage of all documents, whole counts



Source: OECD and SCImago Research Group (CSIC) (2014), *Compendium of Bibliometric Science Indicators 2014*, based on Scopus Custom Data.

The Norwegian research system has considerable degrees of specialisation in fisheries and aquaculture, the Arctic and Antarctic, climate change, maritime, marine biology, environment and climate change. A number of its areas of specialisation, like fisheries and aquaculture, marine biology, environment and notably climate change, also have a relative citation impact well above world average.

These areas also correspond to some of the large Norwegian economic clusters, whose success was partly based on the scientific achievements of Norway's research community. The recent RCN evaluation of Engineering Science in Norway noted that its leading fields, of marine and climate/fossil fuel research correspond with its key industrial clusters (RCN, 2015b). However, the evaluation stated that the country's engineering research was not sufficiently visible in journals with high impact factors.

Another weak point is Norway's lower degree of research specialisation in enabling technologies (ICT, nanotechnology and biotechnology), the basis for some of the most promising emerging industries (OECD, 2016f).

Performance in EU research programmes

Research actors from Norway are quite successful in EU framework programmes (FPs). However, there are a number of other participating member or associated countries, which yields higher participation and success rates.

Comparing the returns from FP7, Norway scores below other Nordic countries of similar size: Norway accounted for 1.69% of EU FP contributions, amounting to EUR 725 million. Denmark and Finland, countries of comparable size, scored higher, with 2.38% and 1.93% respectively (Solberg, 2016, Fresco et al., 2015). The Norwegian EU strategy is specifically concerned with the comparatively low university participation (MER, 2016).

The challenge for Norway appears even greater when looking at the input-output ratio: the Norwegian contribution is tied to the very high and constantly growing national GDP. The EU FPs themselves constitute a second accelerator, as their budget has been growing with each framework. As a result, Norway currently spends more than EUR 250 million annually for the FP participation. This amounts to nearly 8% of total public spending for R&D (Solberg, 2016).

The first two years into Horizon 2020 (H2020, the 8th EU FP 2014-2020) have revealed a similar, and "relatively robust", pattern as in FP7: good but not excellent performance and skewed success rates: while Norwegian actors perform very well in some of the programmes in the societal challenges pillar – like environment, energy, security and notably food security – it does not fare as well on health. The industrial leadership pillar shows strong performance in advanced materials as well as the small biotech programme, but is less successful in the ICT and nanotech programmes. The weakest pillar so far is people, where Norway has a comparatively weak record in ERC and MSCA grants. The statistics (FFG, 2016) show more than 700 Norwegian participations, making up for 1.6% of all participations, which is slightly below what Norway would have if it had an average share. The share of funding amounts to 1.9% of the total funding commitment so far and is therefore higher. The ratio between applications and grants is also a little higher than the average of all countries (15.8% vs. 14.3%).

The record with the prestigious European Research Council (ERC) reveals a continuation of the FP7 pattern, i.e. a low participation share (0.9%) and a very small number of Norwegian universities successfully competing for ERC grants. The University of Oslo alone accounts for half of the Norwegian share of these highly competitive and prestigious grants. The success rate for ERC grants is strikingly low in H2020: while the European average is 12.8%, only 6.7% of the Norwegian applicants are successful (FFG, 2016).

The FP7 final evaluation states that there are three associated countries that managed to win a substantial share of FP7 funding, therefore assessing the Norwegian participation as in principle successful. 19% of all the funds going to organisations in associated countries went to Norwegian participants. 22% were allocated to Israeli actors and 51% to Swiss organisations. Another 10% went to 11 other associated countries (Fresco et al., 2015). However, the Israeli and Swiss success stories are more impressive: Israel because of the active global sourcing policies of its HEIs (also given the scarce competitive national funding) and Switzerland through the sheer numbers, e.g. of ERC grantees in the major universities or the co-ordination of very large international projects.

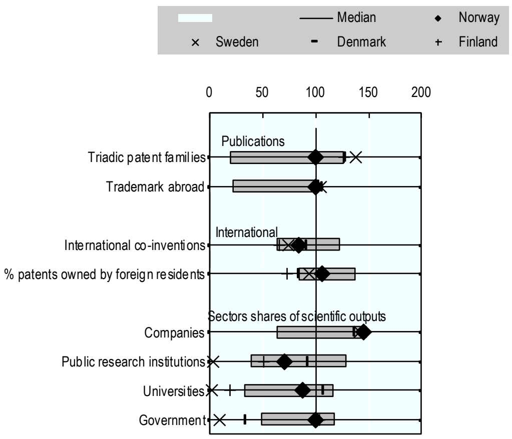
Patents and trademarks and innovation in the business sector

International patenting is used as an indicator of economically valuable technological invention. This indicator is particularly relevant for developed innovation systems. The percentage of foreign inventions (as measured by patents) owned by Norwegian companies (or other actors) is lower than the European average or of innovation-intensive countries like Switzerland, Denmark, Finland, Sweden (Figure 2.21). This may reflect the lower presence of multinational enterprises in Norway compared to other OECD countries.

International trade linkages, as measured by receipts and payments in knowledge assets as a percentage of GDP (Figure 2.22), are lower in Norway than in comparable countries, such as the Netherlands, Israel, Switzerland, Sweden or Finland. Norway's high GDP, however, may in part be lowering its ranking. The average annual growth rate of its international flows of knowledge assets has increased. Revenues from licensing and patents from abroad have been stable in recent years and are lower than in comparable economies.

Figure 2.21. **Inventions, OECD and selected countries**

Index of performance relative to the median values in the OECD area (Index median = 100)

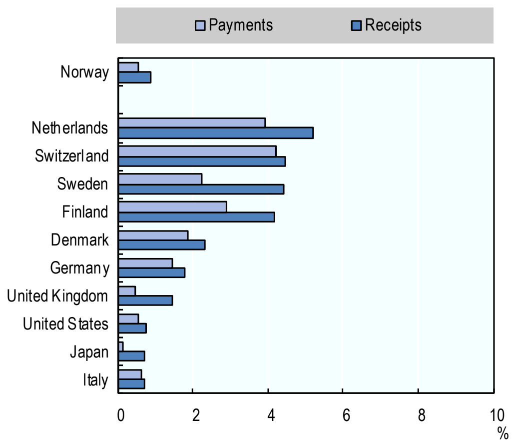


Note: 2015 or latest year available. All indicators are presented in indices and reported on a common scale from 0 to 200 to make them comparable (0 being the lowest OECD values and 200 the highest). The median OECD value is represented by the bar at 100.

Sources: OECD (2015c), *Science, Technology and Industry Scoreboard 2015*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en.

Figure 2.22. **International trade in knowledge assets, Norway and selected countries**

Receipts and payments, as a percentage of GDP, 2013 or latest year available



Source: OECD (2015c), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en.

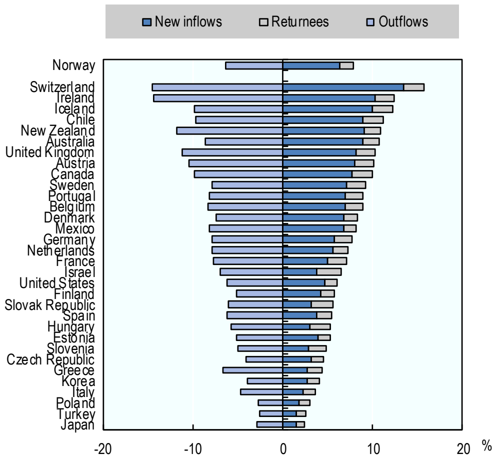
Mobility, attractiveness and performance

Norway is an increasingly appealing destination for scientific activities, which is reflected in the increasing number of Norwegian articles that include the participation of a foreign author, which is the case for 61% of the articles published in 2014 (RCN, 2015a). According to 2013 data, the mobility of researchers appears to have had a positive impact on the quality of its scientific research output.

Figure 2.23 illustrates how researchers who leave the country and then return tend to have a higher citation impact than newcomers or those who do not move. This pattern is certainly a positive development and does not raise the same concerns as in those countries where those who leave (outflow in the figure) are those with the highest citation impact. However, it must be noted that newcomers in other small innovation-intensive countries, such as Switzerland, Denmark or Sweden, have a higher citation impact. This highlights a potential issue: the Norwegian research system's limited appeal by comparison with other comparable OECD countries. The difference in this respect between Norway and Switzerland is particularly striking.

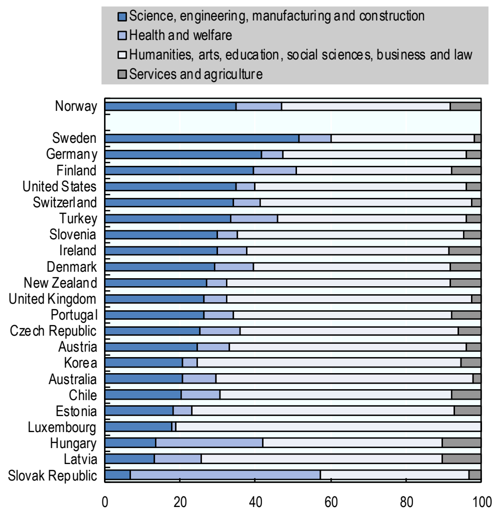
However, according to 2012 data, tertiary education international students in Norway are primarily concentrated in social sciences and humanities (Figure 2.24). Sweden, Finland, Germany and Switzerland are able to attract higher numbers of foreign students in science and technology. More recent data on the distribution of mobile graduates by field show a slightly different picture for Norway, as 39% of mobile graduates are in social sciences and humanities, which is a lower share than in Denmark and Finland, and just somewhat higher than in Sweden (OECD, 2016c).[2] The share of foreign-born PhDs in Norway is lower than in other innovation-intensive small countries (around 30% in Norway, as compared with more than 50% in countries such as Luxembourg, New Zealand, Canada or just below 50% in Austria). Other Nordic countries such as Denmark, Sweden or Finland, however, exhibit lower shares.

Figure 2.23. **International mobility of scientific authors as a percentage of authors, by last main recorded affiliation, 2013**



Sources: OECD (2015c), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en; OECD, calculations based on Scopus Custom Data, version 4.2015, http://oe.cd/scientometrics.

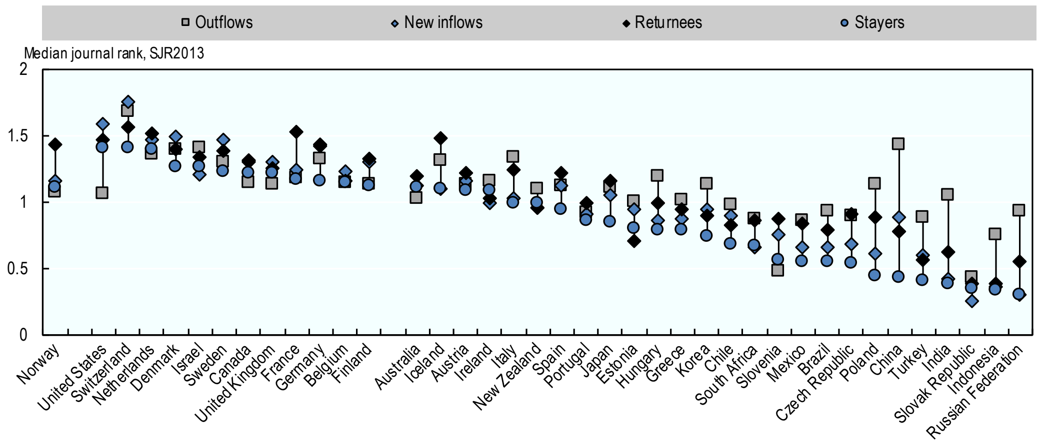
Figure 2.24. **International graduate students in tertiary education, breakdown by field of education, 2014**



Source: OECD (2016b), *Education at a Glance: OECD Indicators*, http://dx.doi.org/10.1787/eag-2016-en.

A proxy for understanding the scientific impact of researcher mobility can also be estimated by calculating the median SCImago Journal Rank (SJR) impact score for each author and mobility profile. SJR is a measure of the scientific influence of scholarly journals that accounts for both the number of citations received by a journal and the importance or prestige of the journals in which the citations appear. This is a variant on the eigenvector centrality measure used in network theory. With few exceptions, individuals not changing affiliations (stayers) are more likely to publish in journals of lower "prestige". For countries with lower median citation impact values, outflows tend to be associated with higher-rated publications than their staying or returning counterparts. In the case of Finland, returnees and new inflows score significantly higher in terms of journal impact scores (Figure 2.25).

Figure 2.25. **Impact of scientific authors by type of mobility, median SCImago Journal Rank scores, 2013**



Sources: OECD (2015c), *OECD Science Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en; OECD calculations based on Scopus Custom Data, Elsevier, version 4.2015, and on Scopus journal title list, http://oe.cd/scientometrics (accessed May 2015).

Estimates are based on the comparison of 2013 Scimago Journal Rank (SJR) scores for articles published by scientific authors, and based on the journal rank corresponding to an author publishing in 2013. Only authors with two or more publications are considered. A mobility episode is identified in 2013 when an author who is affiliated with an institution in a given economy in his/her last publication in 2013 was previously affiliated with an institution in another economy. In the case of multiple publications per author in a given year, the last publication in any given year is used as reference, while others are ignored. Authors are assigned a given status from the perspective of the last destination in 2013. They are designated stayers if the main affiliation for both 2013 and pre-2013 correspond to the reference economy. Returnee status is assigned to those who move affiliation into the reference economy, but were affiliated with it in their first recorded publication. From the perspective of the previous economy of author affiliation, individuals can be computed as outflows, and the count incorporated into the data presentation.

Notes

1. In Norway, business owners who work in their incorporated businesses are counted as employees and are therefore not included in data for self-employment.
2. It should be noted that the number of international students in Norway is underestimated, as some international students are granted residency during their studies (OECD, 2014a).

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Chapter 3.

Developing excellent academic communities for innovation: The Norwegian higher education sector

This chapter discusses the state-of-the-art and potential of the higher education sector to develop excellent academic communities, which is one of the three overarching objectives of the government's Long-Term Plan. The first and second parts describe this sector and research performance. The third and fourth parts focus on the initiatives to improve research excellence via higher education institutions' external and internal structural changes and dedicated public interventions. The chapter concludes with a synthetis of the achievements to date and remaining challenges in achieving excellence and presents some high-level conclusions.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

"Developing excellent academic communities" is one of the three main objectives of the government's Long-Term Plan (LTP). Norway's higher education (HE) sector has been designated to play the key role in achieving this objective, with the help of underlying policy and public support mechanisms. The Higher education sector has performed and developed well in recent decades, but it lags behind the best comparable countries in its key outputs, its influence and the international ranking of its higher education institutes (HEIs). The government has set up a modern, quality-oriented legal framework and well-designed funding programmes. Many HEIs, however, have yet to turn these opportunities into stronger leadership, formation of critical mass and strategies for recruiting world-class expertise. Slow progress in moving in this direction, combined with increasing convergence between HEIs, is making it difficult for Norway's HEI sector to make the vital transition towards an even more sophisticated innovation system.

The higher education landscape in Norway

A relatively young sector with strong public engagement

Norway's HE sector is of relatively recent origin (OECD, 2008). The University of Oslo, founded in 1811, was the first university on Norwegian territory. A few other organisations followed, but the majority of HE institutions were created after World War II. The 1960s ushered in a proliferation of HEIs, resulting in more than 100 organisations, most of them small university colleges (UCs). This increase was driven by regional needs and the upgrading of upper-secondary professional schools, in addition to rapid growth in the numbers of students. The sustainability of many HEIs began to be called into question, including their financial viability, sufficient student enrolment over the long term and meaningful research output.

Norway's government has devised various strategies to consolidate the sector and to achieve greater standardisation and higher quality (Gulbrandsen and Nerdrum, 2009; Öquist and Benner, 2014, Kyvik and Stensaker, 2016). This process included some mandatory as well as many voluntary phases. More ambitious strategies tended to be watered down to conform with the dictates of Norway's prevailing "consensus principle" and also in response to successful (often regional) resistance, which involved heated debates with "reformers".[1] Attempts to reform the system took decades. Much has been achieved, but it is an open question whether Norway's HE system privileges equality over competition, both within and across organisations.

Norwegian universities are characterised as typically Nordic, with dominant state ownership, strong stakeholder involvement and early adoption of third-mission goals like technology transfer, and tensions between egalitarian and leadership visions. Like many higher education systems in Europe, Norwegian HEIs gradually acquired a pronounced degree of autonomy (Pinheiro et al., 2016; Estermann et al., 2011; Auranen and Nieminen, 2010; Elken et al., 2016).

In 2017, Norway has 21 public HEIs[2] with more than 270 000 students, significantly fewer than the total of 38 a few years ago. Both the private and the public Norwegian universities and university colleges (UCs) are governed under a common Legal Act.[3] Under this framework, UCs, which originally focused on their educational mission, are permitted to conduct research activities and to award, although with some restrictions, doctoral degrees like universities.[4] They have in general become more similar to universities over time. All HEIs have three main missions: higher education, research, and the dissemination and application of academic knowledge in various spheres of business and society. The HE Act stipulates that research and education reinforce each other and be conducted at a high international level. The law then lists in greater detail nine tasks, including commercial value creation, dissemination, co-operation with other HEIs and all kinds of actors as well as the participation of HEIs' staff and students in public debates. Students are seen as contractual partners of their HEI and have a number of rights and obligations, as well as representation in the main governing bodies of the HEI, namely the university board.

A few decades ago, Norway still had an overly diversified HE sector with many small UCs. After numerous HE mergers, the number and average size of its HEIs are now comparable to those in Sweden and Finland. Denmark stands out as having fewer HEIs of a greater size, as a result of the many mergers of the past ten years (Table 3.1). As this table and Table 3.4 show, Norway is not a strong outlier as far as the number and size of its universities (and UCs) are concerned.

Table 3.1. **Size of higher education institutions in the Nordic countries, 2014**

	Number of public universities and university colleges	Higher education researchers in full-time equivalent	Number of researchers per institution	Student enrolment, full-time (2014)	Students per higher education institution
Norway	21	10 296	490	264 207	12 581
Denmark	16	15 012	938	301 399	18 837
Finland	38	12 381	326	306 080	8 055
Sweden	33	19 616	594	429 444	13 013

Note: For purposes of comparison, art colleges and business academies have been excluded from the numbers of higher education institutions. The Police University College has also not been included.

Source: *OECD Education Database 2016* (accessed 9 October 2016), http://dx.doi.org/10.1787/edu-db-data-en and national homepages (for number of higher education institutions).

Research expenditure of higher education institutions

The Norwegian HE sector absorbs a large percentage of the gross domestic expenditure on research and development (GERD), comparable to that of other successful smaller European countries. The overview in Table 3.2 shows that all comparable countries lie within a range of 23% and 33%, above the OECD average of 17.9%. The size of the HE sector relative to the overall GERD is average for OECD countries.[5]

Table 3.2. **Percentage of GERD accounted for by higher education sector**

	2000	2010	2012	2014
Norway	...	32.3	31.3	31.0
Austria	...	25.8	24.6	24.3
Denmark	...	30.3	31.6	33.2
Finland	17.8	20.4	21.6	22.9
Netherlands	31.9	40.4	31.6	32.1
Sweden	...	26.3	27.1	29.0
Switzerland	22.9	...	28.1	...
OECD total	16.0	18.6	18.4	17.9

Source: OECD (2016a), *Main Science and Technology Indicators, Volume 2016 Issue 1*, http://dx.doi.org/10.1787/msti-v2016-1-en.

The share of HE researchers as a percentage of the national total (OECD, 2016a) is the third highest of the seven countries studied, at 35.2%. Here the range is from 28.8% (Netherlands) to 52.2% (Switzerland).

The relative input (higher education research and development, or HERD, as a percentage of GDP) into the HE system is lower than in the comparator countries (Table 3.3). Overall, Norway ranks 12th among OECD countries on this score and below all comparator countries.[6] However, as shown in Figure 2.11, Norway ranks much better (in fourth position in 2015) when the HERD per capita rather than per GDP is considered, due to the high level of GDP. The growth rate of HERD between 2014 was around the OECD median (OECD, 2016, at current prices). HE expenditures are high relative to the population. Norway ranks fourth among OECD countries, after Switzerland, Denmark and Sweden (MER, 2016).

Table 3.3. **Higher education research and development (HERD)**

As a percentage of GDP

	2000	2010	2012	2014
Norway	...	0.53	0.51	0.53
Austria	...	0.71	0.72	0.75
Denmark	0.43	0.89	0.95	1.01
Finland	0.58	0.76	0.74	0.73
Netherlands	0.58	0.70	0.62	0.64
Sweden	...	0.85	0.89	0.92
Switzerland	0.53	0.73	0.84	0.88
OECD total	0.34	0.43	0.43	0.43

Source: OECD (2016a), *Main Science and Technology Indicators, Volume 2016 Issue 1*, http://dx.doi.org/10.1787/msti-v2016-1-en.

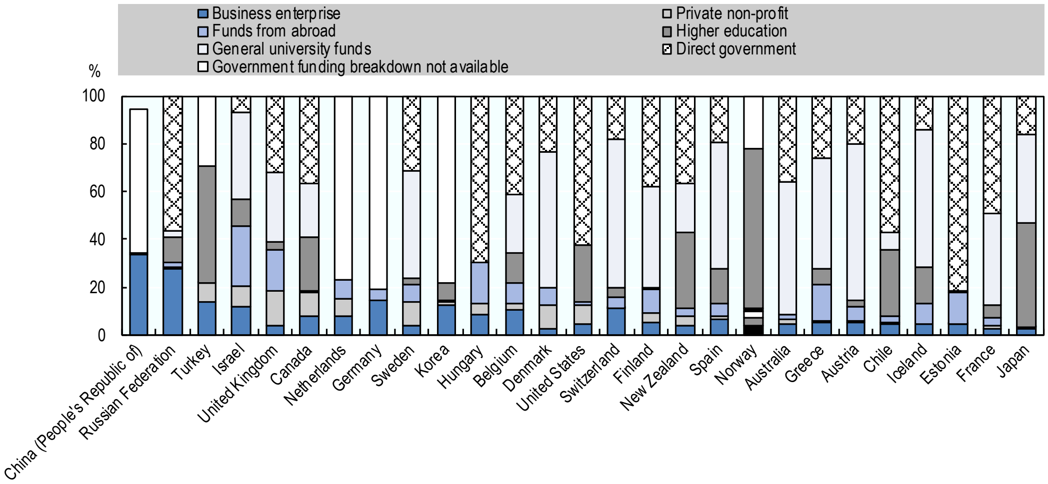
In Norway, as elsewhere, gaps in the data make it difficult to assess precisely the labour productivity of HEIs.[7] However, considering HERD relative to the number of HEI personnel, Norway appears to rank among the leaders and significantly above the median, showing a bias introduced by the high level of national wealth.

Research funding of higher education institutions

Norwegian HEIs are predominantly funded by public, i.e. central government, sources. Ninety percent of HEI income comes from block grants, Research Council of Norway (RCN) plans and other public actors, since there are no student fees to complement these sources. As in comparator countries, block grants dominate (see Figure 3.1). The percentage funded by industry is moderate by international comparison standards, at 3.1% of HERD (in 2015, down from 4.1% in 2013), partly because of the strong presence of an application-oriented public research institute (PRI) sector in Norway. The more recent shift of Norwegian HEIs towards applied and contract research has provoked discussion of the distribution of roles and functions between PRIs and universities in the public research sector.

Figure 3.1. **Funding of higher education research and development (HERD) by source, 2013**

As a percentage of HERD



Source: OECD (2015), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, http://dx.doi.org/10.1787/sti_scoreboard-2015-en.

The share and absolute amount of private non-profit financing for academic research is also comparatively modest in Norway, for historical, societal and political reasons (see Box 3.1).

Box 3.1. **Philanthropic funding in Norway**

Due to the historic development of wealth in Norway, only a few private philanthropic sources fund research. This can be explained by the fact the country became independent relatively late, by its industrial structure, by the creation of the welfare state and the political decision to maintain power over societal allocations in the hands of the government. “Other national sources”, including private foundations, are scarce, accounting for 1.6% of GERD in Norway. This is comparable to Austria, Finland and Switzerland, for which the figures fall between 1% and 2% (OECD, 2016a). In Sweden, this sector (“other national sources”, i.e. mainly private non-profit) contributes 4.1% to GERD; in Denmark 4.3% and in the Netherlands 3.4%. Norway lacks large private sources of funding and has no Wallenberg Foundation (Sweden) or Novo Nordisk Foundation (Denmark) in place. This contrasts with the inception of Norwegian HE policy, given that the University of Oslo, for example, was set up on the basis of private donations. Thousands of private foundations in Norway today are devoted to different social causes, but even the largest are small by international standards. Sweden’s Wallenberg Foundation alone distributed more than the 50 largest foundations in Norway, according to a EUFORI study (Sivesind and Arnesen, 2015). Some foundations, however, do contribute to research and innovation, e.g. the Mohn foundation (Bergen Research Foundation) and other mid-sized philanthropic groups, as well as donor-based health funders like the Norwegian Cancer Society. The government supplements private donations of at least NOK 3 million (EUR 370 000) given to “long-term, basic research” at higher education institutions, or the Research Council of Norway, which accounts for 25% of the amount donated (Sivesind and Arnesen, 2015).

Sources: OECD (2016a), *Main Science and Technology Indicators, Volume 2016 Issue 1*, http://dx.doi.org/10.1787/msti-v2016-1-en.; Sivesind, K.-H. and D. Arnesen (2015), EUFORI Study: *European Foundations for Research and Innovation, Norway Country Report*.

In a recent comparison of European HE systems (EUA, 2015), Norway ranks as one that has enjoyed nominal and real budget growth between 2008 and 2014. In terms of real growth, only Germany and Sweden report increases as high as the Norwegian system, which grew in real terms by approximately 25% (EUA, 2015). Germany and Norway also experienced a rapid increase in the student population over this period.

Strong Norwegian universities have a financial base comparable to their foreign counterparts'. A seven-country overview of well-known comprehensive and technical universities shows that Norway's top HE actors are at no real comparative disadvantage (Table 3.4).[8]

Table 3.4. **Selected university budgets, 2015**

Country	University	Overall budget (EUR)	Students	EUR/student
Norway	University of Oslo	834 810 750	27 886	29 937
	NTNU	845 941 560	39 000	21 691
Austria	University of Vienna	544 386 000	94 000	5 791
	TU Vienna	347 360 217	29 919	11 610
Denmark	Univ. of Copenhagen	1 142 567 365	40 486	28 221
	TU Denmark	664 593 933	10 631	62 515
Finland	University of Helsinki	750 000 000	34 833	21 531
	Aalto University	384 000 000	12 326	31 154
Netherlands	Leiden University	588 000 000	25 800	22 791
	TU Delft	931 800 000	22 188	41 996
Sweden	Uppsala University	688 000 000	43 907	15 669
	KTH Stockholm	477 247 922	12 424	38 413
Switzerland	University of Zurich	1 273 505 000	25 358	50 221
	ETH Zurich	1 572 249 000	19 233	81 747

Sources: Websites of the individual universities; overall budget is the overall income, students include PhD students (author's calculations).

Research performance of higher education institutions

Norway's output of scientific papers is high and has grown rapidly in the past decade. Although it ranks among the countries with the highest scientific performance, it falls below the top-performing countries. These are nevertheless Norway's "natural" benchmarks, given its wealth, as well as its scientific potential.

High scientific productivity can go hand in hand with impressive results in technology transfer. One such example in Europe is the University of Leuven in Flanders/Belgium, which has more European Research Council (ERC) grants than all of Norway and many attractive licence agreements; as well as strong entrepreneurial and research spin-offs including the Interuniversity MicroElectronics Centre (IMEC) research centre (see Box 3.2).

Bibliometric performance

As noted in Chapter 2, scientific output in Norway's research institutions has grown in the past decade. In general terms, for most quantitative (publication outputs) and qualitative (various citation metrics) bibliometric indicators, Norway appears to occupy an elevated, but not top position, often ranking behind such countries as Sweden, Denmark, Netherlands and the United Kingdom.

Box 3.2. **KU Leuven, an example of a successful higher education institute**

Katholieke Universiteit (KU) Leuven is the oldest and largest university in Belgium. The autonomous university was founded in 1425 and has ranked among Europe's most renowned universities ever since. It is also a co-founder of the League of European Research Universities (LERU). KU Leuven is an internationally oriented, research-intensive university, with a strong focus on inter- and multidisciplinarity, both in fundamental and applied research. The university's various faculties and departments are organised into three groups: humanities and social sciences, biomedical sciences and science, engineering and technology. In total, KU Leuven has about 8 000 research and teaching staff. The increasingly international staff (about 20% of whom are not Belgian) educate a total of 57 000 students from about 150 countries.[1] Its overall revenues in 2014 were EUR 933 million.[2]

From the international perspective, KU Leuven can compete with the top universities worldwide. It ranks sixth among European universities, with 60 Horizon 2020 projects, with a total funding volume of EUR 28 million. Its high quality is also underlined by its rank of 40 in the Times Higher Education World University Ranking, making it the highest-ranked university in the Benelux countries. Its researchers have been awarded 92 ERC grants since the start of ERC funding in 2007, more than one-third of all ERC grants in Belgium.

In 1972, the university founded a knowledge technology transfer office, KU Leuven Research & Development (LRD). This has been dedicated to encouraging transfer activities between science and industry, and has resulted in close collaboration with industry ever since, creating more than 90 spin-offs and stimulating regional development by establishing hubs, several network initiatives, science parks and incubators. Between 2005 and 2014, industry contracts, licensing and patents generated nearly EUR 1.4 billion in revenue for the university (Edmondson, 2015). Among the most important outcomes is the Interuniversity MicroElectronics Centre (IMEC), the world-class R&D and innovation hub in nano-electronics and digital technologies, with 3 500 research staff and EUR 500 million in annual turnover.

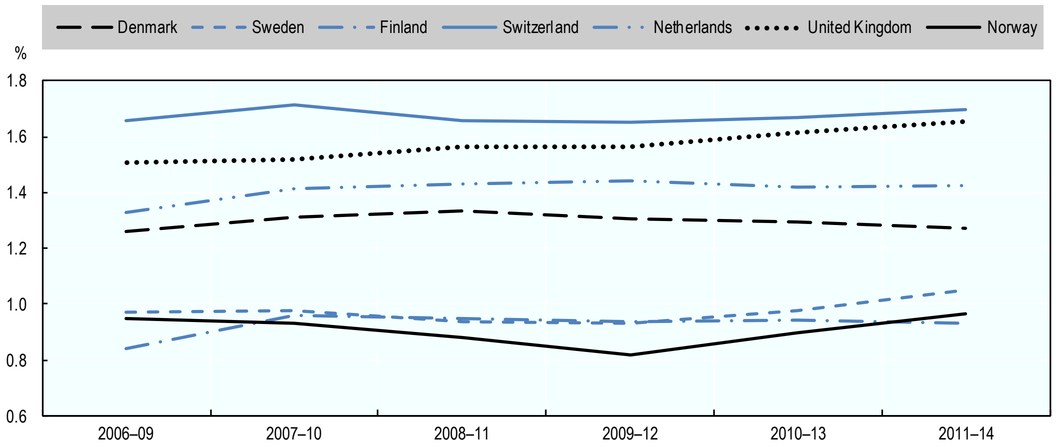
Notes: 1. www.kuleuven.be/about/communicatie/marketing/publicaties/infocus-uk.pdf.
2. www.kuleuven.be/about/communicatie/marketing/publicaties/infocus-uk.pdf, p.6, excluding the revenues of the university hospital. This is about the budget of a large Norwegian university.

Source: KU Leuven webpage, https://www.kuleuven.be/kuleuven.

Analysis of the scientific production of HEIs, which accounted for about 61% of this total scientific production during the period 2003-2012, compared to 11% for PRIs and 21% for the health sector, provides similar results (OECD and SCImago Research Group, 2016). For instance, when considering the share of the top 1% most cited articles from universities over the period 2006-14, countries like Switzerland, Denmark, the Netherlands and the United Kingdom still fare much better, as shown in Figure 3.2.[9] The gap is a little narrower when the top 10% most cited articles are considered, but Norwegian publications in the Top 10% are less often cited than Danish, Swiss, Dutch and also Swedish and Finnish publications (Figure 3.3). The overall relative citation index, however, has shown an upward trend in recent years (MER, 2014a).[10]

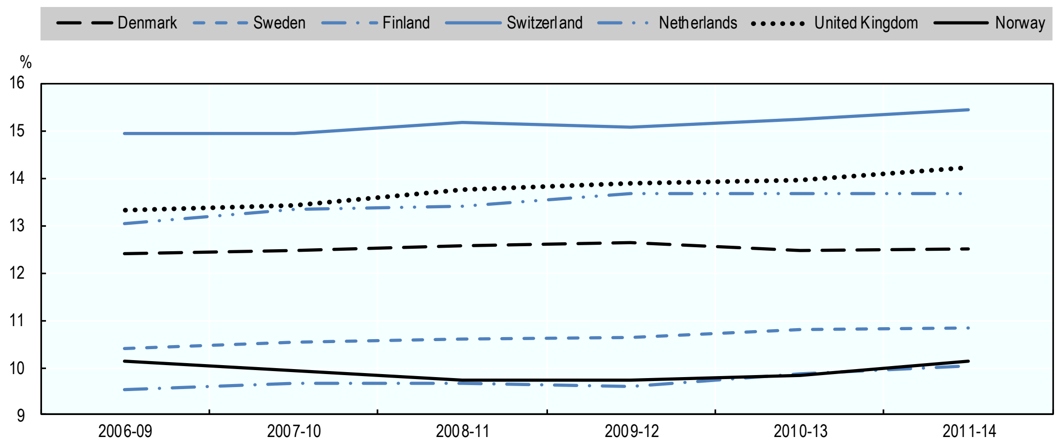
Analyses for each scientific field show similar results, even in life and earth sciences, in which Norway is reputed to have a strong scientific position. Even in Norway's successful engineering-based research and innovation clusters (for example, marine, maritime or oil and gas), only a few research groups are considered to have a world-class position in their field, as revealed in a recent evaluation (RCN, 2015a).

Figure 3.2. **Share of top 1% most frequently cited articles in their respective fields by the top publishing universities, selected countries, 2006-14 (all sciences, fractional count)**



Source: CWTS (2017), CWTS Leiden University, figures for 2016, www.leidenranking.com/downloads (accessed 4 April 2017).

Figure 3.3. **Share of top 10% most frequently cited articles in their respective fields by the top publishing universities, selected countries, 2006-14 (all sciences, fractional count)**



Source: CWTS (2017), CWTS Leiden University, figures for 2016, www.leidenranking.com/downloads (accessed 4 April 2017).

Position of Norwegian universities in university rankings

A comparative study of seven smaller European countries based on a wider set of indicators shows that Norway's university system is not ranked among the top universities.[11] Only one university is ranked between 100 and 200; 4 more make it into the top 500, and 3 are outside the score of the chosen Times Higher Education ranking (> 1 000).[12] This compares unfavourably with the Netherlands, Switzerland and Denmark, most of whose universities are included in the upper tiers of the ranking (see Table 3.5 and Figure 3.4).

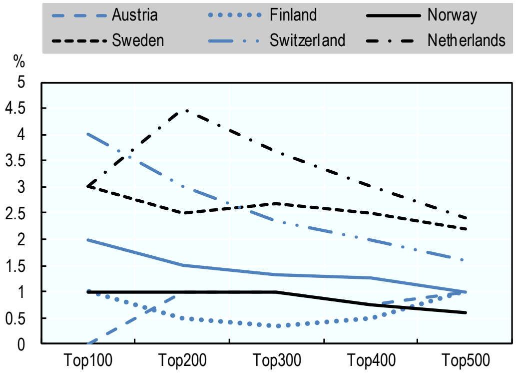
Table 3.5. **University rankings (Times Higher Education), selected countries**

	Top 10	Top 100	Top 200	Top 300	Top 400	Top 500+ and not ranked
Norway			•	••	•	••••
Netherlands		••••••••	•••••			•
Switzerland	•	••	••••	•	••	••
Austria			•	•	••	••••••••••••••••••
Denmark		•	••	•••		•••
Finland		•		•••	••	••••••
Sweden		•••	•••	•••	••	••••

Note: Each point marks a university; a total of 92 universities are included.

Source: THE (2016), Times Higher Education World University Ranking 2016-17 (compiled by the Vienna Science and Technology Fund, or WWTF).

Figure 3.4. **Country share in ARWU ranking of universities, 2016**

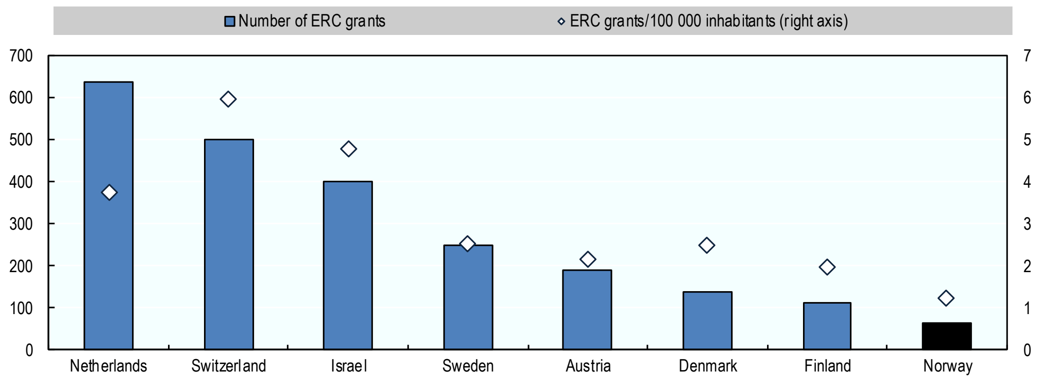


Source: ARWU (2016), Academic Ranking of World Universities 2016, www.shanghairanking.com/ARWU-Statistics-2016.html#2.

Performance of Norwegian universities in European Research Council calls

Within EU funding programmes, the European Research Council (ERC) has marked a dramatic change from co-operative to competitive funding and from multidimensional quality criteria to scientific excellence as the core dimension for evaluation (Nedeva and Wedlin, 2015). Its focus on competition has also made it an instructive quality benchmark system for countries and institutions, making it possible to link it to the structural properties of each system (Edler et al., 2014). From its creation in 2007, the ERC has thus quickly evolved into a much-used indicator for high-quality research across nations, regions and organisations in Europe. Since far more than 70% of ERC grants go to university-based researchers,[13] it is a useful instrument for comparing HEI positioning across Europe.[14]

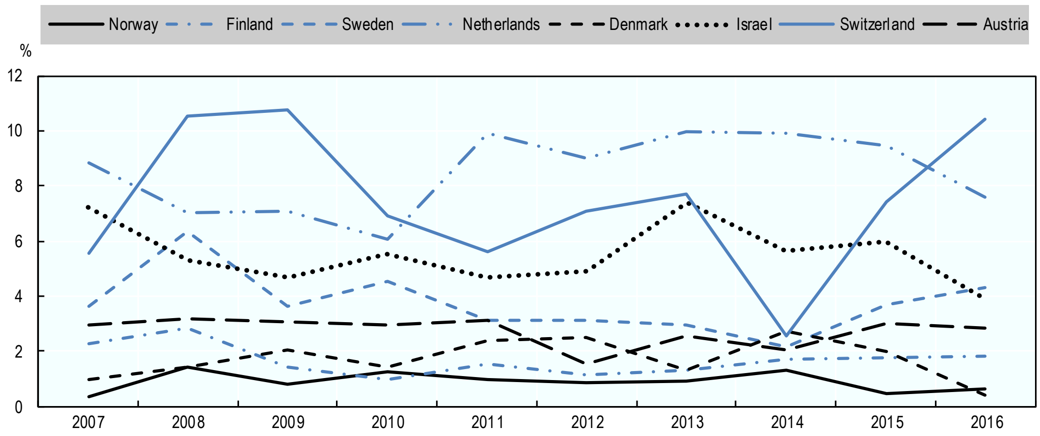
Figure 3.5. **European Research Council grants, absolute and relative numbers per 100 000 inhabitants, selected countries, 2007-16**



Source: ERC (2016), *European Research Council Statistics* (database), https://erc.europa.eu/projects-figures/statistics (accessed 4 April 2017).

In an eight-country comparison (Figure 3.5), Norway, as an Associated Country, has the lowest number of grants, while other countries have achieved strong success rates in ERC calls. This is especially true of the Netherlands and two other Associated Countries, Switzerland and Israel. When normalised per 100 000 inhabitants, these three nations still take the three top positions, but the success of Finland and Denmark as smaller countries becomes more visible. Norway again comes last, see also Figure 3.6. This is coupled with very low success rates.[15]

Figure 3.6. **Share of European Research Council grants, selected countries, 2007-16**



Source: ERC (2016), *European Research Council Statistics* (database), https://erc.europa.eu/projects-figures/statistics (accessed 28 March 2017).

Norway accounts for a lower share of all ERC grants per year than most of its benchmark countries over the period 2007-2016. The relative success rate of Norway in the ERC is way below the average of all participating countries. Norwegian research organisations thus appear to have structural problems in producing and hosting enough researchers who are awarded an ERC grant.

Degree of internationalisation in Norwegian higher education institutions

Among the primary sources for motivation towards international co-operation in research or researcher mobility, both in Norway and internationally, are personal preferences, local factors, diversity of institutional settings and general economic conditions (MER, 2014c). In general, it can be expected that foreign-born researchers improve the quality of research within a country. They bring cultural capital as well as expertise that has been developed abroad (MER, 2014c).

Norway is increasingly attracting foreign researchers. From 2007 to 2012, the number of researchers with foreign citizenship increased by 50% (while Norway's population grew by 6%), raising the share of non-Norwegians in the HE and research institute sector from 15% to 20% (MER, 2014d). The number of incoming researchers is thus higher than the number of outgoing researchers. The Netherlands, Sweden, Denmark and Belgium in particular have a much higher number of researchers who come to Norway than the reverse (MER, 2014d).

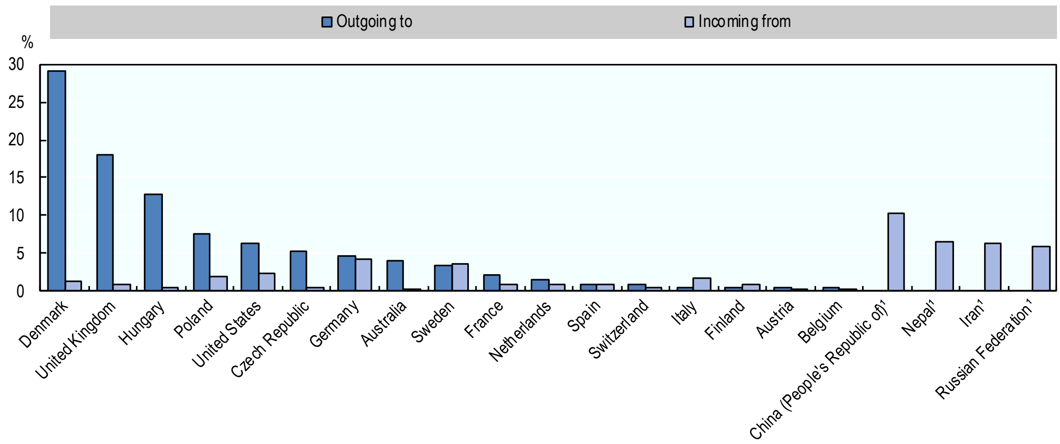
Researchers come to Norway from all over the world, but some patterns are worth noting. Those from Asia have the lowest average age (33 years) and the shortest average period of residency (4 years). Nationals from other European countries are an average of

38 years old, with an average period of residency of 7 years. Researchers from North America and other Nordic countries are on average older than 45 and have lived in Norway for 12 years or longer (MER, 2014c).

Norway's increased appeal as a research location may also reflect the growing number of PhDs and postdoctoral students globally (Stephan, 2012), and the challenges HE organisations and labour markets face in absorbing them.

The mobility of students at the master's and doctoral level is also an indicator of the attractiveness of the Norwegian university system. Of Norwegian citizens studying abroad, 29.2% are enrolled in master's and doctoral or equivalent programmes in Denmark, 18.1% in the United Kingdom and 12.7% in Hungary (Figure 3.7). High percentages of incoming master's or doctoral students originate from the People's Republic of China (10.3%), followed by Nepal (6.5%) and Iran (6.4%), (see also Gjengedal, 2014).

Figure 3.7. **Distribution of international and foreign students in master's and doctoral or equivalent programmes, by country of origin, 2014**



Note: 1. No data is available for the number of outgoing Norwegian students.

Source: OECD (2016f), *Education at a Glance 2016: OECD Indicators*, http://dx.doi.org/10.1787/eag-2016-en; author's calculations.

In Norway, 43% of postdoctoral researchers report having worked in higher education institutes in other countries for a period of more than three months at least once during their post-PhD career. This number is above the EU27 average (31%), and even slightly higher than the corresponding figures for Finland (42%) and Sweden (40%). However, the figure is much lower than for Switzerland and Denmark, both at 53% (MER, 2014c).

A growing number of PhD students come from abroad, another sign of the appeal both of Norway as a workplace and of Norwegian HEIs as research locations. The percentage of non-Norwegians working on their PhDs in Norway has been rising steeply, starting in the early 1990s. In 1990, the percentage was around 10%, growing to approximately 25% in 2005 and to more than 35% in 2015. Although the motivations of PhD candidates are often hard to identify in the absence of a dedicated survey, it is clear that Norway occupies a privileged position, at least partly because it offers generous employment contracts. However, taking into account the high level of R&D investment per student, Norway has a smaller share of international doctoral students than might be predicted by the linear relationship derived from observations for OECD and partner countries between R&D investment and the number of foreign students (OECD, 2016f).

While few students come in from other Nordic countries, many Asians and western/southern Europeans are working on their PhDs in Norway. In the natural sciences and in technology/engineering respectively, 48% and 63% of PhD students are non-Norwegian, and the respective percentages of the total number of researchers are 37% and 30%. Postdoctoral positions include an even higher share of non-Norwegians than PhD students, a figure that rose from 40% in 2007 to 48% in 2012. By contrast, the share of non-Norwegians among those with advanced careers (established researchers and professors) has grown more slowly (at less than 1% annually) (Sarpebakken, 2016; MER, 2014c).[16]

The majority of foreign PhD students or postdoctoral researchers arrived in Norway relatively soon before their recruitment, over 50% of them within the previous three years. The share of established researchers and professors who came within this period of time was much lower, only 16% and 8% respectively (MER, 2014c).

Education performance

More than 250 000 students were enrolled in HEIs in Norway in 2015, and more than 45 000 students graduated from universities and colleges in Norway, 61% of whom were female. Of Norway's population in the age group 25-64, 42% have tertiary education, compared to the OECD average of 33%. One in three people between the ages of 19 and 24 years was a student in 2015. This number has greatly increased in recent decades. In 1985, only one of every eight people in this age group was a student. With 43% of the population of age 25-64 with tertiary education, Norway is well above the OECD average but remains behind the levels of countries like Canada, the Russian Federation, Japan and Israel, and on a par with Finland (OECD, 2016f).

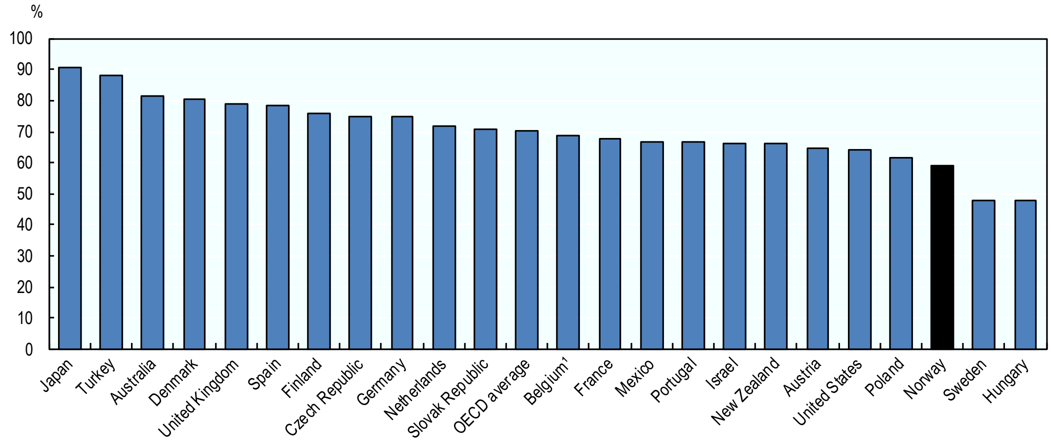
The percentage of students of between 19 and 24-years-old was 52% in 2015. The respective percentage for the group between 25 and 29 years of age was 20%; the percentage of students who were older than 30 was 25%, with a gradual trend towards a lowering of the age (Statistics Norway, 2016).

Norwegian HEIs are subject to a nationally co-ordinated admissions policy, based on a ranking within quotas. Half of all study places are distributed under the quota for students studying for their first diploma. Applicants meeting the requirements for admission in the quota for first-diploma applicants without being offered a place go on to compete in the ordinary quota. The ranking is based on their own priorities and competition points. The so-called "school points" are the main component of the competition points and depend on applicants' performance at school and which courses they attended. In the "first diploma quota", applicants only compete with the "school points". In the "ordinary quota", additional points for age and preliminary specialisations or completion of military or civil service are added (MER, 2007).

The HE system in Norway is described as being rather expensive, with public expenditures well above OECD average. One reason for this is the absence of tuition fees in the system, while stipends and grants for students are generous (OECD, 2016c). Another reason may be the relatively low student-to-teacher ratio, especially in the smaller HEIs. Also, the value of the Norwegian krone and the high wages play a role here. However, students' satisfaction levels with teachers' feedback and individual counselling are low (OECD, 2016c).

Among the other significant challenges of Norway's HE system are the long duration of studies, the high number of dropouts and the strong preferences for a limited number of disciplines, mainly the social sciences. In international comparative studies, completion rates in Norway are relatively low (below the OECD average, see Figure 3.8) and the time taken for completion relatively long. Only 48% of students taking bachelor degrees and 45% of master's students complete their studies within the planned three-year and five-year cycles (Statistics Norway, 2016). Many students stop after a bachelor degree, and the percentage of MSc graduates is slightly lower than the OECD average. The percentage of students who drop out if they have not completed their studies in five years is also relatively high, about 60%. The percentage of students who complete their studies within the expected period has, however, been increasing lately (OECD, 2016c).

Figure 3.8. **Completion rates in tertiary education, 2011**



Notes: Completion rates in tertiary-type A education, which represent the proportion of those who enter a tertiary-type A programme and who go on to graduate from at least a first tertiary-type A programme.

1. Figures for Belgium are for the Flemish Community.

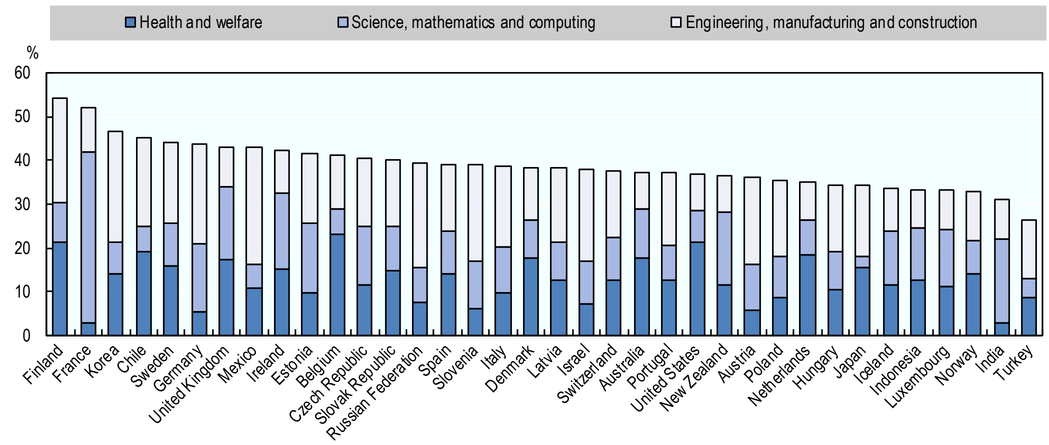
Source: OECD (2013), "Completion rates in tertiary education" Table A4.1, http://dx.doi.org/10.1787/eag-2013-table27-en.

Several factors contribute to the situation of late completions or dropouts. Insufficient academic preparation before enrolment and inadequate career guidance are two reasons. A principal cause may be the "low cost of trying and failing tertiary education" (OECD, 2016c), resulting in a flexible system. More than 10% of Norwegian students interrupt their studies for more than a year. The flexibility of the system also allows for changes in the choice of study. Another reason for dropouts or delays in completion may be the robust job market and the respective job commitments of students (Hovdhaugen, 2012). While this flexibility represents an opportunity for students, it raises the question of whether human and financial resources are efficiently used in the tertiary education sector. The Productivity Commission harshly criticises the low rates of study completion in Norway (NOU, 2016) and has made proposals to tighten up the tertiary education system in this respect.

The long average duration of individual studies also applies at the PhD level. The average completion age, of over 35 years in 2015, is remarkably high, another indicator that has provoked debate about research excellence. PhD graduations have risen steeply in the 1990s and 2000s, mainly thanks to the rise in female participation, with a consolidation in recent years. In 2015, a total of 1 436 doctoral degrees were awarded (Sarpebakken, 2016). At the doctoral degree level, the social sciences and humanities account for the greatest number of PhDs granted (469 in 2015), followed by medical and health sciences (431) and natural sciences (318). Technology sciences only accounted for 170 PhDs in 2015. This number stands in stark contrast to the significant shares of the Norwegian GDP accounted for by technologically intensive industries. In the 1980s, the highest number of doctoral degrees had been awarded in the medical and health sciences, followed by technology sciences and natural sciences (Sarpebakken, 2016).

A comparison of the numbers of PhD degrees awarded and the total number of students in tertiary education in Norway by field reveals that certain subjects, for example social sciences, law and business administration are extremely popular, and that mathematics, the natural sciences and computer sciences appear less so. Of students in Norway, 41% are pursuing a programme in the field of social sciences and the humanities, law or business administration, and 20% are studying in the field of health sciences and sports. Only 18% are studying the natural and technical sciences and 4% in the area of transport, communications, safety, security and other services (Statistics Norway, 2016). The number of new entrants to tertiary education in engineering and natural sciences is also rather low by international standards (see Figure 3.9).

Figure 3.9. **Percentage of entrants to tertiary education in engineering, science and health, 2014 or latest year available, as a percentage of total new entrants**



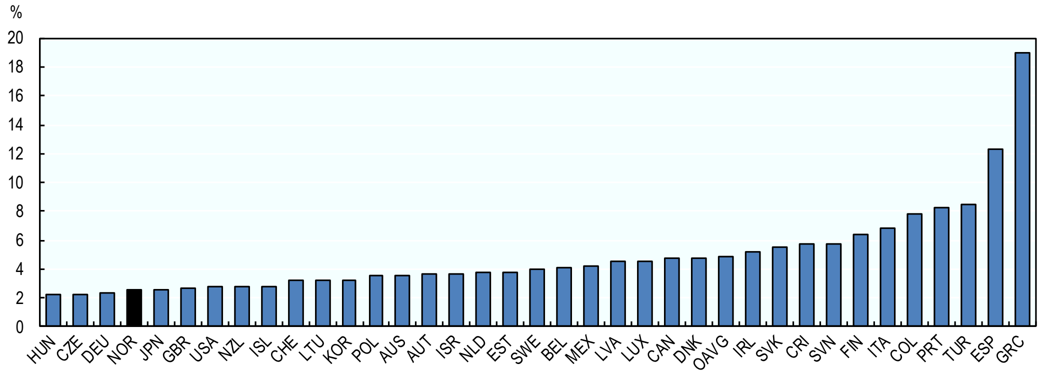
Source: OECD (2016f), *Education at a Glance 2016: OECD Indicators*, http://dx.doi.org/10.1787/eag-2016-en.

The consequences of students' preferences for the supply of the future labour market supply and demand are subject of much discussion. Some people consider that the overall supply of tertiary level graduates in Norway is by and large in line with labour market demands, but others note supply shortages, especially in the science, technology, engineering and mathematics (STEM) field, in which Norway's enrolment share is still below the OECD average (OECD, 2016c). The quality of tertiary education and its consequences for the employability of students is also called into question by the results of the Survey of Adult Skills, conducted in the framework of the OECD Programme for the International Assessment of Adult Competencies (PIAAC). Around 10% of 20- to 34-year-old tertiary graduates in Norway attain only low levels of literacy (Level 2 or below), which is a comparably low number in international comparison (OECD, 2014c).

The low rate of unemployment of people with tertiary raises a question regarding the match between tertiary degrees and the needs of the economy (Figure 3.10). While this indicates the effectiveness of lower educational degrees,[17] it shows that there is no systemic problem in the preparation of tertiary students for the labour market.

Figure 3.10. **Unemployment rates of population with tertiary education, 2015**

Percentage of population of aged 25-64



Note: OAVG: OECD Average.

Source: OECD (2017), "Unemployment rates by education level (indicator)", http://dx.doi.org/10.1787/6183d527-en (accessed 12 April 2017).

As regards how tertiary education prepares students for research careers, the results of the national student survey reveal that the two areas of learning that receive the lowest satisfaction score are the experience with research and development work and the "knowledge of scientific work methods and research" (OECD, 2016c).

A white paper on HE teaching quality is currently being discussed in the Storting. It contains a number of measures to improve the quality level, with more competitive funding elements and incentives for teaching, building on university autonomy and supporting initiatives of HEIs.

Structural changes in the higher education sector

Mergers and consolidation of higher education institutions

Traditionally, university colleges (UCs) have developed out of local upper-secondary specialised schools, and their main mission has been to offer educational programmes relevant to the regional context. In the post-war era and in the decades of HE expansion, their numbers grew rapidly, followed by successive periods of mergers and consolidation. In this period, a binary system of universities and UCs developed. As a result of this process, some UCs are currently among the largest Norwegian HEIs, each with more than 15 000 students.

University mergers are a common trend in Europe, in part due to concerns about efficiency and effectiveness, in part also to create critical mass, quality, higher visibility and to secure better positioning in international university rankings. Some processes are also driven by geographical motives. Mergers came in various forms (Bennetot Pruvot et al., 2015).

In Norway, most mergers have happened among UCs or between universities and UCs:

- Mergers among UCs, as in the case of mergers of regional colleges in 1994. This wave of consolidation reduced the nearly 100 regional colleges to roughly 25 state UCs. A recent series of mergers in 2016 and 2017 further reduced the number of UCs. These mergers can also involve public research institutes (PRIs), as in the case of the large Oslo and Akershus UC, which is the result of a merger of two UCs, plus the integration of social science public research organisations (PROs) (Mathisen and Pinheiro, 2016).
- Recent examples of mergers between universities and UCs, with the former in the driving seat, include the University of Tromsø – the Arctic University of Norway, which integrated a number of UCs (Arbo and Bull, 2016). The Norwegian University of Science and Technology (NTNU) in Trondheim also merged with a number of neighbouring and dislocated UCs.
- Mergers between universities include NTNU, which was the result of a merger between University of Trondheim, the Norwegian Institute of Technology and four other organisations in 1996 (Kyvik and Stensaker, 2016). Another example is the Norwegian University of Life Sciences (NMBU), resulting from a merger between two smaller universities.

Mergers in Norway have come in waves, and unlike in Denmark, not as the result of a single HE consolidation process (Aagaard et al., 2016).[18] In recent decades, the government has played a strong role in incentivising such mergers, e.g. through legal provisions for minimum HEI size. However, most mergers were (semi-) voluntary and took a long time to set up, after a process mixing bureaucratic and market logic involving rejections and strategic games (Kyvik and Stensaker, 2016).

Recently, a big wave of mergers has been taking place, based on the Ministry of Education and Research white paper (MER, 2014b) and a series of dialogues between the ministry and the HE sector. While the government played an important role in initiating these mergers, it was carried out by increasing the difficulty of the accreditation process, rather than by coercion (Elken et al., 2016). A number of incentives have also been instituted, including extra funding for mergers, and steps to include PRIs in these initiatives (Bennetot Pruvot et al., 2015; Kyvik and Stensaker, 2016). As a result of this incremental, negotiation-based approach, the number of public HEIs fell to 21 (from 33) in 2017. This process also suggests that the step-wise, negotiation-based approach of Norway's STI policy can be quite effective.

However, a by-product of this process has been a loss in the diversity of the profiles of HEIs. Starting in the 1990s, the Norwegian government progressively removed structural differences between universities and UCs. Both are subject to the same University Act and financial allocation process. UCs now can perform research and, since 1999, have been able to award doctoral degrees (Kyvik and Stensaker, 2016). This convergence was also a result of the UCs' ambitions to become full universities. Some merged among themselves or with an existing university (Kyvik and Stensaker, 2016, Elken et al., 2016). This led to the claim that as early as the mid-1990s, Norway's higher education system was "no longer a binary system" (Arbo and Bull, 2016). This common legal framework may have encouraged ambitious UCs to become universities or to merge with one, either by a merger of various colleges or by becoming part of an existing university. This has put the binary system under pressure from UCs with strong university ambitions (Kyvik and Stensaker, 2016, Elken et al., 2016). A number of countries have maintained such a binary system by nurturing a small number of excellent universities and/or by strengthening a number of regionally anchored, applied UCs (see conclusions).[19]

Improving strategic management within universities

The 2005 University Act and other regulations give Norwegian HEIs a high degree of autonomy. This allows them to decide on their internal organisation and on the distribution of the combined block funds for research and education. The Act mainly provides for a lean procedural and quality framework, with the Norwegian Agency for Quality Assurance in Education (NOKUT) as the responsible agency for quality assurance, including accreditation and evaluation. A structuring element is its staff members’ status as civil servants and the strong role of unions. HEIs have the authority to determine individual salary levels (Estermann and Nokkala, 2009). Academic autonomy has been ranked by the European University Association (Estermann et al., 2011): Overall, Norway is rated in a “medium high” group for organisational and staffing autonomy. Financial autonomy is rated “medium low”, chiefly given the absence of tuition fees.

The university board is the central collective decision-making body of each of Norway’s HEIs. It is responsible for the students’ learning environment, for appointments to academic and managerial posts, for maintaining a high standard of academic activity and for supervising management. It is also responsible for all major financial matters, including providing financial statements, for the budget for the following year and for the organisation’s strategy and internal structure. The board has a mixed composition, typically including 11 members, including academic staff, employee representatives, students and a number of external members.

The rector, as the chief executive, may either be elected (by faculty, staff and students) or selected and appointed by the board itself. If elected, the rector is the chairman of the board; if appointed, MER can nominate an external board member as chairman. This structure has been in place since the mid-2000s. Traditionally, Norwegian HEIs have elected their rectors, and the potential leadership styles range from a CEO model to *primus inter pares* (see also Estermann and Nokkala, 2009). In future, the model with an appointed rector and an external board chair will become the default option[20] (if the board does not decide otherwise), and all external board members are to be appointed by the ministry MER, 2016), in an attempt to strengthen leadership. The impact of these changes has not yet become fully apparent (Elken et al., 2016). However, some universities, like Tromsø or the NTNU in Trondheim (see Box 3.3), have certain funds as a central budget, to introduce internal strategic funding schemes and mechanisms to create critical mass.

In recent years, a number of steps have been taken to position some of the strongest Norwegian universities as providers of world-class research and teaching. However, some critical issues are still preventing Norway’s universities from realising their full potential. In particular, strategic actorship, bureaucratisation, lack of *ex ante* financial incentives and *ex post* bold “reallocation” actions, as well as the creation of critical mass, still appear to be underdeveloped, at least in a number of HEIs. These limitations have been the subject of criticism in several recent official reports and research papers (see Box 3.4).

Box 3.3. **Internal priority setting at the NTNU**

In the internal budget allocation model of the Norwegian University of Science and Technology (NTNU), its board withholds 15% of the block grant from the government for strategic purposes. Examples of how the strategic funds are being used include:

- The Onsager Fellowship Program to attract research talent from abroad (using the tenure track mechanism), the International Chairs Scheme to recruit professors from abroad and the Outstanding Academic Fellow programme to qualify NTNU's own young research talents for internationally leading researcher careers.
- Financial support for world-class research groups (for instance the Kavli Institute for Systems Neuroscience/Centre for Neural Computation which won the Nobel Prize in 2014).
- Building strategically important research labs, like the NTNU Nanolab, an investment of NOK 250 million.
- Developing a programme for excellence in teaching and education, strategically supporting a range of initiatives designed to strengthen teaching skills by developing innovative teaching, learning and assessment practices.

Source: NTNU official website, https://www.ntnu.edu.

Box 3.4. **The limits of strategic leadership in Norwegian universities in relevant reviews**

- Öquist and Benner argue that the research system within HEIs "seems to be composed of a relatively small number of 'flagships' amidst relatively weak environments", but where "the 'minimum level' has been raised" (Öquist and Benner, 2016). University leaderships could devote more focus to developing strong research environments through internal priority setting and reallocation. Instead, the universities, their leaders and policy makers rely on additional external impulses through RCN programmes to initiate change.[1] Centres of excellence (CoEs, or Sentre for fremragende forskning, SFF) and other RCN centres, however, are apparently useful instruments for creating specialisation on a larger scale (OECD, 2014a).
- Instead of creating strong environments and encouraging horizontal co-operation, the resources of the universities, with their ample block funding, seem to be "more or less fixed, with deans, department heads and rectors responding incrementally to the financial blockages" (Öquist and Benner, 2014). This is seen as even more critical, given the large numbers of relatively small research groups.
- The Engineering Science evaluation (RCN, 2015a) found "universities and university colleges had a relaxed attitude at the department level towards leadership and long-term planning. … Research is performed more on the basis of opportunities and personal expertise/interest rather than on a convincing strategy."
- The Productivity Commission found that governance in the HE sector "has not adequately promoted quality improvement, while it has resulted in more bureaucratisation". Government incentives have increased competition, but according to the commission, HEIs are not able or willing to translate this into internal planning and allocation mechanisms, given the absence of "mechanisms in place to ensure that study programmes with few applicants or weak research establishments are closed down. Nor would it appear that the governing bodies of educational institutions themselves are making use of the room for manoeuvre offered to them. … Public governance needs to be more focused on quality." (NOU, 2016).

Teaching appears to take precedence over research, particularly since the Bologna educational reforms, and despite government efforts to boost research within the universities: "It appears as if a majority of tenured staff emphasises education at the expense of competitive research aiming for ground-breaking results" (Öquist and Benner, 2014). If this holds true, the length of individual studies is a matter of concern, given that an average PhD across disciplines takes 9.5 years to complete (Sarpebakken, 2016).

Note: 1. A similar pattern can also be observed in Sweden (OECD, 2016b).

Recruitment in Norwegian universities

Recruitment of top university staff is one of the most powerful tools in HE management and performance. For the employers' part, it is important to attract academic talent to allow for a positive dynamics.[21] On the other hand, there is strong global competition for the highly mobile top candidates among the vast number of postdocs and young candidates for professorial posts. Many countries and HEIs successfully attract researchers by offering them a tenure track, with early independence, a starting package and the opportunity for a long-term career leading to full professorship after successfully passing a series of stringent evaluations.

In Norway, recruitment and career development structures have been improved, and much is being staked on the introduction of a new tenure track system. However, changes in recruitment policies have been only incremental over the last years.

Recruitment is still often described as "routine" and determined primarily by education-related considerations. In several Norwegian universities, disturbingly, recruitment issues do not yet rank high on university agendas (Öquist and Benner, 2014). A key evaluation study (RCN, 2015b) identified recruitment of academic staff as a major bottleneck. These limitations are related to the lack of strategic leadership and long-term strategic planning. The large number of small research environments is also detrimental in this context.

Although a tenure track system can be introduced in Norwegian HEIs, the old recruitment system often prevails, with in-house careers and non-strategic, overly decentralised procedures. Postings for professor positions are published internationally, and promotions are merit-based and peer-reviewed. However, the entry points are less attractive for top talent and less visible than they could be. This is exacerbated by the relatively low number of permanent positions in Norway's HE sector. Paradoxically, this coincides with the right to obtain a permanent position after a certain number of years, which again leads the HEIs mainly to offer fixed-term positions to young researchers. This results in a dilemma, since talented young people are not offered satisfying career opportunities (see also OECD, 2014a) and HEIs may recruit candidates with weaker profiles. Strong public sector status, labour legislation and the influence of unions form strong, and not always favourable, framework conditions in this context, and make lengthy negotiations necessary to fully roll out a tenure track.

The average age in Norway at which academics become a full professor is also quite high. It is often the result of being there long enough, as the preceding career steps often lack a clear quality-based track. Although many top-class recruitments are made both from abroad and within Norway, there is still a tradition of getting a permanent position after years of staying at the same university without proper evaluation, with incumbents building their own small research fiefdoms.

Experience shows that the rollout of a tenure track system can avoid the distortions of such a setting and allow for active, competitive recruitment of younger talent, mostly from outside. Such a system also has the effect of lowering the average age at which the rank of full professor is reached.

Strategies and policies to support research excellence in higher education

Steering and funding the higher education sector

The Norwegian HE sector has instituted many steering and performance-based mechanisms (Box 3.5). This puts mild pressure on HEIs, staff and students in various dimensions in order to support excellence. Another strategy to support excellence was described above: top-rank recruitment and career schemes attracting the best talent.

The Norwegian university funding model

Box 3.5. A synthesis of the main features of the Norwegian university funding model

The system for steering and funding Norwegian universities has several distinct characteristics:

- A single funding system for universities and university colleges regulates both sub-sectors under the same law. This Higher Education Act provides general rules in a lean and efficient way and includes also the Norwegian higher education quality and accreditation policy, including the Norwegian Agency for Quality Assurance in Education (NOKUT).
- Research and education funding come in a single stream, which increases room for the individual higher education institutions (HEIs) for internal allocations.
- There are no tuition fees, and financial support for students is comparatively generous.
- Access to higher education is managed by a national student allocation system according to their stated preferences and the capacity of the HEIs.
- The share of block funding is comparatively high in Norway (64% of total funding).
- Block grants include a performance-based funding component (representing 30% of total block funding), with a stronger teaching component consisting of four indicators, and a less prominent research component, also with four underlying indicators.
- Performance agreements (PAs) are being introduced step-wise in the HE system, starting in 2017, with five HEIs and gradually expanding. PAs will help to sharpen individual HEI profiles.

Overall block funding for HEIs includes teaching, as block funds come in one stream for research and teaching, unlike in Sweden or the United Kingdom, for example. No other institutional funding source for universities is in place. In Denmark and Norway, the share of public financial contributions to universities, including competitive funding, are highest in a multi-country comparison across Europe, with approximately 90% of overall HE income each (Bennetot Pruvot et al., 2015).

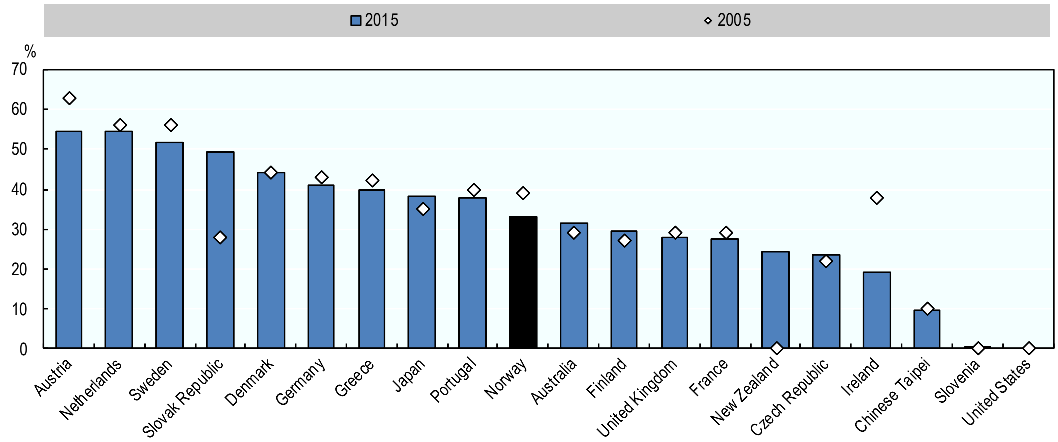
Block funding for R&D comes from MER, accounting for 64% of Norwegian higher education R&D funding in 2013 (Solberg, 2016), a comparatively high share. The rest consists of RCN schemes (17%), other public sources (8%), industry (5%), international (3%) and other private sources (3%). The block funding for teaching comes from MER. As there are no tuition fees in Norway, nearly all the funds for teaching come from public sources.

In advanced countries, HE financing systems for teaching and research vary based mainly on the balance between competitive and non-competitive funding. In OECD countries, a broad variety of methods are used, ranging from very low levels of block funding in a few countries (like the United States and Slovenia) to over 50% of government budget appropriations or outlays for R&D (GBAORD) in Austria, the Netherlands and Sweden.[22]

No clear international trend has emerged in the past decade regarding the evolution of this balance, and the share of block funding and non-competitive funding still represents a significant percentage of the total funds for research received by universities – between 30% and 50% in most advanced countries. Norway, with a share of general university funds of 33% of GBAORD in 2015 (39% in 2005), occupies an intermediate position.

Figure 3.11. **R&D financed from general university funds, select OECD countries**

As a % of government budget appropriations or outlays for R&D (GBAORD)



Sources: OECD (2016e), *Government budget appropriations or outlays for R&D* (database), https://stats.oecd.org/Index.aspx?DataSetCode=GBAORD_NABS2007.

Allocation of block funding in Norway

The Norwegian HE funding and steering approach is specific, but so is each national HE system, due to different combinations of instruments and their individual weight. No golden ratio obtains, and efforts to discover the "right mix" are not straightforward (for differences and changing patterns compare, for example, Whitley and Gläser, 2014; Paradeise et al., 2009). A 2010 study of the subject concluded that more competitive systems are no more efficient than those with higher and less conditional block funding (Auranen and Nieminen, 2010). In an eight-country comparison, Norway, with Finland and the Netherlands, represent a middle group: less competition-driven than the United Kingdom or Australia, but with more output-orientation than Sweden, Denmark and Germany.[23] The study offers evidence that less competitive systems can also be very efficient, measured on a HERD per publication scale. Norway, however, is described as not overly efficient.

The different mechanisms for issuing block grants are shown in Box 3.6, with different mixes between historically set and performance-based shares; as well as different forms of performance-based funding and steering elements.

Before 2002, the block funding was exclusively input-oriented, based on historical levels. Since 2002,[24] the overall block grant in Norway has had two components: one is a historical component, accounting for around 70% of the total amount. Since Norway has a state-financed and -owned HE system, HEIs rely on their recurrent income streams and have no large endowments, although they partly own their own premises.[25] About 30% of

HE financing is linked to performance-based funding (PBF) indicators, on an *ex post*, output-oriented approach. There are two sets of performance criteria:

- A dominating "open budget" PBF element incentivising HE teaching, based on which overall funding for the HE system may be increased if the universities or UCs are successful. Four sub-categories apply: the main bulk of PBF funding is measured against reported student performance (completed study credit points). This makes up for 64% of the overall 30% PBF HE block funding share. Another 15% of the overall PBF is tied to graduation rates and 5% to PhD graduates (formerly part of the "fixed-limit budget"), while 1.2% forms an incentive for student exchange. Around 85% of all PBF are in this open category.
- A much smaller "fixed-limit budget" element relates to research activities. Here, the overall amount for the HE system is fixed, with a ceiling, allowing only for reallocations between HEIs. From 2017 onwards, this element has accounted for a little more than 15% of the overall PBF HE block funding. This component now includes four smaller indicators, each between 2.8% and 5%: publication credits, funding from RCN, funding from EU and other public sources and the "BOA" indicator (*bidrags og oppdragfinansiert*, or contract research indicator) for private revenue, including contract research. The impact of these incentives and the "fixed-limit budget" might be limited, at least for research-intensive universities.

Box 3.6. Models for allocating block funding in advanced economies

Many countries still rely on historically fixed block grants, complemented by a more variable component using a funding formula based on input and, increasingly, performance indicators related to education and/or research performance. The indicators used vary considerably across countries.

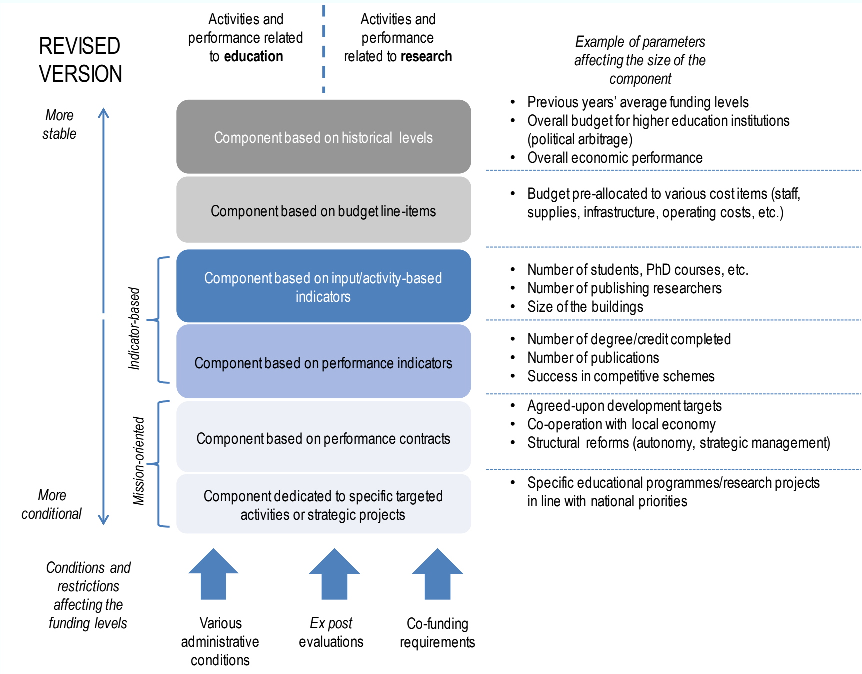
The performance-based component can account for a more or less significant share of the block grant (for comparing the research components, see Hicks, 2012; OECD, 2010) and be used as a primary (as in the United Kingdom) or secondary mechanism (as in Norway or Sweden). Other countries use performance agreements (PAs), either as a main steering instrument covering the whole block-funding appropriation (Austria) or negotiating the surplus for the next period (as in the Swiss federal system or Bavaria in Germany). Some countries use a full-fledged performance indicator system in their PAs (Luxembourg; OECD, 2016d), and others leave HEIs to select the indicators of their choice (Netherlands; OECD, 2014b). For an overview, see De Boer et al. (2015). PAs are always *ex ante* instruments, and they may, but need not necessarily, be coupled to performance indicators. Alternatively, or as a complement to these mechanisms, a system of *ex post* evaluation of universities at department or discipline levels can be used, as in the United Kingdom (see Hicks, 2012; Martin, 2011).

Performance indicators can thus be coupled with other steering and evaluation instruments like PAs or *ex post*-oriented peer reviews, or may also come as stand-alone instruments.

One common approach is to try to find "hybrid" solutions stable enough to provide a solid financial basis, while allowing for some strategic steering. This includes different ways to affect part of the block grant, or a top-up at the defined level for specific targeted activities, in line with national priorities. The Strategic Research Area initiative in Sweden falls into this category (OECD, 2016b).

The scope of the block funding is another important variable differentiating the different systems. The block funding can be comprehensive and cover both education and research activities (Austria, Norway), while other systems are dual, with two different funding streams (Sweden, the United Kingdom).

Figure 3.12. **Possible components in a university block grant**



Sources: Edler, J. et al. (2014); Paradeise, C., E. et al. (2009); Bennetot Pruvot, E, A.-L. Claeys-Kulik and T. Estermann (2015); Hicks, D. (2012); Jongbloed, B. (2009); De Boer, H. et al. (2015); EUA (2015); Martin, B. (2011); OECD (2016b)

The government appointed an expert committee to improve the Norwegian PBF component in HE funding and took on board some of its recommendations in its 2016 budget proposal. The main changes include the new indicator for completed degrees, in order to reduce the length of time students spend on their studies. Greater incentives for success in EU Framework Programmes (FP) and for contract research ("BOA") have also been added. It is still too early to assess the actual effect of these amendments on the funding and, ultimately, activities and performance of universities.

The different approaches to the "teaching" and "research" components are a characteristic feature of the Norwegian HE policy. The two indicator sets vary in size and dynamics, based on the belief that strong incentives are needed to change collective attitudes and patterns in education, and student behaviour in the long term.[26] The latter concept is popular in Norway because of the generous financial conditions for students, including loans and grants covering the cost of living (MER, 2016). The Productivity Commission (NOU, 2016) claimed that the current system has a negative effect on the allocations for different subject fields: In a country with many social sciences and humanities students, the performance-based funding system encourages the creation of many additional small and "cheap" study courses, which is not a good use of resources from the perspective of needs and efficiency.

Like many administrations in OECD countries, MER is also piloting institutional performance agreements (PAs) with a sample of five state-owned HEIs and has plans for a full rollout in 2019 (Elken et al., 2016). These *ex ante*-oriented steering instruments are contracts between the government and individual HEIs concerning specific quality, performance and "mission-based" objectives (for an overview, see De Boer et al., 2015). PAs in Norway shall contribute to the achievement of the two major HE sector goals, 1) excellence; and 2) clearer institutional profiles and better division of labour between the institutions, with individual performance goals for each HEI. PAs are thus potentially a response to concerns regarding the loss of diversity in the HE system alluded to earlier, as long as they are concise, coupled to indicators and action-oriented. The pilot universities are asked to include in their performance contracts a "local development strategy". However, PAs need a clear focus and meaningful indicators to help counteract the prevailing consensus principle and more "middle of the road" HEIs.

MER also uses regular co-ordination and meetings with individual HEIs and the sector, as a way of discussing the situation of HEIs, the agenda for change and the options for the future. These mechanisms are described as trust-building (Elken et al., 2016).

The Research Council of Norway's Centres of Excellence Programme

The Research Council of Norway's (RCN) centres of excellence (CoEs, or in Norwegian, SFF, for Sentre for fremragende forskning) are strong, selective and useful interventions in a university sector relying on equality rather than on hard competition to support research excellence. This ambitious and large RCN programme has created many centres able to leave their mark on university priority setting even after their ten-year running time. In providing multi-year funding to large, neighbouring clusters of researchers, this bottom-up instrument fulfils a crucial need in the Norwegian HE and PRO landscape, as it constitutes one of the very few opportunities for Norwegian research communities to attain real critical mass in more basic research-driven areas.

The programme was first proposed in a government white paper in 1999, based on a pilot scheme, and started in the early 2000s. The main selection criteria are scientific quality and high international standards. In the first round, applicability/social relevance was also a criterion. In 2005, the programme was split into two strands, with the more innovation-oriented Centres for Research-Based Innovation (SFI) scheme (see Chapter 4) as a second, more downstream, scheme (OECD, 2014a).

Box 3.7. **What are centres of excellence?**

Centres of excellence are popular instruments used across OECD countries to create critical mass and excellence within and between individual HEIs and public research institutes. They are usually funded by a research council or a public agency on the basis of competitive programmes with ambitious selection mechanisms. These centres usually obtain a substantial share of their budget from the research council or agency for a multiannual but fixed-term period. The host organisations and sometimes other partners are required to contribute a part of the overall budget, often through physical investment or other in-kind contributions. In most countries, such centres of excellence are not a distinct legal entity but are embedded in the host organisation. However, they often have the autonomy to recruit staff and design their research portfolio (see OECD, 2014a).

RCN has launched a number of funding calls (rounds) to create CoEs with its SFF programme. Currently, 21 centres from rounds two (2007) and three (2012) are operational, and 13 centres from round one (2002) ended in 2012; a fourth selection round has recently been closed.[27] The specialisation pattern of the first 34 centres emerging from the three generations of CoEs reflects the scientific strength of Norway. Geosciences are one asset, given due to the specific Norwegian geographic situation and social sciences and humanities because of the strong research groups existing in Norway in this field. Life sciences also emerge as a strength, while the natural sciences fare less well than in other countries.

Table 3.6. **Annual total funding of Norwegian centres of excellence, by field**

Field	Number of centres of excellence (CoEs) (rounds 1-4)	Total annual funding, million NOK (rounds 1-3)
Geosciences	7	79.3
Engineering	6	64.7
Life sciences/health (broad)	16	169.5
Humanities and social sciences	9	77.9
Natural sciences	6	54.6

Source: OECD (2014a) based on Nordic Institute for Studies in Innovation (NIFU) calculations, all three centres of excellence generations, budget years 2009 and 2013.

CoEs are led and hosted in general by universities and, in some cases, by PRIs. While the research groups forming a CoE are mostly located close together, a few may be multicentre or virtual entities. The average amount of annual RCN funding per centre is considerable, at EUR 1.6 million. The centres further attract, often in substantial amounts, cash and in-kind contributions (for instance in the form of infrastructure), mainly from the host organisation. While CoEs in the social sciences or in the institute sector mostly rely on RCN funding, larger centres, for example in the life sciences, have more partner contributions and staff numbers in three digits. All centres allow for close interaction and critical mass in universities, which often have many smaller stand-alone research groups, given the fact that departments are often small (Öquist and Benner, 2014). A strong correlation has been observed between these centres and top research quality. RCN reports that 60% of the (comparatively few) Norwegian ERC grants are awarded to researchers affiliated with SFF centres.[28]

CoEs organisationally are part of faculties and departments. While this embeddedness is conducive to learning, it also puts pressure on staff, due to the larger size and ambition of the centres and their low level of interaction with other departments, as well as the fixed-term funding of the CoE. Such an organisational setting is quite common in excellence-oriented programmes internationally, but alternative options do exist in other countries (Bennetot Pruvot et al., 2015): for instance, the German *Exzellenzinitiative*, or similar activities in Hungary and Spain, address universities as a whole.

Most CoEs have a board, and all have an academic as well as an administrative leader (OECD, 2014a). While the young researchers work full-time in the centre, more experienced research staff members devote only part of their time to it. Staff is formally employed in the departments, creating some organisational challenges for the CoE and university administration. The centres can recruit in a flexible way and attract talent and top researchers from abroad.

It is not possible to apply for a second consecutive SFF grant, which raises a number of challenges for the integration of "sunset" CoEs into faculty structures. Successful cases contribute to more critical mass and clearer research profiles of faculties. The post-CoE trajectories also differ according to the share of non-SFF funding in the centre.

The SFF evaluation in 2010 (Langfeldt et al., 2010) showed that the scheme has been particularly successful in attracting talent, funding interdisciplinary research and strengthening Norway's efforts towards internationalisation its research. The standards of research have been raised through the programme.

RCN's FRIPRO schemes and the RCN shift towards high-risk funding

RCN is increasingly funding academic, mainly bottom-up research projects through different Norwegian Scheme for Independent Research Projects (FRIPRO) schemes. FRIPRO is the main Norwegian source for scientific bottom-up research. It is divided into three sub-categories, MEDBIO for biomedical research, NATEK for engineering and science and HUMSAM for the humanities and social sciences. HEIs obtain between 80% and 90% of FRIPRO funding (Langfeldt et al., 2012). Funding for independent projects and basic research programmes has grown from NOK 860 million in 2011 to NOK 1 billion in 2015 (MER, 2016). Typical FRIPRO grants are similar to the bottom-up grants for academic research offered by many science-funding research councils across the OECD, including project, mobility and young researcher calls. These Norwegian programmes are all highly competitive, and have even been in this context described even as "elitist" (Langfeldt et al., 2012). Success rates have been falling in the millennium, and currently, around 10% of the applications are funded. This number is alarming, in the light of estimates that only 20% of tenured HE staff is applying for grants at RCN at all (Öquist and Benner, 2014).

The 2012 FRIPRO evaluation concluded that this kind of funding is very important for Norway and has yielded positive results for research quality. It has less impact on structural issues like priority setting or group structures (Langfeldt et al., 2012). FRIPRO projects are "door openers" to other, larger funding opportunities allowing for substantial scientific progress, but they are less useful in supporting interdisciplinary and high-risk research (Langfeldt et al., 2012).

This evaluation contributed to the decision to increase FRIPRO allocations. Growing budgets for bottom-up academic projects can also help achieve Norway's overall LTP goal of developing excellent research communities and raising the relatively low rates of basic research in Norway. In comparison, Danish and Swedish scientists have more and generous funding sources at hand, while the overall budget of the Swiss National Science Foundation is six to seven times higher than RCNs' FRIPRO, plus basic research programme budgets. This is a strong discrepancy, even when SFF and other specific RCN budgets are accounted for. In this context, it is also important to note that academic researchers are successful in most of the RCN funding programmes, including applied research.

In 2015, the Norwegian government and RCN introduced a new scheme, FRIPRO Toppforsk. These much larger grants run for four to five years, offering NOK 15 million to 20 million per project for strong, dynamic scientists and research groups to become international leaders. Toppforsk is embedded in a joint initiative between RCN and the HE sector to raise and concentrate funds on world-class research. The available budget is substantial. In the first round, NOK 1 billion was allocated to 46 such projects. Currently, a second round is under way, providing another NOK 500 million. The HEIs have a say in the final decision as to which of their institutes' highly ranked proposals should be funded. This is an interesting approach that, over the years, could prove instrumental in strengthening HE leadership and building critical mass. It is also an explicit goal of Toppforsk to increase the number of successful Norwegian ERC applicants.[29]

RCN in its current strategy (RCN, 2015c) announced an increase in the open budget lines for research funding and to strengthen investment in long-term, risky and transformative scientific research projects. To achieve this, new support mechanisms and selection procedures are being developed and tested. Five elements in the new procedures are key: 1) an explicit focus on disruptive and cross-disciplinary approaches in the funding criteria; 2) more diversified selection panels; 3) less fine-grained rating scales; 4) a shift away from the consensus principle in decision making; and 5) larger budgets (Warta and Dudenbostel, 2016; RCN, 2016). In contrast to these efforts, the recent RCN Spending Review (MER and MOF, 2017) focuses more on increasing the share of long-term, scientific (and bottom-up) research funding within the RCN portfolio.

Developing excellent research communities in the Long-Term Plan

Achieving excellence is one of the three pillars of the Long-Term Plan (LTP). The plan announces that the government will prioritise special efforts in world-class science (MER, 2014a). Such world-class research is seen as a necessary precondition and seedbed for the future Norwegian knowledge economy.

The LTP clearly acknowledges the gap between Norway and top countries. The objective "is for some institutions to attain a level where they can compete with the best Nordic institutions, and more research groups should be able to assert themselves with the world elite" (MER, 2014a). The LTP also notes: "Norwegian researchers are quoted less frequently. … Quality [of research] varies between disciplines and between institutions. … There are too many academic environments that do not conduct research of acceptable quality. … More research groups should be able to assert themselves with the world elite" (ibid.).

Starting from this assessment, the LTP then stipulates "predictable increase in efforts" (MER, 2014a), mentioning a number of activities, like the RCN SFF programme. More important, three additional funding lines are being introduced, all intended to increase the scientific quality of Norwegian research. These include the STIM-EU co-funding scheme, 500 additional positions for young researchers and investments in infrastructure (MER, 2014a) and further promises of resources for two larger scale research buildings. Much of the resources for these additional initiatives will be funded by the RCN.

More generally, the LTP includes plans to further increase and develop high-quality measures and environments. One rationale for this, as set out in the Plan, is that a small country cannot do everything in science and research, but that a "defensive" attitude would also harm the Norwegian economy and society (MER, 2014a). The LTP emphasises the need to increase the number of top-level scientists and environments to raise their level of ambition and to "take the quality commitment a step further" (MER, 2014a). Regarding recruitment and governance, the LTP aims to support HEI governance development.

The Norwegian government emphasised that an important next step after the introduction of the LTP is to further refine quality-promoting instruments already in place and to design instruments "towards cultivating high aspirations". The funding of top-level research is to be prioritised.[30] In addition, the next LTP 2018 is also to include an investment plan for buildings and infrastructure, on the grounds that world-class infrastructure is a prerequisite for excellent research.

In line with the LTP, RCN is trying to improve its processes and review mechanisms in a number of programmes, to increase the probability that unconventional, risky, often cross-disciplinary breakthrough research will be funded. Such efforts may partially replace traditional peer review with other mechanisms (RCN, 2016; Warta and Dudenbostel, 2016). Meanwhile, RCN has been increasing its funding for bottom-up research projects, as noted earlier. On the other hand, the recent RCN spending review (MER and MOF, 2017) argues that the council should put more emphasis on excellence through more excellence-oriented funding criteria and by reorienting budgets to favour open, high-quality research funding.

In the aftermath of the LTP, a number of follow-up activities took place at the government level, including high-level meetings chaired by the prime minister on issues like research excellence.

Conclusions on the higher education sector

Increasing competition for top-class research, talent and places, globally and across Europe (OECD, 2014a), has resulted in a stratification[31] of organisations, people and output beyond national borders. Norway is no exception to this trend. Raising the quality of the research and HE sector has been a concern in Norway for a long time, competing with other goals and a number of regional, institutional and cultural factors, and has increasingly become a major concern for the Norwegian government. The country nonetheless has some specific features that have influenced the debate over research excellence.

First, Norway is an academic late mover by comparison with other small countries in Europe. Its public research sector was created from the bottom up, involving numerous regional actors. This created a call for standardisation (Kyvik and Stensaker, 2016; Gulbrandsen and Nerdrum, 2009), for critical mass, mergers and high quality, to reposition Norway on the scientific map. Despite these early standardisation and consolidation efforts, it has been widely documented that many academic environments in Norway are deemed "too small" (MER, 2014b) and "too fragmented" (RCN, 2011) to conduct internationally competitive research.

Second, Norway, like Denmark, Sweden and Switzerland, has no basic research institute sector. Such a sector helps countries like Germany or France improve their output and scientific visibility, although it is not a necessary precondition for scientific visibility and success, as indicated specifically by the performance of Denmark and Switzerland.

Third, Norway has strong scientific traditions and visible success stories in applied, engineering-based, research and innovation clusters like marine, maritime industries and oil and gas, with HEIs and research institutes deeply integrated in these networks. Its universities have a strong portfolio of applied research. Norway also has highly developed fields of scientific expertise, in political science or climate research. Norway was even a pioneer in utilising science for practical purposes, such as in the mapping of natural resources and experiments related to fisheries and aquaculture (Gulbrandsen and Nerdrum, 2009).

By contrast, Norway has a much lower relative share of basic research in its R&D portfolio than other small countries. In Switzerland, basic research accounts for around 0.90% of GDP, but Austria, Denmark and the Netherlands all have a share of around 0.55%. Norway comes in last, with 0.29% (OECD, 2016, p. 25).32 This is reflected in the performance of the public research system, as measured by various bibliometric indicators (Table 3.7).

This relative weakness is all the more of a concern, because research excellence is particularly called for in the current Norwegian context (see Box 3.8).

Table 3.7. **Summary diagnostic of the Norwegian higher education sector**

Main elements of diagnostic
Higher education inputs
– High share of HEIs in total research expenditures
– High HE research expenditures relative to the population, to the number of students and HEI personnel (well above the OECD average)
– High share of institutional funding in total HEI funding
– Low share of basic research
Higher education outputs
– HEIs in Norway account for nearly two-thirds of its total scientific production.
– Norwegian universities rank below those of Sweden, Denmark, Netherlands and the United Kingdom, in terms of some key bibliometric indicators, although performance has improved.
– Norwegian universities do not feature prominently among the world's top universities in most university rankings (while those of the Netherlands, Switzerland and Denmark do).
– Norway had a comparatively low success rate in the European Research Council (ERC) calls over the period 2007-16 (as opposed to all comparator countries, including Netherlands, Switzerland and Israel).
– Strong specialisation of HEIs in fisheries and aquaculture, arctic and Antarctic, climate change, maritime, marine biology and the environment
– Several of Norway's fields of specialisation record above-average bibliometric performance and are relevant to strong industrial/service innovation clusters.
Education
– Increasing attractiveness of Norwegian HEIs (number of foreign students at various tertiary education levels)
– High public expenditures by tertiary students, due to the absence of tuition fees and the relatively low student-to-teacher ratio
– Long duration of studies (including PhDs; average completion age was 35 years in 2015)
– High degree of dropouts (completion rates below OECD average), in relation to a dynamic job market and the low cost of studies
– Strong preferences of students for a limited number of disciplines, mainly the social sciences – student shortage in the STEM fields
– Low rate of unemployment of people with tertiary degrees

Significant progress was achieved after the government made efforts to set up a more competitive, quality- and output-oriented policy framework. The reform agendas of the various governments met strong resistance in the 1990s and 2000s, and therefore took a long time to take effect (Öquist and Benner, 2014)[33] The various governments, however, succeeded in introducing well-designed funding programmes, as external incentives to raise the level of quality of Norwegian research, and supported structural changes in the HEI sector and internal reforms within universities. These step-wise, negotiated initiatives resulted in larger and fewer HEIs, increased co-operation between them, introduced new university board structures, strengthened executive leadership and made improvements in career structures. Such changes have created opportunities, particularly for the strongest universities to pursue a strategy towards enhanced quality of research, with some government nudging to support the necessary processes of change. However, a reluctance to take up opportunities and the persistence of traditional attitudes and structures in the majority of the HEIs remains a hurdle. Sectorial compartments and the consensus principle also play a role here, as they do in Norway's governance mechanisms overall.

Box 3.8. **Reasons for Norway to concentrate efforts on excellent research**

Why should Norway, as a successful small country, make the effort to further raise the number and level of top scientific outputs? The innovation system is strong, and some clusters have intense and successful collaboration patterns between HEIs, public research institutes and companies. Efforts to increase outstanding research can be justified in the following way:

- The increasing complexity of the Norwegian "innovation missions" requires top talent and excellent research. This is case of the oil and gas sectors' quest for efficiency, the health sector's adoption of precision medicine and big data. Other relevant examples include fish farming and the challenge of fast growth in the light of increasing environmental concerns and climate change.
- The next wave of radical innovations cannot be predicted, but most of the inventions they will involve are likely to come from top institutions. The ability to be competitive at the "research frontier" is crucial for Norway. While it has been able to create wealth through a number of techno-economic clusters, all of these now face sophisticated transition imperatives. Moreover, not all of them might in the future contribute to the nations' wealth in the same way as in the last decades.
- Excellent research generates strong spillovers and leads to significant increasing returns. "Star scientists" and organisations attract top people, forming clusters of excellence. These clusters – with research organisations at their core – can better spin-off young companies, as well as encourage established firms, including multinational enterprises, to open R&D branches nearby. Excellent HEIs produce top graduates, with positive effects on research, society and the economy, and see their PhD students as a top resource. However, top researchers deserve attention, as they are increasingly mobile and follow the best offers for career positions, often preferring and obtaining tenure track appointments at a relatively young age.
- Finally, high standards are a matter of efficiency and effectiveness. Less well-performing HE organisations are costly. Outstanding organisations cost more but yield disproportionally higher outputs.

The current, LTP-driven developments are in line with long-standing efforts of the Norwegian government to step-wise increase the level of quality in the Norwegian HE sector and to help create excellent research and teaching environments. A white paper on teaching quality is being issued, and another white paper (MER, 2014b) promised structural reforms in the HE sector, although it mostly translated into another wave of mergers, while focusing less on the issue of top quality. The LTP itself provides for a number of initiatives to increase the number of excellent performers. The question remains whether these will suffice, as the government faces two sets of challenges:

- The universities do not make full use of the existing legal framework regarding leadership, allocation processes, recruiting and creation of critical mass. The level of autonomy in universities is considerable, but has so far led to only mixed progress to go against traditional fiefdoms, equal distribution and small-scale environments.
- The waves of mergers have reduced the level of stratification in the Norwegian HE system, with many UCs striving to become universities. International experience shows, however, that some stratification of the HE system is valuable, with applied, regionally anchored UCs (as in Switzerland, Germany and Austria) and a few top universities able to compete in a European, or even world-class league (as suggested by the Swiss, German, Danish and Dutch examples). Performance agreements could help to some degree, but only if they do not degrade into another overly consensus-driven mechanism.

Table 3.8. **Developing excellent academic communities in the Norwegian higher education sector: Achievements and challenges**

Achievements and progress	Remaining challenges
External structural changes	
– Progressive, negotiated consolidation of the higher education (HE) sector	– Higher education instututions (HEIs) considered to be too small and fragmented to achieve world-class research – (Potential) loss of diversity in HEIs' profiles, as a result of the mergers and actions by the government to remove structural differences
Internal structural changes	
– HEIs granted substantial autonomy – Changes in governance (appointment of the rector, board chair and members) could strengthen leadership in the near future – New initiatives in some universities to retain a central budget at board level, for internal strategic funding schemes and mechanisms to create critical mass	– Persistent strategic HEI management weaknesses, in particular, reluctance to take strategic action, *ex ante* financial incentives and *ex post* "reallocation" actions, excessive bureaucratisation – Universities do not take sufficient advantage of the favourable legal framework regarding leadership, allocation processes, recruiting and creation of critical mass.
Recruitment and career management	
– Recent and ongoing improvement of recruitment and career development structures (new tenure track system)	– Recruitment is still often described as "routine-based" and dominated by teaching issues. – In-house and non-strategically managed careers, mean that it takes many years to advance to full professor
Funding of higher education instutitions	
– Greater reliance on performance-based components in the allocation of the integrated teaching and research block funding – Pilot institutional performance agreements have been introduced to enhance excellence and maintain distinct institutional profiles. – Strong scientific achievements of the RCN's SFF Centres of Excellence Programme constitute one of the few opportunities to create critical mass in basic research – Positive results in basic research of RCN FRIPRO programme – FRIPRO Toppforsk, a new initiative to provide generous, multi-year funding to top research groups	– Difficulties to support HE drive for excellence through indicator based steering – Weak European Research Council record – Low participation of HE tenured staff in RCN programmes, at the same time FRIPRO and other instruments highly competitive

Notes

1. Gudmund Hernes, a sociology professor and former research minister who chaired one of the many strategy commissions to overcome fragmentation and complacency in the Norwegian HEI sector, denounced what he called a "tradition of mediocrity" (Öquist and Benner, 2014).
2. In addition, there are also ten private HEIs and a number of specialised post-secondary education institutions.
3. Act relating to universities and university colleges, 1 April 2005 and subsequent amendments, hereafter referred to as the "HE Act".
4. Contrary to universities, UCs also have to accredit their study programmes through the Norwegian accreditation agency NOKUT.
5. The "average relative size", i.e. the relative percentages of higher education research and development (HERD) to gross domestic expenditure on R&D (GERD), also results from two other particularities of the Norwegian situation that cancel each other out: The public research institute (PRI) sector is comparatively large, while business enterprise R&D (BERD) is lower than in comparator countries.
6. Again, there are many specific effects, including the very small institute sector in Denmark and Switzerland.
7. For instance, data measuring how many hours a week university researchers devote to research.
8. The relatively low ratio of budgetary allocation per student relates to the recent mergers of a number of UCs.
9. This statement is valid for all sciences taken together, as well as for the main scientific fields (biomedical and health sciences; life and earth sciences, mathematics and computer science, physical sciences and engineering, social sciences and humanities).
10. Similar results were obtained using a normalised impact factor across 23 subject areas (Citation Impact Total) in 2016, using the Web of Science dataset (as provided in the University Ranking by Academic Performance or URAP, Research Laboratory) (URAP dataset, www.urapcenter.org, accessed 12 April 2017).
11. The Times HE ranking is based on five pillars, each informed by various indicators (teaching, research: volume, income and reputation, citations, industry income, international outlook; staff, students and research). See: https://www.timeshighereducation.com.
12. The QS ranking shows a similar positioning for Norway; the ARWU/Shanghai ranking rates Norwegian HEIs slightly higher.
13. Compilation based on European Commission (2015, Tab. 7.02), https://era.gv.at/object/document/1883/attach/ERC_funding_activities_2007_2013_pd .pdf. Around 75% of the ERC grant holders in EU FP7 (2007-13) are located at universities, when the top-100 ERC host institutions are taken as a basis for analysis.
14. Although ERC calls are open to research institutes as well as universities, almost all ERC grants have been to universities in Norway's case. Of the 65 grants awarded as

of March 2017, only 4 were awarded by non-university organisations (all between 2014 and 2016).

15. The success rate for ERC grants is also strikingly low in H2020. While the European average is 12.7%, only 6.8% of the Norwegian applicants have been successful (FFG, 2017, https://eupm.ffg.at/ui/login; via sitemap, queries for ERC and Norway). Norway had 20 ERC grants in the period from 2014 to early 2017, as compared to 54 for Denmark, 38 for Finland, 69 for Austria and 134 for Switzerland.

16. Norway appears to be a comparatively attractive place for foreign researchers. In 2006, 21.8% of all American HE scientists were foreign-born, a much lower percentage than in Norway (Stephan, 2012). A 16-country review that does not include Norway (Franzoni et al., 2012) compares the share of foreign-born scientists in different countries. However, the numbers listed above for Norway put the country in a group with Australia, the United States and Sweden. Each of these countries are very attractive to foreign-born scientists and PhD students, with approximately 40% of scientists having lived abroad at age 18. Norway's share of foreign-born scientists is comparable. Switzerland and Canada have even higher percentages.

17. Similar data for lower educational levels (below upper secondary, upper secondary or post-secondary non-tertiary) also reflect Norway's lower unemployment rate in international comparative studies.

18. In an international comparison over the last 15 years, made before the last wave of mergers, Norway, like Sweden and Finland, has occupied a middle rank in Europe (Bennetot Pruvot et al., 2015).

19. Switzerland, the Netherlands and Germany exemplify a two-tier approach actively promoting HE excellence and a strong UC sector. Austria is better known for building its UC sector, while Denmark maintains a strong focus on a few excellent universities.

20. The decision to opt for an appointed rector can now be taken by a simple majority in the board. Before, a two-thirds majority was required, and the default option was the election of the rector.

21. Faculty members of exceptional talent tend to attract and accept the best candidates, while mediocre environments often hire people who pose no threat to the incumbents.

22. These figures should be reviewed with caution, since block funding can be allocated in different ways. Slovenia, for instance, has a specific form of allocating HE research funds in a competitive way, sometimes referred to as "*de facto* basic funding" (OECD, 2012).

23. Germany, in fact, has 16 subsystems. Norway qualifies for the middle group because of its output-oriented but still limited, formula-based funding system.

24. Before 2002, block funding was based on historical allocations; changes to the allocation of funds to selected HEIs or to all HEIs were made through individual political decisions.

25. More than 50% of the university buildings are owned by the universities themselves, and the rest is rented from the government's property corporation and from private landlords. According to the Background Report (MER, 2016) rent, operating cost, maintenance and infrastructure cost amounted to nearly 30% of total HEI revenues.

26. As regards the research component, small signals in the incentive structure are seen as appropriate by Norwegian policy makers. They assume that it is sufficient to steer the

(mainly) individual behaviour in research with small incentives, since individuals follow them and act accordingly. Teaching is seen as a more institutional and collective exercise and is therefore considered to need stronger incentives. Some other funding formulae (as in Austria in the late 2000s) also gave greater weight to teaching indicators. These systems, however, vary widely.

27. www.forskningsradet.no/en/Newsarticle/Ten_new_Norwegian_Centres_of_Excellence/1254025588940.

28. www.forskningsradet.no/en/Newsarticle/Three_of_five_Norwegian_ERC_grants_go_to_Centres_of_Excellence/1254021775768/p1177315753918?WT.ac=forside_nyhet.

29. www.forskningsradet.no/prognett-fripro/Nyheter/NOK_500_million_available_for_FRIPRO_Toppforsk_projects/1254025877274/p1226994096494.

30. www.regjeringen.no/en/topics/research/innsiktsartikler/langtidsplan-for-forsking-og-hogare-utdanning/verdensledende-miljoer/id2353318.

31. This stratification is primarily driven by different levels of current performance; however, past performance, financial resources, reputation and other factors play a strong role and contribute to individual trajectories.

32. Norway's low ranking can be explained by its industrial structure and the large institute sector, but may also involve the more application-oriented research portfolio at Norwegian HEIs.

33. Scores of reform commissions and white papers were needed to step-wise introduce governance reforms.

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Chapter 4.

Enhancing competitiveness and innovation: The Norwegian research institute and business sectors

This chapter discusses the state-of-the-art and potential of public research institutes, universities and business firms to contribute to enhancing competitiveness and innovation capacity in Norway, which is one of the three overarching objectives of the government's Long-Term Plan. The chapter first describes the main features of public research institutes and their performance before addressing the governance and policy aspects affecting this sector. The second part analyses the structural conditions for and performance in commercialising universities' research, and the policy to support these activities. The third part on business firms addresses their innovation capacity using various proxies and a discussion of the innovation policy. The chapter concludes with a synthesis of the achievements to date and remaining challenges for enhancing competitiveness and innovation and present some high-level conclusions.

How successful Norway's economy will ultimately be in making the economic transition will depend on structural changes in its industry and service sectors. This challenge will mean helping its universities, public research institutes (PRIs), as well as the business firms that are closely linked to them, to innovate and contribute to diversification.

Public research institutes in Norway

In Norway, research institutes constitute an integral part of the public research system. They have traditionally been seen to play a "dual role" in the Norwegian system, as an R&D infrastructure supporting industry needs through the provision of knowledge, competence and equipment on the one hand, and as key "intermediators" between firms and universities on the other hand (Gulbrandsen and Nerdrum, 2007).

Key figures and main features of public research institutes

Structure of the institute sector

Norwegian PRIs are diverse and heterogeneous (RCN, 2013) in terms of size, activities, scientific orientation, customers and users, financial sources, legal status and forms of organisation. While some institutes, such as the SINTEF foundation, are large, cross-disciplinary organisations with several hundred employees, most of them are small and specialised. Research institutes in Norway have a long history of undertaking applied research in support of the country's industry and public sector. Research organisations in areas such as oceanography and marine sciences already existed in the late 19th century, but many of the institutes were established after World War II (Gulbrandsen and Nerdrum, 2009). The Royal Norwegian Council for Scientific and Industrial Research (NTNF), created in 1946 and linked to the predecessor of the Ministry of Trade, Industry and Fisheries (MTIF), was instrumental in the creation of several multidisciplinary, industry-oriented research institutes, particularly the Central Institute of Industrial Research (SI), which it owned and funded. SINTEF (Stiftelsen for industriell og teknisk forskning), now the largest Norwegian research institute, was established in 1950 by the Norwegian Institute of Technology (Norges tekniske høgskole, NTH), now part of the Norwegian University of Science and Technology (NTNU).

During the 1950s, a few institutes encountered financial problems and were absorbed by SI and SINTEF. The discovery and subsequent exploitation of Norwegian oil and gas resources in the 1970s, and the ensuing technological challenges and demand for solutions from large companies, ushered in a golden age for many research institutes, which became the main R&D sector until the early 1980s (RCN, 2016a).

The research institutes were "owned" by ministries or by ministries' research councils until the mid-1980s. Since then, most of the institutes have become foundations or non-profit organisations and operate as autonomous entities at arm's length from the government. This legal status differs from that of similar organisations in other countries, such as for instance the Netherlands Organisation for Applied Scientific Research (TNO), which are formally public organisations. The Fraunhofer centres in Germany have a semi-legal status, while the Danish centres (GTS-Advanced Technology Group) are limited companies.

The research institute sector in Norway

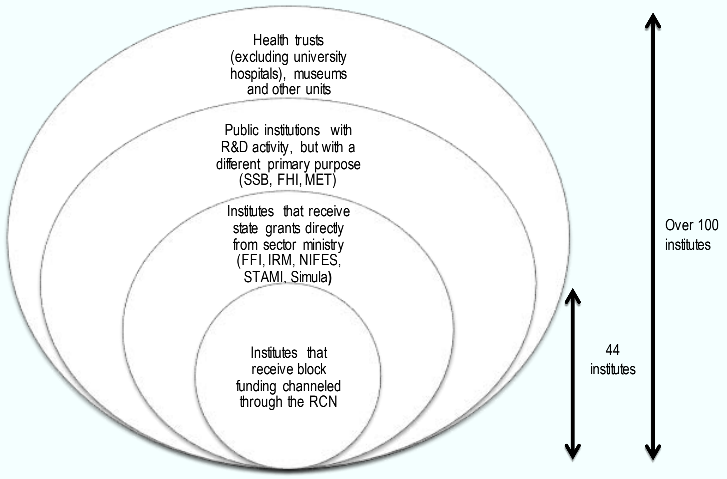
The institute sector in Norway in 2017 includes more than 100 organisations. All of them are entitled to apply for funding in the Research Council of Norway (RCN)'s competitive programmes, but only 44 research institutes can receive public funding from the government through the common block funding system as of 2017. These institutes are divided into four funding arenas reflecting their thematic and sector orientations. Other categories of institutes include publicly owned research centres directly funded by the ministries (such as the Institute of Marine Research), public institutions with significant R&D activity that are also tasked with specific public missions (Norwegian Institute of Public Health, Statistics Norway, Norwegian Polar Institute, etc.). Other entities, such as hospitals, museums and some public sector and private non-profit organisations, are also part of the institute sector at large (see Box 4.1).

Box 4.1. **The different categories of research institutes**

The research institutes that receive block funding (innermost circle) are grouped in four arenas for the allocation of block funding.

- The technical-industrial institutes (TI) undertake research in a broad range of areas. These include industrial processes, materials and chemistry and information and communications technology (ICT), marine technology, energy, petroleum, nuclear technology, geoscience, and technology and society.
- The primary industry institutes mainly meet the needs of the public administration and primary industry.
- The environmental institutes are dedicated to applied research in the fields of the environment, cultural history, social science and natural science. They conduct research and provide expert assistance to the Ministry of the Environment and undertake studies on commission from the ministry.
- The social science institutes undertake basic and applied research on a broad range of thematic areas. They are divided into national and regional institutes. The regional institutes conduct research with a greater regional scope, often commissioned by regional authorities, which have part ownership in them.

Figure 4.1. **The different layers of the research institute sector**



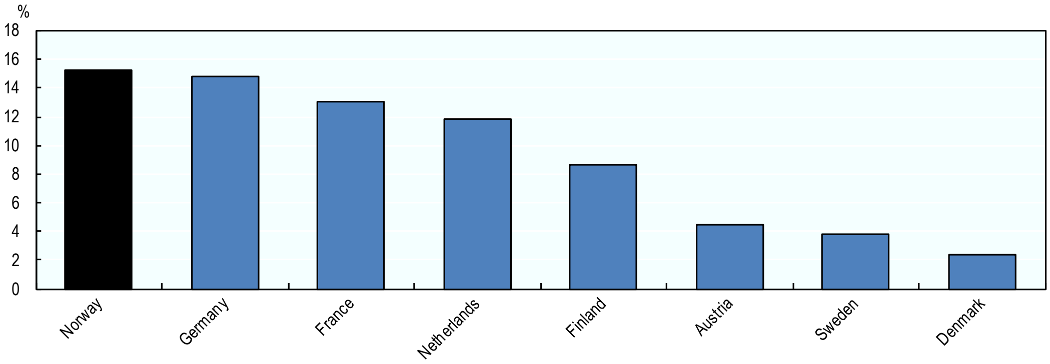
Notes: SSB: Statistics Norway; FHI: Norwegian Institute of Public Health; MET: Norwegian Meteorological Institute; FFI: Norwegian Defence Research Establishment; IRM: Institute for Advertising and Media Statistics; NIFES: National Institute of Nutrition and Seafood Research; STAMI: National Institute of Occupational Health; Simula: Research Laboratory.

The institute sector in Norway is larger in absolute numbers than those of other countries, but more fragmented in terms of the average institute size, with several evaluations noting that they are often too small to achieve critical mass, and that co-operation between them is limited (RCN, 2016a). The size of the largest institute in Norway (SINTEF) is around 2 100 employees, comparable to VTT (with 2 600 employees), Sweden’s RISE centres (about 2 400) and smaller than the GTS Network in Denmark (over 4 000) (OECD, 2016c). Around a third of the institutes have less than 40 FTE staff. The social science institutes are the smallest on average (around 40 FTE), and the primary institutes the largest on average (around 300 FTE).

R&D expenditures

With R&D expenditure reaching NOK 13.7 billion in 2015 (around 23% of the total GERD, and an increase of NOK 1.4 million on the previous year), research institutes are key R&D performers for and with industry in the Norwegian system, particularly compared to other countries such as France, the Netherlands and all Nordic countries.[1] These countries have a larger share of R&D-intensive business as well as of R&D by consultancy and other knowledge-intensive business sector organisations (Solberg et al., 2012). This, and the stronger role played by the university sector in other Nordic countries such as Sweden, explains the higher contribution of the government sector to Norwegian gross domestic expenditure on R&D (GERD) compared to other countries (Figure 4.2).

Figure 4.2. **Percentage of gross domestic expenditure on R&D (GERD) performed by the government sector, selected countries, 2014**



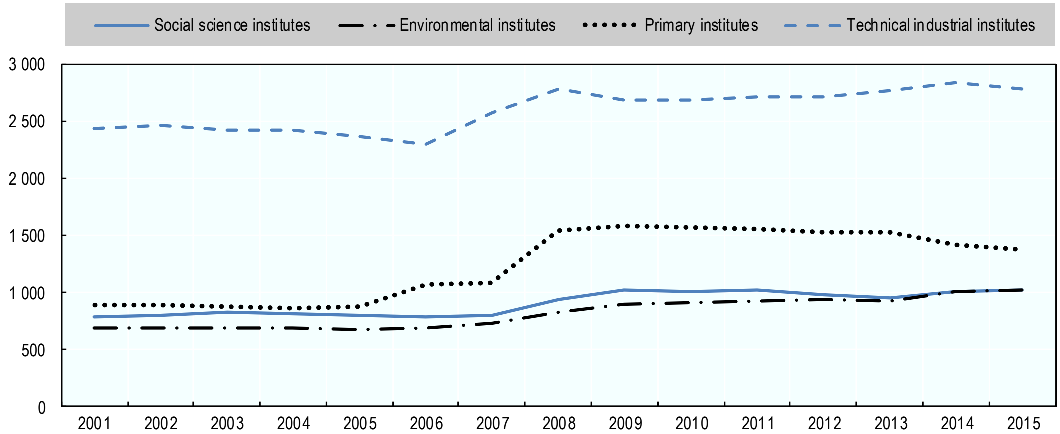
Source: OECD (2016d), *Main Science and Technology Indicators (Edition 2016/1)*, OECD Science, Technology and R&D Statistics (database), http://dx.doi.org/10.1787/db23df7c-en.

Human resources

The institute sector at large had 9 370 full-time equivalent (FTE) R&D personnel in 2015 (of which 71% are researchers). Of these, 6 221 (72% of which are researchers) are in the 44 institutes under the block-funding system guidelines. The number of staff employed by the institutes has remained more or less stable in the last five to six years (see Figure 4.3). This followed a sharp increase in the number of researchers in the period 2006-08, mainly driven by staff increases in the TI institutes and the primary institutes. With 2 486 FTE staff (70% of them researchers), the technical-industrial arena is the largest group, although there are significant differences in size within this arena, between, for example, the SINTEF institutes, with 1 487 total FTE, followed by the Institute for

Energy Technology (IFE) (595), and Norut with only 62. The share of researcher personnel with a PhD in the institute sector at large was 50% in 2015 and 47.6% in 2013. Among the institutes in the block funding system, the share was 60% in 2013, ranging between 74% on average in the primary institutes and 50% in the social sciences institute (RCN, 2015a). Around 37% of the FTE R&D personnel are female, with a higher (50%) and a lower (27%) percentage in the social sciences institutes and the TI institutes, respectively (NIFU, 2016).

Figure 4.3. **Numbers of full-time equivalent personnel in the different types of research institute (public research institutes under block-funding system only), 2001-15**



Source: NIFU (2016) "Key figures for the research institutes", www.foustatistikkbanken.no/nifu (accessed 2 February 2017).

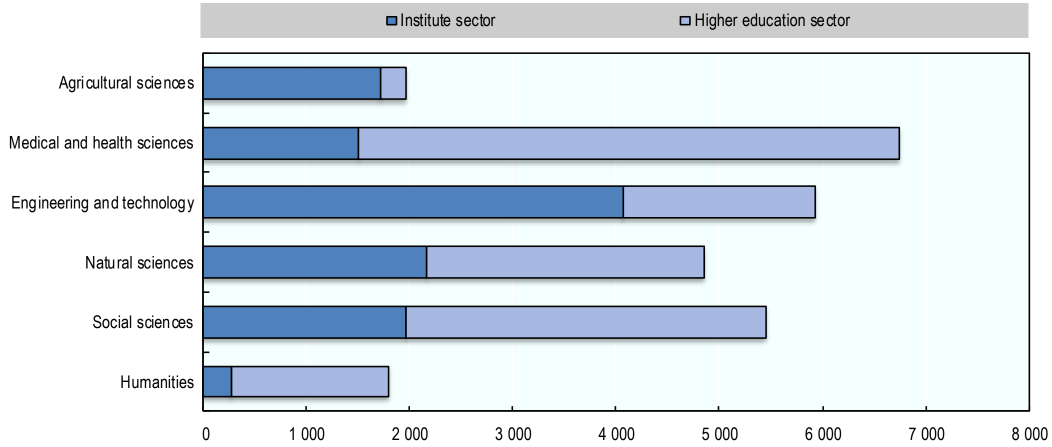
Research specialisation and productivity

The research institutes differ in their scientific focus and orientation, ranging from applied technical institutes to organisations dedicated to fundamental research. However, the majority can be categorised as research and technology organisations (RTOs), i.e. research organisations, partially funded by the state, that undertake research that addresses industrial needs (OECD, 2011).[2] Around 67% of the R&D undertaken in 2015 by the sector has been classified as applied research, 18% as experimental development and 15% as basic research (NIFU, 2016). A recent international comparative study of research institutes (Lekve, 2015) raised some concerns about the small share of fundamental research conducted by the Norwegian research institutes compared to other countries such as Germany, France and the United States.

The sector covers a wide range of disciplines, the most important of which in terms of R&D activity is engineering and technology, followed by natural sciences. Over half of the sector's R&D resources were conducted in these two areas in 2013. Compared to the HE sector, institutes dominate in agricultural sciences and engineering and technology, while most of the research in the humanities and medical and health sciences is conducted at universities and colleges (see Figure 4.4).

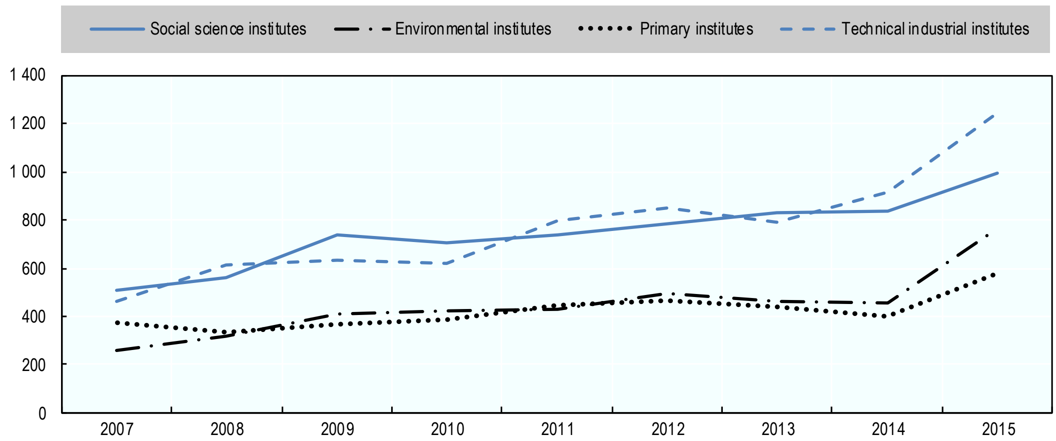
While obviously below the publication performance of HEIs, Norwegian PRIs make a significant contribution to scientific production. Publications in the institute sector rose significantly between 2007 and 2015 (see Figure 4.5). There are significant differences among the institutes in the volume of scientific publishing and their propensity to publish, given their difference in size and in specific balance between basic research and technology development. The social science institutes and the TI in particular have had the largest scientific production in recent years. The SINTEF institutes accounted for 62% of the scientific publishing of all the TI institutes in 2011-13.

Figure 4.4. **Current expenditure on R&D by field of science and sector, 2013**



Source: NIFU (2016) "Key figures for the research institutes", www.foustatistikkbanken.no/nifu (accessed 2 February 2017).

Figure 4.5. **Evolution of scientific publications by institute group (public research institutes under the block-funding system only), 2007-15**



Source: NIFU (2016) "Key figures for the research institutes", www.foustatistikkbanken.no/nifu (accessed 2 February 2017).

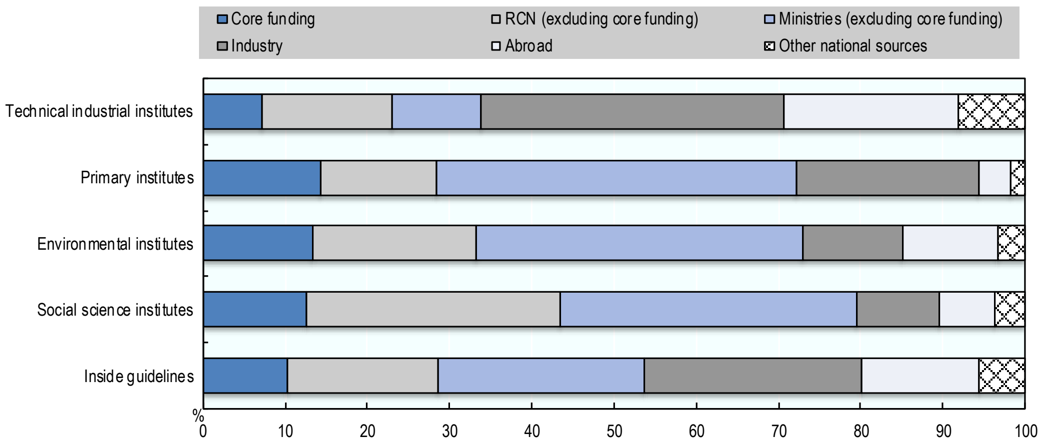
The research institute sector has a relatively high citation impact both nationally, when compared to the HEI and health sectors, and internationally, when compared to its natural benchmarks. Based on publications from 2008-10 (counting citations until 2011), the Norwegian institute sector had a citation impact factor of 1.3, compared to 1.2 for the higher education sector and 1.4 for the hospital sector (RCN, 2015a). Internationally, the government sector in Norway has a comparatively higher citation impact than Sweden and Denmark, on par with Finland, but lagging behind Austria and the Netherlands (see Chapter 2). The citation rate is higher in many engineering subfields, particularly in petroleum engineering and construction and building technology, where the publications of TI institutes are highly cited. Engineering science is not only above the average for scientific quality, but also significantly above the average in terms of the relevance of its research (RCN, 2015c).

Funding of public research institutes

Overall structure of funding of public research institutes

In 2015, approximately 60% of the funding of the institute sector under the block-funding system came from national public funding, of which 11% was core funding, 22% from industry and 12% came from abroad (see Figure 4.6). The proportion of revenue from the various types and sources of funding varies for the different types of institute (see Figure 4.6). For instance, the technical-industrial institutes have the highest proportion of income from business and from abroad, with 37% and 21%, respectively, of the institutes' total operating revenues, and the lowest proportion of revenue from the Research Council of Norway (23%).

Figure 4.6. **Operating revenue of the institute sector by source of funds and funding arenas (public research institutes under block-funding system only), 2015**



Source: NIFU (2016) "Key figures for the research institutes", www.foustatistikkbanken.no/nifu (accessed 2 February 2017).

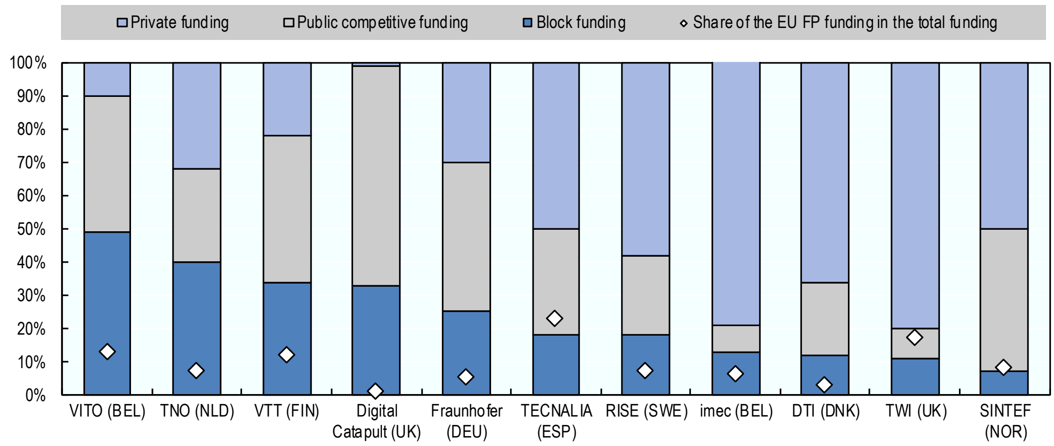
Block funding

The share of non-competitive block funding is around 11% of the institutes' operating revenues (ranging from 6% for TI institutes and around 15% on average for the rest). Internationally, this level of funding positions Norway at the lower end of the spectrum, compared to organisations such as VTT, TNO and Fraunhofer (around 30%) and the Swedish RISE institutes, with around 18% (Figure 4.7).

There is no clear consensus in the literature as to the right mix of funding for the institute sectors and the ideal share of block funding. The Sörlin report (Sörlin, 2006), commissioned by the Swedish Ministry of Industry to study the role of the research institutes, recommended that the institute system maintain a core funding of between

15-20%, to make a significant contribution to the national innovation system. In Norway the Thulin Commission (NOU, 1981) suggested a "golden rule" for financing research institutes consisting of one-third basic funding, one-third strategic funding and one-third contract research. It has also been argued that differentiated levels of core funding may be suitable for different areas and that opportunity may also emerge from linking the funding to the nature of the intended research and to collaboration with other knowledge partners (OECD, 2016c).

Figure 4.7. **Comparison of the structure of funding of selected institutes in Norway and comparator countries**



Source: Data provided by Research Council of Norway (RCN)

Participation in national research funding

More than half of institutes' operating revenue in 2014 is accounted for by the public sector, with the institutes receiving 46% of total public R&D funds, as well as more than 40% of the Research Council's funding (including core funding) (RCN, 2016b). Research institutes show very different levels of dependence on government funding, depending on their mission in the system. The technical-industrial institutes (TI) were awarded 40% of total RCN funding of the institute sector in 2015.

The participation of the institutes is particularly strong in some of the large-scale programmes, such as ENERGIX (42% of the funding goes to the institutes in 2015), PETROMAKS2 (44%), BIONÆR (58%) and MAROFF (68%) (RCN, 2017a). Their participation in the centres of research funding schemes, the centres of excellence, centres for research-based innovation and centres for environment-friendly energy research (SFF/SFI/FME) is also robust. For instance, out of the eight new FME (forskningssentre for miljøvennligenergi) centres created in 2016/17, three are hosted by institutes of the SINTEF group (which is the partner in the other five) and two by IFE. They also benefited from research infrastructure funding to cover infrastructure including advanced scientific equipment, electronic infrastructure, scientific databases and collections, and large-scale research facilities. TI institutes received 17% of the funding (mainly SINTEF) and were involved in almost half of the research infrastructure investment granted during 2009-2013. Most of them involved collaboration with the HE sector, and more than a third with other institutes (especially other TI institutes). Collaboration with industry or the public sector was less frequent. While this funding has contributed significantly to meeting the infrastructure needs of the institutes, it has been suggested (RCN, 2015a) that relatively less attention has been paid in the RCN infrastructure strategy to innovation infrastructure, namely facilities for testing and demonstration.

Revenues from abroad and participation in EU competitive programmes

Revenues from abroad accounted for a total of NOK 1.43 billion in 2015 (12% of the total revenues of the research institutes). The TI institutes receive the most income from international sources, and the primary institutes and the social sciences institutes are the least internationalised, with revenues from international clients accounting for 4% and 7% respectively.

The institute sector performs better than other actors, such as the higher education system, in the FPs. According to the eCORDA database, the institute sector participated in 754 projects under FP7, with a success rate of 27%. With 35% of approved projects and 39% of the funding, the institute had a higher engagement in FP7 than the HE sector (25% and 34%) and industry (29% and 21%). The latest data for H2020 (March 2017) suggest a more even participation, the institute sector accounted for 30% of the retained proposals and 30% of funding, the HE sector for 29% and 31% respectively, and industry for 29% and 28%.

TI institutes alone are responsible for approximately two out of five participations from the institute sector, and receive 57% of the total grant (RCN, 2015a). They also co-ordinate around of half of the projects in which institutes take the lead. Their participation was particularly strong in the ICT programme, and also in the energy and the NMP (nanotechnology, materials and production technologies) programmes.

The SINTEF Foundation is the largest single Norwegian actor participating in EU programmes, with EUR 117 million in revenues from the FP7, far ahead of the University of Oslo and the NTNU. Its participation grew significantly between 2009 and 2013, while it remained more or less stable for the other institutes. However, when compared with international competitors, SINTEF lags significantly behind institutes such as the VTT in Finland or the TNO in the Netherlands (MER, 2013).

According to Åström et al. (2012), the higher participation of research institutes in the EU Framework Programme (FP) can be explained by the less generous national funding conditions of the institutes compared to the HEIs and the hospital sector, which forces institutes to explore all available funding opportunities. The high cost of the institutes, however, limits the number of FP projects they can afford to participate in, since they are not able to charge their full costs. To offset this structural disadvantage in the competitive international context, the STIM-EU scheme was introduced in 2012 (and further revised in 2015) to incentivise the participation of the institute sector in the EU Framework Programme. Institutes receive 33.3% additional funding for each Norwegian krone they receive in funding from H2020. Of the STIM-EU funding, 8% is also set aside to reward institutes collaborating with the business and the public sector, as well as those taking on co-ordinator responsibility.

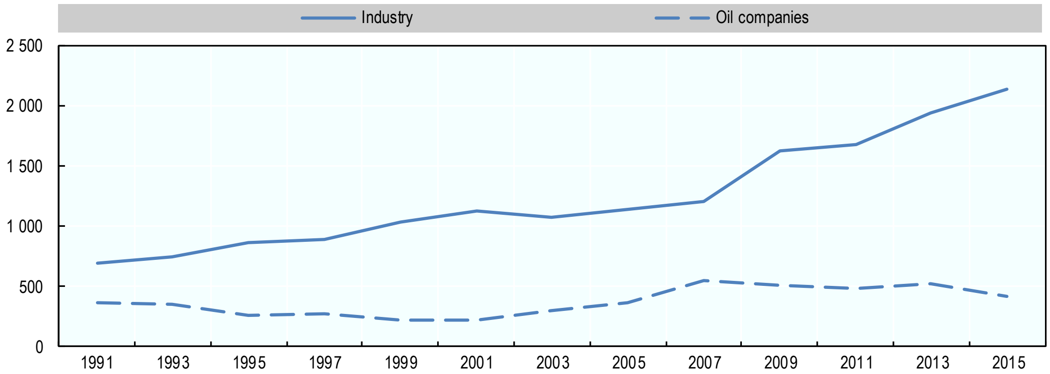
While STIM-EU has been a crucial mechanism for the TI institutes to overcome potential obstacles regarding EU funding, the 2016 evaluation of the TI institutes (RCN, 2016a) noted that more efforts are needed in terms of international co-operation. Many of the institutes have a weak international strategy, and only a limited number of successful institutes can compete at the international level.

Industry funding

The private sector purchased R&D services from the institutes for NOK 2.1 billion in 2015.[3] This accounted for around one-fifth of the institutes' revenues. Income from industry has increased steadily in recent years. The increase in industry funding has been more pronounced for PRIs in the TI arena, which derive the most income from industry (see Figure 4.8). The dependency of the institute on the oil industry has diminished over time, representing only 16% of all income from industry in 2015 (down from 34% in 1991) (NIFU, 2016).

Figure 4.8. **Industry funding of research institutes, 2001-15**

Million NOK



Source: NIFU (2016) "Key figures for the research institutes", www.foustatistikkbanken.no/nifu (accessed 2 February 2017).

Contribution of public research institutes to competitiveness and innovation

Impact of public research institutes on firms' performance

One of the defining features of the Norwegian system is the close relationship between the institute sector and industry. According to the EU's 2014 Community Innovation Survey data, an above-average number of Norwegian firms stated that government, public or private research institutes were the most valuable innovation partners (Eurostat, 2015). Extramural R&D, at 14% of total R&D expenditure in 2014, is also higher than the average value for European countries as a whole (10%) (Eurostat, 2015). Of all the Norwegian businesses reporting R&D co-operation, 29% had co-operated with research institutes. This co-operation was more intensive for larger enterprises (58% of the total number of firms with over 200 employees), manufacturing firms (33%) and firms in other industries (35%) (Statistics Norway, 2017).

Evidence from the Skattefunn scheme also suggests that research institutes are the most important partners for the companies benefiting from the tax credit schemes, with approximately 700 co-operative relationships in 2014 (50% of total collaborations), considerably higher than collaborative activity with universities and university colleges, which accounted for 30% of the total (RCN, 2015b).

Studies and evaluations of the institute sector have generally reported a high level of user satisfaction with the quality of the institutes' services, and significant benefits derived from their use (Åström et al., 2015; Fridholm et al., 2015).[4] Åström et al (2015) estimated that users of the TI institutes experienced 28% higher turnover and 5.5% more productivity compared to non-users and the effect remained positive up to four years after the collaboration. Further, repeat users experienced a higher turnover and productivity gain than one-time users. While TI institutes are highly rated by users for their collaborative skills and adaptability, ratings are lower for their capabilities in market intelligence and the cost of their services (Fridholm et al., 2015).

The dense interaction between industry and research institutes illustrated above can be interpreted as a successful model of collaboration. However, a number of observers have suggested a less than ideal situation of systemic co-dependency whereby institutes are financially dependent on the provision of R&D services to industry and thus mainly undertake research with a short-term industry focus (Narula, 2002; Wicken, 2009), and firms use research institutes to compensate for a lack of, rather than to complement, own intramural R&D efforts (OECD, 2008; Herstad et al, 2010; Solberg et al, 2012).

RCN managed funding programmes mainly focus on fostering collaborations across the different sectors of the innovation system, funding being contingent on the research being done with an external research partner. The flipside of this it that it favours pre-existing relations between incumbent industries and leading research institutes and may disincentivise the building up of internal R&D capacity in firms. For instance, Herstad et al. (2010) point to the danger of funding designed to promote collaborative ventures inducing arm's-length contract R&D with limited impact on the development of knowledge and absorptive capacity of Norwegian firms.

Patents, licenses and spin-off companies

The research institutes also have significant impact indirectly through licensing, patenting and spin-off activities (RCN, 2015a). For the TI institutes, this economic impact was estimated at around NOK 11 billion between 1997-2013 (Åström et al., 2015).

The institutes were responsible for 47 patent applications in Norway and abroad in 2015, and for 31 granted patents (see Table 4.1), up from 33 and 20 respectively in 2014. These numbers do not show significant improvement in the last 20 years, since research institutes applied for between 34 and 71 patents per year during the period 1998-2003 (OECD, 2008). The TI institute and particularly SINTEF Foundation is a major contributor to the overall patent numbers, together with IFE and SINTEF Petroleum. The majority of patent applications have been from the area of instruments, followed by chemistry and electrical engineering.

Table 4.1. **Start-ups, licenses and patents, by institute groups (public research institutes under block-funding only), 2015**

	Number of start-ups	Number of patent applications		Number of patents granted	Number of new licenses sold	Total license revenues NOK 1 000 million
		Norway	Abroad			
Social science	0	0	0	0	0	
Environmental institutes	1	0	4	1	0	100
Primary institutes	3	5	7	4	6	1 823
Technical- industrial institutes	6	16	36	26	176	40 889
Total under Guidelines	10	21	47	31	182	42 812

Source RCN (2016b), *Annual Report 2015 Research Institutes: Summary Report*, www.forskningsradet.no.

There are also big differences across institutes in terms of licensing income. Licensing constitutes a significant source of income for some centres, such as the Norwegian Geotechnical Institute, but a marginal activity for others. Using the number of citations per patent application filed in in 1998 by different categories, it is estimated that the knowledge created by the institutes is of higher quality and impact than the knowledge patented by other Norwegian organisations, particularly in the areas of electrical engineering and instruments (Åström et al., 2015). About 117 companies have spun off from the TI institutes since 1997, although this is a declining trend. Extrapolating from data from a sample of 81 spin-off companies, it is estimated that these companies generated around NOK 10.8 billion in 1998-2013 (Åström et al., 2015).

Despite this positive economic impact, patent, spin-off and licensing activities are a marginal activity for most institutes. The TI institute evaluation (RCN, 2016a) concluded that the institutes could play a larger role in innovation but that they have limited encouragement to do so, in terms of incentives and clear guidelines. Institutes would be more likely to choose publishing than patenting, since the former gives them credit for funding and is less expensive. The evaluation of Norwegian engineering science 2014-15 (RCN, 2015c), in which the institutes play a dominant part, concluded that this field was suffering from a lack of a "visible environment for technology innovation" in areas of engineering research, including support and guidance for spin-off companies, commercialisation of intellectual property rights and incentives for inventors and risk-based financing.

Educational activities

The role of the institutes in doctoral training has increased in recent years. The number of doctoral degrees awarded in which the institutes made a strong contribution increased from 58 to 90 in the period from 2007-15.[5] Note that the total number of degrees awarded has also increased. As a share of the national total, the increase is from 5.6% to 6.2%. Social science institutes are the arena with the highest numbers and growth (35 doctoral degrees awarded in 2015), followed by the TI institutes and the primary institutes.

The Long-Term Plan for Research and Higher Education 2015-2024 (MER, 2014) reiterated the role of the institutes in doctoral training and recruitment, particularly in mathematics, natural sciences and technology subjects, based on the premise that their thematic specialisation and close co-operation with industry and other actors allow them to offer doctoral candidates experience from interdisciplinary and relevant research. The RCN's strategy for the research institute sector from 2014 to 2018 also highlighted the role institutes must play in doctoral education, in order to attract and retain young talented researchers who may not wish to work in higher education. To make this possible, the strategy stressed the need for collaboration between the institutes and degree-conferring institutions, based on institutional agreements that reflect the use of resources and division of labour. In 2016 and 2017 the national budget included additional funding to PhDs for the institute sector. Forty-five fellowships in natural sciences, engineering and technology were announced to be distributed by the RCN, allocated according to criteria related to size but also to R&D expertise and capacity, research quality and experience of doctoral education.

Public research institutes' collaboration with higher education institutions

Research institutes have traditionally had close connections with the university sector. Co-operation takes place through joint projects, co-publications, doctoral projects, joint affiliations as well as other formal and informal means of collaboration. However, concerns have been raised about an increasing overlap between the roles of the institutes and universities. Universities are under mounting pressure to adapt to a "third-mission" agenda of responding to the needs of society. They are thus becoming gradually more engaged in contract research with industry, which is sometimes perceived as unfair competition by institutes.

At the same time, in recent years, the role of the institutes in doctoral education, an activity traditionally performed mainly by the university sector, has grown. Some recent studies (Fridholm et al., 2015) suggest that businesses use research institutes and universities for different tasks and argue that their competition should not be exaggerated. Statistics for the institute sector (RCN, 2015a; NIFU, 2016) indicate that higher education institutes (HEIs) have steadily increased their R&D income from industry in the last year, but the balance of industry R&D going to the institutes and HE has remained stable. The inclusion of industry research contracts as part of the performance-based indicator for the HEI sector may introduce a distorting, thus potentially damaging, bias to existing collaborative relations or prevent new ones from happening. The converging logics, with a growing focus on external industry contracts on the one side and greater pressure for scientific publishing on the other, were found to generate tensions and new challenges for co-operation between the NTNU and the SINTEF (Brother et al., 2015).Finally, the lack of collaboration between institutes has been identified as a concern in several evaluations (RCN, 2002; 2016a). The 2015 TI evaluation exercise (RCN, 2016a) suggests that, outside the SINTEF group, institutes seem to compete rather than collaborate. Only 6% of the institutes' scientific publications are co-authored with other TI institutes, and they only collaborate with each other in 13% of the RCN funded projects (mostly within the SINTEF group).

Governance of public research institutes and support policy

RCN's responsibility for research institutes, and RCN as a funder

The Research Council of Norway has strategic responsibility for the research institutes, a mandate that was reinforced in response to the 2005 white paper (Meld, 2004-05), which asked for its role to be clarified in relation to the institutes. It recommended that the RCN play a role in defining a mix of complementary instruments to ensure the quality and relevance of the sector and promoting a unified policy for the sector. The responsibilities of the RCN include the management of the core funding system, provision of competitive grant funding, performance monitoring and strategic dialogue with the sector (RCN, 2014).

In 2014, RCN published its four-year strategy for the institute sector (RCN, 2014), acknowledging the need to strengthen and develop the role of the institute sector, and committing to support and increase basic funding, support internationalisation, reinforce the institute's role in doctoral education and improve RCN's knowledge base and dialogue with the sector. The mandate of the RCN is not to manage the individual institutes, which are independent organisations, but to ensure their appropriate development, through competitive funding and the management of the block funding system (see below). RCN is in an unusual position of being the main source of funding for the institutes and having the overall strategic responsibility for the sector. In other countries, this is typically done by an umbrella organisation such as the Fraunhofer

Society in Germany, yet RCN is the main source of funding for the sector. RCN therefore has many tasks but the steering power it exercises is limited. The multiple funding programmes – which are vital for many institutes – send a multitude of signals, while the block grants are too small to allow for any real strategic development of the institutes.

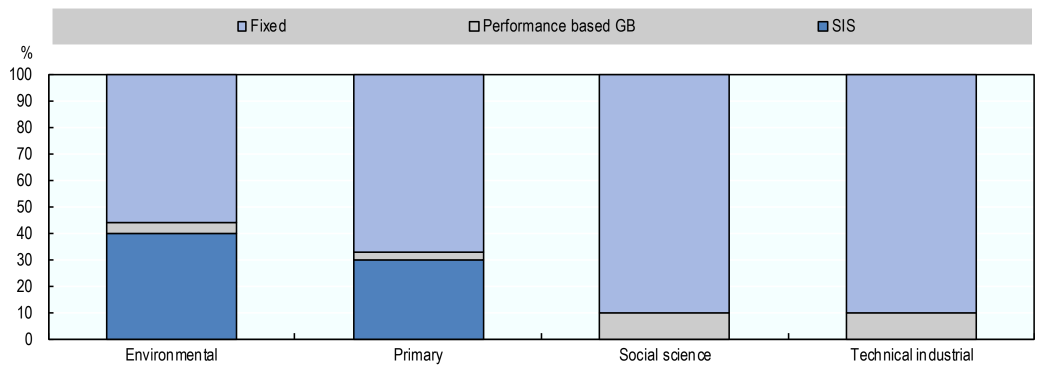
Governance through block funding

The use of the block funding is regulated by the national guidelines introduced in 2009,[6] which were revised in 2013 to include clearer information on eligibility conditions to the scheme. The guidelines sought to address the earlier fragmentation of funding to the institutes, whereby institutes received funding from multiple ministries under different rules and through different channels. Institutional funding had previously been based partly on historical facts and judgement, and partly on funding for strategic institutional programmes (SIP) awarded in competition.

The current model maintains a dual-tier system of basic funding, which comprises a fixed amount and a performance-related amount, plus separate funding for strategic institutional initiatives (SIS) that are funded through dialogue between the institutes, ministries and the RCN within each funding arena[7]. The performance-based component sought to address the market failure associated with excessive market orientation, by rewarding high-quality research and ensuring that that institutes developed long-term capabilities, rather than simply responding to short-term market needs (OECD, 2008). It considers four key performance indicators that are weighted differently: contract R&D (45%), scientific publications (30%), funding from international sources (20%) and number of doctoral degrees completed (5%).

The percentage of the funding distributed on the basis of performance (according to the indicators mentioned above) varies across the different institute arenas (see Figure 4.9). It was initially intended to account for around 10% of the institutional block funding, according to the 2008 guidelines, but at present, the 10% share has only been put into effect in the TI and social science arenas. The performance-based component accounts for a small proportion of the base funding for the environmental and primary institutes, which benefit from the SIS (with a ceiling of 40% and 30%, respectively, of the institute's basic allocation). Despite representing a relatively small incentive, an early evaluation of the performance-based system (RCN and DAMVAD, 2012) suggested that it has brought about behavioural changes, for instance in terms of the greater attention paid to academic publishing.

Figure 4.9. **Distribution of block funding across arenas, 2016**



Source: RCN (2015a), "Technical-industrial institutes. Facts report: Key R&D indicators", www.forskningsradet.no.

The Norwegian system of performance-based research funding of institutes is unusual in the international context. Several other countries have performance agreements that require centres to meet certain targets related to, for example funding, outputs (e.g. publications) and outcomes, for instance in Finland and Luxembourg, and many countries link performance and evaluation results to funding (OECD, 2011). However, monitoring, evaluation and judgement are more frequent forms of assessment (Arnold and Mahieu, 2012). Block funding is to be used for long-term knowledge and competence building, including doctoral degree programmes related to their area of activity, and to stimulate scientific quality, internationalisation and collaboration. In their annual report, institutes need to provide precise information on how they use the block funding, as per the funding provisions in the context of EU research and development and innovation state aid rules, in order to make a clear distinction between economic from non-economic activities. The use of the block funding is thus to a large extent left to the discretion of the institutes.

Other countries have a greater degree of oversight and decision-making power over PRIs' budgets and strategic missions, particularly those whose status as public organisations means that they are more tightly bound to the public sector (OECD, 2011). Steering is greater in Denmark and Finland through the use of performance agreements, and in the Netherlands, TNO is expected to contribute to the priorities set by the "top sectors" policy (Solberg et al., 2012). In Germany, the Fraunhofer centres, on the other hand, have a high degree of autonomy in their use of core funding. Governmental influence is limited to deciding on the setting up of new institutes. Norwegian institutes are similarly autonomous actors operating at arm's length from the government, with less opportunities for direct steering. In Norway, steering is mainly through the quasi-market mechanism of the performance-based component of the base funding and the competitive funding programmes (e.g. by defining thematic priorities). These mechanisms have been considered by some observers to be insufficiently suited to guarantee the institutes' contribution to the government's policy objectives and their ability to undertake the forward-looking, multidisciplinary measures that the industrial transition requires (Solberg et al., 2012, Arnold and Mahieu, 2012).

Further, the performance-based system still only regulates a small fraction of the institutional funding, below the 10% originally stipulated, and not all ministries have been willing to transfer their core transfer to the performance-based part of the funding arena. Strategic funding and dialogue are proposed as additional, more direct, forms of steering, in order to build capacity in institutes and enable them to undertake research that is longer term and more challenge-oriented (see Solberg et al., 2012). The strategic institute programmes now provide institutes with space to undertake strategic research but are in place only in some arenas. Similarly, the evaluation of the TI institutes recommended that a significant fraction of base funding be linked to ongoing innovation contributions, for instance through a panel assessment of these contributions.

Steering through evaluations and consultations

RCN is also in charge of monitoring and evaluation of the institutes. The RCN annually reviews the institutions that are within the basic funding scheme, according to a set of minimum requirements that research institutes must satisfy to qualify for basic funding. Criteria relate to the size of the centres, their publication performance, revenues from national commissioned research, as well as national and international research funding. If an institute fails to meet the requirements, the RCN and the institute engage in discussions regarding necessary structural changes. This involves, in particular, considering whether the underperforming institute should remain independent, join a larger organisation, or merge with other institutions. In recent years, following the trend towards institute sector restructuring seen in other countries (Arnold et al., 2010; OECD, 2011),[8] Norwegian institutes have been given incentives to stimulate mergers across the sector and with higher education organisations.[9] Mergers have been voluntary, encouraged by soft steering and additional funding, rather than enforced, as in the case of Denmark.

Before the 2009 institute funding reform, institutes were evaluated on an individual basis, but since then, evaluations have covered entire arenas. Recent evaluations include the 2012 evaluation of the regional social science institutes, the 2015 evaluation of the environmental institutes, the 2016 evaluation of the technical-industrial institutes, and the evaluation of the social science institutes in 2017. Evaluations are thorough and have been positively received. While arena-level evaluations may have come at the expense of detailed individual feedback (Arnold and Mahieu, 2012), the evaluations include concrete assessment and recommendations for each of the centres.

RCN also supports strategic planning of the institutes, which has so far involved dialogues, soft power and the right to nominate board members in some PRIs (has played a role in nominating board members for around half of the institutes in the block-funding system). The RCN strategy for the institute sector acknowledged that dialogue with the institutes needed to be improved and its role in the governance of the institutes clarified. In particular, RCN's role in appointing members to the research institute's boards has been left ambiguous. The institute sector has not been well represented on the RCN's governing bodies, something that has only recently been addressed. RCN's prerogative to nominate board members is now being phased out.

Conclusions on public research institutes

The institute sector is a key actor in the Norwegian innovation system. It is strong in terms of the quality and relevance of R&D and dominates Norwegian R&D in engineering and technology areas, particularly in areas such as geological engineering, petroleum engineering and ocean engineering, which are also areas of high impact measured by number of citations. By international standards, the Norwegian institute sector is bigger in terms of number of organisations, more prominent in terms of their contribution to national R&D, but more fragmented and diverse, and also comparatively less generously funded in terms of their non-competitive base funding. Despite a low share of basic funding, the institute sector is highly dependent on public sector funding, via competitive funding, commissioned research for the public sector and other income from ministries. However, RCN's efforts and ability to steer the institute's activities have been limited.

An important mission of the institute sector is to supply high-quality research of relevance to industry, the public sector and society at large. The policy governing the institutes has in recent years evolved towards clearer and more precise performance criteria based on research excellence, doctoral training, internationalisation and privately commissioned research. However, the low share of basic funding, as well as the multiple ownership and independent legal status of the institutes, has limited the RCN's capacity to guide the institutes towards particular policy goals, including support for system transition. The steering capacity of the RCN and its principals has as a result been piecemeal, in the form of specific activities and sources of funding, for instance with the STIM-EU or additional PhD funding for some of the institutes. It is questionable whether these efforts are sufficient to support capacity building in the institute sector.

The block funding system has been implemented unevenly across funding arenas, in terms of the use of strategic programmes and the weight of the performance-based component across the different arenas. Ministries have in some cases shown reluctance to transfer their core funding to the performance-based part of their funding arena. A more uniform application of the performance-based component has been called for, increasing its weight in arenas that have the lowest share. The 10% share already seems to shape institutes' incentives towards activities such as publishing. A higher share could have a distorting effect on the institutes' activities and exacerbate existing tensions between, for instance, efforts towards publishing and industrial engagement.

Table 4.2. **Summary of inputs and outputs of the public research instutute sector**

Main elements of diagnostic
Research institute sector inputs
– Among the 100 organisations in the PRI sector in 2017, 44 research institutes, accounting for 70% of the total R&D in the sector, receive block funding.
– The sector in Norway is comparatively larger than in other countries in terms of number of research institutes, but also more fragmented in terms of the average institute size.
– R&D expenditures of the PRI sector increased at a slower pace than those of universities and business companies, which now account for a larger share of the GERD.
– Research institutes account for a larger share of R&D expenditures than in most comparator countries and all Nordic countries.
– Research institutes in Norway are specialised in applied research for industry and the public sector and conduct relatively less fundamental research.
– The sector's share of block funding is significantly lower (11% of total funding) than in most comparator countries, especially for TI institutes (6%).
– Income from industry has increased, despite the stagnation of revenue from the oil and gas sector.
Research institute sector outputs
– Publications of the institute sector have significantly increased between 2007 and 2015.
– The scientific production of PRIs, as well as their productivity per FTE staff remain lower than the HEIs'.
– The citation impact of PRIs, compared to the HEI and health sectors in Norway and to the institute sector in Sweden and Denmark, is high.
– Data over the two last decades do not show a significant increase in the number of patents applied for by PRIs.
– Despite their positive economic impact, patent, spin-off and licensing activities remain a marginal activity for most institutes.
– The role of the institutes in doctoral training in recent years has been increased, in line with the guidance of the Long-Term Plan for research and higher education 2015-2024 and of the RCN's strategy for the research institute sector 2014-2018.
– Consolidating the use of PhD training could help institutes develop and renew capabilities.

RCN's strategy for the institute sector suggested that more funds be channelled through the competitive calls for research projects and away from direct funding from ministries. However, short-term competitive projects are already a big component of institute funding and unlikely to lead to long-term capacity building. The different calls and programmes come with a multitude of signals that can distort the developmental paths of PRIs. Institutes often cannot choose where to apply for grants but have to hunt for every opportunity. The low block funds, and the varying signals and multiple requirements of RCN programmes, often preclude building strategic portfolios in PRIs.

Levels of block funds are too low, given the obvious need for more strategic research agendas and new customer groups. Greater efforts are called for, both through more block funds without strings attached, and in the form of strategic funding schemes for long-term, cross-sectoral, multidisciplinary projects that can support Norway's industrial transition. For instance, an instrument similar to, albeit better resourced than, the old Strategic Institute Programmes in place before the 2009 reform, could give institutes a platform from which to develop long-term capacity.

The PRI sector is therefore in need of ample programme and project funding to secure its short-term future and has difficulties consolidating and growing, in size, ambition and new markets. RCN allocates more than 40% of its budget to the institute sector and has strategic responsibility for it. However, it cannot boldly help this sector to grow in size, find new customer groups and reduce the existing systemic co-dependencies between institutes and industry. (Short-termism, outsourcing of industrial R&D, "clubs" of incumbent companies with recurrent collaboration are among the possible drawbacks.) A first step to alleviate this co-dependency would be to increase the room for manoeuvre for the PRIs by raising the amount of block funding (in part unconditional, in part linked to criteria and incentives, see below). The current transition imperative for the Norwegian economy is an additional argument for such a step.

The institutes play a key role in the competitiveness of the Norwegian industry. The institute sector has a very close relationship with industry, and many companies outsource a significant share of R&D to the institutes. To some extent, the institutes act as substitutes for these firms' internal R&D. Collaboration with institutes has been found to add significant value to firms' innovation and profitability. This symbiotic relationship means that the institute sector can potentially play a key role in the transition process. Recent evaluations of the research institutes have identified a number of potential barriers preventing the institutes from effectively delivering on this role. Firstly, their financial situation may not be robust enough to build existing and new technological competences. Their low base funding means that institutes do not have sufficient space to develop and upgrade capacities. Further, the evaluation of TI institutes noted a certain inertia in the institutes' activities. They appeared to be more focused on well-honed methods and activities (exploitation) than on exploring new market and technological opportunities. Most of the users of institute services are returning clients, which may reduce the institutes' capacity to learn from their clients and engage in strategic long-term thinking. The TI institute's clients rated them lowest for their market intelligence, noting a shortage of staff with industry background and a distinct disinclination to engage in forward-looking, strategic dialogues, with potential new clients and other partners. Some institutes thus face a tension between staying in business and thinking strategically, which may constitute a barrier to industrial diversification.

The institutes' relationships with universities has increased significantly. There is nevertheless room for greater collaboration, particularly in doctoral education. Collaboration agreements can be reinforced for the delivery of doctoral training, particularly in disciplines such as health, natural sciences and engineering subjects. The RCN strategy for the institute sector 2014-18 emphasised the need to identify and address barriers to co-operation between the research institute and HEIs.

The combination of a competitive funding system around collaborative projects, the low innovation intensity of Norwegian firms and the relatively low base funding of institutes suggests that the system may be locked in existing relationships between incumbent industries and leading research institutes, rather than opening up opportunities for renewal and competence development in new and relevant areas. An increase in the base funding should be considered, at least for institutes with good performance that have a low share of block funding. These additional and, in part, unconditional funds should be linked to the institutes that demonstrate their ability to contribute to the industrial or societal transition. A more strategic approach could be based on dialogue (including in the context of possible mergers). Performance agreements (for example using indicators associated with knowledge transfer and industrial diversification activities) would also help advance this agenda. International experience shows that enhancing collaboration with universities and consolidating the use of PhD training – as suggested in the LTP – can also help the institutes develop and renew their capabilities. Intervention on the supply side could help shaping incentives for research institutes to undertake research directed towards future needs and the needs of innovating firms. Demand-side schemes like innovation vouchers, which have been little used, could encourage firms to reach out to research institutes for the first time.

The Long-Term Plan stresses the need to support innovation, start-ups and commercialisation based on research. Some institutes' good performance in terms of generating patents and licenses has been found to have a strong positive, indirect economic effect. Licensing, patenting and spin-off are a relatively marginal activity for most institutes, which do not have the necessary incentives and clear guidelines to encourage them to pursue them. Overcoming potential barriers for research institutes' knowledge-transfer activities and supporting them with better guidelines and additional funding should be made a priority. This would include dedicated commercialisation funds, and/or the inclusion of knowledge-transfer indicators, in the performance-based funding system (including, but not limited to, commercialisation).

Infrastructure is key for the institute sector, requiring significant investment in the acquisition, maintenance and upgrading of large-scale research infrastructure, such as the Ocean Space Centre to be established in Trondheim, as explicitly referred to in the Long-Term Plan. Besides infrastructure for research, it has been suggested (RCN, 2015a) that relatively less attention has been paid in the RCN infrastructure strategy to innovation infrastructure, namely facilities for testing and demonstration. In order to support industry access to such facilities, the 2017 budget allocated NOK 50 million to a new programme ("Norwegian Catapult"), to develop multi-user facilities for testing, piloting, visualisation and simulation. Siva will administer the scheme in collaboration with other funding agencies.

In contrast to the largest and best-performing institutes, the fragmentation and relatively small size of many institutes is a constraint. This holds them back from competing in international arenas and developing quality and competence. A number of voluntary mergers have taken place in recent years to build critical mass in PRIs, in some cases involving the merging of two or more institutes, and in other cases merging with HEIs. Restructuring is ongoing and likely to increase in the future. In addition to encouraging formal mergers of institutes, there is scope for generating greater synergies between them.

Norwegian research institutes have traditionally maintained close connections with the university sector. They co-operate on joint projects, co-publications, doctoral projects and through joint affiliations, and in other formal and informal ways. However, the functions of universities and applied research institutes increasingly overlap, with universities extending their role towards applied research and consultancy activities directly with industry, and the institutes becoming more actively engaged in education activities. There are many instances of synergies between institutes and universities, sometimes leading to mergers or to close partnerships such as the one between NTNU and SINTEF. It could be argued that the activities and areas of specialisation of the institutes and universities are different and complementary rather than in competition, and that industry appears to use institutes and universities for different activities and purposes. There is thus no evidence that this overlap is significant and problematic at present. However, maintaining clearly defined roles and responsibilities between the two sectors that encourage collaboration between HEIs and institutes is important.

Table 4.3. **Achievements and challenges related to the public research instutute sector**

Achievements and progress	Remaining challenges
Public research institutes' collaborative activities	
– A close relationship between Norway's institute sector and industry has been developed, as indicated by a survey of firms, public research institute evaluations and Skattefunn monitoring data. – Collaboration with institutes has had a positive effect on firms' economic performance. – RCN incentivises collaboration with industry in its programmes. – While the overlap between the roles of the institutes and universities has raised some concern, the balance of industry R&D going to the institutes and higher education has remained stable in recent years.	– Dependence of PRIs on industry contracts tend to restrict them to short-term research. – Collaboration with PRIs appears too often to be a substitute for, rather than a complement to, firms' in-house research (although this is difficult to measure). – Questions have been raised over PRIs' contribution to the emergence of new areas. – Insufficient collaboration between institutes
Governance and strategic steering of PRIs	
– The specific guidelines governing the use of the block funding by the 44 institutes makes it possible to enhance the consistency of rules and obligations across the different types of institutions. – Strategic institute initiatives (SIS) complement the basic allocation in the primary and environmental institutes and allow the development of long-term expertise in the institutes' fields of research. – Despite its modest share of the block funding, the performance-based component for PRIs has proved effective in influencing institutes' behaviour.	– Norwegian PRIs are subject to a lesser degree of oversight and decision-making power over their budgets and strategic missions than most of their foreign counterparts (in particular through performance agreements). – The Norwegian PRI funding model's ability to finance the forward-looking and multidisciplinary activities needed for the economy to make a major transition remains in some doubt. – RCN has limited capacity to strategically guide public research institutes. – There are few incentives and demand-side schemes such as innovation vouchers, to encourage firms to reach out to research institutes for the first time.

Commercialisation of research in universities

Universities and other HEIs are expected to play multiple and ever-increasing roles in innovation systems, in addition to the traditional roles of research and teaching, including the contribution to the economic and welfare development of their surrounding regions. The third mission of universities is increasingly acknowledged and supported in Norwegian universities and colleges, and the Long-Term Plan emphasises the contribution of research and education to societal and economic development.

Governments in most OECD countries actively support the "third mission" of universities in addition to teaching and research in order to stimulate and strengthened the relationships between the actors in the "knowledge triangle". For instance in England, the Higher Education Innovation Fund (HEIF) supports universities to work with business, public and third-sector organisations.

In Norway, industry funding stands at 4.1% of R&D performed in the HE sector (HERD), which is moderate by international standards. Variation in industry share of HE R&D can be explained by a range of factors, including the size and organisation of the HE sector and differences in core institutional funding. According to the 2015 Norwegian innovation survey, around 5% of all firms reported having links with HEIs. Considering only firms with innovation activity, this ratio goes up to 13% and 33% in the case of firms involved in innovation collaboration. HEIs are also frequent research partners in Skattefunn funded collaborative projects, with a participation of around 30% of the collaborative Skattefunn projects in 2014, after research institutes (50%) (RCN, 2016a).

Regulatory and policy reform of research commercialisation in universities

A series of legislative changes in the early 2000s in Norway gave universities a mandate to develop the incentives and framework conditions for commercialisation of academic research. The so-called professors' privilege was removed and universities were required to promote the diffusion and application of research, and become more active in commercialisation. Universities have since then increasingly set up technology transfer offices (TTOs) and other infrastructure, such as science parks and incubators, to link up with industry. Similar legislative changes took place in Germany, Austria, Denmark, Norway and Finland during the same period, while Sweden has maintained its professors' privilege. It is unclear, however, whether these changes have led to increases in academic patenting. Some studies have found a sharp decline in the quantity of start-ups and patenting by Norwegian university researchers (Hvide and Jones, 2016).

Changes in the governance structures of universities have also been introduced to strengthen the links between universities, industry and the broader society. For instance, universities have been mandated to incorporate in their governing boards external members representing society and working life and establish "Councils for Co-operation with Working Life" (RAS) tasked with ensuring relevance in education (see Chapter 3).

Norwegian universities are increasingly expected to play a strong third-mission role. There is no dedicated separate government funding stream for universities to support third-mission activities as exists for instance in the United Kingdom. However, since 2017, the performance-based funding system includes an indicator for contract research and sponsored funding (grant-supported activities). No similar incentives exist for staff to engage in research commercialisation (patents, spin-outs, licensing income) in external engagement related to teaching (internships, engagement of external actors in the curricula, continuous education) or outreach activities. In the framework of a pilot initiative, some universities are encouraged to develop their own approach through institutional performance agreements negotiated with MER. Norwegian universities thus differ in the extent to which they see themselves as a regional, national or even international institutions (Borlaug et al., 2016, see Box 4.2).

Despite the lack of an explicit policy for the regional mission of universities, a number of instruments encourage the development of collaborative research links between universities and regional stakeholders, including the Norwegian Clusters programme, the Programme for Regional R&D and innovation programme (VRI) and the centres for research-based innovation (SFI). However, these initiatives tend to benefit those regions with more dense industrial configurations, populated with users more able to co-fund research rather than those regions arguably most in need of regional investments (Benneworth et al, 2017).

Contribution of universities to research commercialisation and economic development

Evaluations of the system of research commercialisation in Norway suggest that, while the system is still immature and fragmented, a fairly well-functioning system of commercialisation has developed around several universities, supported by more professionalised TTOs and a more effective system of project selection and entrepreneurship and funding support (Borlaug et al., 2009; Spilling et al., 2015;). Over time, many universities, institutes and hospitals have established joint TTOs or merged existing ones to encourage critical mass and specialised expertise (for instance in Oslo and Tromsø). *Bergen Teknologioverføring* (BTO) is unusual in this respect since it was already set up in 2005 to serve all research institutions in Bergen (including the hospitals, the universities and the Institute of Marine Research), which makes it a long-standing actor and key intermediary in the regional innovation ecosystem of Bergen.

Box 4.2. **Different engagement profiles of Norwegian universities: UiT and NTNU**

The Artic University of Norway (UiT) is an example of a regionally oriented university. UiT is a multi-campus universities located in Nordland, Tromsø and Finnmark which emerged out of the merger of the University of Tromsø with the University College of Tromsø. In 2009, it developed a central strategy encompassing the missions of research education and innovation and aimed at contributing to the economic, cultural and social development of the High North. The strategy has consisted of several pillars, namely the development of research-based and innovative education of relevance to industry and working life; commercialisation and research and innovation collaboration with applied research institutes and industry; research in areas of relevance to the region (such as energy production and the sustainable use of marine resources, as well as areas related to public health and welfare services). Initiatives geared towards increasing co-operation with industry and working life have included the creation of a Council for co-operation with working life (RSA), the centre for career and working life and the creation of "industry professor" positions held by people from industry to contribute to education activities. It also offers entrepreneurship education offered through the Masters programme in Business Creation and Entrepreneurship at the School of Business and Economics, which includes teaching from academic staff and business sector representatives, as well as practical training in developing entrepreneurial ideas or innovation projects. Commercialisation support and incubation services are provided by Norinnova Technology Transfer (NTT), which is the TTO for UiT and the University Hospital of North Norway (UNN), which a particular focus in areas such as marine biotechnology.

NTNU has adopted a different strategy based on national and international research. NTNU is one of the more traditional universities in Norway, as well as the largest university with nearly 40 000 students and a leading institution for technology development in Norway. Knowledge transfer is an integral part of NTNU activities, with significant investment in infrastructure for commercialisation of research and entrepreneurship education. This commitment to entrepreneurship and innovation is embedded in its governing structures, which include a pro-rector for innovation alongside a pro-rector for education and a pro-rector for research. Instruments and structures directed at co-operation with industry include the co-operation forums for the development of educational programmes with industry; Technoport, an initiative aimed at providing meeting arenas for industry, researchers, students investors and entrepreneurs. They have also developed a range of entrepreneurship education initiatives, including a master programme in entrepreneurship, and a number of mentoring (e.g. Spark NTNU), idea contests (such as AppLab), internships in the TTO for commercialisation projects. Technology transfer and incubation is supported by the NTNU Technology Transfer (TTO), as well as the Innovation centre at Gløshaugen and the NTNU Accel providing support for knowledge-based start-ups.

Source: Borlaug, S. et al. (2016), "The knowledge triangle in policy and institutional practices: The case of Norway", www.nifu.no/en/publications/1424180.

Further, while scientists appear to have a more positive attitude towards commercialisation than was the case in the past, missing incentives for commercialisation are preventing a more active engagement with industry. Against this backdrop, Spilling et al. (2015) recommended a better integration of commercialisation activities within HEIs broader activities and institutional strategies, a better alignment of expectations regarding commercialisation and collaboration with industry with the funding agreements of HEIs, and a better system of reporting of commercialisation activities of universities.

Beyond commercialisation activities, the contribution of universities to economic development occurs through a wider range of mechanisms and actors. In fact commercialisation of formal IP is a relatively infrequent form of interaction compared to other means such as consultancy and training activities and Norway is no exception to this. A recent survey (Thune et al., 2014; 2016) reported that a relatively small percentage (7-8%) of academics are involved in research collaboration with private industry, of which only 13% were involved in commercialisation activities. Collaboration was by contrast more extensive with the public sector and with hospitals (30% and 17% respectively). Exchange mainly happened through dissemination of research to user groups and the general public (78%), training (including continuing education and training of employees outside campus) (59%) and research collaboration (32%). While 44% of surveyed staff participate in industry-oriented continuing education programmes, particularly in state university colleges, relatively little attention has been paid to continuing education as mechanism for engagement (Borlaug et al., 2016). The LTP seems to also neglect the innovation-education forms of knowledge exchange in addition to traditional forms of technology transfer. The recent white paper on industrial policy (MTIF, 2017), by contrast stress the importance of vocational education and the need to strengthen the college sector.

The differentiated role that university colleges play in commercialisation and knowledge exchange in their regions has tended to receive relatively little attention (Herstad and Brekke, 2012). Compared to universities, university colleges have a more extensive interaction with regional private and public actors, and are more active when it comes to offering industry-oriented continuing education (Spilling et al, 2014).

As previously mentioned (see Chapter 3), the current focus on world-class research excellence in Norway may come at the expense of local relevance, with universities potentially changing their research, teaching and engagement activities in order to fulfil the performance expectations associated with the current funding model. National level policies on HE teaching, research and administration – driving mergers and increased centralisation – may be unintentionally crowding out the regional engagement activities of universities in Norway, for which there are no incentives (Benneworth et al., 2017) and may endanger the traditional role of regionally oriented universities located in more peripheral areas.

Policy to support research-based innovation

The Long-Term Plan emphasises the need to facilitate research-based new businesses and commercialisation of public research results, and announced the strengthening of the FORNY (Commercialisation of R&D Results) programme. FORNY is the main support mechanism for commercialisation of public funded research in Norway. It provides funding mainly to TTOs and research institutions (universities, colleges, research institutes and university hospitals) for infrastructure activities and commercialisation projects. FORNY was reorganised in 2011 with a clearer focus on creating value and stricter selection criteria. The revised FORNY2020 programme focuses more on proof-of-concept project funding and less on basic infrastructure funding. FORNY2020 also includes a scholarship programme of NOK25 million to promote student entrepreneurship.

Another mechanism for enabling collaboration between innovation and research is the Centre for Research-based Innovation (SFI). Modelled after competence centre schemes found in other countries such as Australia, Sweden and the United States, the Centres for Research-based Innovation (SFI) scheme was introduced in 2007 with the aim of supporting business sector innovation through collaboration between research-intensive firms and research institutions. They receive substantial funding (around NOK 10 million per year from RCN, match funded by partners) over a period of up to 8 years to research groups that collaborate with public/industrial partners. SFI can be hosted at a university, university college, research institute or an enterprise.

Thirty-eight centres have received SFI status so far, 14 during the period 2007-15. Seven were established in 2011, and 17 in 2015. One SFI has been hosted by an industry partner (Microsoft Development Center Norway), 15 by research institutes, 16 by universities, 4 by university hospitals and 2 by university colleges. These tend to be strong research organisations. For instance NTNU has hosted ten SFIs (seven currently) and is a partner in eight of them. SINTEF has hosted 6 SFIs. More than half are hosted by SINTEF or NTNU, or have either one as research partner.

The mid-term evaluation of the first centres (RCN, 2010) found the SFI to be a very important tool for stimulating of research-based innovation. It pointed to some areas for improvement, including a more active participation of all partners in the generation of new projects, greater international visibility, the need for an international scientific advisory board and a development plan for PhD students.

Conclusions on research commercialisation

The LTP stresses the importance of knowledge sharing across the business community, academia and investor groups through strengthening the commercialisation system. The last decade has witnessed sustained efforts towards developing a commercialisation infrastructure, particularly the establishment of technology transfer offices, science parks and incubators. As a result, a fairly well-developed system of commercialisation has emerged, and the third mission is increasingly acknowledged and supported in universities and colleges. However, the third mission is not integrated in the university-wide strategies except in a few cases, most notably NTNU, where innovation and knowledge transfer is deeply embedded in its governing structures.

Norway does not have a comprehensive mechanism for incentivising knowledge-exchange activity of its universities. Support for commercialisation support has an implicit linear model of knowledge transfer that neglects the diversity of knowledge-transfer modes (e.g. through training and continuing education), actors (not just in industry but also in the public sector and hospitals) and universities (different roles of universities and colleges). Acknowledging this diversity in knowledge diffusion is important for Norway's economic transition but may at present not be sufficiently encouraged by a system overly preoccupied by academic excellence.

Table 4.4. **Achievements and challenges related to research commercialisation**

Achievements and progress	Remaining challenges
– A fairly well-functioning system of commercialisation has developed around several universities, supported by more professionalised technology transfer offices. – Researchers now take an increasingly positive attitude towards commercialisation. – Centres for Research-Based Innovation (SFI) have been evaluated as a very important tool for stimulating research-based innovation.	– Limited incentives for commercialisation in higher education institutions – Lack of support and attention to industry-oriented continuing education programmes (including in the Long-Term Plan) – The third mission is not integrated in the higher education instutions' strategies. – No dedicated mechanism for incentivising knowledge-exchange activity of higher education instutions

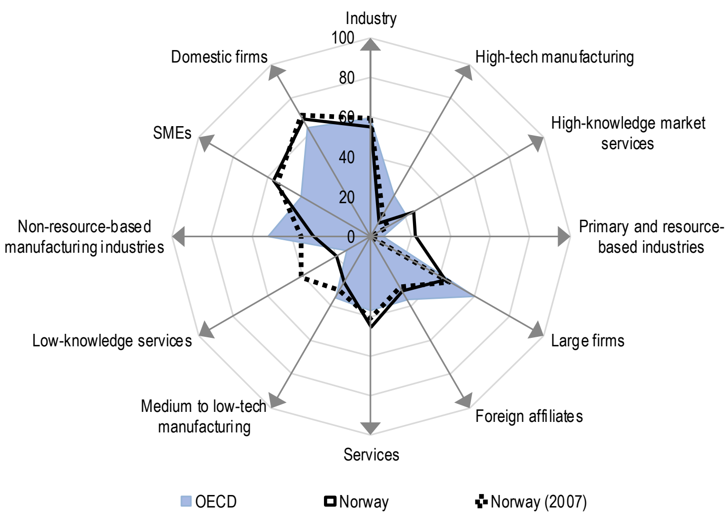
Innovation in business firms in Norway

Business firms' R&D and innovation capacity

Business firms' R&D

BERD intensity (BERD as a per cent of GDP) in Norway has increased over the last decade (from 0.79% in 2005 to 1.05% in 2015). However, it remains below the OECD average (1.09% in 2015) and the shares in other Nordic countries (around 2%).This low performance is partially explained by the structure of the Norwegian economy, with its significant share of commodity-based activities and few industries of high R&D intensity (see Figure 4.10). Norwegian innovation is closer to "doing, using and interacting" than to science, technology, and innovation (STI) modes of innovation (Jensen et al., 2007). This may mean that much of Norway's innovation activity is not reported in official statistics (Cooke, 2016). Adjusting for industry structure[10] brings the business R&D intensity for Norway closer to the OECD average (OECD, 2013; 2015a).

Figure 4.10. **Structural composition of business enterprise R&D, 2013**



Source: OECD (2016e), OECD (2016), *OECD Science, Technology and Innovation Outlook 2016*, http://dx.doi.org/10.1787/sti_in_outlook-2016-en.

Compared to the OECD average, a large proportion of R&D is performed by SMEs in Norway (see Figure 4.10). The largest 100 R&D performing firms are responsible for less than half of the total business R&D expenditures in Norway. There are relatively few large R&D-intensive companies in Norway. The main R&D performing firms are in the oil and gas sector, with the state-owned company Statoil heading this group. State ownership remains extensive in Norway, with around 11% of total employment (OECD, 2016a), not only in oil and gas but also in telecommunications (Telenor), energy and aluminium production (Norsk Hydro), chemicals (Yara International, ASA), banking and financial services (DNB Bank) and manufacturing (Kongsberg Gruppen). Only 10 Norwegian companies appear in the list of the world's top 2 500 R&D companies (European Commission, 2016, see Table 4.5). A large proportion of R&D in the petroleum sector is performed outside the companies, generally in research institutes serving the sector.

Table 4.5. **The ten largest R&D performers in Norway, 2016**

World rank	Name	Industrial sector	R&D, million EUR (2015/16)	Sales, million EUR (2015/16)	R&D intensity, %	Employees (2015/16)
386	Statoil	Oil and gas producers	281.5	50 336.5	0.6	22 300
741	Visma	Software and computer services	124.4	869.3	14.3	0
763	DNB	Banking and financial services	120.3	5 629.3	2.1	11 380
955	Kongsberg Gruppen	Aerospace and defense	88.4	1 775.7	5.0	7 688
1 127	Telenor	Telecommunications, IT and media	70.7	13 363.5	0.5	35 000
1 186	Aker Solutions	Oil equipment, services and distribution	66.9	3 325.5	2.0	15 395
1 655	Norsk Hydro	Industrial metals and mining	40.6	9 142.9	0.4	13 263
1 726	Petroleum Geo Services	Oil equipment, services and distribution	38.1	883.5	4.3	2 153
2 071	Tomra Systems	Industrial engineering	29.0	645.7	4.5	2 475
2 198	Orkla	General industrials	26.3	3 399.9	0.8	14 532

Notes: The data used for the Scoreboard are different from BERD data provided by statistical offices. The Scoreboard refers to all R&D financed by a particular company from its own funds, independent of where that R&D activity is performed, while BERD refers to all R&D activities performed by businesses within a particular sector and territory.

Source: European Commission (2016), "The 2016 EU Industrial R&D Investment Scoreboard", http://iri.jrc.ec.europa.eu/scoreboard16.html (accessed 10 February 2017).

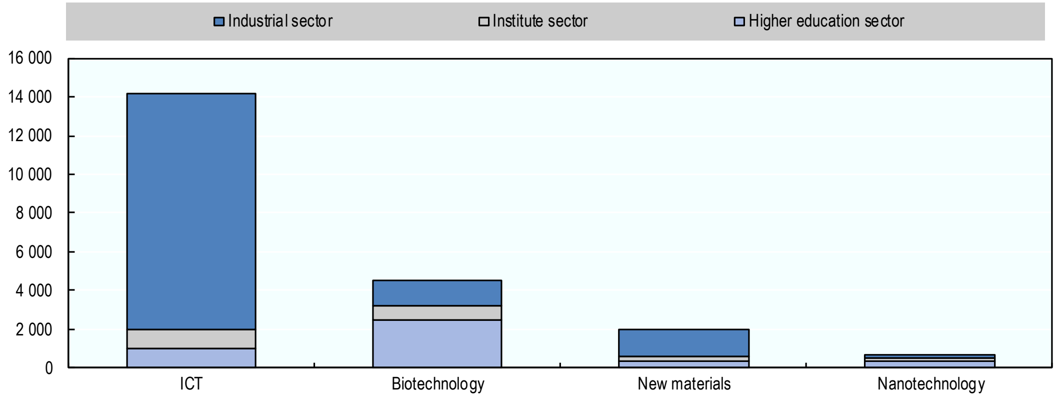
Despite its relatively low share of total GERD by international standards, Norway's business R&D spending has been one of the fastest-growing in recent years, with an increase of 12% between 2014 and 2015 (9% at constant prices).[11] As in other countries, its service industries have experienced the strongest growth in R&D, and now account for more than half of private R&D. Geographically, the capital region (Oslo and Akershus) dominates R&D spending with 42% of the total, followed by Trøndelag and Western Norway. Oslo, Sør-Trøndelag, Akershus and Hordaland were the four largest counties in terms of R&D and accounted for around 70% of Norwegian R&D expenditure in 2014. Trøndelag has the highest R&D expenditure per capita. The share of industrial R&D in the capital region is just below the national average. It is substantially higher in South-Eastern Norway, while in Northern Norway the share of industrial R&D is very low compared to higher education.

With regards to the enabling technologies identified as national priority areas by the Long-Term Plan, the industrial sector dominates expenditure in new materials and ICT, while the higher education sector accounts for more than half of R&D expenditures in biotechnology and nanotechnology (Figure 4.11). Health trusts are key R&D performers in biotechnology. Since 2013, R&D expenditures in ICT have grown more than NOK 2.5 billion in current prices, and biotechnology has also experienced considerable growth (by almost NOK 1 billion).

In the last few years, R&D personnel levels have grown faster in industry than total industry employment. The industrial sector has seen the strongest growth in R&D employment, compared with the higher education and the institute sector (see Chapter 2).

The service sector (with 55% of the total R&D FTEs) experienced a higher growth than manufacturing, with 8% and 5% growth respectively, between 2014-15. Within manufacturing (37% of the total) the highest growth has been in instrumentation, electrical equipment and machinery and equipment.

Figure 4.11. **R&D expenditures in selected technology areas, by sector, 2015**



Source: NIFU (2016).

Innovation in business

Norwegian enterprises reported innovation expenditure of NOK 59.7 billion in 2014, which accounted for 2.4% of the turnover of innovative enterprises, and 1.6% of turnover of all enterprises (RCN, 2015b). In terms of the results of innovation, 5.9% of the enterprises' combined turnover came from product innovations introduced during the three-year period from 2012-14.

The EU's 2015 Innovation Union Scoreboard (IUS) classifies Norway as a moderate innovator and places it in 16th place, just below the EU average and one position up from the previous three years. Looking at the indicators that make up the IUS, Norway is rated particularly low on indicators related to high-tech industries and research-based innovation.[12]

The relatively low performance of Norway in the IUS can be attributed to structural factors, in particular its industrial structure (with a high weight of commodity-based industries) and the high value of GDP. Another factor is its relatively low innovation rate, as reported by Norwegian firms in the Community Innovation Survey. However, data from the most recent Norwegian innovation surveys[13] show a much improved performance in these indicators, including a considerable increase in reported innovation activities by Norwegian firms. In the CIS 2014, the percentage of "innovative enterprises" is 57.6% in Norway, 49.1% in the EU and 50%, 54%, 55% in Denmark, Sseden and FInland respectively. Using these CIS 2014 figures for the relevant indicators in the IUS, the position of Norway would improve significantly, and rise several places in the IUS ranking (from 16th to 13th place).

As noted earlier (Chapter 2), new enterprise creation is of key importance for Norway if it is to secure long-term growth and diversification of the economy. Analyses undertaken by the Productivity Commission (NOU, 2016) and the OECD (2016a) suggest that Norway has an institutional setting and regulatory conditions conducive to venture creation. Moreover, new enterprise creation has increased in recent years (OECD, 2016a), start-ups are larger and enjoy a higher survival rate, and young SMEs contribute disproportionately to job creation in each country (although less than in most other comparator countries).

R&D and innovation policy

Recent evolution of innovation policy in Norway

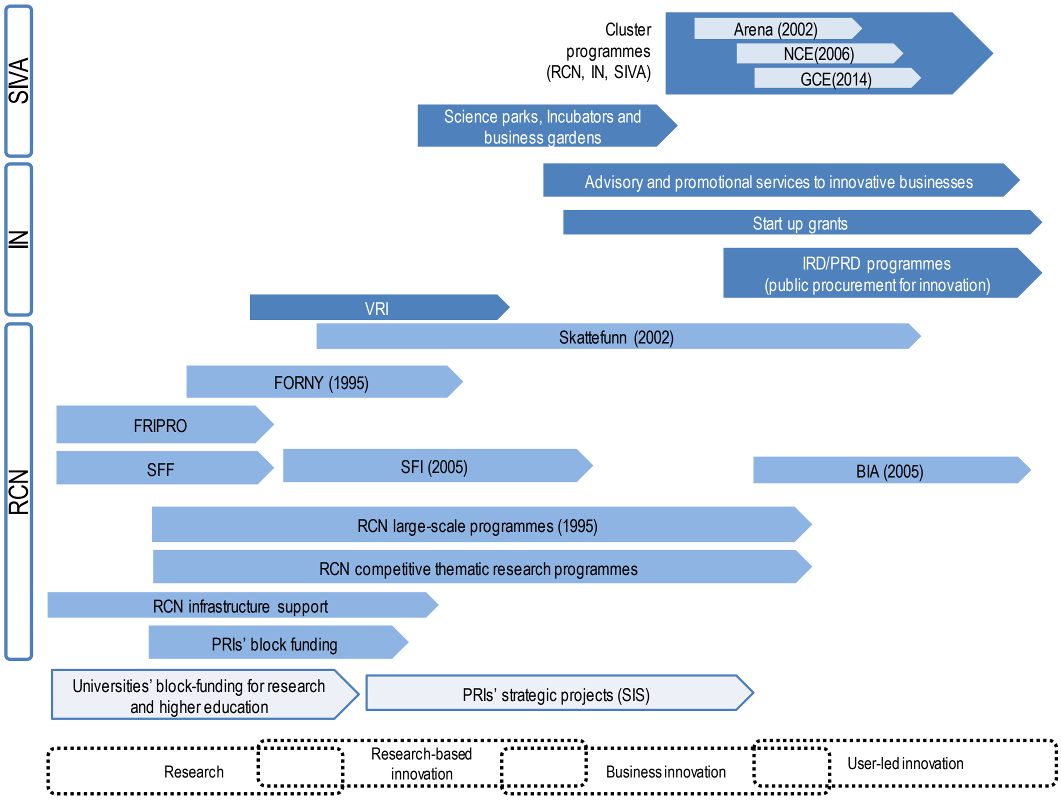
Stimulating R&D activity has been among Norway's main policy goal for decades, at different intensities depending on the period (see Chapter 6). In 2005, Norway, like many other countries, adopted the general target of increasing total R&D expenditure to 3% of GDP, in line with the original EU Lisbon strategy. The 2005 and 2009 research white papers proposed thematic priority areas around energy and the environment, oceans, food and health. The 2009 white paper placed a stronger emphasis on the challenges faced by the public sector and on global research perspectives, and proposed the introduction of national R&D strategies for biotechnology, nanotechnology and ICT. According to Arnold et al. (2011), the thematic priorities have tended to reflect existing structures and priorities, and as such, are conservative rather than disruptive. Private R&D and innovation were given renewed attention in the 2013 election, and placed emphasis on the need to take the economy in a more sustainable direction (Fagerberg, 2016). In 2014, the Long-Term Plan for Research and Higher Education reiterated these R&D intensity targets, stating that the 3% target should be reached in 2030, and setting three generic and four thematic priorities.

To support entrepreneurship, the "Entrepreneurship plan" launched in 2015 by the Ministry of Trade, Industry and Fisheries proposed a number of measures to improve access to capital for start-ups in an early stage, facilitate access to competence and make Norway an attractive place for entrepreneurs. The recent white paper on industrial policy (MTIF, 2017) "Industry: Greener, smarter and more innovative" expresses strong support for environmentally friendly development. It stresses the need to diversify from petroleum-based activities and contemplates a series of expedients for achieving this. These include increased funding for enabling technologies such as biotechnology, nanotechnology and ICT; greater use of procurement as a driving force for innovation; increasing the block funding of the TI institutes; and improving businesses' infrastructure access, in terms of testing, prototyping, etc.

Analysis of the policy mix

Support for business R&D and innovation is provided mainly through R&D tax credits, as well as in the form of grants and other financial and technical instruments. Like most advanced countries, Norway has broadened its portfolio of direct and indirect support to business R&D and innovation. The policy mix is now comprehensive, and covers the various needs of the different communities of research and innovation actors, throughout all stages of the innovation process (Figure 4.12). None of the numerous evaluations of the Norway STI system has revealed any major missing support instruments, and the debate has focused mainly on the balance between the types of initiatives. The policy mix reflects a division of labour between the different ministries and agencies (the Research Council of Norway [RCN], Innovation Norway [IN] and Siva), in charge of different but related dimensions of R&D policy, innovation policy and industrial policy, with some instruments jointly managed between the three agencies. Besides RCN and IN, the county municipalities also have responsibility for economic development and innovation, especially in relation to the regional research funds (RFF) and also in the regional collaborative initiatives of the Ten-Year Programme for Regional R&D and innovation (Virkemidler for regional Forskning og Utviklingsarbeid og innovasjon, VRI) programme.

Figure 4.12. **Overview of Norway's main research and innovation support schemes and programmes**



The share of direct and indirect funding is more or less evenly split in Norway, but the share of indirect funding has increased in recent years. From 2014 to 2015, the funding via Skattefunn has increased by 47%. By contrast, business R&D support in Sweden and Finland has mainly consisted of direct funding, while in Denmark, indirect support predominates over direct funding (see Figure 4.13).

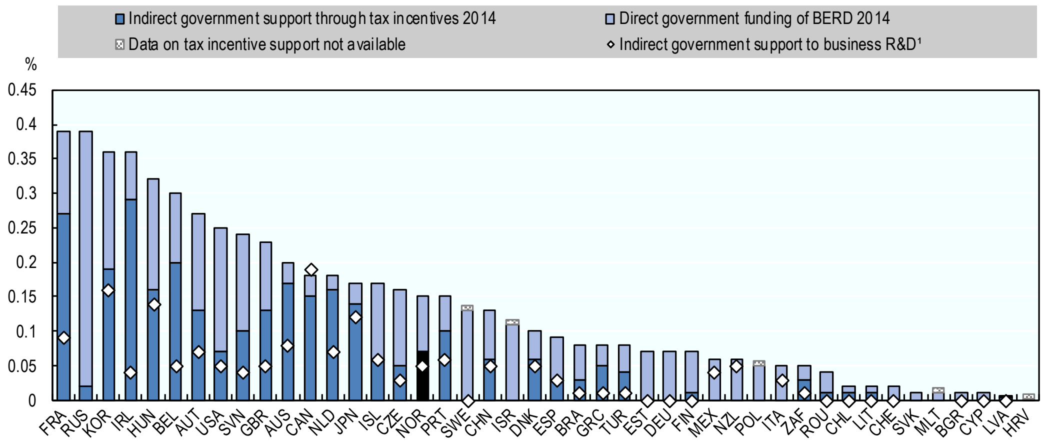
Between 2007 and 2015, direct government funding of business R&D increased nominally by 104%, while indirect support increased by 200%. In 2007, direct and indirect funding accounted for 57% and 42% of government-funded intramural business R&D respectively, while in 2015, these shares had changed to 47% and 53%.[14]

RCN provides R&D subsidies for firms in the form of research grants, mostly on a competitive basis. Innovation Norway provides a suite of services including funding, advice, competence building, networking and promotional services aimed at supporting entrepreneurs, companies with growth potential and innovative clusters.

The combined appropriations for research and innovation through IN, RCN and Skattefunn amounted to NOK 12.6 billion in 2014, NOK 1.3 billion higher than 2013. This increase was mainly due to a 30% increase in the budgeted tax deduction for Skattefunn projects, and a growth of 12% in RCN funding, while net grants from Innovation Norway were reduced by 3% compared with 2013 (RCN, 2015a). Allocations from the RCN and Skattefunn tend to be stronger in counties with a strong concentration of research and industrial R&D respectively, while the funding from Innovation Norway has a greater distributive effect, a larger share of its funding going to peripheral regions in the country.

Figure 4.13. **Direct government funding of business R&D and tax incentives for R&D, 2014**

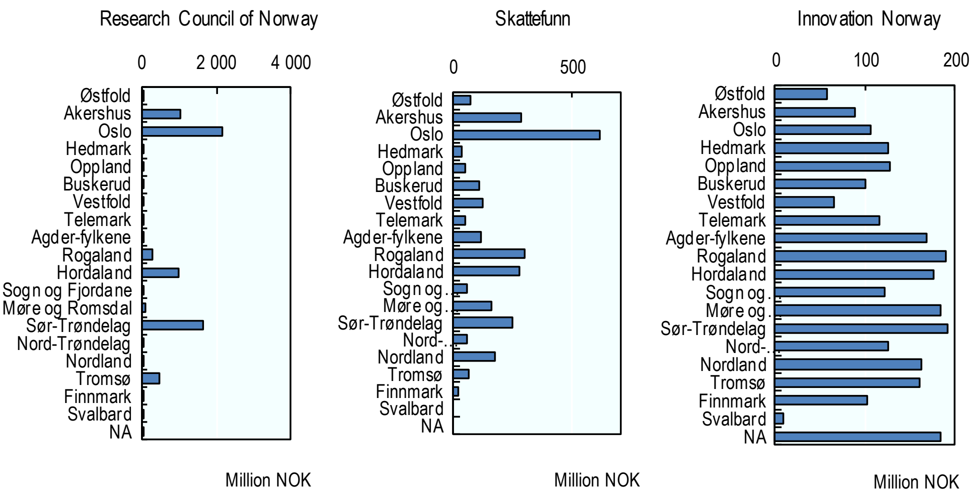
As a percentage of GDP



Note: 1. 2006 or nearest year, where available.

Source: OECD, R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm.

Figure 4.14. **Funding from the Research Council of Norway, tax deduction (Skattefunn) and net grants from Innovation Norway by county, 2014**



Source: RCN (2015b), *Report on Science and Technology Indicators for Norway*, www.forskningsradet.no/en/Report_on_Science__Technology_Indicators_for_Norway/ 1254017091560 (accessed 7 June 2017).

RCN business R&D funding instruments

RCN awarded approximately NOK 1.3 billion to industry through its various funding instruments in 2015. RCN's programme portfolio encompasses four programme categories: basic research programmes, large-scale programmes, policy-oriented programmes and user-directed innovation programmes. The industry share is around 60% in the user-driven programmes, and almost 20% in large-scale programmes.

User-driven programmes have grown significantly in recent years, with a growth in budget of 46% between 2011 and 2015. They represented around half of the RCN funding received by businesses. The main programme is BIA (*Brukerstyrt Innovasjonsarena*, or

User-Driven Research-Based Innovation), which part-funds (up to 50%) R&D projects of any industry for which there are no targeted RCN programmes to be developed in collaboration with companies and R&D institutions. Other user-driven innovation programmes with significant funding of industry actors include MAROFF (Maritime activities and offshore operations), BIONÆR (Sustainable innovation in food and bio-based industries), PETROMAKS2 (Large-scale Programme for Petroleum Research) and DEMO 2000 (Project-oriented technology development in the petroleum sector).

The large-scale programme focuses on eight areas: ICT, bio- and nanotechnology, aquaculture, energy, petroleum and climate change. Typically, the programme funds up to 50% of the project cost of the company and its R&D partners. The largest programmes in terms of funding in 2015 were ENERGIX, PETROMAKS, NANO2021 and HAVBRUK (aquaculture). The institute sector is the biggest recipient in the programmes, particularly the PETROMAKS2, BIONÆR and MAROFF, but industry participation is strong in the ENERGIX programme, with 37% of the funding (RCN, 2017b).

In recent years, RCN has placed greater focus on technology and technology transfer between the sectors, particularly between the petroleum sector and the maritime and marine sector (see Box 4.3).

Evaluations of RCN programmes (innovation projects in industry, IPN) are regularly undertaken (Bergem and Bremnes, 2014). Economic benefits identified have included competence building, innovation and dissemination and a positive input additionality, with firms reporting that without support, the projects would not have happened or would have been smaller in scale. A wider evaluation of the impact of innovation support instruments during 2001-13 (Cappelen et al., 2016), including RCN R&D programmes, Skattefunn, innovation-oriented instruments of Innovation Norway (IN) and export support programmes, revealed positive effects in value creation, sales income and employment. The effects increased with the amount of support, and showed no effects on productivity. This does not necessarily reflect a causal relationship, since many other factors can influence the likelihood of getting funding and the success of the measures.

This seems consistent with international comparative reviews (OECD, 2011; Cunningham et al., 2016) which find evidence of positive input additionality but less clear-cut evidence of impact in terms of new products or services, greater market shares, increased exports, employment, productivity or behavioural changes. The modes of implementation, in particular the selection process, marketing and advice for potential bidders, have been found to have a key influence on the adoption and success of R&D measures (OECD, 2011).

Innovation Norway's support for innovation and entrepreneurship

Innovation Norway provides funding and services with the aim of promoting innovation at the regional and national level, with a focus on small and medium-sized companies. The main target groups are entrepreneurs, young companies and SMEs with growth potential, which are assisted in four main key areas: internationalisation (assistance in the form of market advisory services and promotional services), funding (loans or grants), cluster support and advisory services/expertise in other areas of internationalisation. It supports all sectors, but a large percentage of allocated funding (approximately 25%) is with the agricultural sector. Of the funding, 43% is in the form of grants and around 50% in loans, of which only 20% are high-risk loans. Enterprises received 73% of the total funding in 2015, and entrepreneurs 18% (Innovation Norway, 2016).

Box 4.3. Seas and oceans: A successful example of the innovation-based growth of a sector

Economic activities in the marine sector represent a growing sector of Norway's economy. In recent years, aquaculture and seafood have grown steadily in importance as a source of income. In 2016, Norway was the second-largest export nation of seafood. It exported around NOK 92 billion to 146 countries, corresponding to 36 million meals every day. The value of Norway's seafood exports had increased by 23% since 2014, mostly due to an increase in aquaculture production in volume and, even more, value, since fisheries have been relatively stable.

Research and innovation have been crucial for the development of this industry. The success of Norway's aquaculture industry is a result of technologies that have made this industry more productive than in other countries since the 1970s. The quality of research in this area significantly contributed to this virtuous circle between innovation and economic value. In fisheries and aquaculture, Norwegian research is the 7th-largest in volume globally (4.2% of global publications) and in marine and freshwater biology, the 12th-largest in volume (2.5% of global publications). Norway is also very successful in Horizon2020 in these fields, with a success rate of approximately 11%.

According to NIFU, in 2015, NOK 4.7 billion was allocated to research and development in the seas and (including aquaculture, excluding the maritime and offshore sector), 8% of the total R&D expenditure in the country. Forty-five per cent of the research on marine activities is performed by the institutes, followed by universities (18%) and the business sector (36%). The RCN also promotes research and innovation in marine-related areas by means of a number of programmes. These include thematic research programmes such as MARINFORSK, HAVBRUK2, BIOTEK2021, BIONAER, MAROFF,the Norwegian centres of excellence, the Norwegian innovation clusters, as well as infrastructure.

To encourage collaboration and knowledge transfer between the petroleum sector and the maritime sector, and also other sectors such as aquaculture and fisheries, joint calls for proposals have been launched to provide funding for technology projects that would cross-cut the maritime industries with applications in the petroleum, renewable energy, fisheries and aquaculture sectors. One of the calls, for instance, consisted of joint efforts between the programmes ENERGIX (renewable energy), PETROMAKS2 (petroleum research) and MAROFF (Maritime activities and offshore operations), and another was undertaken jointly between the MAROFF and HAVBRUK2 programmes. The former call aims to leverage the knowledge and expertise from the petroleum industry in the renewable energy industry so it can be used to develop novel applications in areas such as offshore engineering, construction of wind turbine foundations, maintenance of offshore installations, etc. Its objective is also to support the transfer of technology of the renewable energy sector into the offshore oil and gas energy system. The latter call aims to use technology from the offshore industry to develop solutions to address environmental problems facing the aquaculture industry, for instance to develop solutions for offshore farming.

In 2016, approximately NOK 1.7 billion was allocated to ocean-related research and innovation programmes (including marine, maritime and offshore). Currently, exports of fish and fish products are subject to a fee of 0.3% that goes to R&D through the Norwegian Seafood Research Fund. Part of these funds are also managed by RCN.

To promote research and innovation in the maritime field, the initiative Hav21 (Ocean 21) was initiated by the Ministry of Fisheries and Coastal Affairs, to develop an integrated research strategy for the maritime and ocean economy. The steering committee of Hav21 included representatives from marine sector, industry, research institutions, public authorities and NGOs. However, the Hav21 committee convened only to formulate a strategy, and it is not a permanent committee.

Seas and oceans are one of the six long-term priorities of the Ministry of Education and Research's Long-Term Plan. As for the other priorities, working groups of experts have been created to draw it up. These working groups are re-enacted to participate in the discussions of the allocation of the budget to each priority area. In addition, in the framework of the LTP, the Ocean Space Center, a research facility in Trondheim, is being upgraded and expanded.

The government is developing a new strategy for the ocean economy, aiming to make Norway a global leader in the field. The strategy was published on 21 February 2017.

According to recent assessments, these efforts are yielding positive results (see Box 4.4). A key question, however, is the extent to which they can contribute to the economic transition. In order to work towards a more solid foundation for Norway's economic restructuring process, Innovation Norway initiated a strategic process during 2014-15 in consultation with Norwegian industry and other players. The"Dream Commitment" report that resulted from this exercise identified several opportunity areas for Norway's future, including clean energy, ocean space, bio-economy, tourism and creative industry, health and welfare and smart societies. There is strong overlap between the research priorities identified in the LTP and the opportunity areas identified by Innovation Norway's "Dream Commitment" report. However, it is unclear how the commitment to the priority areas will be co-ordinated between ministries and agencies and how Innovation Norway and RCN are working together on the objectives of the LTP.

This strategic orientation has not translated into new instruments, for which it has little room for manoeuvre. It has sought instead to steer existing tools, such as clusters and other instruments (loans and financial support), in order to promote greater connectivity across industries to support the opportunities identified. IN's strong regional presence and customer orientation puts it in a good position to identify such "crossover" opportunities. In one example of such innovation platforms, Cooke (2016) notes how in Hordaland, shipping activities are connecting oil, gas and marine engineering clusters with a thriving tourism sector (see also next section).

Box 4.4. **Evaluation of Innovation Norway innovation support**

The impact of innovation and entrepreneurship policies, particularly soft forms of intervention such as advisory services and cluster support, can be difficult to assess, given the difficulty of defining the units of input, the presence of confounding factors and given the length of time over which effects can build (Rigby and Ramlogan, 2016; Uyarra and Ramlogan, 2013). Many of the programmes to support entrepreneurship reviewed by Rigby and Ramlogan (2016) were not evaluated, and when they were, evaluations showed mixed results in terms of sales, employment and survival.

An evaluation of Innovation Norway conducted in 2010 concluded that the agency probably contributed to increased value creation. to the Norwegian economy. However, it recommended that it should have a clearer goal of supporting high-risk innovation and firms with an international orientation, and that it should further simplify and prioritise support for business. As a result, internationalisation and early-stage support have received greater attention in recent years. IN has also attempted to reduce the complexity of supporting businesses, developing a simpler, web-based interface with customers and simplifying funding applications. Statistics Norway estimates that enterprises that were supported by Innovation Norway achieved 9.7% percentage points higher growth in 2015 than similar, non-supported firms; 2.5% higher productivity growth and 0.3% higher return on capital. However, these results are similar or lower (for productivity growth and profitability) than the effects found for 2013.

Not all elements of IN have been found to be equally effective. According to a recent evaluation (Cappelen et al., 2015) participation in IN's innovation and regional development programmes resulted in improved performance in terms of employment, sales revenues and valued added in firms, while no effect was observed on labour productivity and returns to total assets. Firms that participated in cluster programmes also exhibited higher sales and employment in the immediate period after enrolment. In relation to lending activities, the evaluation found no evidence that the commercial and low-risk loans enhanced firms' performance. The programmes targeting start-up firms did not appear to improve the chances of a firm's survival, compared to those of a control group.

Source: Innovation Norway (2015), "Norwegian Clusters 2015: For the future's innovative industries", www.innovationclusters.no/globalassets/filer/nic/publikasjoner/norwegian-clusters-2015.pdf.

Siva support for innovation and technology transfer

Complementing Innovation Norway’s innovation promotion activities, Siva supports industry through physical and organisational infrastructure for innovation. Siva operates throughout Norway, but has a special responsibility to promote growth in rural areas.

Its main instruments are the incubation and business garden programmes, which include 35 incubators and 39 business gardens, normally in rural areas; investment in real estate and infrastructure; and the ownership of around 84 so-called innovation companies, both small and large. Many of these innovation companies are, in addition to managing assignments from other public and private stakeholders, operators of Siva’s industrial cluster and incubation programmes, or providers of front-line service and various business development projects.

Since 2002, Siva’s real estate business has been handled by a separate subsidiary, Siva Eiendom Holding AS (SEH). Siva’s property portfolio consists mainly of industrial and production buildings, commercial parks and buildings, and research and knowledge parks. In the past ten years, the composition of its property portfolio has changed, shifting from an emphasis on industrial and production buildings to commercial buildings and knowledge and research parks (Jakobsen et al., 2015). A recent evaluation of Siva’s real estate activities suggested that there are substantial synergies between property and innovation activities, and that these could be increased by integrating the physical organisation of collaborative activities with innovation activities (Jakobsen et al., 2015). A recent report (Oxford Research, 2016) suggested that Siva and IN’s responsibilities for activities such as counselling and mentoring support for entrepreneurs and firms tend to overlap should therefore be clarified. They suggest that Siva should take on a stronger leadership role in advisory and mobilisation activities, and recommend that they be integrated within IN’s organisational structures and strong regional apparatus.

Incubator programmes in Norway are considered rather specialised (Cooke, 2016; Clausen and Rasmussen, 2011), and newly created incubators (such as the new Oslo Cancer Incubator or the CERN incubator in Trondheim) are oriented towards exploiting innovative ideas in specific technical fields and disciplines. This raises the question of whether these incubators sufficiently exploit the opportunities of knowledge recombination across sectors and technologies, and whether “crossover incubation” approaches as described by Cooke (2016) could complement these efforts.

Recently the government has stressed the need to develop high-quality and accessible facilities for piloting, demonstrations and simulations. In 2016, the MIF commissioned a study to map private and public demonstration plants in Norway and found that these exist across the country and in a variety of industries. They mainly consist of pilot and test plants owned by large companies and R&D facilities by research institutes and universities (Menon Economics, 2016). In order to make it easier for Norwegian industrial companies, particularly SMEs, to gain access to infrastructure and other equipment, the 2017 budget earmarked NOK 50 million to support a national multi-purpose facility for testing, piloting, simulation and visualisation. Siva will use the funds to support investments in the necessary equipment. According to the recent white paper on industrial policy (MTIF, 2017), plants should be established where there is a critical mass of business and thus a large customer base.

Cluster support

There is evidence of strong specialisation and clustering in Norwegian regions (see e.g. Isaksen, 2009; Strand and Leydesdorff, 2013). Examples include the maritime, offshore and marine industries on the industrial counties on the west coast, in particular the maritime cluster in Møre og Romsdal and the oil and gas cluster in Rogaland, with its main city, Stavanger; or the electronic industry cluster in Vestfold, close to Oslo.

Cluster policies have been a staple regional innovation policy in many OECD countries. They have been given renewed impetus in the context of the smart specialisation agenda, which has aimed at helping regions to focus on their respective comparative advantages so that they can identify new areas of diversification (OECD, 2013).

Norway's support for clusters is consistent with a life cycle cluster model that considers the emergence, growth and maturity stages of clusters (Menzel and Fornahl, 2010; Fornahl and Hassink, 2017). Clusters are thus supported according to their developmental stages. These include newly established or immature collaboration initiatives (for example, Arena, created in 2002); clusters that are well established nationally and with further growth potential (the Norwegian Centres of Expertise, or NCE, programme, introduced in 2006); and clusters that are fully functioning and well-established in global value chains (global centres of excellence, or GCE, introduced in 2014). In 2016, there were 22 Arena clusters, 14 NCE clusters and 3 GCE clusters.

The goals of the cluster programme are to increase capacity for innovation and renewal, increase value creation in the cluster and strengthen attractiveness and position in global value chains. The programme is open to all industries, according to selection criteria specific to the three programme levels, whose common denominator is that they must demonstrate potential for collaboration-based growth.

The programme, with a total budget of around NOK 150 million in 2015, is managed jointly between Innovation Norway and the RCN, and provides a combination of financial and expert services, including advisory, networking and promotional services, and services to upgrade the level of clusters' competences.

The results of several studies and evaluations conducted since the creation of the cluster programme have shown that, overall, it can encourage collaboration between cluster members and business growth, but that its effects on innovation capacity are hard to measure (see Box 4.5). Innovative clusters have been expected to take "a leading role in the restructuring and renewal of Norwegian industry" (Innovation Norway, 2015), but past evaluations have suggested that the clusters have been too narrowly conceived and have tended mainly to support interactions between relatively homogenous actors within existing value chains (Isaksen and Jakobsen, 2017).

Support for cross-sector collaboration has been increased in recent years. Cluster-to-cluster collaboration is one of the priority areas for cluster funding support. This would include collaboration with other cluster environments at regional, national or international levels, to foster learning across sectors, technologies or value chains. Both the NCE and GCE clusters have to report on issues related to such collaborative activities. Selection criteria for cluster support is also shifting. The most recent call for cluster projects[15] states that the programme aims to "stimulate new cluster initiatives that have as an explicit aim to renew an existing industry or to innovate through development of new industries". The call encourages projects with a particular focus on solving challenges at the intersection between different fields and disciplines.

Box 4.5. **Results of the main evaluations of the cluster programme**

According to an analysis by Statistics Norway for Innovation Norway, businesses supported by the cluster programme had 13 percentage points higher growth in turnover and an 8% increase in the number of employees in the first three years of the company's membership, compared to those who were not supported by the programme. Profitability, however, was lower than that of the control group after three years (Innovation Norway, 2016). Innovation Norway is conducting an evaluation of the cluster programme that is expected to be completed in summer 2017.

Mid-term evaluations of the Arena and NCE programmes (Econ Pöyry, 2011; Jakobsen and Røtnes, 2012) identified positive impacts in terms of increased collaboration among cluster members. Another benefit was softer impacts, such as the creation of a common identity for the participating actors and providing greater visibility and increased attractiveness for potential investors, new businesses and potential employees. The evaluation noted that the success of the projects owed much to the high calibre and competence of cluster managers, who had gained credibility and legitimacy in dealing with the different stakeholders. Innovation effects were difficult to measure, however, and a stronger emphasis on innovation was recommended. Greater coherence in the interface between RCN and Arena programmes as well as with other policy instruments, was also recommended, to support collaborative R&D and innovation projects with long-term potential. Concerns were raised, however, about the potential of cluster support schemes to support industrial diversification and path renewal. Evaluations of the Norwegian Centres of Expertise programmes (Oxford Research, 2013; Njøs and Jakobsen, 2016), suggest that projects have tended to support groups that are already collaborating, and existing value chains, raising issues about whether the programme can generate new synergies. Njøs and Jakobsen (2016) recommended broadening the scope of cluster policy to stimulate regional cross-industry co-operation.

Examples of cross-sector learning in clusters and the use of collaborative projects as platforms for restructuring are becoming increasingly common. They include the developments in green shipping at the NCE's Maritime CleanTech, and the launch in 2015 of the world's first "plug-in hybrid ferry". NCE Smart Energy Halden's expertise in ICT and big data has helped to launch profitable new IT solutions by sharing its expertise with other clusters. The Norwegian Smart Care Cluster is taking solutions developed in the oil and gas sector for safety, training and use of robots and signal handling, and exploring their application for welfare technology (Innovation Norway, 2016). GCE Subsea and NCE Seafood have jointly launched several cross-cluster or "crossover" initiatives to develop projects using competences and technology from the oil and gas industry to address challenges in aquaculture (Isaksen and Jakobsen, 2017).

Programme for Regional R&D and Innovation

Another Norwegian initiative in line with similar European initiatives to support regional innovation systems and smart specialisation, was VRI, the Programme for Regional R&D and Innovation, in operation between 2007 and 2017. The programme has two components: regional collaborative projects/initiative (to strengthen knowledge diffusion between businesses, research institutions and public actors), and support to research projects on innovation/(regional) innovation policy. The two components were initially supposed to complement each other; however, in later stages research projects were granted on merit of scientific quality, not geography. The county municipalities are responsible for the regional collaborative initiatives, with a steering group with regional participation. A total of 15 VRI collaborative initiatives have been funded by the RCN, with an approximate annual budget of NOK 70 million, each with its own organisation, strategies and projects.

The programme adopts s a bottom-up approach to priorities and regional collaboration and emphasises the importance of research institutions in regional development. It builds on previous regional policy initiatives, such as VS2010 and Competence Brokering, which were merged under VRI. It inherited from these programmes a broad definition of regional innovation strategies (RIS) as regional development coalitions (VRI1), and later on (VRI2) adopted a more explicit aim of linking regional industry to regional research organisations to promote a more R&D-based mode of innovation (Herstad and Sandven, 2017). Following the VRI, the RCN launched FORREGION ("Research-based innovation in the regions"), aimed at stimulating linkages between firms and the R&D sector in Norwegian regions, and more recently FORKOMMUNE, aimed at supporting research-based innovation in Norwegian municipalities.

The VRI programme has been found to help build regional capacity to support learning and innovation and building social capital (see Box 4.6), with varying degrees of success. Studies of the VRI programme have highlighted some key challenges and raised important questions about the co-ordination of policies for innovation and industrial renewal at multiple levels. First, efforts to build regional innovation systems have been deemed insufficient since they are set against a (sector-neutral) national funding system for R&D since the weights of sectors are very unevenly distributed geographically. Furthermore, regions are encouraged to identify their own priorities, which contrasts with the less selective approach of national policy and raises questions about lack of overall co-ordination and potential fragmentation of regional innovation efforts (Arnold et al., 2011). Finally, it is not clear whether the degree of policy tools being devolved to the regional level is sufficient to facilitate self-discovery processes and interactive learning (Rodrik, 2004; Dahl Fitjar, 2016).

Partly in response to this gap, in addition to the VRI the RFF were established in 2010. The RFF regions (seven in total, consisting of two to four county municipalities each) appoint independent boards for the funds, which award competitive R&D funding based the regions' strategies to promote regional innovation and development. Funding is provided by the Ministry of Education and Research, which also has established guidelines for the scheme. The RCN provides administrative support for the RFF boards. The funding amounts to NOK 215 million in 2017, and NOK 267 million in 2016 (including one-off additional support for South-Western Norway, due to the oil-price induced unemployment increase).

An evaluation was commissioned in the first year of the programme, which also delivered reports the three following years, the last of which was in 2013. The evaluation concluded that the scheme had been well established, and functioned well according to its objectives. It was found to work in interplay with other regional actors and initiatives, have strong anchoring in the regions and high legitimacy. The evaluation also raised the issue that although filling a role in the policy mix and contributing to the development of the research and innovation system, the introduction of new schemes also increases complexity. The evaluation recommended looking more broadly at the policy mix with a view to simplifying and consolidating it. As the evaluation followed the programme in its first years, the possible conclusions on its impact were limited.

Box 4.6. Results of the main evaluations of the Programme for Regional R&D and Innovation (VRI)

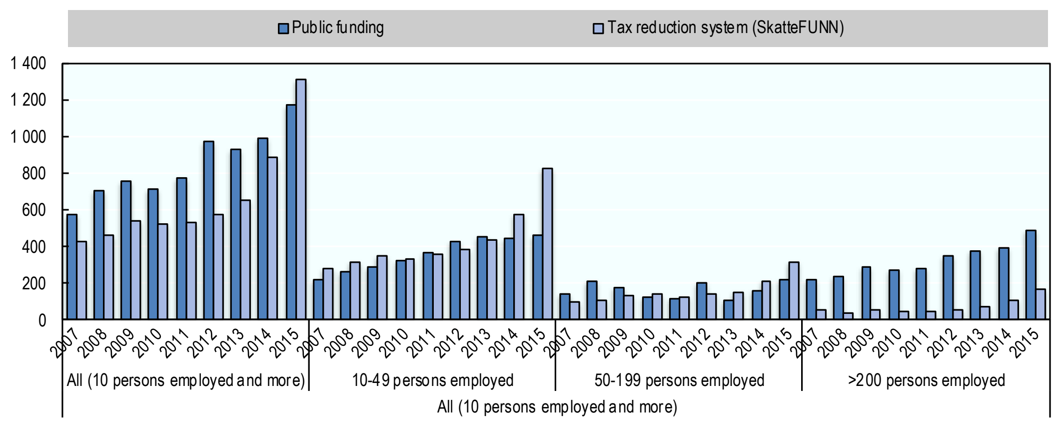
A mid-term evaluation of VRI (Furre et al., 2012) concluded that the initiative had contributed significantly to strengthening regional partnerships, including the relationships between research institutions and industry. The programme helped build regional capacity for formulating policy, and also to set regional priorities based on the regions' individual weaknesses and strengths (Fløysand et al., 2015; Sörvick and Midtkandal, 2016). However, differences between the regions meant that some did not have functioning partnerships or the social capital required to build regional innovation systems. This suggested a need to account for different stages of RIS evolution and to provide better support for institutional and organisational development.

A recent study on the influence of the VRI on the development of regional innovation systems in Norway (Herstad and Sandven, 2017) found that during the period there was a decline in the share of employment in innovation-active firms and a weakening of collaboration within the local industrial and research system. Some regions performed well, and developed dense local research collaborations and industrial linkages, but most had a weak RIS configurations. An overall conclusion was that few regions displayed the characteristics of a truly networked regional innovation system. This raises the question whether regional innovation policies are building on too narrow definition of RIS, and failing to mobilise broader industrial capabilities. The study also suggested that the efforts of VRI to build diverse regional innovation systems were overshadowed by the centralising effect of national funding schemes like Skattefunn and BIA, which have tended to reinforce linkages with national research institutions and international networks rather than with the regions.

R&D tax incentives

With a total support of approximately NOK 2.9 billion in 2015, the R&D tax incentive scheme Skattefunn is the main public support programme for business R&D in Norway (see Figure 4.15). Skattefunn has expanded in recent years, in line with the expansion of R&D fiscal instruments in other countries (CPB, 2014; OECD, 2016b). Its total tax credits more than doubled between 2013 and 2015, and it now commands more public funding for the business enterprise as a whole, particularly in the case of small firms and service sector firms (see Figure 4.15).

Figure 4.15. **Funding of intramural R&D in the business enterprise sector, from Skattefunn and other sources of public funding by firm size, 2007-15**
Million NOK



Source: Statistics Norway (2017), "Research and Development in the business enterprise sector", www.ssb.no/en/statistikkbanken.

Originally, Skattefunn only targeted SMEs, but eligibility was extended to include all firms after 2003. However, SME are still the main beneficiaries of this scheme. Firms can receive a tax credit of up to 20% in the case of SMEs (18% for large firms) of the eligible costs of approved R&D projects. Ceilings set for eligible costs have increased over the years and are higher if the enterprise collaborates with an approved R&D institution (universities and research institutes). In international terms, the scheme scores moderately in terms of the relative generosity of R&D tax incentives, but it is among the most generous for profitable and loss-making SMEs (OECD, 2016b) and one of the easiest for firms to use in terms of its administrative requirements (CPB, 2014).

In line with international evidence, the programme appears to be especially beneficial for small and inexperienced R&D performers (see Box 4.7). The increase in the use of Skattefunn in the last two years has coincided with a notable rise in the figures of recorded business R&D spending. It is thus likely that the tax credit has stimulated additional R&D and encouraged firms to start doing R&D. This applies particularly to smaller firms and firms in service industries, which are not targeted by means of direct R&D funding. But it is also possible that firms claim tax credits against spending that they would not have classified as R&D in the past. Other types of biases exist, which explain why the recorded increase in nominal R&D may not translate into an increase in innovation levels (Appelt et al., 2016).[16]

This suggests that the use of R&D tax incentives does not guarantee innovation or greater diversification that replaces existing technological trajectories (which is admittedly not the aim of the scheme). This calls for a careful balance between indirect support and direct support measures in technological and geographical areas where the market is unlikely to provide sufficient incentives on its own.

Box 4.7. **Impact assessments of Skattefunn R&D credits**

Comparing the impact of R&D tax incentives is difficult, given the wide variety in their designs and features (see e.g. CPB, 2014; Laredo et al., 2016; Appelt et al., 2016). However, studies generally show positive effects for SMEs, while the effects on larger firms, as well as on productivity and other measures of firm performance, are less clear (Laredo et al., 2016).

SkatteFUNN has been evaluated on several occasions to assess its impact on R&D expenditure, innovation, productivity and its interaction with direct R&D policy instruments and a new evaluation is under way (to be published in 2018). For instance, Hægeland and Møen (2007) found that the scheme significantly increased private R&D expenditure, with input additionality effects ranging from 1.3 to 2.9 per unit of support. They also found that the strongest impact was for firms without or with limited previous R&D activity, which may suggest that the scheme encouraged some firms to start doing R&D. Focusing on innovation success, Cappelen et al. (2012; 2016) found that firms using SkatteFUNN innovated more frequently, but that it led to product and process innovations that were new to the firm, rather than innovations that were new to the market or that could be patented. This is in line with other studies that suggest that the R&D supported by tax incentives is mainly associated with incremental rather than radical innovation innovations (CPB, 2014). When compared to other forms of support for R&D, Hægeland and Møen (2007) found that tax credits had a slightly larger effect than direct support measures on Norwegian firms. This contrasts with other studies such as Westmore (2013), which found the impact to be larger for direct support schemes compared to R&D tax incentives.

Finally, in terms of behavioural additionality of the scheme, its effect on collaboration seems to be limited according to Hægeland and Møens (2007), who show that few firms start collaborating with approved R&D organisations as a result of Skattefunn, and those with a history of collaboration do not collaborate more. Isaksen et al. (2017) focused on the geographical effects of Skattefunn and found that funding tended to favour firms in specific industries and in regions with a relatively developed regional innovation system.

Conclusions on business firms' innovation

Enhanced competitiveness and innovation is one of the core objectives of the Long-Term Plan, which emphasises the need to diversify and increase the absorptive capacity of industry, to prepare for the transition to a low-emission society. This is particularly pressing for the Norwegian economy, which is characterised by strong specialisation and at the same time low GERD, innovation and entrepreneurship levels.

Table 4.6. **Main elements of the diagnostic on business innovation**

Main elements of diagnostic
– Low level of business R&D expenditures in international comparison, even when adjusting for industry structure (but rapidly growing)
– Few large R&D-intensive companies, the main ones being in the oil and gas sector
– High share and fast growth of the R&D in the service sector
– Share of Norwegian innovative firms on a par with or slightly higher than neighbouring Nordic countries

Public funding to support business innovation has risen substantially in recent years. RCN and Innovation Norway offer a comprehensive portfolio of financial support schemes and technical services to support it. Evaluations of R&D and innovation support instruments generally show promising results, and industry is well-served in terms of R&D support, with no obvious gaps in the policy mix for innovation. It could be argued, however, that the policy mix has traditionally been better suited to support existing strengths than new sectors and new areas for diversification.

As in many countries, Norway has strengthened generic, neutral policies, for instance through investments in the Skattefunn programme and user-led R&D schemes. Investment in Skattefunn has increased significantly, and it is now the largest mechanism for R&D funding in firms. While tax incentive schemes have a positive effect on firms' R&D investment, their wider effects on innovation, productivity and, more importantly, industrial renewal, is much less clear. Supposedly neutral instruments are never neutral in practice, and are likely to further reinforce relationships between strong incumbents in existing supply chains, at the risk of reducing variety and generating systemic lock-in.

Diversification of the economy will require tools to facilitate connections between different but related sectors and technologies. There are signs that this is happening. For instance, several of the Research Council programmes are aimed at transferring knowledge across existing clusters and technologies. Cluster support is also increasingly encouraging cluster-to-cluster interaction. Cross-sectoral linkages are now being used as criteria for cluster selection. Recent developments in "smart" maritime activities, ocean mining and ocean fish farming, drawing on the accumulated technological expertise of the oil and gas sector, are some examples where this transfer is already occurring.

In order to favour diversification and industrial renewal, an institutional framework is needed to provide incentives for self-discovery processes, interactive learning and trial and error. Concerted action is needed across policy areas, actors and levels to encourage activities that contribute to diversification and increased economic welfare. As the LTP notes, this requires that the agencies involved (RCN, Innovation Norway and the Industrial Development Corporation of Norway) adopt a "co-ordinated and cohesive commitment to prioritised areas". The current division of labour between the three may not be sufficiently stimulating productive linkages between research and public funding and the more distributed landscape of innovation capabilities. Greater co-ordination is needed to tap into entrepreneurial discovery processes driving diversification, further leveraging regional structures for the purposes of diversification and renewal and informing instruments at the national level.

The LTP does not address the spatial dimension of economic transition and diversification. Support for innovation and structural change requires that interregional variety and regional specificity be taken into account. Regions are not only the places where the effects of external shocks (such as the decline of the oil industry) are being felt. They are also where innovation leading to structural change happens, where competences are located in R&D departments of firms and research institutes and where collective learning through spillovers occurs.

Table 4.7. **Achievements and challenges related to business innovation support**

Achievements and progress	Remaining challenges
Innovation support scheme	
– A comprehensive policy mix covering the various needs of the different communities of research and innovation actors, throughout all stages of the innovation process – Increased focus of RCN on technology and technology transfer between the sectors – Evaluations of RCN thematic programmes and other innovation support scheme show significant positive impacts	– The share of indirect funding has increased in recent years, which favours relationships between strong incumbents in existing supply chains.
Long-Term Plan for Research and Higher Education	
– Acknowledgement in the Long-Term Plan (LTP) of the need for better co-ordination of innovation support provided by RCN, Innovation Norway and Siva	– Overlap between the research priorities identified in the LTP and Innovation Norway's "Dream Commitment" report – Limited focus on the spatial dimension of the need for economic transition and diversification

Notes

1. Comparison with other countries is difficult, since comparative international statistics do not use the term "institute sector". In international statistics, the industry-oriented research institutes are included in the business enterprise sector, and the remaining units are included in the government sector.
2. Such as for instance, VTT in Finland, the Fraunhofer Society in Germany, TNO in the Netherlands and the RISE institutes in Sweden.
3. However, industry income is somewhat inflated by the fact that some of the revenues originating from commissioned research from industry are derived from RCN funding allocated to companies.
4. Åström et al. (2015) estimated that collaboration with TI institutes had an effect on the turnover of user firms of around 28% compared to non-users, and that the effect remained positive up to four years after the collaboration.
5. Awarded doctoral degrees with an institute contribution of at least 50% (PRIs under block funding only).
6. Regulated by Royal Decree of 19 December 2008.

7. Strategic institute initiatives (SIS) are relatively large, multi-year projects defined with and funded by the ministry in charge of the institute. The projects are intended to develop long-term expertise in the institute fields of research that cannot be realised by other means. The funding for the initiatives is added to the envelope of the block grant.

8. In Denmark, for instance, the GTS institutes merged, halving their number in the last decade. In Sweden, the Ministry of Enterprise and Innovation encouraged mergers among the institutes and created a structure of four large technology-based institutes. In the Basque Country region in Spain, the integration of several PRIs to form Tecnalia in 2001 was initially motivated by the centres involved, but due to delays and co-ordination difficulties, the regional government eventually drove the merger from the top down (Shapira et al., 2015).

9. The last few years have witnessed a number of mergers involving universities and independent and public research institutes. For instance, the Norwegian Institute for Agricultural and Environmental Research (Bioforsk), the Norwegian Agricultural Economics Research Institute and the Norwegian Forestry and Landscape Institute merged in 2016 to create the Norwegian Institute of Bioeconomy Research (Nibio).

10. Applying the sectoral share of OECD value added for a given year rather than each country's actual sector shares.

11. R&D investment in Norway sloweddown in 2009 and 2010 after the financial crisis, as in many other countries, but to a lesser extent.

12. Following some of the same (regional) indicators, the EU Innovation Regional Scoreboard 2016 identifies only two regional strong innovator regions in Norway, Oslo and Akershus and Trøndelag, while the rest are included as regional moderate innovators.

13. The survey conducted in 2013 was the first exercise that was not combined with the R&D survey, in order to avoid a "science bias".

14. If the tax credit for the R&D costs is greater than the amount that the firm is liable to pay in tax, the remainder is paid in cash to the firm, in connection with the tax settlement the year after the tax year. Nearly 80% of the total Skattefunn support is paid out in this way.

15. www.innovasjonnorge.no/no/Bygg-en-bedrift/klynger-og-bedriftsutvikling-2/klynger-og-bedriftsnettverk/utlysning-2017.

16. An increase of R&D may also reflect changes in input prices, particularly the wages of scientists and engineers. Impacts may also be moderated by firm and project heterogeneity, as additional projects financed through R&D tax incentives are sometimes those with the lowest marginal productivity (Appelt et al., 2016).

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Chapter 5.

Tackling societal challenges through research and innovation and public sector innovation in Norway

This chapter discusses the state-of-the-art and potential of the Norwegian research and innovation system to address major challenges facing society, which is one of the three overarching objectives of the government's Long-Term Plan. The first and second parts analyse respectively the investment and progress towards achieving this objective. The third part focuses on the strategies and policies supporting actors involved in these activities. The last section presents a synthesis of the achievements to date and remaining challenges in tackling societal challenges through research and innovation and public sector innovation in Norway and presents some high-level conclusions.

Tackling societal challenges has a prominent place both in the LTP and on the government's general agenda. Norway earmarks a significant funding to research on areas relevant to societal challenges (particularly health, energy, the environment and climate) and the RCN runs a multitude of programmes that target both specific themes and the generic ability particularly in the public sector to address societal challenges.

R&D investment to tackle societal challenges

In many advanced countries the strategic agendas driving research and innovation policies have already shifted towards environmental and societal challenges. This has led to a reorientation of national research and innovation policies, reflected in increased public budgets for R&D in areas associated with environmental and health-related objectives. Norway itself has a strong tradition of investing in research on societal challenges and significant shares of its R&D expenditure are directed to areas such as health. Since the mid-1980s, important government documents on future research policy orientations presented regularly to the Storting as White Papers (the *Stortingsmeldinger*) have had dedicated priority areas focusing on societal challenges.

Norway has one of the highest shares of R&D budgets earmarked to societal challenges (22%), above the OECD average and its traditional comparator countries such as Denmark or even Sweden, which hosted the Lund Declaration and had strong ambitions in this matter (OECD, 2016a). Norway's investment is especially strong in the area of health and care, which accounts for almost 17% of all R&D expenditures (see Figure 5.1).

This structure of R&D expenditures in Norway is the result of a significant increase of research funding on medicine and health. Starting in 2003, this increase has been considerably higher than for any other field of science (see Figure 5.2). In 2015, expenditure for R&D in medicine and health accounted for more than one-quarter of total R&D funding in the higher education and institute sectors (including hospital trusts). In 2015, R&D personnel in medical and health sciences accounted for 37% of all R&D personnel (full-time equivalents) at Norwegian higher education institutions.[1] In 2014, Norway had the second-highest direct budget support for health R&D among the OECD countries after the United States (OECD, 2015a). The largest single source of these funds is the direct allocation by the Ministry of Health and Care Services to four regional health authorities, which in turn allocate the money among their hospitals.

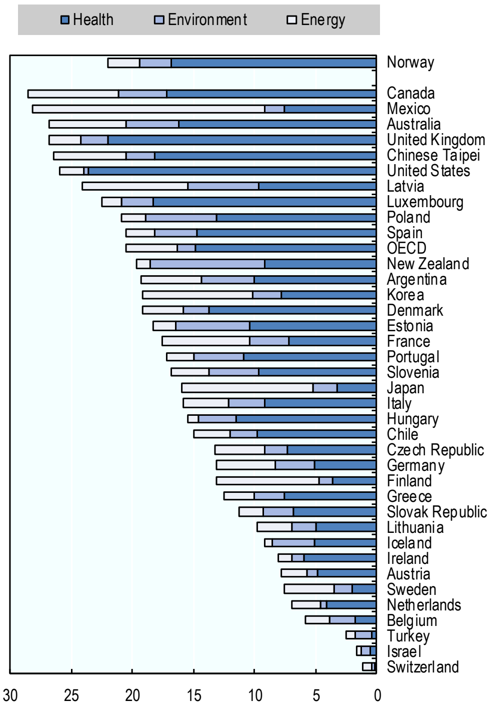
Looking at R&D expenditure by thematic area and performing sector, the largest area for the business sector is energy, followed by maritime, food and health. In the HEI sector (which includes university hospitals), as mentioned before, health is the dominant sector by far (see Table 5.1).

The main actors engaged in societal challenges

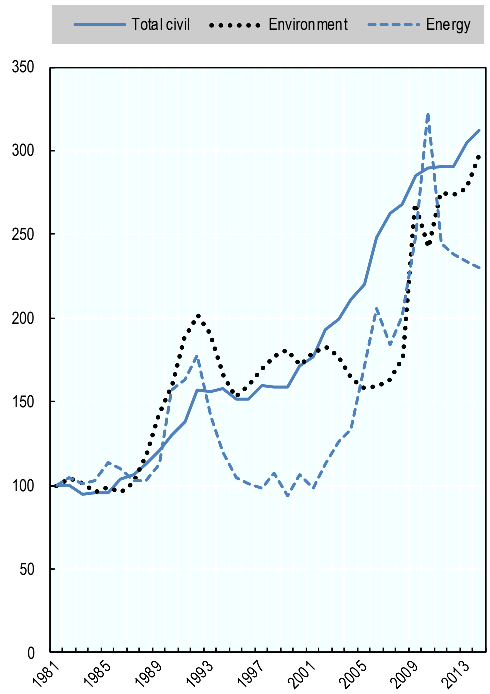
Government shapes many of the framework conditions for tackling societal challenges. It decides on what basis, to whom and for what, public funding for research is allocated. It funds, governs and monitors education – most of which is public in Norway. It thus has an overarching responsibility for ensuring the provision and functionality of resources and systems for education, skills and knowledge necessary for tackling societal challenges.

Figure 5.1. **R&D budgets earmarked to societal challenges**

A. Share of R&D budgets earmarked to societal challenges, 2016 or latest year available



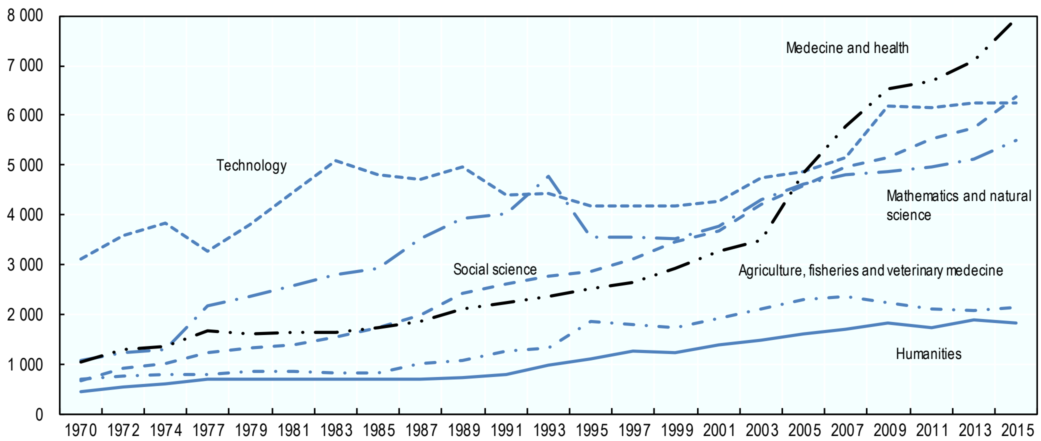
B. R&D budgets earmarked to societal challenges, billion USD 2010 PPPs (1981=100, 1981-2015), Norway



Sources: OECD (2016b), *OECD Science, Technology and Innovation Outlook 2016* http://dx.doi.org/10.1787/sti_in_outlook-2016-en (for Panel A); OECD (2016c), *OECD R&D Statistics (RDS) Database*, www.oecd.org/sti/rds (for Panel B).

Figure 5.2. **Current expenditure for R&D to higher education and institute sector according to field of science, 2015 prices**

Million NOK



Source: Data provided by Research Council of Norway (RCN) based on Statistics Norway and Nordic Institute for Studies in Innovation (NIFU).

Table 5.1. **R&D expenditure by thematic area and performing sector, 2015**

Million NOK

	Total	Business sector	Institute sector	HEI sector
Thematic area				
Energy	9 376	6 094	2 119	1 164
Including renewable energy	1 738	584	690	463
Including petroleum	5 699	4 254	1 035	410
Environment	3 029	1 384	956	689
Climate	2 525	424	1 276	826
Marine	1 861	292	924	644
Maritime	2 125	1 582	349	194
Food	4 367	1 940	1 813	615
Health and care	9 757	1 479	2 278	6 000
Welfare	1 244		524	720
Education	1 378		102	1 276
Other public sector	722		334	388
Development research	513		127	386
Travel	139		46	93

Note: Thematic areas can overlap and can therefore not be added up according by sector.

Source: Data provided by Research Council of Norway (RCN) based on Statistics Norway and Nordic Institute for Studies in Innovation (NIFU).

RCN and the Ministry of Health and Care Services might be singled out as particularly important actors when it comes to funding research that can contribute to tackling societal challenges. RCN channels funding from ministries into programmes with various aims, including tackling societal challenges (programmes discussed later) while the Ministry of Health and Care Services allocates significant funding for research on health and care to the four regional health authorities which in turn allocate them among their hospitals.

Laws, regulations and policies governing the use of data, competition, procurement also play a key role in enabling and promoting innovation and in creating markets for solutions that might contribute to tackling societal challenges. Finally, government has a critical responsibility in ensuring that policies, laws or regulations in different areas or sectors do not conflict with each other. Cross-sectoral and both horizontal (across policy domains) and vertical (international-national-regional-local) policy co-ordination are particularly important given the cross-cutting nature of many societal challenges.

Universities need to ensure that the research and education performed at their institutions is of high quality and relevant to tackling societal challenges. The latter requires a combination of blue sky research, interdisciplinary and multidisciplinary research and education, and mutually beneficial interaction and two-way flows of knowledge with "users" of knowledge and other relevant stakeholders.

PRIs often work relatively closely with universities, on the one hand, and companies or the public sector, on the other hand. They provide an important platform for "translating" research into useful knowledge and solutions and might be nimbler in responding to demand, and changes in demand, for knowledge and research.

With regards to public sector innovation, the Government Agency for Public Management and e-Government (Difi) was established in 2008 with the mission "to strengthen the government's work in renewing the Norwegian public sector and improve the organisation and efficiency of government administration" (Difi homepage). Difi is also the secretariat for the "Digitalisation Council" (Digitaliseringsrådet), which primarily gives voluntary advice and guidance on plans for ICT projects submitted by public authorities. It thus acts as a quality assurance mechanism for ICT projects ranging from NOK 10 million to NOK 750 million, supplementing the external quality assurance scheme operated by the Ministry of Finance for all public investments above NOK 750 million. Strategic use of ICT is one of the five priorities of the government's "Program for better governance and leadership in government". Several other agencies and public sector actors have important functions regarding public sector innovation and renewal, such as the Directorate of eHealth, the Directorate of Health under the Ministry of Health and Care Services, the Centre of Competence on Rural Development, etc.

The Research Council has several initiatives and programmes for promoting research and innovation in and for the public sector. Innovation Norway's most prominent initiative for the public sector are the Public Sector R&D contracts (OFU). The Ministry of Industry, Trade and Fisheries has an important responsibility for public procurement and has been working to strengthen innovation procurement in various ways. Finally, the Ministry of Education and Research views its role as securing the provision of generic knowledge and education resources and ensuring that the research and education systems function well as a whole, including for the public sector and the provision of public services.

Progress towards addressing societal challenges

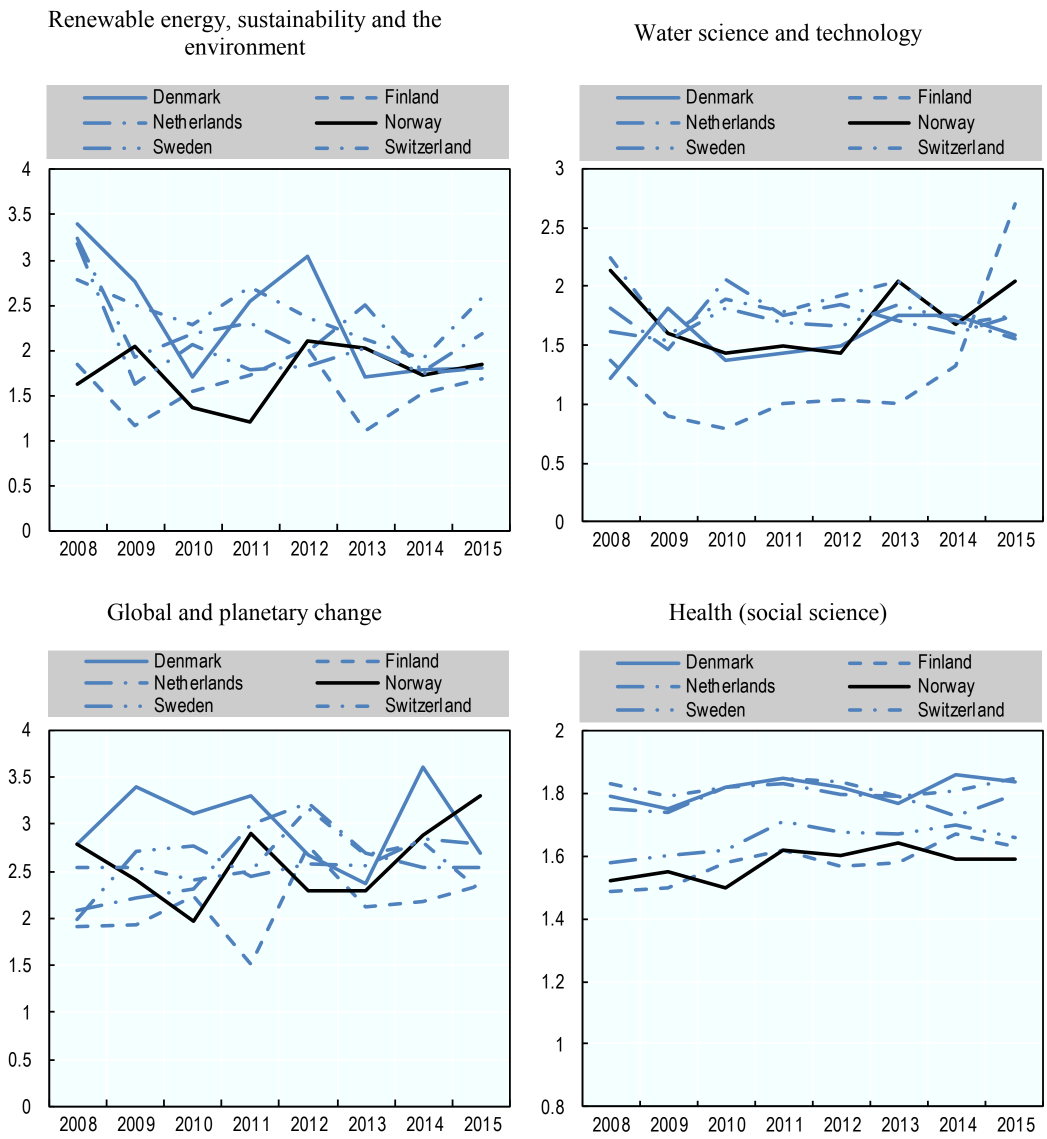
Scientific performance

The significant research funding allocated to areas regarded as relevant for social challenges over the past three decades, has enabled capacity building in these areas, resulting in some clear successes in terms of scientific impact. Thus, for example, the citation impact[2] for Norwegian publications in the area of "Global and Planetary Change" has consistently been higher than the citation impact for all Norwegian publications since 2008. Furthermore, in recent years, in contrast to Norway's performance for all disciplines, its citation impact in this field has been higher than that for most other countries with which Norway is frequently compared.[3] In "Water Science and Technology" Norway has also recently emerged as a strong performer in terms of citation impact, only recently surpassed by Finland. In the social sciences applied to the health sector, however, as well as to a lesser extent in renewable energy, Norway is lagging behind its comparator countries in terms of research excellence and shows no clear sign of improvement (Figure 5.3).[4]

Norway remains strong in areas which, although they have now been well integrated into the sustainable development agenda, are still pillars of the former paradigm, contributing to climate change and environmental problems. The Norwegian University of Science and Technology (NTNU) in Trondheim, for instance, is ranked as one of the world-leading institutions in "Oil and Gas" by Thomson Reuters (2016), based on its volume of publications and high normalised citation impact. Most other institutions in this top 10 of most influential research institutions in this field are from the United Kingdom and the United States.

The European Union's Horizon 2020 framework programme focuses on a series of societal challenges, including health, demographic change, food security, sustainability, clean energy, green transport, climate action, and inclusive and secure societies. Norway has been relatively successful in the programmes relating to societal challenges with a 2.6 return rate overall in this area, exceeding the national goal of 2% (Piro, Scordato and Aksnes, 2016). It has been particularly strong in areas such as food security, blue growth and bio-economy with a return rate of 7% as well as energy, environment (including climate change). However, health constitutes a notable exception with Norway submitting significantly fewer project applications than other comparable countries (Austria, Denmark, Finland, Netherlands, Sweden). Norway also has much lower funding per project than any of the other five countries and a low return rate in the programme "Health, demographic change and well-being" (1.1%) (Piro, Scordato and Aksnes, 2016).

Figure 5.3. **Field-Weighted Citation Impact (FWCI) publications, 2008-15, selected countries**



Source: Author's calculations based on SciVal® database, Elsevier B.V. (accessed 24 October 2016).

Innovation performance

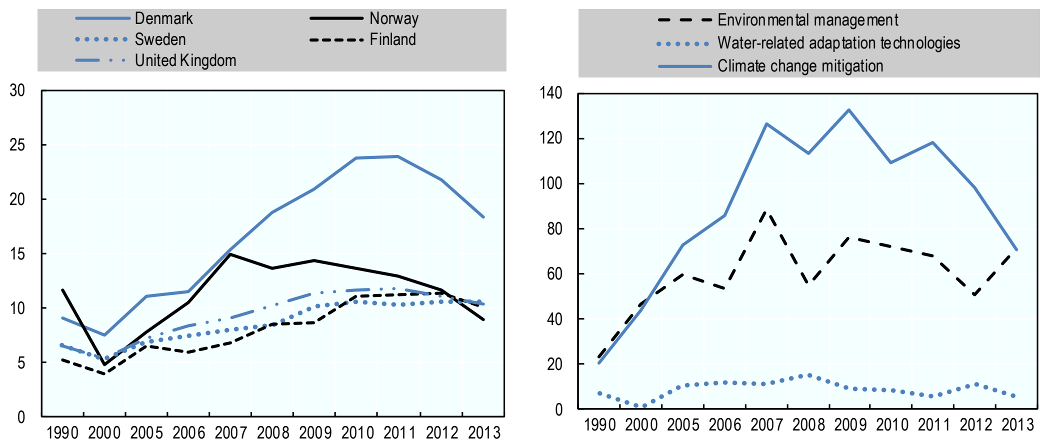
Measuring the innovation performance of Norway with regards to societal challenges is difficult. Addressing societal challenges goes well beyond the traditional technological areas where indicators such as the number of patents or spin-offs are meaningful. Furthermore, even when only considering the "tip of the iceberg" of innovation for societal challenges, i.e. its technological dimension, the pervasiveness and cross-sectoral dimension of these innovations make the selection of, for instance, a relevant patent class complicated.

Taking into consideration these important caveats the Figure 5.4 shows the evolution of the number and share of patents applied for in the area of selected environment-related technologies, i.e. technologies relevant to environmental management, water-related adaptation and climate change mitigation. Norway appears here also in a rather good position compared to some of the leading countries in the field; however, significantly behind Denmark and experiencing a clear declining trend since 2010, while other countries have kept on increasingly patenting in this area during the same period. The reduction of the number of patents is particularly pronounced in the sub-area of climate change mitigation technologies, which include crucial technologies such as renewable energy generation, waste treatment, clean transport technologies and, not least in the case of Norway, mitigation technologies applied in the oil refining and petrochemical industry.

Figure 5.4. **European Patent Office patent applications, selected environment-related technologies**

Share of selected environment-related technologies in total EPO patent applications, 2001-13

Total number of EPO patent applications, per technology, 1990-2013



Notes: The patent statistics presented here are constructed using data extracted from the Worldwide Patent Statistical Database (PATSTAT) of the European Patent Office (EPO) using algorithms developed by the OECD. The relevant patent documents are identified using search strategies for environment-related technologies. Please refer to: www.oecd.org/environment/consumption-innovation/ENV-tech%20search%20strategies,%20version%20for%20OECDstat%20(2016).pdf. They were developed specifically for this purpose. They allow identifying technologies relevant to environmental management, water-related adaptation and climate change mitigation. An aggregate category labelled "selected environment-related technologies" includes all of the environmental domains presented here.

Source: OECD (2017c), *OECD Innovation in Environment-related Technologies Database*, http://stats.oecd.org/Index.aspx?DataSetCode=PAT_DEV (accessed 17 April 2017).

The Norwegian public sector, at central and local levels, benefits from a lot of dynamic incremental and bottom-up innovation (see for example Teigen, Ringholm and Aarsæther, 2013; Haug, 2014). Innovation in the municipal sector is of particular importance given both its significant size, in terms of share of total national output, and the fact that municipalities as a whole are responsible for a large portion of social and care services in Norway (Teigen, 2013). However, a large share of innovations happening in the public sector is defined as incremental (Foyn, 2011). The LTP identified "renewal of the public sector" as a clear priority, acknowledging that the comparatively large size of the public sector – in terms of employment and resources – and its responsibility to provide high-quality and efficient services to the population.

Strategies and policies to support societal challenges

Government intervention is essential to maximise the contribution of research and innovation to societal challenges for reasons relating to the nature of public goods and the public sector and the complexity of many of the problems which require regulatory changes. Market mechanisms will provide insufficient incentives for the private sector to invest in these activities (see also Box 5.4).

Societal challenges in the Long-Term Plan

Societal challenges are one of the three pillars in the LTP emphasising the government's commitment to this priority. The LTP identifies global challenges such as "climate change, security and preparedness, disease and epidemics, safe access to energy, water and food" and also changing demographics and a "growing percentage of elderly citizens". It also emphasised the fact that the three overarching pillars of the LTP are interconnected: the ability to find solutions to societal challenges is enhanced by excellent science and new solutions in turn can contribute to strengthening competitiveness and innovation. The RCN is tasked with following up the funding of research to tackle societal challenges.

Before the LTP, societal challenges already figured prominently in public research funding. The sector principle has probably contributed to giving societal challenges a prominent role in research funding since ministries have a better knowledge of the concrete needs – as well as of the necessary and acceptable trade-offs– related to these challenges in their respective policy fields. Based on this intimate understanding of societal challenges and their implications, ministries of environment, energy, transport and justice and public security, for example, can better articulate elaborated demands directly to research performers or to RCN, in connection with concrete challenges, such as combating pollution and increasing the use of renewable and environmentally sustainable transportation, strengthening prevention of crime, fighting terrorism and increasing public security. While the LTP clearly identify tackling societal challenges as one of the three overriding objectives, it does not pinpoint specific societal challenges that should be prioritised but rather calls more generally for a strengthening of Norway's ability to tackle societal challenges. In practice, policy efforts and programmes seem to centre around areas such as health, education, welfare, environment, ageing, seas and oceans and climate. Neither does the LTP identify mechanisms, initiatives or approaches to achieve this overarching objective. It only states in general terms that multidisciplinary approaches and multi-stakeholder collaborations and partnerships will be required for developing the required solutions:

> Knowledge is put to use where people, organisations and cultures meet. The success of new solutions, whether they involve change, adaptation or new technology, requires a wide range of perspectives from the humanities, health and care disciplines and social science. This is crucial in achieving greater understanding of which solutions can actually be implemented in our society, and how this can best be accomplished.

Against this backdrop, each of the six LTP priorities of enabling technologies, world-leading research environments, better public services, an innovative business sector and investments in seas and oceans and climate, the environment and energy are seen as ways of strengthening Norway's ability to tackle societal challenges and turning some of them into economic opportunities.

Box 5.1. **Societal challenges and the strategic debate "excellence versus relevance"**

In its second report presented in 2016, the Productivity Commission appointed by the Ministry of Finance was critical of strategic research funding, particularly challenge-driven research and innovation funding, arguing that the government should invest in excellent curiosity-driven research, and thus adopt a less directional research and innovation policy. It claims that there was an extensive political skewing of research funding towards social objectives and that government should fund basic research to a much larger degree, with less focus on allocating research funding according to social challenges. It states that "the Norwegian research council model may have led to an imbalance to the disadvantage of research of high scientific quality, as a result of many other considerations which affect the distribution of research funds" (NOU 2016). The Commission propagates that researchers rather than government, or the Research Council, should prioritise what research should be done and, by extension, on the basis of which research results, innovation should happen (Koch, 2016).

Critics of the Productivity Commission's findings argue that already today the majority of research funding is not allocated strategically but rather as a block grant to universities. The Research Council – the single most important actor when it comes to competitively allocated public research funding to universities and research institutes – only accounts for around one-fourth of public research funding and only a portion of the RCN's funding is allocated on the basis of strategic or thematic priorities (Koch, 2016;Lykve, 2016). The ability of universities and researchers to make strategic priorities is also questioned by the authors, pointing to their weak track record and a strong proclivity towards path dependency (ibid). Finally, they question the democratic legitimacy of delegating research prioritisation to researchers (ibid). An alternative view to the Productivity Commission can also be found in Sarewitz (2016) and Gulbrandsen (2017) who argue that research orientation and interaction with users are found to strengthen both the quality and societal value of science. When left too much to its own devices and sheltered from "the real world", science can actually be "self-destructing" rather than "self-correcting". The Productivity Commission argued that reducing earmarks to thematic areas or societal aims in Norwegian research funding is necessary in order to raise research quality to an internationally competitive level, thus pointing to a perceived tradeoff or relative incompatibility between research excellence and societal relevance, at least from the perspective of research funding allocation decisions. However, an evaluation of the engineering sciences commissioned by the RCN in 2015 showed that research groups or institutions that scored high on research excellence also scored high on societal relevance and impact. Norway appears to have a good track record of funding high quality research in areas which are considered of relevance to society – in terms of identified social challenges such as climate and the environment – but also to Norwegian industry, such as the marine and maritime industry and oil and gas. The evaluation of engineering sciences in Norway carried out in 2015 identified marine technology and climate and fossil fuel research as research fields where Norwegian engineering science is significantly outperforming, pointing out that "[t]he excellence in these areas corresponds with the key technologies in Norway, which indicates a good linkage between research and industry" (RCN, 2015a).

Source: Koch, P. (2016), "Rattsø 2: Very good, but bothering innovation policy", *Innovasjonsbloggen*, https://innovasjonsbloggen.com/2016/02/15/rattso-2-mye-bra-men-bommer-pa-innovasjonspolitikken.

Wirth regards to public sector renewal specifically, the LTP listed three overarching aims: 1) more knowledge-based public services; 2) a public sector that drives innovation; and 3) a knowledge system for better health and care services. The LTP emphasised the importance of the private sector in contributing to and participating in the renewal of the public sector, e.g. in developing technology, providing expertise and co-operating with the public sector in developing solutions. Improving the ability of the municipal sector to provide good services to its citizens is prioritised in the LTP, as is the health and care sector. In its implementation, emphasis so far has been on raising knowledge base and evidence-based decision making in the public sector, e.g. through public sector PhDs, a programme run by the RCN.

The RCN's programmes towards societal challenges

The three core missions of the Research Council are to promote research quality, contribute to tackling societal challenges and to strengthen innovation in the business sector. Formulated slightly differently, one of their key tasks is to fund research and promote innovation in areas of relevance to society where Norway needs more knowledge and competence.

Many of the RCN's programmes target specific societal challenges such as health, welfare, climate, environment, or promote generic efforts aimed at promoting responsible research and innovation or public sector renewal (see Table 5.2), as opposed to larger and more open programmes. This might be partially explained by the fact that RCN is tasked by various ministries to run its R&D programmes through detailed requests (see Chapter 6), which tend to prevent the Council from being able to design broader programmes.

Table 5.2. **Examples of RCN programmes targeting societal challenges**

Programme	Societal challenge
Programmes targeting specific societal challenges	
BEDREHELSE	Better health and quality of life
BYFORSK	Research and innovation for cities of the future
CLIMIT	Research and commercialisation of carbon capture storage (CCS)
FME	Centres for environment-friendly energy research
GLOBVAC	Global health and vaccination research
HELSEVEL	Health, care and welfare services research
MARINFORSK	Marine resources and the environment
MILJØFORSK	Environmental research for a green transition
KLIMAFORSK	Large-scale programme on climate research
SYKEFRAVAER	Sickness absence, work and health
TRANSPORT	Transport 2025
VAM	Welfare, working life and migration
SAMRISKII	Societal Security
NORGLOBAL	Norway – Global partner (research in support of global efforts towards the UN's Sustainable Development Goals)
POLARFORSK	The Polar Research Programme
ENERGIX	Large-scale programme for energy research
SAMANSVAR	Responsible innovation and corporate social responsibility
DEMOS	Democratic and effective governance, planning and public administration
FINNUT	Research and innovation in the educational sector
FORKOMMUNE	Research and innovation in the municipal sector
FORREGION	Research-based regional innovation
OFFPHD	Public sector PhD scheme

In this aspect, RCN differs from the Swedish Government Agency for Innovation (Vinnova), which has a rather broad mandate and task to promote innovation for sustainable development (ecologically, economically and socially) and is given rather broad autonomy with regard how to achieve this (OECD, 2016). The Agency has created an umbrella programme for "Challenge-Driven Innovation" (UDI) (for an analysis of this programme, see Palmberg and Schwaag Serger, 2017). The Dutch government also runs an initiative called "Green Deals" with a broad focus on green growth and social issues. Green Deals is a joint initiative by the Dutch Ministries of Economic Affairs (EZ), Infrastructure and the Environment (I&M) and the Interior and Kingdom Relations (BZK). Both the Swedish and Dutch initiatives have a strong emphasis on involvement of companies and public sector actors (such as municipalities). Whereas UDI focuses on developing innovative solutions in multi-actor consortia which join the supply and demand side, Green Deals targets the stage "when innovations are actually put into practice, a phase during which projects often encounter barriers".[5] The primary mechanism for UDI is the funding of consortia which have been created to target specific challenges, while for the Green Deals the aim is to remove barriers in order to help sustainable initiatives get off the ground and to accelerate this process where possible. This includes a wide range of actions far beyond the research and innovation areas, such as removing obstacles in legislation and regulations and providing access to networks and capital market. Finally, Finland recently launched the Strategic Research Council, with a mandate to fund long-term and programme-based research aimed at finding solutions to the major challenges facing Finnish society (OECD, 2017b). The government regularly identifies priority areas for funding. The Finnish approach has a clear focus on research, differentiating it from UDI and Green Deals which are more strongly oriented towards innovation.

RCN's programmes span both research and innovation but tend to be more targeted to specific areas than the other countries' initiatives and, viewed as a whole, they also have a somewhat stronger emphasis on research than innovation, when compared with the Swedish and Dutch initiatives, though not the Finnish one (see table 5.3). Innovation Norway's activities are less structured according to societal challenges than the examples given above, though it has identified health and healthcare as a prioritised area.

Table 5.3. **Research and innovation initiatives targeting societal challenges in Norway, Sweden, the Netherlands and Finland**

Programmes targeting societal challenges	Thematic focus	Focus on research or innovation?	Primary mechanism
RCN programmes	Numerous programmes targeting specific challenges	Both but with slight leaning towards research	Funding projects; building research and innovation capacity in the public sector
Challenge-Driven Innovation Program (UDI), Sweden	Broad focus	Applied research, development and innovation?	Funding projects, promoting new consortia around specific challenges
Green Deals, Netherlands	Emphasis on green growth	Clear emphasis on innovation	Removing barriers to the implementation of innovations (regulation, financing networks)
Strategic Research Council, Finland	Broad focus on major challenges to Finnish society (though identification of priority areas by government)	Research	Funding research with special attention to dissemination

Other policies and programmes to address societal challenges

In addition to the funds channelled through the RCN, several ministries allocate funds directly to research institutes and universities for research on issues of relevance to societal challenges. Although, as in most countries, it is not easy to track all efforts for a given transversal policy objective. They include notably actions from the Ministry of Health and Care Services, which allocates the vast majority of its research funding on health and care issues to the regional health authorities, the Ministry of Local Government and Modernisation, the Ministry of Climate and Environment, the Ministry of Transport and Communications, the Ministry of Labour and Social Affairs and the Ministry of Justice and Public Security.

In its budget for 2017, the Ministry of Local Government and Modernisation (KMD) earmarked 6.5 m NOK to be allocated directly to the Norwegian Institute for Regional and Urban Research (for research on sustainability and vitality in sparsely populated regions), (KMD budget, 2017). The Ministry of Justice and Public Security allocates research funding directly to the Norwegian Defence Research Establishment (FFI), to the Norwegian Police University College, to the Centre for Cyber and Information Security and to the Transatlantic Council on Migration.

In addition to the above-mentioned research-oriented initiatives, there are a number of public technology programmes targeting societal challenges such as energy, climate, environment and transport. Enova is a public enterprise owned by the Ministry of Petroleum and Energy, established in 2001 to promote a transition to environmentally sustainable energy production and use, and the development of energy and climate technology. Enova offers investment support for energy projects, where it seeks to derive maximum value in terms of energy for the support it provides. The energy support covers all sectors, including transport, and also includes subsidies to households for investments in energy-smart solutions. Enova's other main objective is new energy and climate technology, aiming to reduce emissions and contribute to a long-term restructuring of energy end-use and production. In 2016 it pledged a total of NOK 515 million in support of 80 projects developing or implementing new energy or climate technology. For the period 2012-16, total pledged support to new technology was NOK 3 761 million for 179 projects. Technology projects in industry can be of a substantial scale.

The Environmental Technology Programme was established in 2010, constituting the main part of the National programme for environmental technology (2010-13). It is administered by Innovation Norway. The programme supports pilot and demonstration projects developing environmental technology (technologies that directly or indirectly improve the environment: more environmentally friendly products and processes, reducing pollution, increased resource efficiency, etc.). Support is mainly in the form of grants, or a combination of grants and loans. Support levels vary from 25% to 45% depending on the size of the firm. Since its introduction, annual allocations under the programme have increased rapidly, from NOK 140 million in 2010 to NOK 461 million in 2016. The programme was evaluated in 2014 (Espelien et al., 2014). Based on the information available at that time, evaluators described it as a public funding scheme with a relatively high degree of success. The evaluator's assessment and the companies' own statements indicate that the programme generates a high degree of additionality, with evaluator's calculations showing that one unit of public funding triggers 3.6 units in private investment. The evaluation also characterised the programme as lacking a clear definition of objectives, and found potential for improvement in the way projects are selected.

CLIMIT is the national programme for research, development and demonstration of technology for CO_2 capture, transport and storage. It is organised as a co-operation between the RCN and Gassnova, a public enterprise responsible for managing the state's interests in CCS. The RCN is responsible for the R&D part of the programme, while Gassnova is responsible for the pilot and demonstration activities. The total budget in 2016 was NOK 255 million, of which the R&D part was NOK 105 million. CLIMIT was established in 2005.

The Technology Center Mongstad (TCM) is the world's largest facility for testing and development of CO_2 capture technologies, and a main pillar of the government's strategy for CO_2 capture, which sets the ambition of realising at least one full-scale demonstration facility for CO_2 capture in Norway by 2020. The government owns 75% of the TCM through Gassnova, and partner petroleum companies own the remaining 25% (Statoil owns 20%). The TCM co-operates with national and international companies and research institutions developing CO_2 capture technology. The TCM has also initiated the CCS Test Centre Network, an international co-operation between CO_2 capture test centres. Around NOK 5 billion was spent on planning and construction of the technology centre from 2006 until its launch in 2012. The Ministry of Petroleum and Energy allocated NOK 617 million to Gassnova in 2017 for R&D services from the technology centre, which also covers the government's share of the operating and borrowing costs. The ministry also allocated NOK 330 million to Gassnova for the planning of a full-scale demonstration facility for CO_2 capture, with a view to taking an investment decision in 2018.

Pilot T is the name of a proposed scheme for innovation, pilot projects and R&D for transport, which was proposed by the Ministry of Transport and Communications in the National Tranport Plan 2018-29 in April 2017. The scheme will include a competitive instrument where various participants in the relevant fields will be able to test new solutions in practice. To supply the necessary expertise and to ensure the quality of the piloting activity, the scheme may also include research funding. The scheme is planned to be administered by the existing actors in the public support system for STI.

The ministry has also invited the municipality of Oslo and the county municipalities to participate in a competition called "Smarter Transport in Norway", in order to stimulate local innovation and development in the public transport sector. The plan is to allocate NOK 100 million to be distributed between from one and three winners in 2018-23. The competition is open to concrete solutions that implement new technologies, and that make use of zero-emission technologies where applicable. The National Transport Plan anticipates an allocation of NOK 1 billion to Pilot T and the "Smarter Transport in Norway" competition for the period 2018-29.

Initiatives and programmes to promote innovation in the public sector

RCN and Innovation Norway have instruments and initiatives targeting public sector innovation and renewal. Since 1968 there are Public Sector R&D contracts (OFU), run by Innovation Norway with funding from the Ministry of Trade, Industry and Fisheries, where suppliers co-operate with a customer from the public sector in developing a service or product. An evaluation of the programme in 2012 found that it had contributed to the modernisation and improvement of the productivity of the public sector and therefore recommended increasing its funding and reach (Oxford Research, 2012).

RCN has a number of programmes aimed at strengthening evidence-based decision making, knowledge resources and innovation in the public sector (see Table 5.2). In particular, the primary focus of the DEMOS programme is to "increase knowledge about, and the development of, a democratic and efficient public sector". It had a budget of NOK 28 million in 2016, and runs until 2024. The RCN has proposed an increase of the innovation component in the DEMOS programme of NOK 10 million for 2017, and to increase the use of public innovation projects. Other programmes are also relevant to public sector reform in various areas, such as the FINNUT programme for the education sector, the TRANSPORT programme, and the SAMRISK programme on societal security.

The RCN has also proposed to start up a new programme in 2017 on research and innovation in the municipality sector (FORKOMMUNE) with NOK 17 million, with an ambition to increase the annual budget in the following years RCN is also planning an innovation programme with municipalities as project leaders and a researcher linked to the project.

The government presented a "Digital Agenda for Norway" in 2016, which identified "effective digitisation of the public sector" as one of its five prioritised areas, the others being "a user-centric focus", ICT as a key input for innovation and productivity, "strengthened digital competence and inclusion" and data protection (KMD 2016a; see KMD, 2016b for the full text in Norwegian). The White Paper sets out clear and ambitious goals for advancing digitisation in the public sector. Among other things it commits to a "digital-by-default strategy", putting pressure on agencies to digitise its services and operations. It calls for integrated information management across agencies and includes competence-building measures for civil servants. It requires all public agencies to co-operate with collaborate with Difi and the Norwegian Association of Local and Regional Authorities on digitisation matters and it has a particular focus on digitisation in municipalities, recognising that "[m]ost public sector services are municipal" (KMD 2016a). In the White Paper, the government charges Difi with the important function of monitoring progress on digitisation in the public sector particularly on measures affecting municipalities. Since 2009, the Ministry has also annually presented so-called "Digitisation Circulars" ("*Digitaliseringsrundskriv*") which sets out guidelines and instructions for agencies on how to advance with digitisation. The Digitisation Circular 2016 requires ministries to map both the potential for digitisation of services and processes and which services remain to be digitised (KMD, 2016c).

Conclusions on societal challenges' research and innovation

Mixed effort beside the Ministry of Education and Research and the RCN

So far, most of the research funding for following up the priorities set out in the LTP has come from the Ministry of Education and Research and the Ministry of Trade, Industry and Fisheries. It has taken longer for some other ministries to allocate, or reallocate, funding according to LTP priorities. There are large differences in how much individual ministries spend on research, both in absolute terms and in relation to their total budgets. Some ministries that are responsible for important societal challenge areas allocate little funding to research and innovation. One example is the Ministry of Justice and Public Security which allocates large sums of money to fighting crime and policing but only 0.2% of its total budget to knowledge creation and innovation on these issues. Others are the Ministry of Local Government and Modernisation, the Ministry of Transport and Communications, the Ministry of Labour and Social Affairs, the Ministry of Children and Equality and the Ministry of Finance, all of which spend less than 1% of their budget on R&D.

Thus, there are important areas of societal challenges (such as security and crime prevention, transport, social affairs) where, judging by the R&D budgets of the responsible ministries, there is relatively little focus on research, innovation and renewal.

Furthermore, there is a wide variation in how much of respective ministries' R&D spending is channelled through the RCN, which has implication on both the efficiency of the research being undertaken and on the possibilities of interdisciplinary and cross-sectoral co-operation between the different projects and programmes. The Ministries of Health and Defense stand out as two ministries that spend considerable amounts on R&D – both in absolute terms and in relation to their budgets – but channel very little of their R&D spending through the RCN (see Figure 6.2 in Chapter 6).

There is a view that some sector ministries underinvest in research in areas prioritised in the LTP. This was the case for instance of projects in the area of the renewal of the public sector. The Ministry of Education and Research has a separate budget that originally comes from a research fund created in 2002 (see Chapter 6). They can use this fund to finance areas in the LTP which are not covered by other line ministries. It is not clear which areas have been financed with the resources drawn from this "common pot".

Particularly, the Ministry of Local Government and Modernisation has not yet taken an active role in orchestrating, co-ordinating and driving public sector renewal. This would be especially instrumental since municipalities, which fall under the purview of this minister, are key actors in the provision of a number of public and social services (in education, healthcares, social and welfare services etc.). There are therefore significant potential synergies between the two main missions of the ministry. It has, however, not contributed significantly to the overarching goals LTP in terms of funding. While the importance of experimentation and learning in the public sector is acknowledged the ministry does not appear to dedicate significant resources to these activities. The ministry's efforts regarding public sector innovation and renewal focus on digitalisation, working primarily through Difi, the Agency for Public Management and e-Government. It allocated around 10 million NOK to IKTPLUSS, the RCN's programme for ICT research and digital innovation, in 2016 and proposes the same figure for 2017 (KMD, 2016d).

Lack of cross-sectoral co-ordination

Innovations in areas such as integration, healthcare, green growth, social mobility and cohesion are often interrelated and require systemic change and horizontal policy co-ordination. Norway's sector principle has ensured that many ministries feel ownership for research in their respective areas and can contribute to setting research agendas, both within their own ministries and underlying agencies and through RCN initiatives and programmes. However, tackling societal challenges – precisely because of their cross-cutting nature – require effective co-ordination across ministries and sectors that does not just result in ministry representatives defending their own ministry's interests. Thus, co-ordination must imply a clear common vision and ambition that goes beyond a "lowest-common-denominator-approach". The need for improved co-ordination was also identified in the "Program for better governance and leadership in government" presented by the government in 2014. It highlighted that interventions to address societal challenges and to realise the potential of ICT investments and digitisation have to be better integrated and co-ordinated across sectoral, ministerial and other boundaries.

In particular, the analysis of the health and care sector reveals clear co-ordination problems between ministries regarding research, innovation and education in the context of the sector principle. This results in a tendency to build small research systems and agendas around specific issues (see Box 5.2).

Box 5.2. **Research and innovation in the health and care sector**

Health research and innovation takes place in a complex system with different key actors under the authorities of different ministries, with strict regulations and a weak tradition of interactions both among healthcare providers at the different levels of the healthcare system but also with actors outside the narrowly defined realm of health and care (e.g. industry and other private actors, entrepreneurs, social sciences, etc.).

In recent years, Norway has undertaken a number of important changes in the healthcare system and the research funded and performed in hospitals has increased significantly. The government has launched an ambitious strategy process for research and innovation in health and care resulting in the Health&Care21 Strategy and followed this up by presenting a "Government Action Plan for Implementation of the Health&Care21 Strategy". The government has sought to promote innovation in healthcare by funding innovation projects and by promoting awareness-building and learning platforms. There is also an increasing policy focus on public procurement as a means of driving innovation and national business development in healthcare. Efforts are also being made to reform the education system to meet the changing needs and nature of healthcare provision.

However, while lots of innovation projects are being carried out both in hospitals and in primary care facilities, there is no structure for diffusing, scaling or robustly testing promising innovations. Moreover, in addition to supporting innovation projects that have been generated bottom up, there is a need for leadership that enables and promotes innovation "from the top" since this sector is characterised by strict regulations and procedural requirements, which can result in a culture and atmosphere that is not conducive to experimentation and change.

The research financed by the regional health authorities, mainly allocated to hospital trusts, could benefit from more interdisciplinary approaches including the incorporation of social sciences and technological and engineering sciences, neither of which is naturally present in hospitals. Furthermore, even though the Ministry of Health and Care Services (MHCS) emphasises the importance of the "usefulness" of the research it funds through the hospital trusts, the research is not very needs-driven, but mainly bottom-up driven by researchers' interests. The emphasis on patient involvement in the design of research of research projects is laudable and important. However, it is not a guarantee that the research effort as a whole will be more oriented towards areas where there is greatest need or relevance. This would require patient, user or citizen involvement not just at the project level but also at the level of programme design and prioritisation. Paradoxically, while much of the research in hospitals can be described as "applied research", it is not necessarily needs- or challenge-driven from a societal perspective since the prioritisation is left up to the individual researchers. However, the MHCS has tried to identify some overarching priorities in its annual instructions letters to the regional health authorities in areas such as addiction, mental health, the elderly and women's health.

Innovation and primary care are two areas which appear to fall in between the remit of ministries' responsibilities and co-ordination. The MTIF is seen as responsible for innovation but does so primarily from a business perspective and refuse to prioritise the industry and "pick the winners". The MHCS focuses on the quality and efficiency of medical care provision and has up until rather recently not seen innovation as an integral driver of this; The MER has focused on bottom-up funding and excellence of research; The Ministry of Local Government and Modernisation has not assumed responsibility for strengthening the research and innovation capacity and performance of municipalities (with exception of certain aspects of digitalisation).

The LTP's clear identification of healthcare and the public sector as prioritised areas but also the fact that it linked health, welfare and modernisation have made an important and necessary contribution to advancing research and innovation in healthcare. The development of the Health&Care21 Strategy and the government's action plan has also been instrumental. The focus on municipalities brought attention to the demands for knowledge and innovation in this sector and to the fact that municipalities are important actors in this new landscape of health, knowledge and innovation.

Policies should be implemented not only at the level of individual areas but also at the systemic level. The former, often referred to as the "niche level", requires measures to support experimentation and learning in a given area, most often with a strong involvement from users and a wide array of stakeholders. At the system level, where these niches compete and are combined, large-scale transformations require an interdisciplinary and intersectoral interaction framework, in the form of wide-ranging strategies, roadmaps and platforms.

While incremental innovation in niche areas appears to be accepted and facilitated in Norway, transformative change at the systemic level may require new instruments, organisation and co-ordination. Solutions for societal challenges often require a multidisciplinary approach. Furthermore, they require translational activities in which different solutions are first developed in close co-operation with users and then tested in different contexts. Much bottom-up experimentation and incremental innovation is under way, for example, in municipalities and in education, healthcare and in the provision of public services, one of the great strengths of the Norwegian public sector. However, there is little systematic policy experimentation and learning with a focus on disseminating, scaling up and incentivising the wider implementation of successful initiatives and approaches. Incentives, mechanisms and structures for scaling good practices are often lacking in the public sector, an area that merits closer scrutiny.

Overall, therefore, there is a need for a co-ordinating function for innovation in the public sector or an architecture for ensuring structured learning and driving systemic change (examples of these can be found in Mindlab in Denmark, the Government Policy Analysis Unit of the Prime Minister's Office in Finland or the UK Prime Minister's Delivery Unit).

Overemphasis on the development of the basic knowledge base underpinning societal challenges

The focus of actions to address societal challenge, including in the LTP, is still strongly on supporting research in the hope that it will lead to solutions. For the reasons outlined above, a linear approach is particularly unsuitable for tackling many of the societal challenges Norway, and the world, face today. There is still relatively little systemic focus on innovation to tackle societal challenges and on the transformative and institutional changes that might be needed to develop, test and scale successful approaches and solutions. The latter requires a need for balancing evidence and action (OECD, 2017a), for promoting more "learning by doing" and reflexive governance.

The sector principle has been useful in creating "ownership" for research, and its importance for policymaking, across a wide range of ministries. However, combined with the strong focus on research in the LTP, it may also inadvertently have contributed to an emphasis on research at the expense of innovation, the latter of which is sometimes still regarded as belonging to the domain of – and therefore primarily the responsibility of – the Ministry of Industry, Trade and Fisheries.

Twenty-one processes as an important but insufficient complement to the Long-Term Plan

Starting before the LTP, so-called "21-Forums" were created at the initiative of the government in a number of areas such as oil and gas, climate, energy and marine research. These initiatives have been described as "actor-driven strategy work commissioned by the government or a ministry to promote research-based value creation and development in important societal areas" (TOF, 2015).[6] The "21-forums" are OG21 (oil and gas), Energi21 (energy), Klima21 (climate), Maritim21 (maritime), Hav21 (marine), Bygg21 (construction), HelseOmsorg21 (health and care, see Box 5.3) and Skog22 (forestry). The recent white paper on industry announced that new 21 processes for digitalisation of trade and industry as well as for the processing industry will be initiated (MTIF, 2017).

Box 5.3. **The "21-Forums" and the "Health&Care21 Strategy"**

The 21-Forums draw up sectoral R&D strategies and serve as advisory bodies and stakeholder forums. The objective of the 21-forum strategy processes is to obtain strategic advice from industry, research and other actors to develop STI policies that prepare for industries and a society of the 21st century. Since 2001 several 21-forum processes have been initiated. The 21-strategies are formulated by committees that serve as advisory bodies and stakeholder forums. The committees are appointed by the government ministries and with representatives from businesses, research institutions and public administrations. The committees both formulate strategies for R&D and innovation and serve as forums for strategic collaboration. For some of the strategies the committees function as permanent advisory bodies that advise the government of the implementation of the strategic recommendations, and may be given the task of updating the strategies

In 2013, the Ministry of Health and Care Services initiated a process for developing a "Health&Care21 Strategy". The ministry appointed 15 people to make up the Health&Care21 Strategy Committee, representing industry, universities and university colleges, hospitals, regional health authorities, user organisations, and government agencies. The Ministry also established a "Strategic Forum on Health and Care Research and Innovation (Chief Executives' Forum)". The three overall aims of the strategy were better public health, breakthrough research at a high international level and national economic and business development. The Strategy, submitted by the Committee to the government in June 2014, identified five main priority areas – knowledge mobilisation for the municipalities, health and care as an industrial policy priority, easier access to and increased utilisation of health data, an evidence-based health and care system, a stronger emphasis on internationalisation of research. Based on the strategy, the government drafted an "Action Plan for Implementation of the Health&Care21 Strategy" in November 2015 in which it identified and committed itself to carrying out a number of initiatives to implement the Health&Care21 Strategy. A Health Care 21 Advisory Board, with a dedicated Secretariat, funded by the Ministry of Health and Care Services and located at RCN, has an ongoing remit for overseeing the implementation of all the recommendations in the original strategy. This high-level, multi-stakeholder group, provides advice to Ministries and other users.

In response to the strategy, the government reported that it had "increased funding of basic research and the industry-oriented instruments for research and innovation" as well as establishing three new health research programmes at the RCN "targeting public health, treatment, development of services and innovation and global health" (Norwegian Ministries, 2017). A further response was the commissioning of a report – jointly by the Ministry of Education and Research and the Ministry of Health and Care Services – on the barriers to co-operation between universities and hospitals which was presented in December 2016 (MER and MHCS, 2016).

According to an evaluation by the Norwegian Board of Technology (Teknologirådet) and the RCN, the main task of the 21 processes is to advise ministries on how research and development can contribute to a certain thematic area and how initiatives can best be organised and supported (TOF, 2015). In particular, the 21 processes focus primarily on co-ordinating activities within their respective area, on supporting political priorities (stotte vedtatt politikk) and on creating consensus among the participants (ibid). The evaluation concludes that "the 21 processes are expected to co-ordinate and optimise – rather than challenge – the direction of adopted (existing) policies."

The 21 processes tend to promote dialogue with actors within, rather than across, sectors or areas. The processes would have benefited from involving more actors who could have contributed more "outside perspectives" and ensured a broader societal context and anchoring. The literature on 'Responsible Research and Innovation' (RRI) – which has arisen concurrently with a growing focus in research and innovation policy on tackling societal challenges – emphasises the importance of responsive and reflexive strategy processes and programmes. Such an approach in turn acknowledges and tries to address complexity, risk taking, experimentation, uncertainty, and a cross-sectoral and inter-, multi-, or cross-disciplinary perspective (see, for example, Kuhlmann and Rip, 2014, 2016; Stilgoe, Owen and Macnaghten, 2013). The aforementioned evaluation concluded that the 21 processes "lack the type of broad reflexiveness which a responsive RRI process requires" (TOF, 2015).

Box 5.4. **The "challenge" with societal challenges**

In recent years, a growing body of literature has pointed to the challenges and limitations of research funding, but also science technology and innovation policies in ensuring the transformative change needed to tackle societal challenges. They point to issues such as institutional and systemic failures, particularly resistance to change, the radically enhanced need for policy experimentation and learning, but also policy co-ordination, new forms of stakeholder involvement and reflexive governance (see, for example, Weber and Rohracher, 2012; Geels, 2002; Schot and Geels, 2008; Kuhlmann and Rip, 2014, 2016). There are several "challenges" with promoting innovation to tackle societal challenges which differentiate them from more general and non-directional promotion of innovation. Firstly, they tend to be very complex, sometimes also referred to as "wicked", problems, involving stakeholders that transcend disciplines, constituencies or policy areas (OECD, 2017a). This also means that few societal challenges can be slotted neatly into existing governmental or organisational structures. Ministerial and organisational silos (often accentuated in coalition governments where different parties run different ministries) and turf wars also contribute to the difficulty in driving system renewal and transformation. Secondly, there is rarely a track record or well-established best practice to fall back on, for example there are few precedents on how to deal with climate control, with the refugee crisis, or with an ageing population. A related problem is that, often, "the perspectives on what is the problem and what constitutes its resolution differ across various societal groups" (Kuhlmann and Rip, 2014). Thirdly, they are often characterised by uncertainty, unpredictability and rapidly changing conditions.

A further complicating factor concerning societal challenges is that they are often located in or strongly linked to the public sector and the provision of public goods. They often involve systems that cannot be "turned off", such as education or the continuous provision of healthcare. More fundamentally, the public sector is often characterised by strong risk aversion and resistance to change and a lack of mechanisms for promoting innovation, experimentation and the scaling of successful solutions (see also OECD 2017). Part of this has to do with the imbalance between the risk of failure ("wasting taxpayers" money') and the difficulty in appropriating the gains of successful innovation ("you don't get elected or promoted for preventing cost increases") (see also RCN and DAMVAD, 2012). The nature of the public sector, and its complicated relation to innovation can be summed up as the following:

> …public services cannot be made obsolete. They can and should be continually renewed but their core function must remain constant. This structural dilemma requires a non-standard approach because any intervention aimed at transformation must be at once sympathetic and disruptive to the old system (OECD 2017a).

The 21 processes provide an important and valuable complement to the LTP in bringing together stakeholders within thematic areas to agree on, co-ordinate and further advance efforts to strengthen prioritised sectors and areas. They are at the same time strongly sector-driven and consensus-oriented processes which lack a broader and more visionary perspective and the ability to accommodate and drive the transformative (and often disruptive) change that is likely to be necessary to address the grand challenges our societies face today. Furthermore, they tend to be quite nationally oriented, as epitomised by the Health&Care 21 process and strategy, lacking a strong global dimension with regard to both supply and demand of knowledge and innovation but also the need for international co-operation to tackle societal challenges.[7]

Centres for Research-Based Innovation Barriers to public sector innovation and renewal

The public sector is a key actor and stakeholder in tackling many societal challenges and this is particularly so in countries like Norway, where the public sector is relatively large. The government has emphasised the importance of increasing competence, leadership and knowledge resources in and for the public sector. In particular, there is an ambitious agenda for digitisation of the public sector where Norway is already one of the leading countries globally.

Similar to the other Nordic countries, Norway has a comparatively large public sector, particularly in terms of share of total employment.[8] The public sector accounted for 34.6% of total employment in 2013 compared to an OECD average of 21.3%. It is generally considered to be working well, both in international comparisons and when looking at citizens’ confidence in both government and the public sector (OECD, 2015b). However, an ageing population, increasing public expenditures for pensions, healthcare and elderly, weak productivity development in the public sector, increased complexity in public administration are putting pressure on the public sector to adapt by developing new methods, solutions, organisations and partnerships for delivering good and cost-effective public services in the public sector (see, for example NOU, 2016).

Many of the challenges increasingly facing the public sector – and its ability to provide efficient, effective and high quality public services in the future – are interrelated and require systemic change and horizontal policy co-ordination. Examples of these are integration, healthcare, green growth, social mobility and cohesion etc. What currently seems to be missing is a co-ordinating function for innovation in the public sector or an architecture for ensuring structured learning and for driving systemic change (examples of these can be found in Mindlab in Denmark, the Government Policy Analysis Unit of the Prime Minister’s Office in Finland or the UK Prime Minister’s Delivery Unit).

The RCN views itself as being able to assume the following roles in promoting innovation in the public sector: Funding body, advisor, providing meeting arenas, knowledge dissemination and brokerage, national and international knowledge development, mediator and network building, implementation driver, promotion and creation of co-operation between public and private sector, guardian of the main principles of the innovation strategy of excellence, breadth and impact (“spiss-bredde-nytte”) (RCN and Damvad, 2012). In recent years, RCN has taken and supported a wide range of initiatives aimed at catalyzing and enabling innovation in the public sector, indicating a strong commitment to this area. However, it cannot be the responsible for the overall architecture which is required for driving systemic change, including ensuring the systematic upscaling of good practices, the removal of institutional, regulatory and other barriers, establishing conducive incentive structures, strengthening public procurement as a driver of innovation and the creation of demand / markets where necessary.

Norway is in fact confronted with many of the principal challenges of innovation in the public sector. An analysis by RCN and Damvad (2012) acknowledged that there are significant barriers to innovation in the public sector, such as political factors, organisational issues, incentive structures and regulations. In particular, it criticised that it is unclear who is responsible for public sector innovation in Norway and that several ministries that should be at the forefront refrain from engaging in innovation in the public sector, for example regarding municipalities. Ministers claim that they are not rewarded for innovation, which lead them to focus increasingly on control and regulations rather than on creating spaces for renewal and innovation (RCN and Damvad, 2012). Similarly, a government report from 2014 argued that Parliament is more concerned with plans, targets and decisions than results (KMD, 2014). Norway has also particular difficulties in ensuring the scaling up and implementation of successful pilot projects in the public sector, partially because scalability is not taken into consideration in innovation projects. It also acknowledged that a lot of research – by its very nature – tends to be empirical, i.e. backward-looking, when there is a need for forward-looking analysis (RCN and DAMVAD, 2012). In its analysis of innovation in municipalities in Norway in 2013, Teigen points out that diffusion of innovation in the municipal sector an important but under-analysed issue.

Notes

1. NIFU R&D Statistics Database, www.foustatistikkbanken.no.
2. Here measured by the Field-Weighted Citation Impact (FWCI) in order to factor in the difference in citation rates across disciplines. Data originated from the SciVal database, last accessed on 24 October 2016.
3. The Norwegian Institute for Public Health, one of the top ten publishing institutions in Norway, has seen a dramatic increase in its citation impact from 1.6 in 2011 – nearly identical to the Norwegian overall citation impact in that year – to 3.09 in 2015, far above the level of Norway as a whole (1.59).
4. Similar results are found when considering the other fields related to health (i.e. medicine, health professions, etc.).
5. www.greendeals.nl/english/green-deal-approach.
6. Authors' translation.
7. It should however be noted that there is a section on global health and a section on high quality and internationalisation in the Health&Care21 strategy (Norwegian Ministries, 2017).
8. In 2013, reaching 33%, Norway had the highest share of its labour force occupied in the public sector, and recorded one of the most significant increase from 2009 (OECD, 2015b).

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Chapter 6.

Improving science, technology and innovation system governance in Norway

This chapter discusses the state-of-the-art and potential of the science, technology and innovation system governance framework to provide strategic orientations and ensure the necessary co-ordination to achieve the three overarching objectives of the government's Long-Term Plan. It begins with an overview of the historical evolution of science, technology and innovation governance and policy in Norway. It then examines the main current policy actors and governance arrangements, before assessing the added value of the LTP as a strategic plan and co-ordination instrument. The last section synthetises the achievements to date and remaining challenges in improving science, technology and innovation system governance in Norway.

The history of science, technology and industry governance and policy in Norway

Norway gained its full sovereignty only in 1905, after being joined in a union with Denmark for three centuries and then, for nearly a century, in a union with Sweden. In both cases, Norway enjoyed a high degree of autonomy but was not fully independent. Industrialisation in Norway arrived late by comparison with the larger continental economies, and it came only in a few regions. The economy was long dominated by shipping, agriculture, forestry, fisheries and mining. These industries and the sectors that supplied them tended to be local and limited in scope. Today, however, building on these industries and on the recent development of the oil and gas industry, Norway today is among the richest countries in Europe, with a unique financial capacity in reserve to face challenges in the future.

A three-stage industrial development path

The historical development of Norway can be described as an evolution of three developmental paths that co-exist even today in the Norwegian innovation system (Wicken, 2009a).

The small-scale decentralised path was driven by the needs of agriculture, forestry and fisheries, and provided incremental growth and learning opportunities for smaller scale industrial development, e.g. in shipbuilding. This path was embedded in local communities and of low capital intensity, and was financed through communal savings banks and gradual innovation. Many Norwegian companies today grew out of such environments; in addition, Norway still has a tradition in regional communities of protected spaces and of companies serving local needs. Over the decades, centralised distribution and financing channels have evolved, helping to preserve decentralised smaller producers that still play a major role. Newer developments, like the expanding fish-farming sector, started with hands-on experience and gradually turned into more organised R&D activities. These involved universities and research institutes and subsequently transformed into a more mature industry that requires ever more scientific expertise to allow for environmentally friendly growth (Wiig Aslesen, 2009).

The large-scale centralised path has evolved along with industrialisation and the management of national resources. The large-scale use of hydropower allowed for the processing of basic materials for the production of metals, alloys, pulp and paper, fertilisers and other energy-intensive basic industries like aluminium smelters. These industries were capital-intensive, influential in politics, increasingly knowledge-intensive and in part state-owned. This led to large investments – often of foreign capital – in the decades around 1900, based on some of the largest hydropower installations in Europe. Drawing on the power sources, industrial companies were created in different parts of the country. A small number of (academic) innovators were part of this development from the outset. Later, these companies relied more on R&D capacities of Norwegian higher education (HE) and public research (PRI) institutes for product and process innovations (Moen, 2009). Some were at the heart of the creation of the first industrial clusters.

The development of the offshore oil and gas sector was also part of this second development path. State companies, private national and, in particular, foreign countries were granted concessions to exploit the Norwegian Continental Shelf. In cities like Bergen, Stavanger or Trondheim, specific scientific and technical clusters emerged, resulting in specialised engineering clusters and the highly specialised shipbuilding industry serving the oil and gas industries (Engen, 2009). Oil and gas has remained a key sector, even when oil prices were low (see Chapter 2).

Finally, an R&D-intensive network-based path developed from the 1960s onwards. Knowledge producers, with the pervasive force of information and communications technology (ICT), began to play an increasing role in the economy and in society. Research and development became a greater part of the production process, with labs integrated into production settings. Companies with strong ICT competences became important nodes in these large industry networks. This development was coupled with an active innovation-oriented industrial policy approach (Wicken, 2009b).

The three developmental paths – each with their own path dependencies – co-exist today in Norway's innovation system. Some industries, like shipbuilding, which was once local and decentralised, have since become large-scale and specialised (Wicken, 2009a). In the post-World War II era of active industrial policy, the influence of corporatist, collaborative elements favourable to research grew (Gulbrandsen and Nerdrum, 2009). Later, knowledge producers co-evolved with industries in, for example, the marine, maritime or oil and gas sectors.

The emergence of innovation policy

During this process, innovation has been vital in allowing Norway to seize opportunities, drawing upon and co-operating with a system of higher education institutes (HEIs) and public research institutes (PRIs). These were built gradually, evolving out of different origins (Gulbrandsen and Nerdrum, 2009; Fagerberg et al., 2009). The state was instrumental in guiding these developments, using different policy approaches during the different developmental stages.

The big wave of institution building came in the post-war period. The first university was founded only in the early 19th century, followed by a few others at the turn of the 20th century. The first PRIs were created by sector industries before World War II. Regional economic and societal needs (Cooke, 2016), as well as conservatism and the dominance of the "consensus principle," appear to be among the reasons why the organisational R&D landscape developed late and then resulted in multiple and rather small institutions.

Science, technology and industry (STI) policy in the earlier phases of development had a strong focus on regulatory and investment incentives. Hydropower and the rights to exploit waterfalls led to specific regulatory instruments, which were then adapted to other industries, like oil and gas. These concession laws were developed in the early 1900s to allow for large-scale investments, while at the same time requiring that the non-public owners return ownership of their sites to the state after 60 years. They also provided incentives for Norwegian (co-)ownership in industrial investment (Wicken, 2009a; Moen, 2009). This helped boost the state share of industrial ownership, which is still very high (NOU, 2016, Figure 1.20). At a later stage, some of these companies, for example, Norsk Hydro, attempted to expand and diversify, with mixed success. The concessions were coupled with specific tax instruments, most notably the requirement to invest part of the returns in Norwegian technological capacities. This has helped to develop a local/national knowledge base, in contrast to other North Sea oil and gas industries, for example in Denmark or the United Kingdom (Fagerberg et al., 2009).

Norway's economic development was also marked by periods of active technology-based industrial policies in the post-war era. These were mainly led by the so-called modernisers, an influential fraction of the Social Democrat party. These policy makers combined two goals: first, they aimed to strengthen the capacity of Norway to defend its territory with the help of a robust armaments industry;[1] second, they actively supported the development of companies, mainly in the information and communications technology (ICT) sector, through a research-driven strategy for industrialisation (Wicken, 2009b). This led to a few remarkable national champions. Some of them were brought to an abrupt end in the 1980s and early 1990s, as a result of a mix of risky strategies, the small size of Norway's home market and the emergence of a few US and Asian global champions of ICT (Sogner, 2009). This shock weakened the dynamics of active industrial policy in Norway. A positive result of this top-down policy approach, however, was the major build-up of high tech, or ICT, capacity for civil and defence purposes.

Collaboration between public and private actors increased in the 1960s and 1970s, together with the creation of a strong national support structure, including grants, loans, tax deductions and regulation favourable to innovation. On the funding side, the Royal Norwegian Council for Scientific and Industrial Research (NTNF) was created as early as 1946, under the auspices of the ministry in charge of industry. In 1949, the Norwegian Research Council for Science and the Humanities (NAVF) was added, a funding organisation for basic research, with some sub-councils. A further proliferation of actors with different funding roles ensued, whose limited performance and ability to interact and manage cross-cutting issues were repeatedly criticised (Arnold et al., 2001). This led in 1993 to the creation of the Research Council of Norway (RCN) as a singular council to cover all scientific fields and most of the application-oriented research funding, with special responsibilities for the PRI sector and a role as advisor for the government. The portfolio of the council has not changed significantly since. It is still the dominant operational actor in innovation policy.

RCN was supplemented in 2004 by Innovation Norway (IN), an innovation funding agency with a pronounced regional mission.[2] IN traces its history to the first real estate loan bank, Hypotekbanken, started 150 years ago to support rural development. It was followed by specialised financial instruments like Industribanken before World War II and the Regional Development Fund in the post-war period, and then by the Industry Fund and other instruments. These all were merged into IN as a single organisation. The Industrial Development Corporation of Norway (Siva) was founded in 1968, focusing on physical infrastructure.

Main policy actors in science, technology and innovation policy

The overall policy landscape and its guiding principles

Overall policy principles

Norway is a constitutional monarchy with a parliamentary democracy. The legislation and overall budgeting is decided in the single-chamber Norwegian parliament, the Storting. It enacts legislation, approves the national budget, authorises plans and guidelines for state activities and votes on bills and proposals by the government.[3]

The annual budget proposal to the Storting is subject to extensive negotiations within the government. For individual policy initiatives, plans and strategies, the government and individual ministries can formulate white papers and submit them to the Storting. Although of a different form and scope than previous white papers on research, the 2014 Long-Term Plan for Research and Higher Education 2015-2024 (LTP) itself is a white paper.

Norway can be described as a centralised state, most of whose policy fields and budgets are governed at the central government level (for the regional level, see Box 6.1). Public R&D spending almost exclusively comes from central government budgets. The government, led by the prime minister, includes 15 ministries, and each, under the Norwegian constitution, is quite independent in terms of policy formulation and execution.

Box 6.1. **Regional innovation policy in Norway**

Norway has three levels of government: the central government (NUTS1), 19 counties (at the NUTS3 level) and 426 municipalities (at the NUTS5 level; currently some mergers are under way). The Ministry of Local Government and Modernisation (KMD) is responsible for regional development. Since the administrative reform of 2010, the county councils have had greater responsibility for regional economic development and innovation, for instance in the Regional Research Funds and the regional VRI R&D programme, to facilitate collaboration between regional industries, R&D and public institutions on innovation. The counties are also developing regional plans central to strategies related to innovation policy. Below the county councils, municipalities are responsible for business planning and land use, but do not receive funds directly to support innovation-oriented activity (Dahl Fitjar, 2016).

Innovation Norway (IN) has regional offices in all county administrations, and regional boards to encourage co-ordination with other regional actors. Its regional apparatus is well developed, giving it considerable insight into regional business environments (Oxford Research, 2016). The RCN, IN and Siva, the Industrial Development Corporation of Norway, also jointly operate the Norwegian Innovation Clusters, an agency that finances regional business clusters through the Arena, Norwegian centres of expertise (NCE) and global centres of expertise (GCE) programmes.

A recent report by Oxford Research (2016) evaluated the interface between Innovation Norway, Siva, RCN and the county authorities. It concluded that, despite the overlapping objectives in support of knowledge-based innovation, there is good communication between the different actors involved. The division of roles between the agencies is, it argues, clear and well delineated, with successful co-operation between the actors at the national level in all overlapping areas of policy. However, the study argues that the roles and division of responsibilities are less clear at the regional level, particularly in relation to activities associated with needs assessment and mobilisation (e.g. VRI, the regional R&D and innovation programme). This also applies to counselling and mentoring support activities for entrepreneurs and firms, and in the context of innovation companies, for which there seems to be a lack of unified responsibility.

Sources: Dahl Fitjar, R. (2016), "Towards a regional innovation policy?"; Oxford Research (2016), *Simpler and Better? Interfaces Between Innovation Norway, the Research Council, Siva and County Municipalities*.

Science, technology and industry policy

The Norwegian science, technology and industry (STI) policy landscape has some unique features. One of its main structuring elements is the sector principle, with the consensus principle as an underlying approach to policy making. The sector principle is a constitutional principle that gives each ministry a great deal of independence in terms of policy formulation and execution within its policy portfolio, including for matters of research and innovation. Each ministry decides, for instance, how much resources it will devote to research and innovation (Solberg, 2016; OECD, 2008). This can generate issues with horizontal co-ordination.

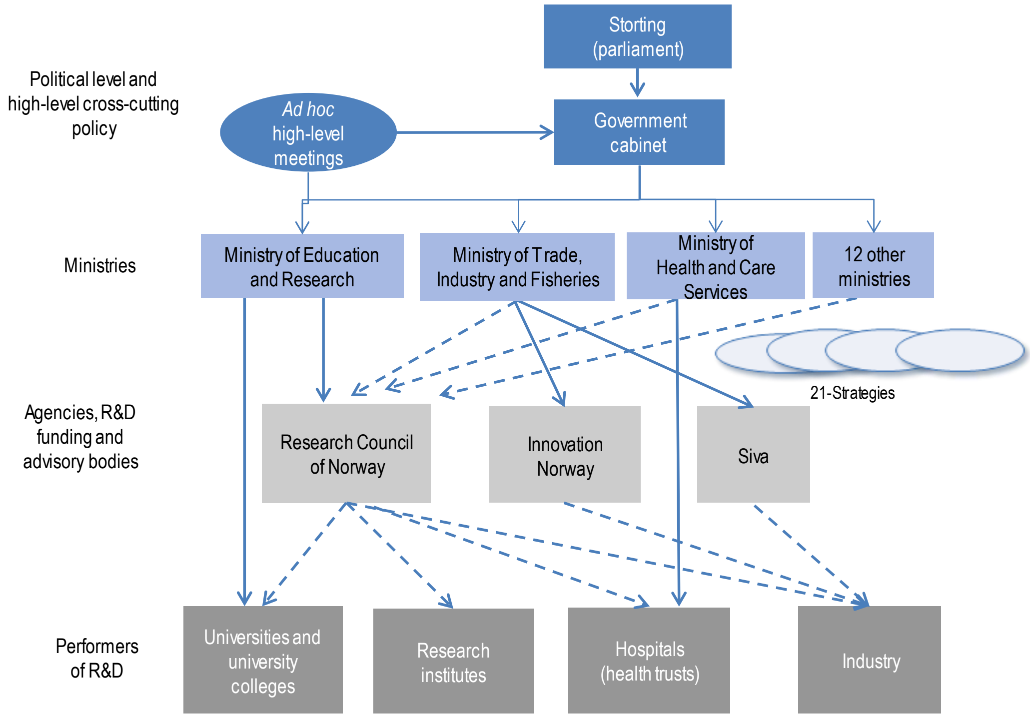
As a result of the sector principle, nearly all ministries have research budgets. Three of them (the Ministry of Education and Research, the Ministry of Trade, Industry and Fisheries and the Ministry of Health and Care Services), however, account for 75% of the appropriations in 2016. This alleviates to some extent the challenge of co-ordination in a highly sectorial policy set-up. However, while R&D budgets are the most visible parts in STI policies, the mobilisation of other resources, like regulatory power, human resources and other "qualitative" and "technical" policy measures, can be even more important for successful cross-departmental policy delivery, e.g. in health, transport or other public sector innovations.

As a member of the European Economic Area, Norway is required to follow EU R&D state aid rules, which govern the types of innovation and industry-oriented measures the government can support. These rules stipulate what types of activities are eligible for support, which costs relating to these activities may be covered in part or in full, and the maximum aid intensity that may be granted for the various activities.

Main actors on the ministry level

Figure 6.1 shows the most important actors and the relations between the different policy levels, with the central role of RCN and the specific advisory and co-ordination structures.

Figure 6.1. **Main science, technology and innovation policy actors and governance relations**



Source: MER (2016a), "Background report: OECD Innovation Policy Review of Norway".

The Ministry for Education and Research (MER) is responsible for universities, university colleges, a small section of the institute sector and for co-ordinating general research policy within the limits of the sector principle. It allocates half of all government budget allocations for R&D, including the block funding for HEIs and a large share of the

RCN budgets. MER's respective departments for research and department for higher education are responsible for the governance of RCN and of the HE sector. Within this scope, MER employs both hard and soft governance and co-ordination instruments, albeit within its own sector (see Chapter 3). Hard measures include performance-based funding or university legislation; softer measures consist of a mix of incentives and pressure in the case of university mergers.

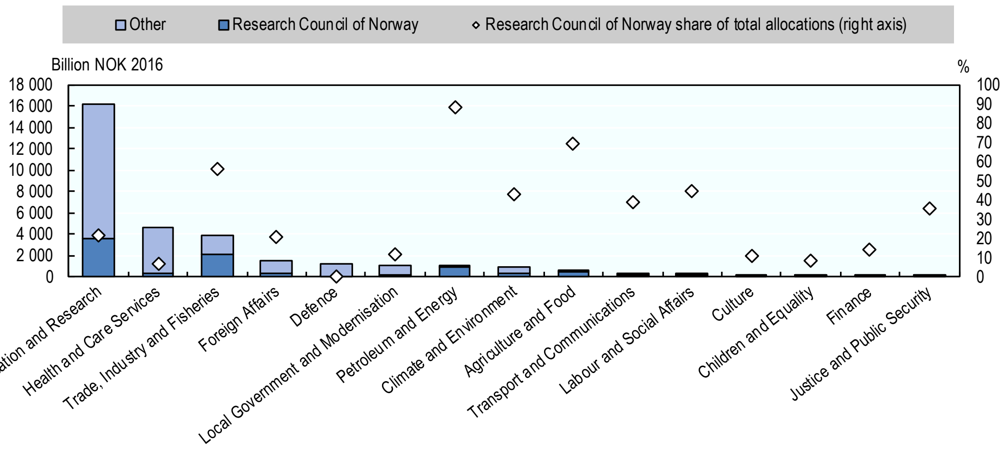
The Ministry for Trade, Industry and Fisheries (MTIF) is the result of a merger in 2014 of the Trade and Industry and Fisheries portfolios. It commands the third-largest R&D budget after MER and the health ministry. It has overall responsibility for industrial and innovation policy and its own research and innovation department. It is the authority governing IN, with 51% ownership shares, while 49% belong to the county authorities. Siva is also owned by the ministry. It also provides a quarter of RCN funding and is responsible for the technical-industrial public research institute (PRI) sector.

The Ministry for Health and Care Services is the second-largest provider of public R&D spending after MER. This is due to considerable budget growth in recent years. This ministry takes a special role, as a large percentage of its budget is not channelled through RCN programmes.

Other ministries with considerable R&D portfolios include the Ministry of Foreign Affairs, the Ministry of Petroleum and Energy, the Ministry of Climate and Environment, the Ministry of Local Government and Modernisation and the Ministry of Agriculture and Food. The Ministry of Defence also can dispose of a considerable funding budget, which in part is reserved for its own sector Research Institute, the Norwegian Defence Research Establishment (*Forsvarets forskningsinstitutt*, or FFI).

Figure 6.2 shows the pattern of R&D allocation per ministry and how much goes through RCN. This RCN percentage share varies widely.

Figure 6.2. **Government budget allocations for R&D by funding ministry and recipient, 2015**



Source: MER (2016a), "Background report: OECD Innovation Policy Review of Norway", based on NIFU and RCN data.

The Research Council of Norway

Structure, positioning and responsibilities

The Research Council of Norway has been the dominant intermediary actor in Norwegian STI policy since 1993. It has a unique position and mandate among OECD countries,[4] since it combines funding for basic research as well as for applied, industry-oriented and collaborative research. The council's role (RCN, 2015a) is among other things, to "promote an integrated R&D system that supplies high-quality research, develops knowledge for dealing with key challenges to society and the business sector, fosters dynamic interaction within the R&D system nationally and internationally, and creates a framework for learning, application and innovation".

RCN is also responsible for co-ordination tasks across different policy sectors, for research and policy evaluations, for strategic and financial steering of the institute sector and for providing strategic advice to the government on science and technology (policy) matters. This is a combination almost unique by international standards. The reasons for its comprehensive mandate originated in the major co-ordination problems of Norway's council and funding system before 1993, as well as in the sector principle.

RCN is government agency reporting to MER with special extended authority. Its funding comes from nearly all ministries (MER provides 40% and MTIF 25%). Its overall budget was NOK 8.5 billion (about EUR 950 million) in 2015, quite substantial for a country of 5 million people (see Box 6.2), although it includes some block-funding elements for PRIs. About 25% of all public R&D funding is channelled through RCN (Solberg, 2016). It has more than 470 employees, and in 2015, awarded grants to about 5 000 projects, from large-scale funding of scientific centres to small individual grants to small and medium enterprises (SME).

RCN has a three-layered board structure, consisting of an Executive Board, its highest authority, four division research boards and 60 specific programme boards and committees. Each of these boards includes members from different walks of life (universities, UCs, institutes, industry, etc.). The two top layers are staffed with Norwegian representatives. Of 512 programme board members, 38 are not Norwegian. A large majority of the external experts reviewing RCN applications and serving on panels for proposal evaluation is recruited from abroad.

The RCN's operations are run by the chief executive, plus four executive directors responsible for the four topical divisions (science; innovation; society and health; energy, resources and the environment), complemented by a fifth division for administrative tasks and a few horizontal units, including a unit responsible for international activities.

The council has adopted six main objectives for the period 2015-2020 under a new strategy (RCN, 2015a): 1) increase investment in breakthrough research and innovation; 2) enhance research for sustainable solutions in society and the business sector; 3) cultivate a more research-oriented, innovative business sector; 4) promote a public sector that initiates and implements research in reform and renewal efforts; 5) increase international co-operation and participation in EU initiatives; and 6) serve as a strategically oriented research council to promote coherence and renewal in the research system.

With this strategy, RCN has also made a first step to incorporate the LTP priorities, a plan the Council welcomes, since it states to have been instrumental in its design process. Some concrete activities are linked to the LTP and its budget appropriations to RCN, including young research talent and increasing EU participation.

Box 6.2. **The Research Council of Norway's scope and budget in a four-country comparison**

The Research Council of Norway (RCN) has a substantial budget. It is difficult to compare it directly with other countries' innovation agencies, as it is more than simply the combination of a research council and an innovation agency; other countries have much more diversified funding structures. Sweden has more than half a dozen potentially comparable organisations and Denmark at least three.

Small countries that allow for an easier comparison include Switzerland, Finland and Austria; however, the goals are different: In Switzerland, over 80% of third-party funding is allocated via the Swiss National Fund (SNF) to fund academic research and only 20% via the "applied" Commission for Technology and Innovation (KTI). In Austria, applied research funding dominates. Over 70% goes to the "applied" Austrian Research Promotion Agency (FFG) and only 30% to the Austrian Science Fund (FWF). In both countries, this ratio has remained stable for a long period. In Finland, the Academy of Finland (AKA) funds academic grants and TEKES, the Finnish Funding Agency for Innovation, funds applied research and innovation. The relation is more balanced, but has changed considerably: in 2008, the TEKES budget (then EUR 530 million) had been more than 75% higher than the AKA budget (then EUR 300 million).

Table 6.1. **Research funding in selected small advanced European countries**

Country	Inhabitants (millions)	"Basic" research funding (million EUR)		Applied research funding (million EUR)		Total (million EUR)	Budget per capita (million EUR)
Norway	5	RCN (estimated 2/3 for "applied" research funding)			**850**		170
Austria	8.5	FWF	200	FFG	520	720	85
Finland	5.5	AKA	440	TEKES	380	820	149
Switzerland	8	SNF	800	KTI	150	950	119

Note: All numbers are approximate and refer to the years 2014/2015.

Sources: Websites of the organisations.

RCN is exceptional in organisational terms. Its funding budgets are high (namely for more applied research, and given the additional opportunities for Norwegian companies provided by the Skattefunn tax incentive scheme). The overall amount is nevertheless comparable to what countries like Finland offer as a funding base.

Main RCN programmes

One of the particularly important actions within the current RCN strategy for the period 2015-2020 is to strengthen activities aimed at providing knowledge-based advice and simple-to-use, readily accessible funding instruments (RCN, 2015a).

The RCN is now running a three-digit number of distinct programmes and initiatives. As a result of rationalisation efforts in the years before 2012, it reduced the number of funding programmes or schemes from 229 to 178 over the 2000s (Arnold and Mahieu, 2012). In recent years, the number fell even further, to nearly 130 individual initiatives, including about 30 larger programmes.[5] Although much progress has been made, this is still a considerable number, by comparison with other, larger countries.

The funding programmes and schemes can be clustered into different categories (see Table 6.2).

Table 6.2. **Main RCN funding programmes related to societal challenges**

Type of research programmes	Programme purpose
Research programmes	Creation of new knowledge in thematic areas addressing public sector interest, or industry branches through user-directed innovation programmes. Depending on the research area and recipients, projects are either 100% government financed, or, in the case of user-directed programmes, on a shared cost basis with private actors.
Large-scale programmes	Long-term knowledge to identify solutions to societal challenges. Funding through a wide variety of actors from industry, academia, the public sector and the civil society, including: – BIOTEK2021: Agriculture, marine, industry and health – HAVBRUK – Sustainability, marine – NANO2021 – Nanotech and advanced materials – KLIMAFORSK – Climate change research – PETROMAKS2 – Petroleum research – ENERGIX – Energy research – IKTPLUSS – Increasing ICT relevance.
Independent projects	Individual independent academic research with funding in three pillars, according to scientific area, and top-up funding for young researcher programmes.
Infrastructural and institutional measures	Comprehensive funding according to institutional measures: – Basic funding (with performance-based element) for 48 PRIs. – R&D support for groups outside government framework. – Funding equipment and database creation.
Centre schemes	To support "critical mass" mainly in HEIs and PRIs. Supporting networks, research excellence and organisational capabilities. Supporting specific goals that need a certain size, funding and visibility. Current centre schemes run by RCN are: – SFF (centres of excellence) – Enable larger research communities for long-term, basic research. – SFI – linking academic and industrial partners for industrial research. – FME – research programme on green energy challenges. – NCE (together with IN) – Encourages regional industrial innovation.
Networking measures	Soft measures, including funding networks that constitute approximately 5% of the overall annual budget.

Sources: MER (2016a), "Background report: OECD Innovation Policy Review of Norway"; Solberg, E. (2016), *RIO Country Report 2015: Norway*, https://rio.jrc.ec.europa.eu/en/library/rio-country-report-norway-2015, and RCN homepage: www.forskningsradet.no/en/Funding_schemes/1138882212929.

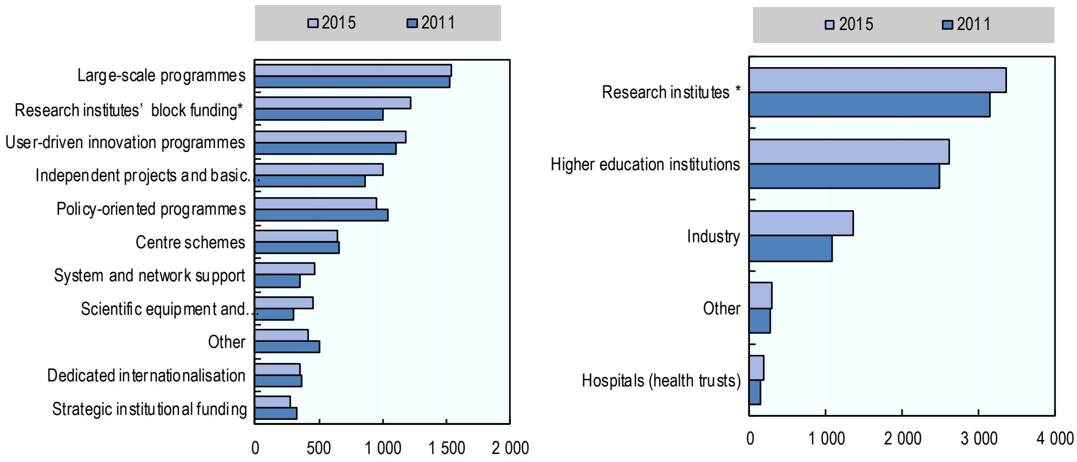
Analysis of the allocation of RCN funding to the different instruments in recent years shows that budgets for bottom-up projects, infrastructure and PRI block funds have increased, but other funding lines have stagnated (Figure 6.3).

Innovation Norway

Innovation Norway (IN) is the second major provider of public support for innovation. It was created in 2004 as a merger of different public business support banks and agencies, including agricultural, industrial growth and export-funding instruments. The agency is co-owned by the MTIF (51%) and the county authorities (49%), with 700 employees all over Norway. The agency is governed by a board of directors, which appoints 15 local boards to steer its regional offices. Its overall budget is NOK 3.4 billion (about EUR 380 million). NOK 2 billion is provided by the Ministry of Trade, Industry and Fisheries, NOK 716 million by the Ministry of Agriculture and Food (reflecting IN's important role in this sector) and NOK 471 million by municipalities. The rest comes from the Ministry of Foreign Affairs for internationalisation matters, and from the Ministry of Local Government and Modernisation (Innovation Norway, 2016).[6]

Figure 6.3. **RCN funding by type of instrument and recipient, rounded, 2011-15**

Million NOK



* The public research institute (PRI) percentage is in fact higher, as it also receives RCN funds indirectly through collaborative industry projects.

Source: MER (2016a), "Background report: OECD Innovation Policy Review of Norway", using RCN data.

The agency describes its task as a "broad and complex social assignment", with the support of private sector value creation at the core of its activities (Innovation Norway, 2015). IN's mission and activities have a global as well as a regional dimension. It has international offices, technology sourcing and promotion activities, export promotion and tourism marketing. IN also carries out its regional mandate through offices across Norway, with a focus on less industrialised and less central regions, which receive most of its funding.

While RCN has a unique comprehensive mission, IN is focused on more downstream and regional innovation activities. Innovation Norway's current strategy[7] has six priorities for 2020, to: 1) prioritise areas where Norway has international competitive advantages; 2) elevate the challengers with global growth potential; 3) strengthen entrepreneurial and co-operative culture to fuel the jobs of the future; 4) develop a strong national brand, to increase competitiveness; 5) encourage value creation based on regional advantages; 6) advise and provide knowledge on future-oriented innovation and industry policy. The five cross-cutting priorities are digitisation, sustainability, "Brand Norway", innovation policy (including innovation policy analyses and advisory services and developing an innovation policy think-tank) and competence building. "Green thinking" is also a common denominator of the IN strategy, including areas like clean energy, the marine environment, bio-economy and smart society.

The agency's chief areas of action are defined functionally:[8] start-ups; growth companies; clusters and business environments. Internationalisation and sustainability are the two main cross-cutting activities. The four main tools are internationalisation assistance, funding through loans and grants, cluster services and advisory services (Innovation Norway, 2016):

- Start-ups: The main goal is to support entrepreneurs. IN works on quality and growth potential with financial and nonfinancial instruments. IN directly funds companies through pre-seed, seed and early growth funding, and also supports intermediaries like technology transfer offices (TTOs) or investment companies with special loans.

- Growth companies: Main support activities are grants and loans for company investment and growth, with an emphasis on innovation loans. This area is also linked to IN's internationalisation and export support.
- More innovative business environments: This area includes local services as well as cluster initiatives and business networks. The cluster initiative, managed in co-operation with RCN and Siva, has three layers (and a new initiative, called "Clusters as vehicles for transformation"):
  - arena: 22 comparatively smaller cluster projects
  - Norwegian centres of expertise (or NCE, also in co-operation with RCN): 14 mixed centres as the core of a cluster, each with an important regional component
  - global centres of expertise: 3 large clusters with a global reach.

Nearly half of IN's budget is allocated to the agricultural and the marine and maritime sectors. All other sectors, including tourism, industry, oil and gas, ICT and services, each receive around 10% of the agency's financial support. This is a reflection both of the traditional mission of IN and the regional structure of the Norwegian economy (Cooke, 2016). The portfolio includes both R&D and non-R&D-related innovation support mechanisms, with a focus on the latter. For a general overview, see Table 6.3.

Table 6.3. **Main Innovation Norway instruments**

Main instrument	Detailed instrument/sectors	Appropriations, million NOK (2015)[1]
Low-risk loans	Industry and services	720
	Agriculture	410
	Fishing vessels and quotas	830
Innovation loans and guarantees	Industry, services and agriculture	960
Grants	Regional development	360
	Start-up grants	370
	Environmental Technology Programme	340
	R&D contracts	360
	Clusters and networks	140
	Agriculture	690
	Other	300

1. Approximate numbers for IN spending, from authors' calculations based on the regional budgeting table in IN Annual Report 2015 (www.innovasjonnorge.no/aarsrapport/2015/assets/hovedtabell_en.png).

Source: Innovation Norway (2015), *Annual Report 2014*.

Innovation Norway's intervention has a considerable leverage effect. While a small percentage of its budget is used to provide a service structure, the rest is used for loans and grants in roughly equal amounts. Due to the nature and structuring of the loans, IN can annually provide overall financial support of over NOK 6 billion. This is further leveraged with another NOK 10 billion, provided mainly by commercial banks and equity financing as part of the financing packages (Innovation Norway, 2016). IN reports a high additionality of its funding: funded companies grow faster than non-funded ones, and IN funding has been highly influential in helping the companies start projects or invest (Innovation Norway, 2015; 2016).

Other actors

Siva, the Industrial Development Corporation of Norway, based in Trondheim,[9] is a MTIF-owned public innovation investment company that was founded in 1968 with 40 employees. It complements its policy portfolio by investing in and owning physical infrastructure that can host promising individual companies that want to grow or to relocate. The agency has full or partial ownership of more than 40 real estate companies and a number of incubators. In addition, it has equity in more than 100 innovation companies and offers them advice, space, networks and, some cases, funding. Siva also receives funds from the Ministry of Local Government and Modernisation for its role in the three-agency cluster programme. In total, Siva is invested in 150 buildings of more than 600 000 m^2 and around 40 incubators housing many start-ups (MER, 2016a).

The Norwegian Industrial Property Office (NIPO) is the national intellectual property rights authority, including patents, trademarks and designs, acting under the auspices of MTIF.

Statistics Norway, established as an independent entity in 1876, and is Norway's national statistical institute and its main repository of official statistics.

Overall governance: Agenda setting, co-ordination and evaluation

Governance and co-ordination on government level

The existing co-ordination mechanisms

Government co-ordination and agenda setting is particularly challenging in the context of the sector principle, under which 15 ministries maintain their own objectives and research budgets. MER is the dominant actor in research policy, but its role as "first among equals" is achieved on the basis of the sheer size of its budget, using soft co-ordination mechanisms and lengthy negotiations. The sector principle itself is well-established and accepted. It yields a number of advantages, most notably the inclusion of all ministries in R&D policies and tasks. It comes with a price, as horizontal policy approaches are more difficult to employ.

A number of interministerial co-ordination processes soften the practice of the sector principle (see Box 6.3), mainly at the operational, rather than strategic, level. The first main instrument is an extensive weekly Cabinet meeting to discuss ministry initiatives and drafts of white papers (these are prepared through memos that are circulated among the different ministries to seek consensus). The annual negotiation of the national budget is also a crucial stage in the co-ordination of research and innovation policies. The Norwegian government uses a well-structured annual process to agree upon the financial framework and the overall ministry budgets. The process includes two large budget conferences, with negotiation rounds in between. In some years, an interministerial negotiation process is held to distribute an exceptional small "common pot" for research and innovation funding.

The Interministerial Committee on Research Policy (*departementenes forskningsutvalg*, or DFU) is a committee staffed by civil servants whose monthly meetings deal with LTP-related and other research policy issues. Last but not least, the

RCN, given its wide scope, large number of principals and its role as government advisor, acts as a *de facto* co-ordination institution.

MER has a distinct, if soft, co-ordination function in the practical operation of most of these co-ordination mechanisms. It plays a special role in the DFU civil servant committee for day-to-day government research policy co-ordination. The views of the Minister of Education and Research are solicited for all research matters in the Cabinet discussions. MER gives the Ministry of Finance advice on distribution of the common pot.

The LTP process has introduced a few additional tools to manage what has been defined as "weak co-ordination" (Arnold and Mahieu, 2012), mainly in the form of various forum and high-level meeting formats. For instance, when the LTP is prepared (and revised every four years), high-level co-ordination is required to agree on STI priorities. In its implementation, the LTP also influences interministerial negotiations in general (for instance during annual budget conferences) and within priorities (via the LTP interdepartmental groups and the annual "high-level LTP workshops"). The LTP process has also "activated and given new energy" to the DFU (MER, 2016a).

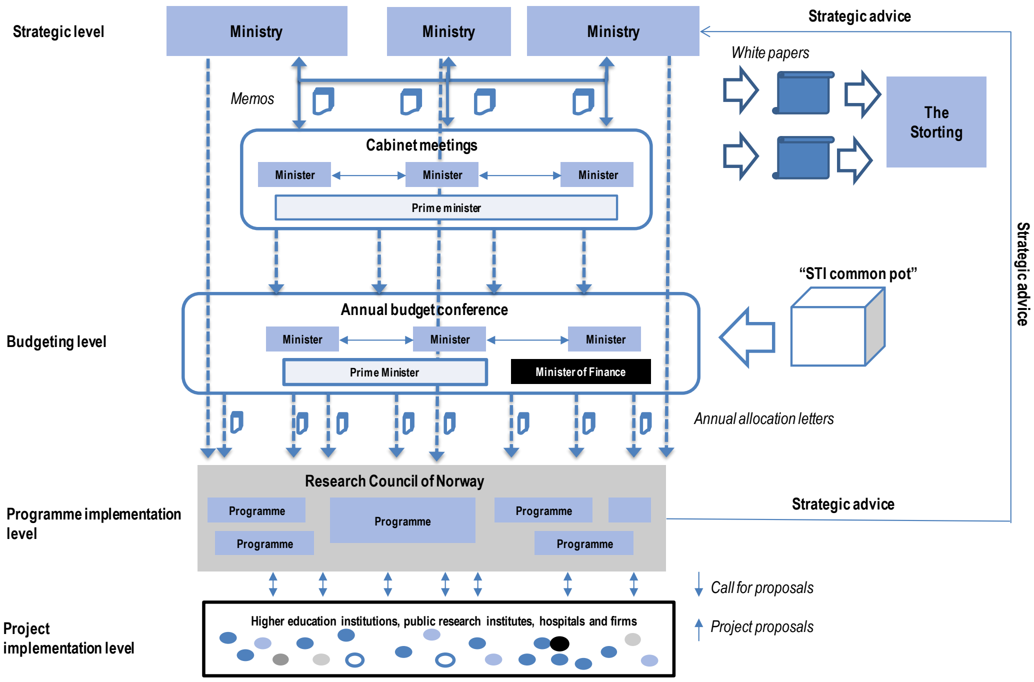
All these instruments deal with horizontal co-ordination (see Box 6.3 and Figure 6.4), but Norway's STI system is dominated by the vertical sector principle.

Box 6.3. **Main instruments and mechanisms for supporting interministerial co-ordination**

1. The discussions of science, technology and innovation policy issues in the Cabinet, supported by the work of DFU.
2. The negotiation of Science, technology and innovation (STI) budget in the context of the annual budget conferences.
3. The "STI common pot", distributed during the annual budget conferences.
4. The Research Council of Norway (RCN) as a co-ordination institution.
5. RCN activities and programmes: RCN has designed some of its funding instruments to allow for more synergies between areas (joint calls, specific provisions in calls to increase synergies, specific programmes to incentivise transfer of skills.
6. As it is drafted on a four-year cycle, the Long-Term Plan calls for some high-level co-ordination to agree on STI priorities.
7. When it is implemented, the Long term plan (LTP) influences interministerial negotiations overall (for instance during annual budget conferences) and within given priorities (via the LTP interdepartmental groups and the annual "high-level LTP workshops").
8. The "21" strategies are documents setting priorities in key Norwegian sectors. In a few cases (oil and gas, energy, health), permanent platforms support and monitor their implementation.

Until 2014, the Cabinet Research Committee (RFU) co-ordinated research policy initiatives and budget allocations. It was composed of the ministers most relevant for research policy and was headed by MER. Without formal authority, the influence of this committee was in practice limited by sectoral interests (Solberg, 2016) and it was abolished after the creation of the LTP.

Figure 6.4. **Main instruments and mechanisms in place to support interministerial co-ordination**



Vertical co-ordination

The vertical relations in Norwegian STI policy appear to be simple but numerous. There are only two major agencies on the national level. Moreover, in contrast to other countries like Belgium, Austria, Germany, Spain and Switzerland, regional policy makers have rather weak competences and act only as subsidiary actors in the STI arena. Most action is taken at the national level. There are many relations because 15 ministries place their orders with RCN and there are so many funding programmes. Meanwhile, the consensus principle (see also OECD, 2008) requires that numerous actors must to agree on potential changes in the system.

These processes are described as trust-based and "cordial", a reflection of the consensus principle. This may not reflect the full picture, since, at a higher level, trust in principle may be complicated for the following reasons:

- RCN cannot act freely, given the numerous detailed earmarks and steering processes coming from the ministries.
- The ministries, as principals, may not trust their main agent to operate without tight control. Their funding might otherwise be spent in other ways.

Horizontal co-ordination by the RCN

Bridging the gap between political decision making and the institutional logic of performing actors requires intermediary organisations. According to principal-agent theory (Braun and Guston, 2003), the principals, for example government ministries, install agencies with more operational specialisation to better serve the performing actors, to install competent negotiators for the expert communities in the policy field (Pichler, 2014) and also to minimise fraud and to provide precise incentives.

The Norwegian setting is unusual in that the agent, RCN,[10] serves the whole innovation system actor set, composed of 1+14 principals. The principals, within their sectorial realms on the "top floor", steer RCN through the annual "allocation letters" of the ministries (*tildelingsbrev)*, sent as instructions together with the sector ministries' budget allocations, as well as other instructions.

The numerous Norwegian principals thus delegate the main tasks of horizontal co-ordination to an agent on the "ground floor". This leads to operational complexity and an extensive annual budgeting process, with multiple interactions between ministries and the related communities of research actors. Another consequence is the large number of programmes that respond to the different demands.

Box 6.4. **Useful, dissolved for a reason, but leaving a gap: The Fund for Research and Innovation**

The Fund for Research and Innovation (FFN) was a special allocation instrument to ensure stable funding for RCN, with a weaker link to ministry earmarking. Set up in 1999, it received a substantial annual inflow of capital. While formally a distinct source of funds, the FFN in fact increased the Minsitry of education and research (MER) budget, mainly for the RCN to help overcome fragmentation. According to Arnold and Mahieu (2012), FFN funding streams to RCN empowered both the council and MER. The ministry could reinforce its co-ordination role. Some FFN funds were also used for activities outside RCN's scope. In the late 2000s, FFN made up 15% to 20% of RCN's budget and was used as a major source for newer instruments like centres and infrastructure; bottom-up basic research was also increased. FFN was terminated in 2011 because of low interest rates. Instead of FFN, MER's "normal" budget was increased, which, however, might "run[s] counter to the original reason for creating the fund: namely, the need for long-term and cross- or inter-sector resources in the research and innovation funding system" (Arnold and Mahieu, 2012).

As in many other innovation systems, the tendency is to respond to new challenges or demand by creating new funding programmes, rather than by directly solving structural problems, for example by governance reforms and priority setting in the PRI or HE sectors (Öquist and Benner, 2014). In Norway, the multiplicity of principals with their individual demands has resulted in a large number of such programmes. Considerable efforts have been made at the RCN level to reduce the overall complexity of the current configuration. To add flexibility to this process, the council has adopted a matrix-style portfolio of instruments, where many types of measures can be used for different sectors and principals and a broad array of criteria are available for many kinds of programmes (MER and MOF, 2017). Another strategy in recent years was to reduce the number of the programmes it runs.

The transaction costs of the current system are considerable, although they are not apparent, since they are mainly absorbed within RCN. The RCN evaluation documented the high costs associated with the sector principle and the "ground-floor" co-ordination model (Arnold and Mahieu, 2012).[11] This resulted in increasing administrative budgets and unwieldy co-ordination tasks that consumed more time than the actual programme management. Some progress has been made in recent years on overhead, task allocations and manpower. The external spending review, however (MER and MOF, 2017), has proposed further streamlining the portfolio and cutting overhead by 10%.

The consensus principle prevents any harsh confrontations, and bolder decisions need the acceptance of all those involved. Moreover, the steering by ministries is again operational rather than strategic. The RCN evaluation noted that the unit of analysis in the steering dialogue tends to be programmes or other activities, rather than high-level objectives, and that both ministries and RCN ask for detailed, operational instructions. This does not align with the Norwegian goals of management by objectives and New Public Management.

Another concern relates to the impact of this system on RCN's excellence agenda, the time it has available to deal with the outer world and on its reactivity. RCN has to balance a demanding policy setting, which might at times collide with the mission to apply more dynamics, risk and track-change in the Norwegian system. This situation creates a "considerable risk for 'over-stretching' and 'over-planning' of RCN, where programmes are too many and too complex, intended to serve too many purposes with the risk of diluting quality demands" (Öquist and Benner, 2014).

On the other hand, the Norwegian set-up also has clear advantages: consensus fosters a robust policy setting with broad acceptance on each step taken. The learning feedback loops are numerous and lead to evolving programmes and policy initiatives.

Strategic orientation and priority setting

The multiplicity of science, technology and innovation-related strategies

Norway has a plethora of strategies, white papers, steering mechanisms and high-level groups for *ad hoc* advice. The RCN alone has 15 strategies in place for different policy issues (MER, 2016a). There are "21" strategies for all kinds of sectors, while the LTP also quotes other strategy papers. Öquist and Benner (2014) as well as the Background Report, list many high-level commission reports and other papers. This is at variance with the slow, cautious (albeit constant) policy shifts and reform processes, which can take decades. Some sector strategies, for example "OG21" for the oil and gas sector (RCN, 2012) have a very clear link between longer term goals and operational tasks, as well as RCN programmes, RCN budget allocations and the ministries' *tildelingsbrev*, and have strongly influenced the LTP. Priorities are formulated by the main stakeholders, including industry and research organisations. They are based on long-term business concerns and list a number of R&D challenges.

More generally, the evidence base is very well developed, with many evaluations, white papers and strategy forums. This is a traditional Norwegian strength (OECD, 2008). As a result, sectoral priorities are abundant (Öquist and Benner, 2014). Each of the 15 ministries has its priorities, translating into a large number of RCN programmes. RCN and IN support many thematic cluster initiatives. The LTP is also broad and quite encompassing in its priorities. There is no explicit strong mechanism at the national level for prioritisation. Norway of course may be rich enough to set a multiplicity of priorities in parallel, a view that is quite common in the Norwegian STI policy landscape. The 2008 OECD review noted contradictions between the creation of critical mass in many priority fields and regional (policy) ambitions, which aim at decentralised structures. This tendency was found to be of a piece with micro-management of ministries and their sometimes narrow priority fields (OECD, 2008). At a more granular level, priorities appear to be missing. In engineering science, for instance, no meaningful research priority-setting activities were reported, despite the importance of this field for Norway's economy. Quite the contrary, financial and human resources for research are evenly distributed over the whole field (RCN, 2015b).

The absence of a strong referee at the highest level

There is no single referee or strong external voice at the top level of Norway's policy arena to complement the interactions between MER and the other ministries. 1) The Prime Minister, due to her constitutional function, does not have a co-ordinating role, and there is no research advisory council in the Prime Minister's Office. The Ministry of Finance is in a stronger position through the budgeting process but does not act as co-ordinator. 2) RCN has co-ordination tasks but, as an operational agency below government level, is focused on keeping the multi-customer, multi-requirement system stable. 3) No external government advisory council exists, because this is RCN's role. 4) Finally, influential lobbying groups with an overall generic STI policy agenda are less visible than, for example, in Sweden, where organisations like the Royal Engineering Academy have always played an important role.

Unlike other (Nordic) countries, Norway has not established a high-level Research and Innovation Advisory Council. Finland has had such a council since the 1990s, including the prime minister and other ministers as well as high-level experts from industry and academia. In Sweden, the recently created Innovation Council includes the prime minister, four other government members and ten experts who are responsible for deal with cross-cutting innovation policy matters. Austria has established an STI policy council consisting of both local and international external experts. Such councils provide for advice, contribute to prioritisation and can play a referee role. Norwegian policy actors have been hesitant to consider such an option. They refer to RCN's as government advisor, to the (operational) co-ordination mechanisms at the Cabinet level and to general resistance: "Committees to advise government on research and/or innovation policy in Norway have had a troubled and uncomfortable history, during which few have had strong influence" (Arnold and Mahieu, 2012).

The question remains as to how to incorporate an external strategic element into the Norwegian policy making system. Given the very specific governance model, there is no obvious best practise, but there are functional needs for an external voice, for support in strategic co-ordination and also for a referee. The role of RCN as a "policy advisor from below" does not solve this issue, because the constant quest for consensus is demanding enough and because of the mere fact that the advice comes from below. This matters, as RCN is not an independent or high-level body, but closely steered by a number of ministries. For RCN the priority is to balance the various ministry demands and to get sufficient funding without too much earmarking. The advisory function is valuable, but also leads to a considerable double bind: The advisor is the main funding agency. These are colliding functions even in a consensus-based system.

The use of foresight and evaluation to support priority setting

The structure of Norway's STI policy governance implies that research policy is guided not *ex ante* by strategic decision making but is the *ex post* result of the balance between the different elements of the system. Elements of better forward planning are more typical within the individual priorities, as some of the "21" strategies show, rather than at the higher, overall level.

While smaller scale foresight exercises do exist in the Norwegian STI landscape, a more strategic and comprehensive foresight element is missing. While a Norway 2030 foresight exercise was conducted in 1998-2000 and government is using long-term overall forecasting methods, the lack of such a foresight study is remarkable. The last OECD review (OECD, 2008) already recommended conducting a national foresight exercise.

Given the many parallel priority areas in Norway, such an instrument would fit well into the overall portfolio of instruments and could be coupled with revolving use of the LTP. The policy discourse is now dominated by the question how to optimise the existing sectors. The transition challenges, however, call for a broader approach, to identify new opportunities, as well as to take a holistic view of the current Norwegian portfolio. Proper foresight activities can inform future revisions of the LTP; with one larger exercise every ten years and clear links between foresight and strategic decision making.

The government has evaluated the RCN every decade since its creation (Arnold et al., 2001; Arnold and Mahieu, 2012). These comprehensive exercises are complemented by initiatives like the RCN Spending Review 2016 (MER and MOF, 2017), or broader initiatives such as the Productivity Commission report (NOU, 2016).

Overall, Norway's evaluation culture can be characterised as typically Scandinavian, learning-oriented, open and comprehensive. Research evaluation is rooted in the Norwegian system (OECD, 2009). Within this architecture, RCN is both the main organiser and customer of evaluations. The evaluation system is professionally organised, employing well-known Norwegian evaluation groups and international policy and domain experts. It is also highly prolific, with over 100 such studies in the last 15 years, including evaluations of research disciplines, programmes and PRIs/sectors (MER, 2016a). The RCN evaluation has criticised the underuse of such evaluations, their often conservative approach and less than optimal placement within the policy cycle (Arnold and Mahieu, 2012). RCN has reacted with an appropriate new evaluation strategy. The combination of the two roles of RCN as main funder and main evaluator could in principle be criticised. However, there are no signs that this has led to overly positive evaluations. On the contrary, evaluations are frank, to the point and often critical. Many evaluations are conducted by Norwegian experts, but peer-based activities often involve international scientists. Innovation Norway uses a number of mostly quantitative evaluation exercises to prove the added value and leverage effect of its funding.

The Long-Term Plan and the Norwegian science, technology and innovation policy system

History and process of the Long-Term Plan

The LTP has the official status of a white paper (*Meld. St.*) as did previous strategic documents. Its origins trace back to the former (social democrat) government, which already had tried to build greater consensus around long-term planning in Norway. Their white paper "Long-term perspectives – knowledge provides opportunity" paved the way for a long-term plan that would include priorities for research and higher education on a ten-year perspective (MER, 2012). A key objective, as set out in this early document, was also to develop a structuring document to guide investments in this policy field and to push further structural reform in the HE sector, with three overarching objectives: 1) larger and more robust research entities and HEIs; 2) stronger regional development and increased specialisation; and 3) more efficient use of resources. The conservative successor government adopted some of these ideas and presented a Long-Term Plan for Research and Higher Education 2015-2024 (MER, 2014) in October 2014.

The planning process for the LTP officially started in summer 2013, with a number of preliminary consultation steps in spring 2013. Through a first call for input from various stakeholder and institutional actors, the MER received 150 contributions. In the following winter, high-level government meetings and summits took place, followed by intense interactions between MER and the other ministries in a number of working groups and other negotiations and hearings. These consultations fed into the strategy process and allowed for the formulation of thematic priorities. This process led to a government decision and its presentation to the Storting in October 2014 (MER, 2016a).

The process for developing the LTP is deemed a success by many actors in the Norwegian research and innovation system, including other ministries. MER and the other stakeholders managed to accomplish the first long-term planning process in Norwegian STI policy in an expedient fashion, and with broad actor inclusion. Difi, the Norwegian Agency for Public Management and e-Government, monitored the LTP process and assessed it positively (Difi, 2015).

The Long-Term Plan as a governance tool

The LTP has some specific built-in features that differentiate it from former STI strategic documents. It aims to adopt a long-term perspective, to serve as a plan and not only a strategy, and to cover a broad policy spectrum, not confined to the policy fields in the remit of the MER. In reality, these initial expectations have been only partially fulfilled:

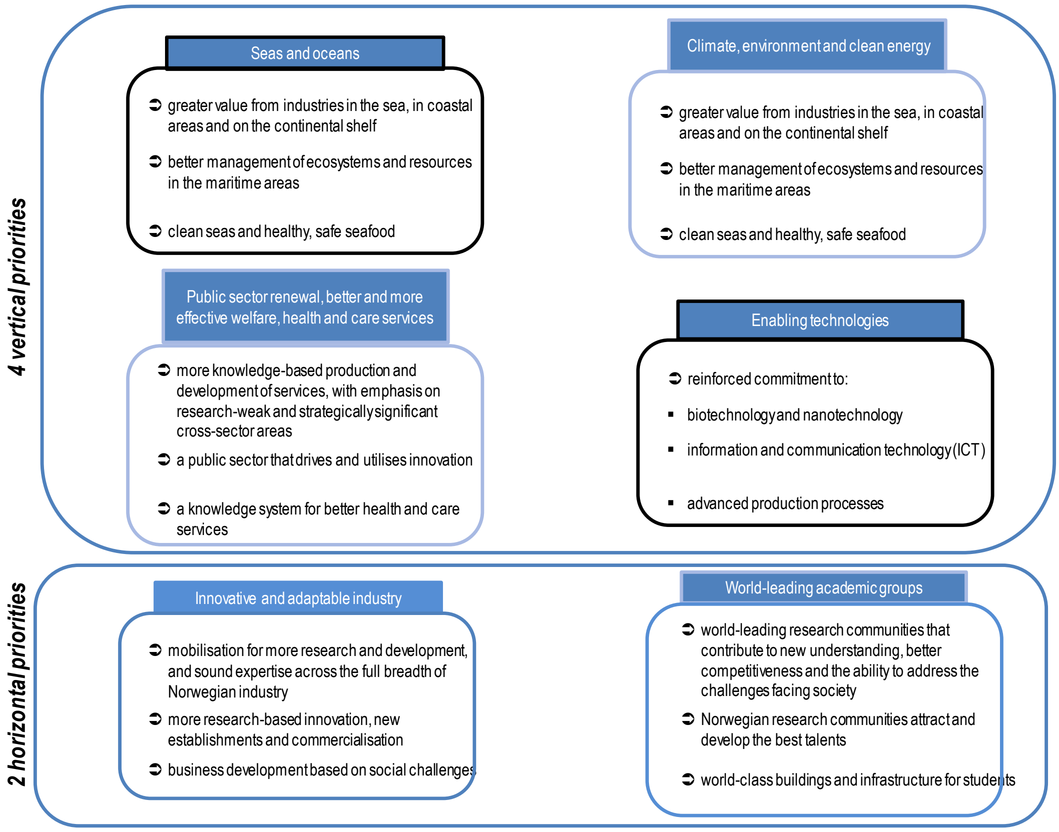
- Despite its formal title, the LTP is not a ten-year planning document. It has a ten-year perspective for designing longer term avenues in broad terms, but it is in practice conceived on a four-year rolling basis, with the first revision to come in 2018.
- Although the government expressed a commitment to follow up the long-term plan in the annual fiscal budgets (MER, 2014), it is not a multiannual research bill, of the kind adopted by Sweden or Switzerland. The ministry itself sees it as a new approach to make prioritisation politically more acceptable and to increase commitment for some priorities across government as a whole. Financial predictability has been increased almost exclusively in the remit of the MER. The only three concrete funding activities are all in the field of research. In other areas, actions are more broadly defined, without clear financial commitment.[12]
- The LTP employs an "asymmetric budgeting" approach, under which several ministries have provided priorities, but only MER has earmarked budgets. This can be seen as a first step towards more ambitious and broader commitments. With the first LTP, the MER set an example for the next LTP round, which, given its rolling timetable, is only a few years away. Ideally, in the next planning period, more ministries will use the LTP as a tool that entails financial commitments.
- A further limitation of the LTP is that its title does not accurately reflect its content. The Long-Term Plan for Research and Higher Education does not in practice cover HE issues in detail. MER launched another white paper dedicated to HE policy issues in January 2017 to make up for the missed opportunity. This white paper will be discussed in the Storting in June 2017.

Priority setting in the Long-Term Plan

The LTP aims to increase the predictability of the Norwegian research and innovation system through a number of topical and structural priorities (see Annex B). They are embedded in a framework of three overarching government objectives for STI policy, consistent with those of the European H2020 framework programme: enhanced competitiveness and innovation, tackling major societal challenges and developing research communities of outstanding quality (MER, 2014).

At a slightly more granular level, the Plan lays out six priority areas, four thematic and two horizontal (Figure 6.5).

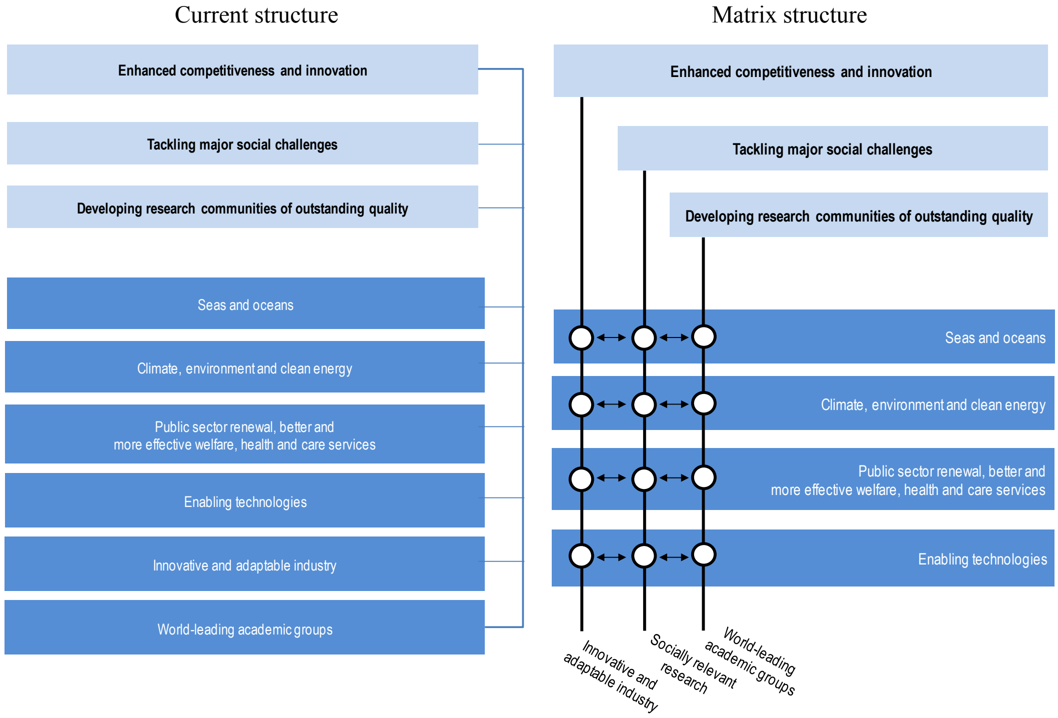
Figure 6.5. **The Long-Term Plan'ssix priority areas**



Source: MER (2014), "Long-term plan for research and higher education 2015-2024", https://www.regjeringen.no/en/dokumenter/meld.-st.-7-2014-2015/id2005541.

Although the LTP marks significant progress, the design of its priorities is strategically less than optimal. The two horizontal priorities, respectively, industrial innovation and academic research, correspond largely to two of its overarching objectives, giving the plan a somewhat intricate structure. This mix of horizontal and vertical priorities at the same level precludes a matrix-like approach allowing for systematic consideration of the research (and higher education), innovation and societal dimensions in each of the four broad thematic priorities. An approach of this kind could also have improved the co-ordination, in each of the themes, of the three dimensions themselves. As it stands, the LTP juxtaposes the research and business innovation dimensions, although experience has shown that the interface between these two is among the most critical drivers of performance in an innovation system. It is also one of the most challenging areas to co-ordinate, since, in most countries, Norway included, these two policy fields fall under different ministries.

Figure 6.6. **Example of a matrix-like approach applied to the Long-Term Plan**



The choice and scope of the priorities of the LTP also reflect the well-established tradition of the consensus principle. The LTP makes strong statements about its priorities, but their range is broad, and the LTP's approach is agglutinative rather than selective. The four thematic priorities cover very broad areas, with many sub-areas, which – remarkable for priority planning – leave few policy fields excluded. Topics like social sciences and humanities are covered in form of horizontal activities.

The LTP's priorities do not renew the portfolio of previous priorities. They are mainly linked to the "21" sector strategies and draw on existing priorities. Some even date back decades,[13] either because of the long trajectories and path dependencies of sectors like oil and gas and marine/fish farming, or because of the areas of conflict, like governance and excellence in the HE sector. This is epitomised by the significant apparent effect of the LTP priorities on the RCN programme structure and priorities, as depicted in the new RCN strategy. However, this strategy is mostly about the arrangement of existing RCN activities around the headlines and six major areas of the LTP.

A certain inertia over priorities is typical of strategic plans in many OECD countries and beyond, but the LTP seems to devote even less space to new areas, apart from the ones that might emerge from developing world-class expert environments.

However, the plan has succeeded in establishing a new approach that makes prioritisation politically more acceptable and increases commitment for some priorities across the government. It is a step in the direction of more ambitious goals in the future.

Co-ordination in the Long-Term Plan

The plan has also taken an initial step away from the "ground-floor" co-ordination model. The government seems willing to do more co-ordination work at its level. However, this structuring effect still seems superficial at this stage, even on the actions of the RCN, the key LTP implementation body. Its 2015-20 strategy, launched later, lists many goals and activities in lofty language and appears to be an effort to harmonise the LTP structure with the many ongoing RCN activities. The strategy mentions the LTP only once, stating that the RCN "will help to follow (it) up" (RCN, 2015a). For external observers, the link could be made much clearer.

The LTP has already had some effect on horizontal co-ordination, including the high-level meetings chaired by the prime minister, Cabinet discussions on STI issues, the installation of some interdepartmental steering groups at the administrative and political level, alignment work in RCN and other soft co-ordination questions (see above).

Conclusions on science, technology and innovation system governance

Co-ordination mechanisms have been instituted on an operational level, through various mechanisms and processes, but little co-ordination exists at a higher level. RCN has to deal with most of the co-ordination activities in Norway, since horizontal co-ordination tends to take place on the "ground floor" within the national policy architecture. RCN receives ministry-specific allocation letters and answers by 1) employing complex operational co-ordination and budgeting mechanisms and by 2) designing a large array of funding programmes.

One solution to these issues is to design multi-ministry sponsored programmes. This has the advantage of somewhat offsetting the sector principle, but could entail co-ordination costs. The RCN has already introduced a number of such programmes. Another option would be to increase the agency's room for manoeuvre, with fewer earmarks and a more flexible budget. Funding organisations in other countries receive their budgets with different degrees of freedom (see Braun, 1997).

The current Norwegian STI policy set-up, dominated by the sector and the consensus principle, also raises questions about its strategic governance and orientation. The sector principle gives each ministry considerable leeway to defend its budgetary and policy interests both for their own and for cross-government initiatives. They have a very strong position in Cabinet discussions and in interactions with the RCN. The consensus principle allows for common viewpoints and practices once an agreement is set in place. However, the process has high transaction costs, results in many parallel priorities, and leaves little room for experiments and bold, disruptive, innovations. The current setting allows for consistent incremental steps in development, while a long-term, overarching view might attract less attention.

While the need for a holistic and horizontal approach in research and innovation policy has been widely documented, support for an encompassing innovation policy seems to have lost prominence in recent years (Solberg, 2016). In the 1990s and 2000s, there had been efforts for such a holistic innovation policy, including a strategy plan from 2004, a white paper in 2008 (OECD, 2008; Solberg, 2016) and a short-lived Innovation Board in the mid-2000s, chaired by the Minister of Trade and Industry (OECD, 2008), but these efforts have not continued. The 2008 strategy was an ambitious white paper with an emphasis on industrial needs and broad sustainability goals (Fridholm et al., 2012).

The development of areas like health or the green economy (see Chapter 5) would particularly benefit from the continuation of a broader approach. Instead, individual issues like entrepreneurship or specific industry policies have become more important. The current 2015 MTIF Entrepreneurship plan (see Chapter 4) has been described as "at present the most central policy document in terms of innovation policy in Norway" (Brorstad Borlaug et al., 2016).

The prioritisation process also indicates the relative lack of a comprehensive approach to STI policy making. Despite the stable core of priorities in recent decades, discussions of priorities have only increased the number of such priorities within the policy portfolio. These are typically agglutinative, individually decided upon without a clear strategy, and insufficient attention has been paid to the interfaces between the individual priorities. The LTP and the RCN portfolio are examples of this approach, although in the case of the RCN, a number of initiatives have been launched to cross-link individual priorities and programmes.

This policy setting only imperfectly allows Norway to fulfil its transition challenge, since the prevalence of a soft and consensual co-ordination of sectorial interests at operational level draws attention to preserving existing solutions. This is thus not conducive to the radical and systemic innovations necessary for the transition. Alternative and challenging options more frequently emerge at the frontier between disciplines or areas, rather than within the silos of established trajectories. This is particularly, if not exclusively, the case for innovation that aims to address societal challenges, which call for new interdisciplinary and trans-disciplinary research environments that bring together a variety of natural and social scientists (OECD, 2015). This is also true, almost by definition, for the development of converging and enabling technologies, whose potential has been widely documented.

Furthermore, new/external voices and actors may find it difficult to contribute to the Norwegian STI policy in this setting, which favours established actors' positions in the system. This can impede the search for new viewpoints, the inclusion of new actors and the development of alternative approaches. Elements of inertia and lock-in exist to a certain extent in every innovation system, but the characteristics of the Norwegian system make these elements particularly pervasive.

The LTP has allowed significant, but rather piecemeal, progress in terms of co-ordination and prioritisation. Its overall reception in the Norwegian research and innovation community was positive. Most Norwegian stakeholders welcomed the ambitions of the plan and the increase of predictability both in terms of financial resources over a four-year period and of strategic focus on certain areas.

Since it was launched, different communities have pointed to various omissions in the LTP. As noted above, this was the case first of all for the higher education policy, which has since then been compensated for by the dedicated white paper. MER has also initiated a strategic process in response to criticism that no commitment has been made to updating buildings and infrastructure (MER, 2016b).

The softness and the broad range of the LTP present a challenge when it comes to implementation of the plan. Many specifically Norwegian topics are addressed, as well as others that are on priority lists in each country. Apart from the three MER budget lines mentioned, the numerous links to the "21" sector strategies and other documents appear to substitute for concrete action. From this perspective, the effect of the LTP on the predictability, prioritisation and co-ordination of public investments in R&D is soft and often indirect. It sets the agenda for a common dialogue, but the plan still reflects a situation that assumes Norway is rich enough to afford and juggle many parallel priorities.

The revolving character of the LTP process, however, offers a major opportunity to add more concrete structural and programme-style policy activities to its agenda. Other ministries might use the LTP. Such a (soft and gradual) adjustment over the next LTP periods would allow more policy actors to enter this policy negotiating instrument, without giving up the sector and consensus principles, with better co-ordination and priority-setting mechanisms at a higher level.

Notes

1. The Norwegian government still spends relatively more on defence R&D than the other Nordic countries, Switzerland, Austria or the Netherlands (OECD, 2016a).
2. www.innovasjonnorge.no/en/start-page/our-organization/our-history.
3. See: www.stortinget.no/en/In-English/About-the-Storting.
4. The 2001 RCN evaluators went on to Austria to evaluate the Austrian intermediary level, concluding that “Nothing in the international experience that is visible to us, speaks for merging FFF and FWF,” its Industrial Promotion Research Fund and Austrian Science Fund, Austria’s applied and basic research funding organisations at the time (Arnold et al., 2004).
5. Document on “RCN activities/programmes” provided by MER and RCN, according to RCN’s revised budget 2015.
6. Online version of the 2015 IN Annual Report, www.innovasjonnorge.no/aarsrapport/2015/index.html#keynumbers.
7. www.innovasjonnorge.no/aarsrapport/2015/index.html#strategi.
8. www.innovasjonnorge.no/en/start-page.
9. https://siva.no/om-oss/?lang=en#post-7087.
10. The interface between the agencies RCN, IN and Siva has been described as unproblematic; neither policy makers nor studies and the literature note major overlaps, problem zones or misunderstandings.
11. The 2012 evaluation states among other things that: 1) The proportion of people at Special Advisor or Director level at the RCN rose from 27% in 2004 to 37% in 2010. This is surprising given that the number of the council staff grew by more than 20%, from 330 to 411, in the same period. 2) Time allocation data suggest that RCN personnel spend 25% of their working hours on creating and sharing strategic intelligence, 15% on national “meeting places” and 10% on internationalisation, while devoting only 25% to programme management. 3) Half the RCN staff (228 people in 2012) is involved in internal co-ordination groups. A total of 60 people play a role in various ministry co-ordination forums.

12. The LTP also provides, less explicitly, for budget growth for RCN innovation programmes like BIA or FORNY.
13. The thematic and structural priorities of the LTP can be traced to the 1980s (MER, 2016a).

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Annex A.
Main findings of the 2008 OECD *Review of Innovation Policy in Norway*

In 2008 the OECD reviewed the Norwegian innovation system, identifying main strengths and weaknesses of the country's innovation system and its underpinning policies. Among the most relevant findings of the 2008 review were Norway's low performance against conventional S&T and innovation indicators, notwithstanding its persistently high economic performance. At the same time the review also found that a strong "social contract" between the state, labour and capital that contributes substantially to social welfare, and a high level of acceptance of technological change in the labour force.

Overall, a key strategic task that had been identified was to maintain sustainable economic growth beyond the country's peak in oil and gas production. Restructuring the Norwegian economy accordingly would entail a shift towards other knowledge-based activities, and as such improve innovation capabilities that required increased investment in R&D, matched by the ability of policy to catalyze these investments into concrete and viable goals.

Main strengths

Within Norway's innovation ecosystem, main strengths included a dynamic, high-performing private services sector, with innovative business models in many types of services as well as resource-based industries. Political commitment and institutional capabilities to foster science, technology and innovation had been a priority of successive governments, and well-functioning institutions encourage innovation via information flows and both direct and indirect financial support. Norwegian policy makers have over the years been very active in developing a broad portfolio of support instruments for S&T and innovation, and a critical mission of Norway's research institutes has been to support industrial development through applied research. Well-developed national sources of strategic intelligence on the research and innovation system facilitate policy formulation and delivery.

Additional factors that had been identified to be beneficial to Norway's innovation system include a stable, high-performing economy underpinned by disciplined macroeconomic management and substantial and well-managed natural resource endowments. Norway possesses a high level of social capital, education and skill levels and economic and socio-cultural framework conditions that favour technical change. The country has a strong political commitment to strengthen capabilities in science, technology and innovation, and a strong industrial base, especially in industries conventionally classified as low or medium technology are beneficial to strengthen the country's innovation base. A strong export-oriented resource-based industry, innovative clusters around extraction, and a large and dynamic services sector are underpinned by segments of excellence in scientific research.

Main weaknesses

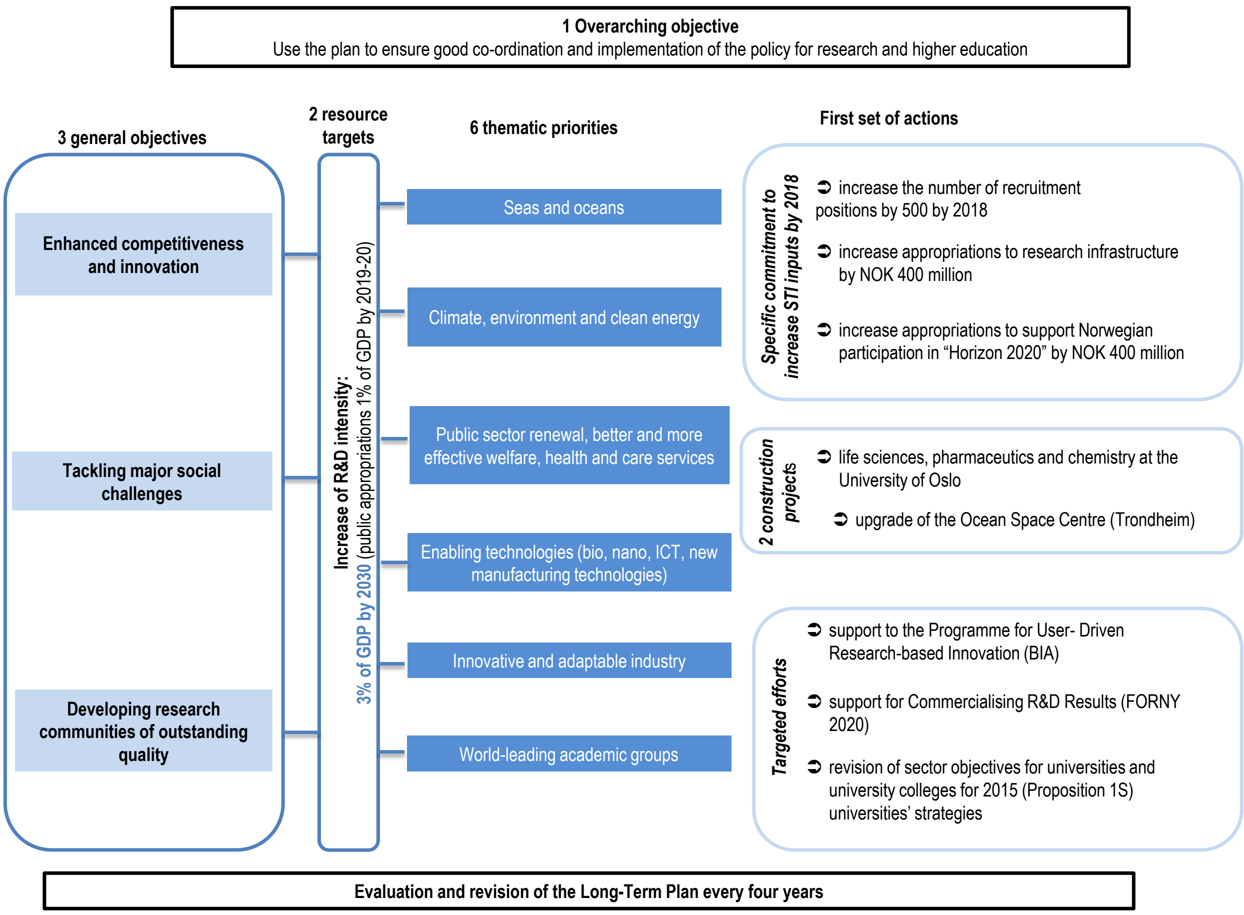
On the contrary the country's main weaknesses were seen in the lack of benefiting sufficiently from R&D conducted abroad, while at the same time Norway does not attract enough R&D investment from abroad. A potential shortage of people with appropriate research skills due to a fall in the numbers of students opting for scientific and technical disciplines had been identified to be a challenge for the country's economic restructuring towards a more knowledge-intensive direction if the supply of people with scientific and technical skills remained unchained. Existing policy contradictions had been identified to possibly result in ineffectiveness, such as the conflict between building a critical mass in many fields of research, and the dispersion of research inputs through regional policy. Improving governance of the innovation system regards also a clear distinction between policy formulation and policy implementation.

Other weaknesses have been seen in the intensity of Norway's rate of R&D and innovation in manufacturing that was relatively low, and weak links between university and industry. The absorptive capacity of some parts of the industry has been limited, while potential skills shortages in the future might be evoked through a low share of students opting for mathematics, science and technology. Governance and direction setting in the country's innovation system is fragmented and overall weak, and insufficiencies in some aspects of the innovation system's internationalisation, e.g. international learning of firms and R&D internationalisation in industry exist.

Reference

OECD (2008), *OECD Reviews of Innovation Policy: Norway 2008*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264043749-en.

Annex B.
Architecture of the 2014 Long-Term Plan for Research and Higher Education



Annex C.
List of people interviewed during fact-finding missions

Organisation	Name	Designation
Agency for Public Management and e-Government (Difi)	Inger Johanne Sundby	Project Leader
AKVA group ASA	Trude Olafsen	General Manager, Atlantis Subsea Farming
Akvaplan-niva AS	Anita Evenset	Head, Environmental R&D Department
AkvArena	Kristian Henriksen	Managing Director
Aqualine AS	Noralf Rønningen	R&D Manager
Bayer AS	Thomas Ramdahl	CEO
Bergen Technology Transfer Office	Anders Haugland	Managing Director
Bergen University College	Gro Anita Fonnes Flaten	Research Director
Bergen University College	Eva Haukeland Fredriksen	Vice-Rector
BerGenBio ASA	Richard Godfrey	CEO
BerGenBio ASA	Jim Lorens	Professor
Borregaard ASA	Kristin Misund	Director for Research and Development
Calanus AS	Jan Erik Olsen	Sales and Product Manager
Central Norway Regional Health Authority	Marit Bratlie	Innovation Advisor
Central Norway Regional Health Authority	Øyvind Hope	Senior Advisor
Central Norway Regional Health Authority	Henrik Sandbu	Director of Health Sciences, Research and Education
Centre for International Climate and Environmental Research – Oslo (CICERO)	Steffen Kallbekken	Research Director
City of Bergen	Elin Sjødin Drange	Director
City of Bergen	Ann Iren Fagerbakke	Director
City of Trondheim	Ola By Rise	Municipal Director of Culture and Commerce
Confederation of Norwegian Enterprise (NHO)	Ingeborg Laukvik	Advisor
Confederation of Norwegian Enterprise (NHO)	Tore Li	Senior Advisor
Confederation of Vocational Unions (YS)	Håvard Lismoen	Director
Ecotone AS	Øystein Hveding	Finance and Administration Manager
Employer's Association Spekter	Trond Bergene	Special Advisor
Enova	Øyvind Leistad	Programme Director
Federation of Norwegian Professional Associations	Øyvind Berdal	Advisor
Helse Bergen - Bergen University Hospital	Alf Henrik Andreassen	Director R&D
Helse Bergen - Bergen University Hospital	Clara Gram Gjesdal	Deputy Director
Innovation Norway	Per Koch	Special Advisor
Innovation Norway	Per Niederbach	Director of Regions and Financing
Institute for Social Research (ISF)	Tanja Storsul	Director
Institute of Marine Research	Karin K. Boxaspen	Research Director
Institute of Marine Research	Sissel Rogne	Director
Institute of Marine Research	Geir L. Taranger	Research Director
Institute of Transport Economics (TØI)	Gunnar Lindberg	Managing Director
Inven2 AS	Ole Kristian Hjelstuen	CEO
Kongsberg Gruppen ASA	Sverre Gotaas	Corporate Technology Officer

Organisation	Name	Designation
Kongsberg Maritime AS	Thor Hukkelås	Director Aquaculture R&D
Memoscale AS	Per Simonsen	CEO
Ministry of Agriculture and Food	Gry Færevik	Senior Advisor, Research, Innovation and Regional Policy Division
Ministry of Climate and Environment	Kristin Thorsrud Teien	Deputy Director General, Department for Nature Management
Ministry of Climate and Environment	Viggo Lindahl	Senior Advisor, Department for Nature Management
Ministry of Education and Research	Geir Arnulf	Deputy Director General, Department of Research
Ministry of Education and Research	Erling H. Dietrichson	Senior Advisor, Department of Higher Education
Ministry of Education and Research	Live Haaland	Deputy Director General, Department of Research
Ministry of Education and Research	Monica Hanssen	Senior Advisor, Department of Higher Education
Ministry of Education and Research	Bjørn Haugstad	State Secretary to the Minister
Ministry of Education and Research	Kari Balke Øiseth	Director General, Department of Research
Ministry of Education and Research	Sigve Berge Hofland	Senior Advisor, Department of Research
Ministry of Education and Research	Lise Holden	Senior Advisor, Department of Research
Ministry of Education and Research	Torbjørn Røe Isaksen	Minister
Ministry of Education and Research	Toril Johansson	Director General, Department of Higher Education
Ministry of Education and Research	Haakon Kobbenes	Senior Advisor, Department of Education
Ministry of Education and Research	Gørill Kristiansen	Senior Advisor, Department of Research
Ministry of Education and Research	Hege Landmark-Høyvik	Senior Advisor, Department of Higher Education
Ministry of Education and Research	Rolf Larsen	Senior Advisor, Department of Higher Education
Ministry of Education and Research	Kristine Naterstad	Senior Advisor, Department of Research
Ministry of Education and Research	Anne Karine Nymoen	Senior Advisor, Department of Research
Ministry of Education and Research	Marius Seljedal	Deputy Director General, Department of Early Childhood Education and Care
Ministry of Education and Research	Pål Sørgaard	Deputy Director General
Ministry of Education and Research	Fredrik Dalen Tennøe	Deputy Director General, Department of Higher Education
Ministry of Education and Research	Sigrid Tollefsen	Senior Advisor, Department of Research
Ministry of Health and Care Services	Maiken Engelstad	Deputy Director General, Department of Specialist Health Care Services
Ministry of Health and Care Services	Nils-Olav Refsdal	Senior Advisor, Department of Specialist Health Care Services
Ministry of Health and Care Services	Marte Rønningen	Higher Executive Officer, Department of Specialist Health Care Services
Ministry of Health and Care Services	Hjørdis Møller Sandborg	Senior Advisor, Department of Specialist Health Care Services
Ministry of Petroleum and Energy	Tore Grunne	Assistant Director General, Climate, Industry and Technology Department
Ministry of Petroleum and Energy	Torgeir Knutsen	Deputy Director General, Climate, Industry and Technology Department
Ministry of Petroleum and Energy	Astrid Stavseng	Advisor, Climate, Industry and Technology Department
Ministry of Trade, Industries and Fisheries	Kjetil Kolsrud Jåsund	Director, Research and Innovation Department
Ministry of Trade, Industries and Fisheries	Thomas A. Malla	Specialist Director, Research and Innovation Department
Ministry of Trade, Industries and Fisheries	Jartrud Steinsli	Director, Research and Innovation Department
Norwegian Agency for Quality Assurance in Education (NOKUT)	Ole Jacob Skodvin	Director of Analysis and Development
Norwegian Confederation of Trade Unions (LO)	Arvid Ellingsen	Special Advisor
National Union of Students in Norway (NSO)	Wenche Åsheim	Political Advisor
National Union of Students in Norway (NSO)	Madeleine Sjøbrend	Officer of Academic Affairs
Nofima AS – Norwegian Institute of Food, Fisheries and Aquaculture Research	Arne Mikal Arnesen	Director, Aquaculture Division
Nofima AS – Norwegian Institute of Food, Fisheries and Aquaculture Research	Morgan Lillegård	Director of Communication

Organisation	Name	Designation
Nofima AS – Norwegian Institute of Food, Fisheries and Aquaculture Research	Magnar Pedersen	Director, Fisheries, Market and Industry Division
Nofima AS – Norwegian Institute of Food, Fisheries and Aquaculture Research	Grete Winther	CFO
Nordic Institute for Studies in Innovation, Research and Education (NIFU)	Egil Kallerud	Special Advisor
Nordic Institute for Studies in Innovation, Research and Education (NIFU)	Liv Langfeldt	Research Professor, Director R-QUEST
Nordic Institute for Studies in Innovation, Research and Education (NIFU)	Espen Solberg	Head of Research
Norinnova Technology Transfer	Asbjørn Lulletin	CEO
Norwegian Association of Local and Regional Authorities (KS)	Jon Anders Drøpping	Senior Advisor for Research and Development
Norwegian Association of Local and Regional Authorities (KS)	Anne-Cathrine Hjertaas	Director, Department for Employer Policy
Norwegian Association of Higher Education Institutions (UHR)	Bente Ringlund Bunæs	Senior Advisor
Norwegian Association of Higher Education Institutions (UHR)	Mette Mo Jakobsen	Senior Advisor
Norwegian Association of Higher Education Institutions (UHR)	Ragnar Lie	Senior Advisor
Norwegian Association of Higher Education Institutions (UHR)	Alf Rasmussen	Secretary General
Norwegian Association of Research Institutes (FFA)	Lars Holden	Chairman
Norwegian Association of Research Institutes (FFA)	Sveinung Skule	Vice-Chairman
Norwegian Association of Researchers	Bente Søgaard	Senior Advisor
Norwegian Centre for International Cooperation in Education (SIU)	Harald Nybølet	Director
Norwegian Centre for International Cooperation in Education (SIU)	Gro Tjore	Deputy Director
Norwegian Centre of Expertise - Maritime CleanTech	Ivan Østvik	Business Development Manager
Norwegian Centre of Expertise - Seafood Innovation Cluster	Tanja Hoel	Director
Norwegian Geotechnical Institute (NGI)	Lars Andresen	Managing Director
Norwegian Institute for Air Research (NILU)	Pål Midtlien Danielsen	Head of Innovation, Innovation Department
Norwegian Institute for Nature Research (NINA)	John Linnell	Senior Research Scientist
Norwegian Institute for Nature Research (NINA)	Norunn S. Myklebust	Director
Norwegian Institute of Public Health	John-Arne Røttingen	Division Director (until 1 March 2017)
Norwegian Marine Technology Research Institute (MARINTEK)	Oddvar Inge Eide	President
Norwegian Oil and Gas Association	Hildegunn Blindheim	Director, Climate and the Environment
Norwegian Oil and Gas Association	Torjer Halle	Member of the board, Chairman, Schlumberger Norway
Norwegian Oil and Gas Association	Maiken Ims	Senior Advisor, Industry Policy
Norwegian Oil and Gas Association	Erling Kvadsheim	Director, Industry Policy
Norwegian Polar Institute	Sebastian Gerland	Section Leader, Oceans and Sea Ice
Norwegian Polar Institute	Jan-Gunnar Winther	Director
Norwegian School of Economics (NHH)	Frøystein Gjesdal	Rector
Norwegian School of Economics (NHH)	Nina Skage	Director
Norwegian Shipowners' Assosiation	Karin Gjerløw Høidahl	Head of Section
Oslo and Akershus University College of Applied Sciences (HiOA)	Bjørn Hvinden	Director, Norwegian Social Research
Norwegian Society of Graduate Technical and Scientific Professionals	Lise Lyngsnes Randeberg	President

Organisation	Name	Designation
Norwegian University of Life Sciences (NMBU)	Ragnhild Solheim	Director of Research and Innovation
Norwegian University of Life Sciences (NMBU)	Mari Sundli Tveit	Rector
Norwegian University of Science and Technology (NTNU)	Linn Benedicte Brubakken Øfsteng	Advisor
Norwegian University of Science and Technology (NTNU)	Johan Hustad	Pro Rector Innovation
Norwegian University of Science and Technology (NTNU)	Kari Melby	Pro Rector Research
Norwegian University of Science and Technology (NTNU)	Stig William Omholt	Director/Research professor, NTNU Biotechnology
Norwegian University of Science and Technology (NTNU)	Ingrid Schjølberg	Director NTNU Oceans/Professor
Norwegian University of Science and Technology (NTNU)	Nina Sindre	International Co-ordinator
NTNU Technology Transfer Office	Stein Eggan	CEO
Oslo and Akershus University College of Applied Sciences (HiOA)	Gro Jamtvedt	Dean, Faculty of Health Sciences
Oslo and Akershus University College of Applied Sciences (HiOA)	Tore Hansen	Director of Department
Oslo Medtech	Kathrine Myhre	CEO, member of Health&Care21 Advisory Board
Peace Research Institute Oslo (PRIO)	Kristian Berg Harpviken	Director
Powel AS	Geir Nysetvold	Vice President, Strategy and R&D
Prime Minister's Office	Vegard Sørebø	Senior Advisor
Research Council of Norway	Christina I.M. Abildgaard	Director, Department for Marine Bioresources and Environmental Research
Research Council of Norway	Kristin Danielsen	International Director
Research Council of Norway	Tobias Elingsen	Director, Department of Strategic Analysis and Development
Research Council of Norway	Anne Kjersti Fahlvik	Executive Director, Division for Innovation
Research Council of Norway	Sigurd Falch	Special Advisor, Department for Technologies and Industries
Research Council of Norway	Hilde Dorthea Grindvik	Special Advisor, leader of the Health&Care21 secretariat
Research Council of Norway	Arvid Hallén	Director General (until 1 March 2017)
Research Council of Norway	Anders Hanneborg	Executive Director, Division for Science
Research Council of Norway	Christen Krogh	Director
Research Council of Norway	Gunnar H. Lille	Director, leader of the OG21 secretariat - Norway's oil and gas technology strategy for the 21st century
Research Council of Norway	Gro Elisabeth Mæhle Helgesen	Special Advisor, Division for Society and Health
Research Council of Norway	Trygve Utheim Riis	Special Advisor, Department for Energy
Research Council of Norway	John-Arne Røttingen	Chief Executive (as of 1 March 2017)
Research Council of Norway	Camilla Schreiner	Director, Department for Climate and Polar Research
Research Council of Norway	Jesper Simonsen	Executive Director, Division for Society and Helath
Research Council of Norway	Fridtjof Unander	Executive Director, Division for Energy, Resources and the Environment
Research Council of Norway	John Vigrestad	Director, Department for Challenge-Driven Innovation
Rock Physics Technology AS	Steffen Boga	CEO
Rock Physics Technology AS	Erling Jensen	CTO
Siemens AS	Olav Rygvold	Area Manager Trondheim
SINTEF	Inge R. Gran	President, SINTEF Energy
SINTEF	Petter Haugan	Vice President, Corporate Communications
SINTEF	Vegar Johansen	President, SINTEF Ocean
SINTEF	Ernst Kristiansen	Vice President, Research, SINTEF Digital
SINTEF	Anders Lian	CEO, SINTEF TTO
SINTEF	Atle Minsås	Special Advisor, SINTEF Ocean

Organisation	Name	Designation
Siva	Roy Strømsnes	Senior Vice President
Sør-Trøndelag County Authority	Karen Espelund	County Director of Regional Development
South-Eastern Norway Regional Health Authority	Kjetil Storvik	Head of Innovation
Statistics Norway	Erik Fjærli	Researcher, Research Department
Statoil ASA	Per Sandberg	Vice President Innovation
Statoil ASA	Kjetil Skaugset	Chief Researcher, Upstream Technology
Statoil ASA	Roger Sollie	Project Manager
Telenor ASA	Dagfinn Myhre	Vice President/Head of Communications & External Relations, Telenor Research
TrønderEnergi AS	Gøril Forbord	Business Developer
Uni Research	Aina Berg	Director
Uni Research	Hans Kleivdal	Research Director
University of Bergen	Kjell Bernstrøm	University Director
University of Bergen	Heidi A. Espedal	Director for Research Management
University of Bergen	Anne Lise Fimreite	Prorector
University of Bergen	Jarl Giske	Pro-Dean, Faculty of Mathematics and Natural Sciences
University of Bergen	Knut Helland	Dean, Faculty of Social Sciences
University of Bergen	Dag Rune Olsen	Rector
University of Oslo	Tove Kristin Karlsen	Deputy Director
University of Oslo	Ole Petter Ottersen	Rector
University of Oslo	Pål Vegard Pettersen	Senior Advisor
University of Oslo	Taran Thune	Associate Professor, Centre for Technology, Innovation and Culture
University of Oslo	Nina Køpke Vøllestad	Head of Department, Institute of Health and Society
University of Tromsø–The Arctic University of Norway	Michaela Aschan	Vice Dean, Faculty of Biosciences, Fisheries and Economics
University of Tromsø–The Arctic University of Norway	Edel O. Elvevoll	Dean, Faculty of Biosciences, Fisheries and Economics
University of Tromsø–The Arctic University of Norway	Morten Hald	Dean, Faculty of Science and Technology
University of Tromsø–The Arctic University of Norway	Kenneth Ruud	Pro-Rector for Research and Development
University of Tromsø–The Arctic University of Norway	Pål Vegar Storeheier	Deputy Director General, Department for Research and Development
University of Tromsø-The Arctic University of Norway	Kathrine Tveiterås	Head of Department

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The Long-Term Plan for Research and Higher Education 2015-2024 (LTP) launched by the Norwegian government has set the base to enhance the capacity of the research and higher education system to cope with these transition challenges. This report proposes recommendations to take advantage of the revision of this comprehensive strategic plan in 2018 to improve the horizontal coordination and add more concrete structural policy initiatives, without changing the plan's general orientation nor giving up the sectorial and the consensus principles that form the basis of Norwegian policy making.

Consult this publication on line at ***http://dx.doi.org/10.1787/g2g7c200-en***.

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