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Science & Technology Indicators for Norway 2019

Main trends and figures

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Foreword

The world is being digitised, and so is the Report on Science and Technology indicators for Norway ("The Indicator Report") and the Research Council of Norway. The report continues to offer a collection of indicators, statistics and analysis of the Norwegian research and innovation system. From 2018, the full-length version (in Norwegian) can be found via the following address: https://www.forskningsradet.no/indikatorrapporten/. The digital edition provides the opportunity to access statistics and indicators faster than before, and as soon as new figures are available. It aims to become a living website with continuous publication of updated figures and associated analyses.

In addition to the full-length version in Norwegian, this English language shortened version of the report is produced both on paper and online. It is available via the same address as the Norwegian report. The English version contains material that is expected to be of particular interest for an international audience.

The Report on Science and Technology indicators for Norway contains key figures and trends, both from an international and national perspective. Furthermore, it highlights the status and development in some selected areas. The theme will vary from year to year. This year's edition has the UN Sustainability Goals as a special theme. What can we really say about the goals, both in terms of the alignment of R&D and innovation efforts, and the results in terms of goal achievement? Such a theme is important because we need to know if we are successful in this important effort. However, as stated in the report, there is much left to do before the activity is well documented, both in Norway and internationally. The thematic approach helps to shed light on such shortcomings – and opportunities – in the research and innovation statistics.

The report is produced as a collaboration between Nordic Institute for Studies in Innovation, Research and Education (NIFU), Statistics Norway and the Research Council of Norway. NIFU has the editorial responsibility, with senior adviser Kaja Wendt and head of research Espen Solberg. Innovation Norway, SIVA and the University of Oslo are also represented on the editorial committee. There is a great deal of work done and the editorial staff and other contributors deserve a big thank you for their efforts!

John-Arne Røttingen

Chief Executive

Research Council of Norway

Key findings and trends

In the past ten years, the world's expenditure on research and experimental development (R&D) has grown by 50 per cent. Norway has had about the same growth rate.

In just over ten years, China's R&D expenditure has almost tripled. If the trend continues, China will be the world's largest R&D nation in 2019, both in terms of R&D expenditure and in the number of scientific publications.

Preliminary figures show that Norway spent NOK 73 billion on R&D in 2018. It still accounts for more than 2 per cent of GDP, but the growth is lower than in previous years. Business R&D efforts show almost zero growth after several years of strong growth. R&D allocations over the state budget have also levelled off after 2017.

Compared with other countries, Norway has a high proportion of highly educated people. But the share of education at master's degree level is lower than the average in the OECD and the EU, both for the population as a whole and for those aged between 25 and 34 years.

In Norway, the number of doctoral candidates has increased sharply in the past 25 years, from about 500 in the mid-1990s to over 1,500 in 2018. The main reasons for the growth are that more women and more foreigners obtain doctorates in Norway.

Norwegian researchers published 15,900 articles in 2018. This accounts for 0.65 per cent of world production. Measured by number of published scientific articles in relation to the population, Norway is number four in the world. Switzerland, Denmark and Sweden top the statistics.

The number of Norwegian Open Access scientific articles has more than doubled in five years. In 2018, two-thirds of all Norwegian articles were published in open channels.

Over 60 per cent of Norwegian enterprises have had innovation activity in the last two years. A higher number of innovative companies is an important reason why Norway is, for the first time, ranked among Europe's 10 most innovative countries. The degree of innovation in small and medium-sized enterprises is among the areas where Norway has especially high values.

New surveys show that innovation is widespread in the public sector as well. In the Scandinavian countries, 70–80 per cent of public entities report that they have had innovation activity in recent years. New technology appears to be a more important driver for innovation in the Norwegian public sector compared with the other Scandinavian countries.

The UN sustainability goals are increasingly important in research and innovation policy. However, few of the goals and sub-goals are *directly* related to R&D and innovation. Like many other OECD countries, Norway is far ahead when it comes to fulfilling the UN sustainability goals in the areas of poverty, health, gender equality, clean energy and social inequality. Norway is farthest away from achieving the goals related to responsible production and consumption and efforts to stop climate change.

Contents

Introduction

The main report in Norwegian
This report presents a selection of science and technology (S&T) indicators for Norway. It is based on the more comprehensive Norwegian report, *Indikatorrapporten,* and a short version of this. The abridged English report has been published biennially since 2001, aiming at providing useful information and perspectives on a range of S&T issues for foreign readers who may not be familiar with the Norwegian S&T system and its context. Thus, it complements the full version, which can be found online (in Norwegian).

R&D and innovation statistics
The report draws on measurements and indicators with a long history and time series. Statistics on resources devoted to research and experimental development (R&D) in Norway, in terms of expenditure, full-time equivalents and personnel, have been compiled since 1963. This report continues the series' original aim of presenting a wide range of relevant statistics and indicators and of ensuring their ongoing development.

Norwegian R&D statistics are based on the guidelines of the OECD Frascati Manual, which were revised in 2015. Innovation studies were first introduced in the 1990s, and the range of innovation indicators has been considerably extended following the revision of the Oslo Manual in 2018. The full-length Norwegian report presents a more extensive set of indicators and commentary, divided into international, national and regional sections, with sections on results, effects and cooperation on research and innovation. It also includes a separate section with detailed tables.

Structure of the report
This abridged English report offers information across a wide range of topics. Some key findings are already presented at the beginning of the report, and following this introduction, a brief description of the Norwegian system of education, research and innovation in presented. Chapter 1 presents some main international trends with results from R&D surveys, as well as comparisons over time and between countries by sector. Chapter 2 provides a closer look at Norwegian R&D by sector and funding source. Chapter 3 presents available data on publications, citations and collaboration, including indicators of Norwegian participation in Horizon 2020. Chapter 4 presents statistics on educational level, economic return on education and higher educated and R&D personnel in working life. The chapter also presents trends related to doctoral degrees in addition to the monitoring system for researcher recruitment in Norway. Chapter 5 includes indicators for innovation in Norwegian industrial sector and public sector in addition to an overview of digital priority, competence and activity in public sector. The final chapter describes the status and future challenges, especially for Norway, related to the UN's Sustainable Development Goals with a focus on R&D efforts.

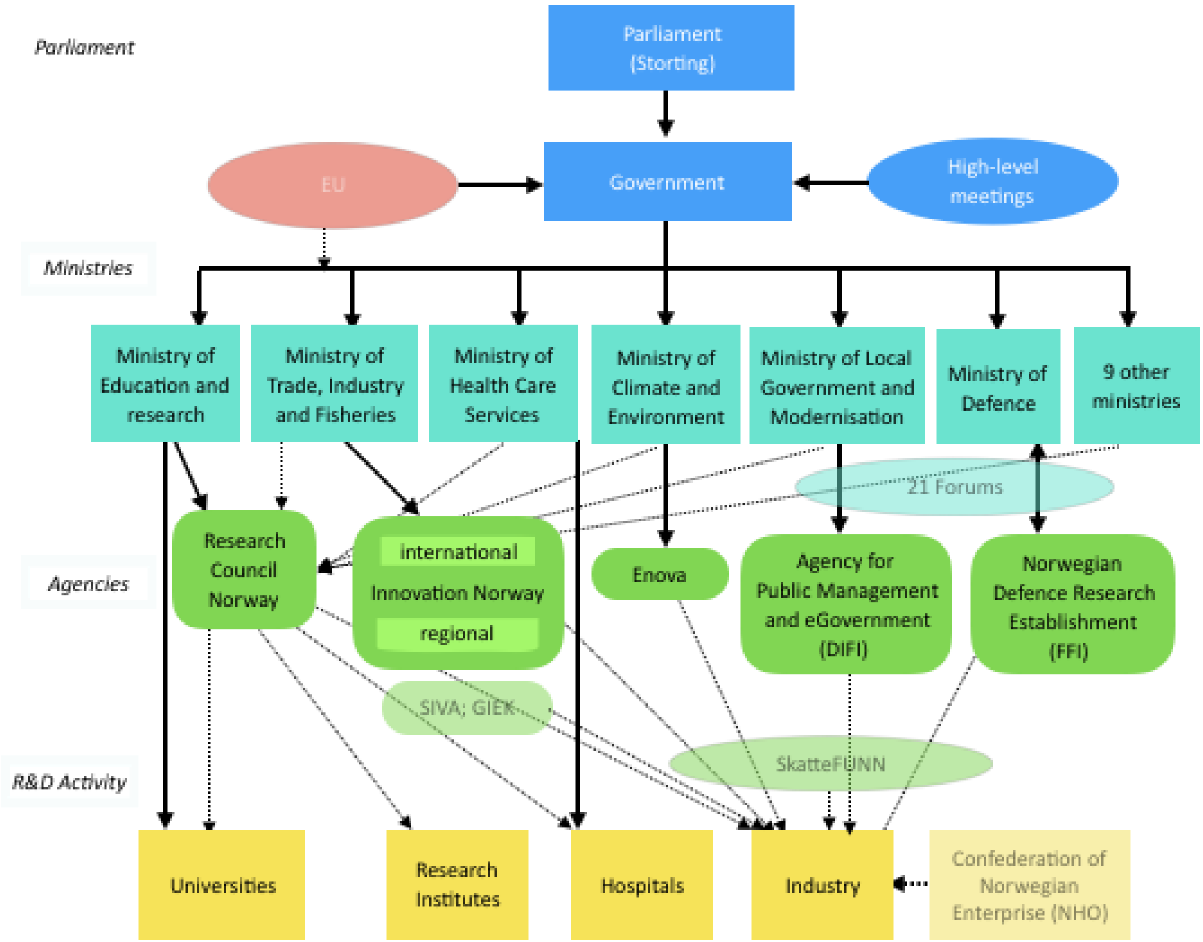
This English edition is less extensive than the original Norwegian report. However, it includes several "fact boxes" with supplementary information such as sectoral differences, reforms in Norway or special projects. We should also mention that this abridged report does not feature full references. These can be found in the Norwegian report, which is available online, together with a complete set of updated tables:
http://www.forskningsradet.no/indikatorrapporten

Currency rates

As of 2017 (year average):
1 Euro = 9.3 NOK (Norwegian kroner)
1 US$ = 8.3 NOK

As of December 2019:
1 Euro = 10.0 NOK
1 US$ = 9.0 NOK

The Norwegian system of education, research and innovation



Main Science, Technology and Innovation (STI) actors in Norway.

SIVA–The Industrial Development Corporation of Norway.
GIEK–The Norwegian Export Credit Guarantee Agency.
SkatteFUNN: The Norwegian tax deduction scheme.

The Norwegian research and innovation system include a large number of institutions with different roles. It is common to distinguish between three levels: *the political*, *the strategic* and *the performing* level. Extensive internationalisation also applies to Norwegian research and contributes an increasingly important dimension to all parts of the Norwegian R&D system. The figure above provides a simplified picture of the organisation and the division of labour in the R&D and innovation system, including the international dimension (EU).

The political level
The system can be characterised by considerable pluralism at the political level. According to the "sector principle", all 18 ministries are responsible for financing both short-term and long-term research within their respective sectors. Hence, public research funding and science policy involves extensive coordination. At the same time R&D budgets are fairly concentrated, as five ministries account for 85 per cent of total R&D funding. The most important one is the Ministry of Education and Research. This ministry also prepares the long-term plan for research and higher education and is responsible for coordinating research policy across ministries at the national level. Other important contributors are the Ministries of Trade, Industry and Fisheries, Health Care Services, Climate and Environment, Local Government and Modernisation and Defence. The Research Council of Norway (RCN)

also supplies advice to the government on STI policy and network governance between various actors in the STI system.

The strategic level

At the strategic level, there are several agencies that are important for Norwegian STI policy. The two most important players are the RCN, which focuses on research and technological funding, and Innovation Norway and SkatteFUNN, which focuses on innovation. More than half of the budgetary funding for Norwegian R&D activity goes through the Ministry of Education and Research and the RCN. While universities and state university colleges have a larger budget, the RCN has more than 25 per cent of public R&D funding. They receive funding from all 15 ministries. Innovation Norway encourages innovation at the regional and national level, with a focus on small and medium sized companies and SkatteFUNN R&D tax incentive scheme has become a major tool for encouraging innovation by supplying tax credits for the R&D activity.

In addition to RCN, Innovation Norway and SkatteFUNN, there are several other key players. SIVA encourages the development of science parks, incubators, and services to start-up firms. GEIK supplies long-term guarantees that encourage Norwegian industry to take part in more international trade and export. Enova, owned by the Ministry of Climate and Environment, encourages environmentally friendly production and consumption of energy and to explore new sources of clean energy. Difi aims to strengthen the Norwegian public sector and improve the organisation and efficiency of government administration. Finally, FFI aims to advance knowledge in artificial intelligence, additive manufacturing, quantum computing, nanotechnology, the Internet of Things, and autonomy.

The performing level

At the performing level in Norway, there is the higher education sector (including university hospitals), the institute sector and the industrial sector. The higher education sector performed almost one third of Norwegian R&D activity in 2017. There is a broad variety of institutions in the higher education sector, including universities, state university colleges and private higher education institutions. At the same time, research activity is concentrated, as universities, including university hospitals, accounted for more than 80 per cent of the higher education sector's total R&D expenditure in 2017.

Compared with other countries, a relatively high share of Norwegian R&D is performed by research institutes (22.6%). The Norwegian institute sector is rather heterogenous in terms of institute size, profile and legal status. The sector includes both public sector oriented and industrial sector oriented institutes, of which the latter group plays an important role in carrying out contract research for Norwegian and foreign companies.

Even though the industrial sector accounts for nearly half the R&D expenditure in Norway, the proportion of research performed in this sector is low compared with other countries. Given the resource-based structure of the economy, there are relatively few large R&D-intensive companies in Norway.

The S&T statistical infrastructure

The production of STI statistics is distributed across different parts of Norway's statistical system. The official statistical agency: Statistics Norway, is a key pillar. The agency produces R&D and innovation statistics for the businesses, conducts evaluations and research and provides a macro and micro-data warehouse.

NIFU is the other major actor in S&T studies. NIFU produces R&D statistics for the government and higher education sector and is also involved in evaluations and research projects covering education, innovation and research studies. Statistics Norway and NIFU cooperates in reporting R&D statistics to Eurostat and OECD.

Norway has recently undergone a process of transformation in digital support services to the research and higher education sector by reforming the key agencies. A new agency, UNIT (Directorate for ICT and joint services in higher education and research), organises administrative data on research and the higher education sector, students and Cristin (the current Research Information System in Norway). The availability of administrative data resources, provides for significant opportunities to collect data, minimising the need for ad hoc inquiries addressed to STI actors.

Key indicators

The following two tables present a set of key indicators to introduce essential trends of Norwegian research and innovation. The first table shows main trends in Norway. The second table compares the status of Norway with that of the other Nordic countries, the EU, and the OECD.

Key indicators for R&D and innovation in Norway in 2009, 2013, 2015, 2016, 2017 and 2018.*

INDICATOR	2009	2013	2015	2016	2017	2018*
Resources for R&D and innovation						
R&D expenditure as a percentage of GDP	1.72	1.65	1.94	2.04	2.10	2.07
R&D expenditure per capita in constant 2010 prices (NOK)	9,000	8,932	9,854	10,045	10,695	10,874
R&D expenditure funded by government as a percentage of total R&D expenditure	46.8	45.5	44.9	45.7	46.7	..
R&D expenditure funded by industry as a percentage of total R&D expenditure	43.6	43.1	44.2	43.2	42.8	..
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	32.0	31.5	31.1	32.6	33.7	34.4
Human resources						
Percentage of the population with higher education	36.7	39.8	42.7	43.0	43.2	43.6
R&D full-time equivalents per 1,000 capita	7.5	7.6	8.2	8.4	8.9	8.8
R&D full-time equivalents per qualified researcher/scientist per 1,000 capita	5.4	5.6	5.9	6.1	6.4	6.4
Percentage doctoral degree holders among qualified researchers/scientists	29.6	33.7	34.5	34.4	34.3	..
Percentage women among qualified researchers/scientists	35.2	36.1	37.4	37.6	31.8	..
Cooperation in R&D and innovation						
Extramural R&D expenditure compared with intramural R&D expenditure in the industrial sector (%)	31	27	24	24	23	
Companies involved in cooperation on R&D as a percentage of all R&D companies	39	33	39	..	36[1]	23[5]
Companies involved in cooperation on innovation as a percentage of all innovative companies	37[2]	47[4]	..	38	..	28[5]
Articles in international scientific journals co-authored by Norwegian and foreign researchers as a percentage of all articles by Norwegian researchers	55	60	65	67	68	69
Results of R&D and innovation						
Percentage innovative companies in the business enterprise sector[6]	27[2]	40[4]	..	53	..	61[5]
Percentage of turnover of new or substantially altered products in the industrial sector[6]	4,5[2]	6,8[4]	..	6,8	..	7,5
Number of articles in international scientific journals per 100,000 capita	198	238	253	275	281	299
Number of patent applications to the European Patent Organisation per million capita[7]	125	107	88	91	95	..

* R&D figures for 2018 are preliminary.
[1] Preliminary figures for the number of companies with R&D.
[2] 2008.
[3] 2010.
[4] Break in series.
[5] The Innovation Survey 2016–2018 is based on definitions in the 4th edition of the Oslo Manual. This means a break in the time series.
[6] Includes companies with at least 5 employees. In industries F41-43, H49-53 and I56, only companies with at least 20 employees are included.
[7] By inventor address, application date and patent type EPO_A in OECD's dataset "Patents by technology", European applications only (EP-A).
Source: NIFU, Statistics Norway, OECD, Eurostat

Key indicators for R&D and innovation in last available year with comparable data in Norway, Sweden, Denmark, Finland, OECD and EU.

	Year	Norway	Sweden	Denmark	Finland	OECD	EU 28 (est.)
Resources for R&D and innovation							
R&D expenditure as a percentage of GDP	2017	2.07[3]	3.34[3]	3.07[3]	2.74[3]	2.37	1.97
R&D expenditure per capita (NOK)	2017	13,109	17,870[3]	16,668	12,868	10,573	8,453
R&D expenditure funded by the government as a percentage of total R&D expenditure	2017	46.7	25	27.2	29.1	25.1	30.7[2]
R&D expenditure funded by the business enterprise sector as a percentage of total R&D expenditure	2017	42.8	60.8	58.5	58	62.8	56.7[2]
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	2017	33.7	25.4[3]	32.1	25.4	17.2	22.1
Human resources							
Percentage of the population with higher education	2018	43.6	43.3	38.1	45.2	38.6	35.6[7]
R&D full-time equivalents per 1,000 capita	2017	8.8	9.2[3]	10.9	8.9	..	6
R&D full-time equivalents of? qualified researcher/scientist per 1,000 capita	2017	6.4	7.5[3]	7.9	6.7	3.8[2]	3.8
Cooperation in R&D and innovation							
Companies involved in cooperation on innovation as a percentage of all innovative companies.	2016	37.4[5]	33.3	39.0	39.3	..	32.5
Companies involved in cooperation on innovation as a percentage of innovative companies in manufacturing and mining	2016	42.7	34.0	42.9	43.2	..	29.8
Results of R&D and innovation							
Percentage of innovative companies in the business enterprise sector	2016	60.4[5]	42.6	36.6	58.2	..	39.5
Percentage of innovative companies in manufacturing and mining	2016	62.2	47.5	39.1	66.1	..	44.2
Percentage of turnover of new or substantially altered products in the business enterprise sector	2016	7.3[5]	8.7	7[1]	11.3	..	13.4[1]
Percentage of turnover of new or substantially altered products in Manufacturing or Mining	2016	10.6	13.9	14.1[1]	15.7	..	20.3[1]
Number of articles in international scientific journals per 100,000 capita	2018	299	304	365	261	86	111
Number of patent applications to the European Patent Organisation per million capita[4]	2017	95	328	259	258	106	122

[1] 2015
[2] 2016
[3] 2018
[4] By inventor address and by application date, European applications only (EP-A).
[5] Only companies with at least 20 employees are included in business enterprise H49-53.
[6] The Innovation Survey 2016–2018 is based on definitions in the 4th edition of the Oslo Manual. It means a break in the time series.
[7] EU23 average.
Source: NIFU, Statistics Norway, OECD, Eurostat, DG Enterprise

Chapter 1: Norwegian R&D in an international context

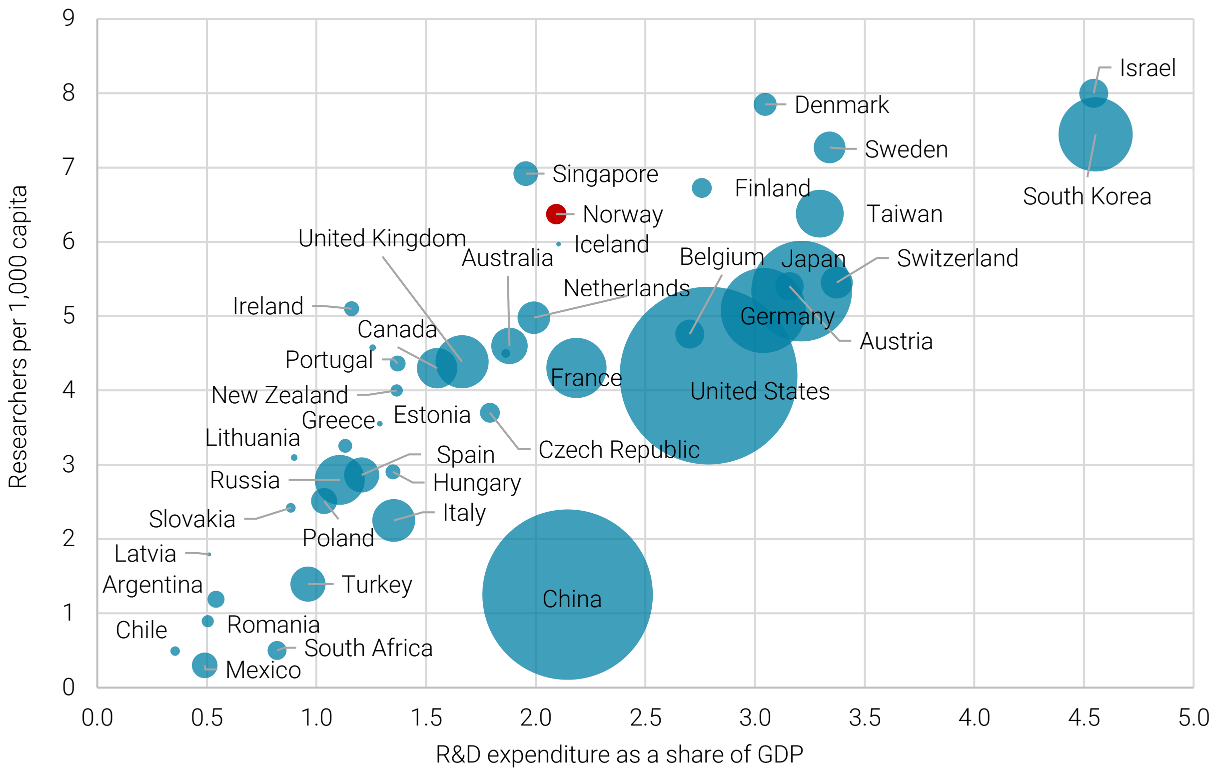


Figure 1.1: R&D expenditure in PPP (fixed 2010 prices), as a percentage of GDP and the number of researchers per 1,000 inhabitants. OECD area and selected countries. 2017 or last available year.
Source: NIFU, based on OECD MSTI 2019–1

10 countries account for 80 per cent of the world's R&D expenditure

The world's research and development (R&D) resources are still dominated by a few large countries. UNESCO figures show that the top 10 nations account for 80 per cent of the world's investment in R&D. The United States and China together account for just over half. Figure 1.1 shows the balance of power between key R&D nations in Europe, Asia and North America.

Norway is naturally among the smaller R&D nations measured in total R&D expenditure. However, when studying the proportion of researchers in the population, Norway is among the leading countries, and quite average with regard to total R&D resources as a share of GDP.

Small and "new" R&D nations are growing the most

During the ten-year period from 2006 to 2016, the world's R&D expenditure has grown just over 50 per cent. Norway has had about the same growth rate, while the general trend in Western countries is a real growth of 23 per cent. The overall picture globally shows that small and "new" R&D nations are increasing their R&D expenditure more than the established ones. In China, R&D spending has increased by more than 260 per cent over the past ten years. During the same period, Arab and African countries also experienced overall R&D growth well above the world average and significantly above western countries. If China's growth continues, it will be the world's largest R&D nation by 2019.

The major nations are still likely to hold on to their positions, without significant changes, for a long time to come. The countries with the strongest growth are mainly small R&D nations, and their growth accounts for a small part in the global context.

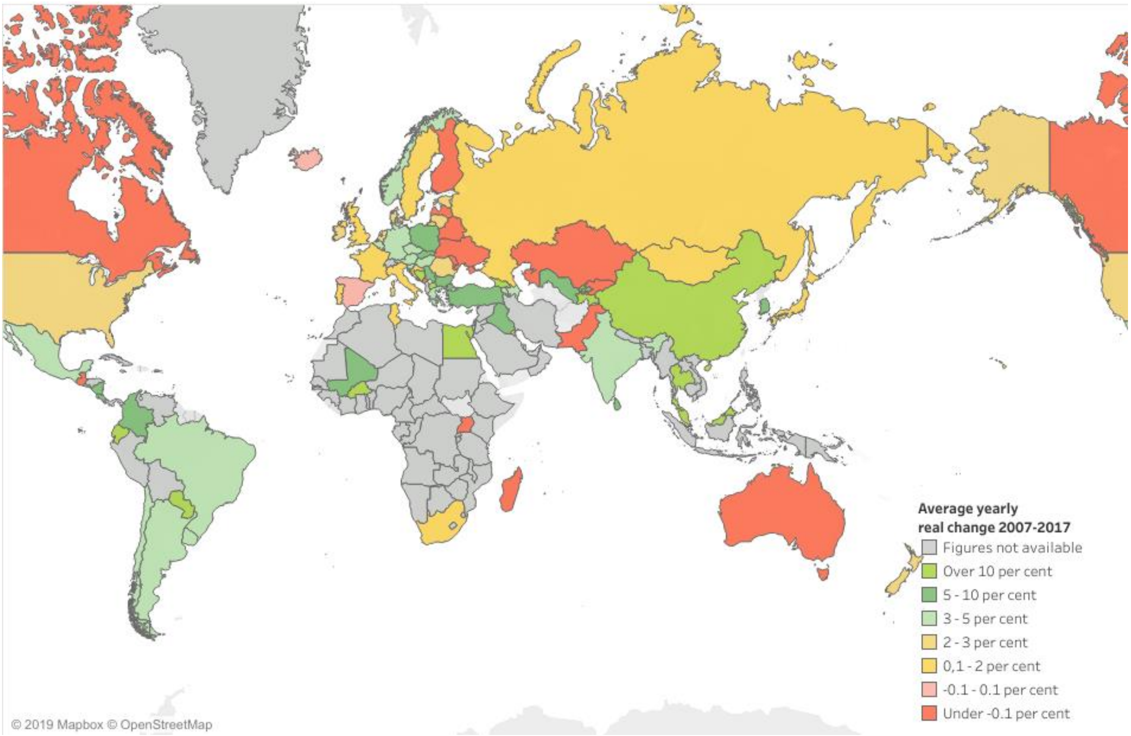


Figure 1.2: Global main trends – Average yearly real growth in R&D expenditure. 2007–2017.
Source: OECD MSTI 2019–1

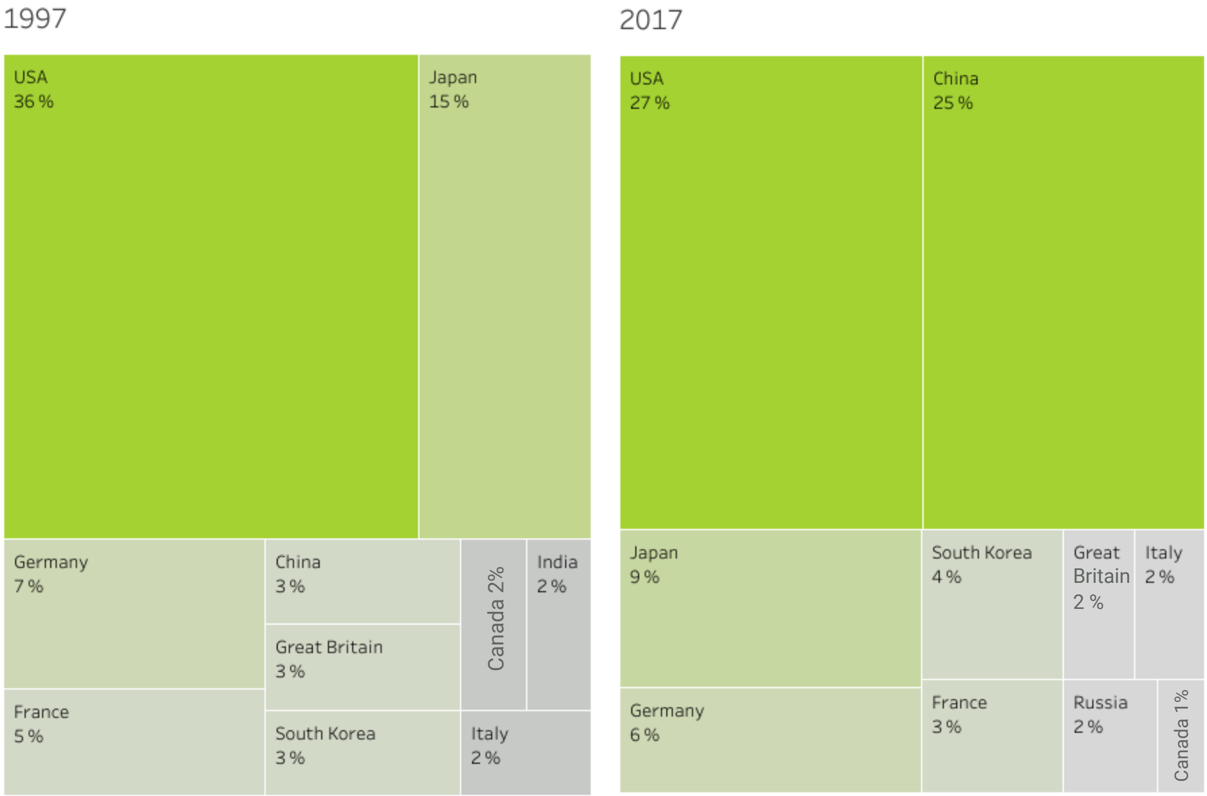


Figure 1.3: The world's 10 largest R&D nations. Percentage of total R&D in PPP$. 1997 and 2017.
The rest of the world accounted for 22 per cent of total R&D in PPP$ in 1997, and 19 per cent in 2017.
Source: OECD MSTI 2019–1

R&D expenditure as a share of GDP

Norway's R&D investments exceed 2 per cent of GDP, but the growth seems to be levelling off
Total R&D investments in Norway account for over 2 per cent of GDP in 2017. This is still below the OECD average and well below the agreed target (3% of GDP). Until 2017, Norway has experienced a stronger R&D growth than most other comparable countries, primarily due to an increase in Norwegian R&D grants and a corresponding flattening and decline in the other Nordic countries' public investment in R&D.

However, preliminary figures for 2018 indicate a weaker development in R&D in the business enterprise sector in Norway. Furthermore, public investment in R&D is flattening out, when at the same time Norway's GDP is increasing. Overall, this indicates that the growth in Norway's R&D expenditure as a share of GDP is levelling off. Preliminary figures for the other Nordic countries indicate the same flattening. Denmark, as the only Nordic country, seems to be increasing its R&D share.

Public funding in Norway at the top among the OECD countries
For a long time, Norway has been among the countries that use the most public resources on R&D. Figures from 2017 show that R&D expenditure from public funding accounted for 0.98 per cent of GDP in Norway. Together with South Korea, Norway is thus at the top among the OECD countries.

About the data sources for international R&D statistics

In this chapter, we are using data from OECD – MSTI (Main Science and Technology Indicators) 2019: 1, Eurostat and the UNESCO Institute for Statistics (UIS). NIFU and Statistics Norway report R&D statistics for Norway to the OECD and Eurostat. UNESCO conducts an annual survey among statistical bodies (OECD, Eurostat, RYCIT, etc.) and individual countries. All statistical bodies work to ensure quality and timeliness of reported R&D data on human and financial resources and type of R&D. It is continuously sought to utilise existing and new data for best possible indicators. The indicators are important for policy design and for evaluating national innovation systems. The data can be used to say something about whether the investments are at the desired level or going in the desired direction, and whether the distribution on industries, fields of science and sectors is appropriate.

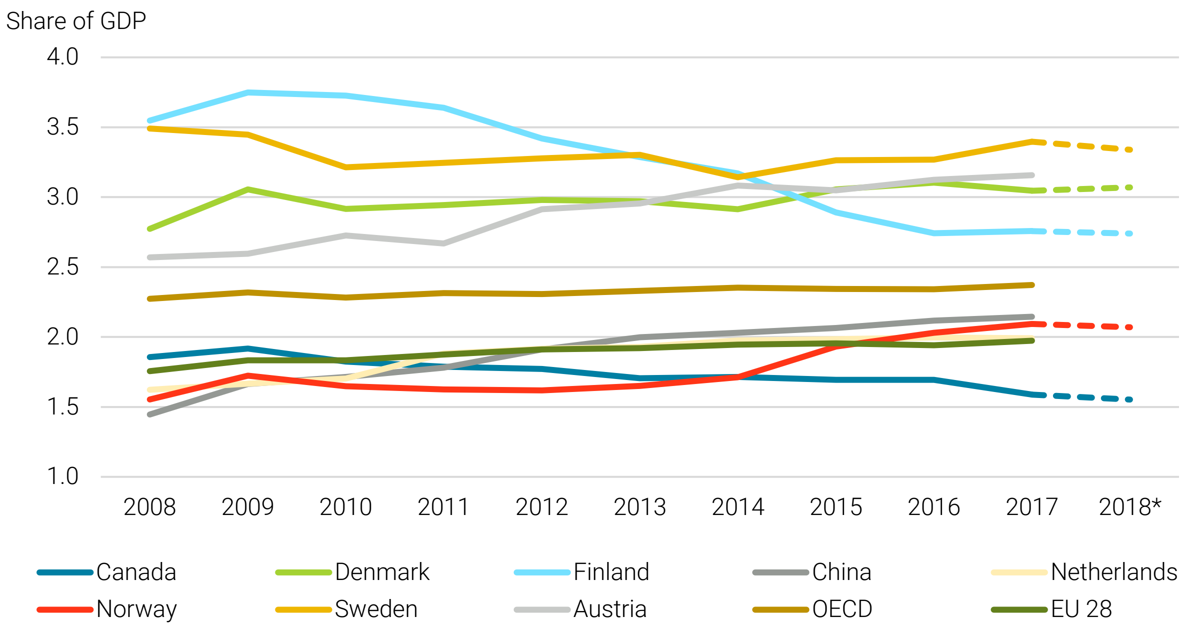


Figure 1.4: R&D expenditure as a share of GDP. Selected countries 2008–2017/2018.
* Preliminary figures.
Source: NIFU, based on OECD MSTI 2019–1

R&D in the business enterprise sector

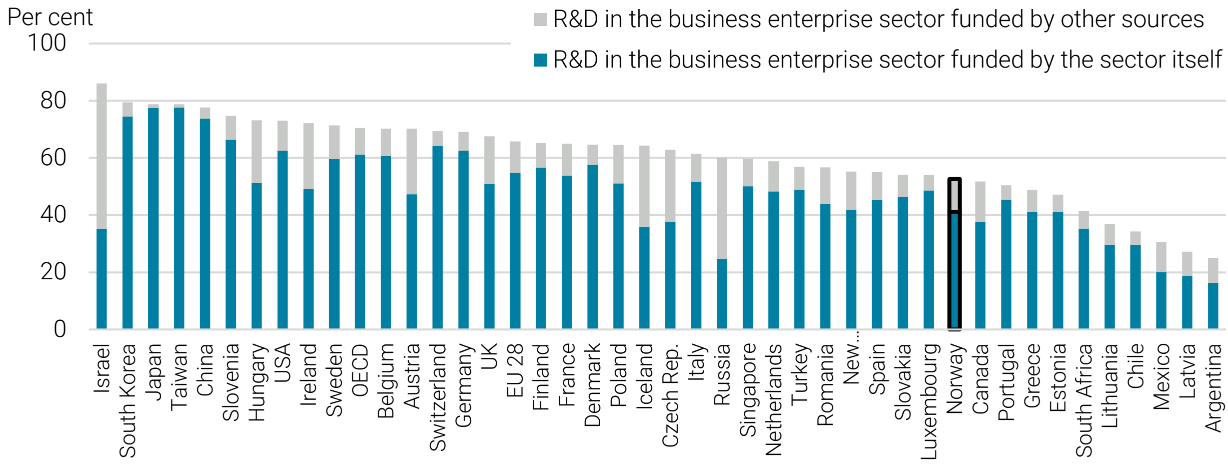


Figure 1.5: R&D performed in the business enterprise sector (as a share of national R&D) financed by the business enterprise sector and other sources. Selected countries. 2017 or last available year.
Source: OECD MSTI 2019–1

More than two thirds of all R&D in the OECD area take place in the business enterprise sector
Although the business enterprise sector is the dominant R&D performing sector in the OECD area overall, there are major differences between countries. Figure 1.5 shows the proportion of the countries' total R&D performed in the business enterprise sector.

In several of the largest and most research-intensive countries, the business enterprise sector accounts for over 70 per cent of all R&D. This applies to the USA, South Korea, Japan and Sweden, among others. Thus, the OECD average is also about 70 per cent. Norway's share of R&D in the business enterprise sector is just over 50 per cent. The difference is largely related to differences in the industry structure (see next page).

Most of the business enterprise sector's R&D is financed by the sector itself
The figure also shows that it is generally the business enterprise sector itself that finances R&D efforts in the sector. However, there are some interesting exceptions. In Israel, Austria, Ireland and the Czech Republic, a large proportion of the R&D (performed in the business enterprise sector) is financed by foreign sources, most often as a result of national research companies being owned and financed by international groups. The low proportion of R&D in the business enterprise sector financed by itself in Russia and Hungary is mainly because a large proportion is funded by public sources. The same applies to some extent to Norway. It should be noted that the business enterprise sector also consists of business-oriented research institutes that obtain much of their funding from public and other sources.

International sector classification

According to OECD guidelines (Frascati manual) the production of R&D statistics is to be based on four performing sectors: business enterprise sector, government sector, Private non-profit sector; PNP sector and higher education sector.

In Norway, the business enterprise sector includes, in addition to the enterprises, business-oriented institutes that primarily serve business. The government sector comprises units in the institute sector which are government-related, as well as other public institutions. The PNP sector is small in Norway and only included as an R&D funding sector. The higher education sector is identical in national and international statistics. In terms of R&D funding, own revenues and public and private parts of the general university funds are classified differently in national and international statistics, which may cause minor discrepancies. Both sectoral division and sources of funding in national statistics deviate somewhat from international R&D statistics.

Differences in business enterprise structure

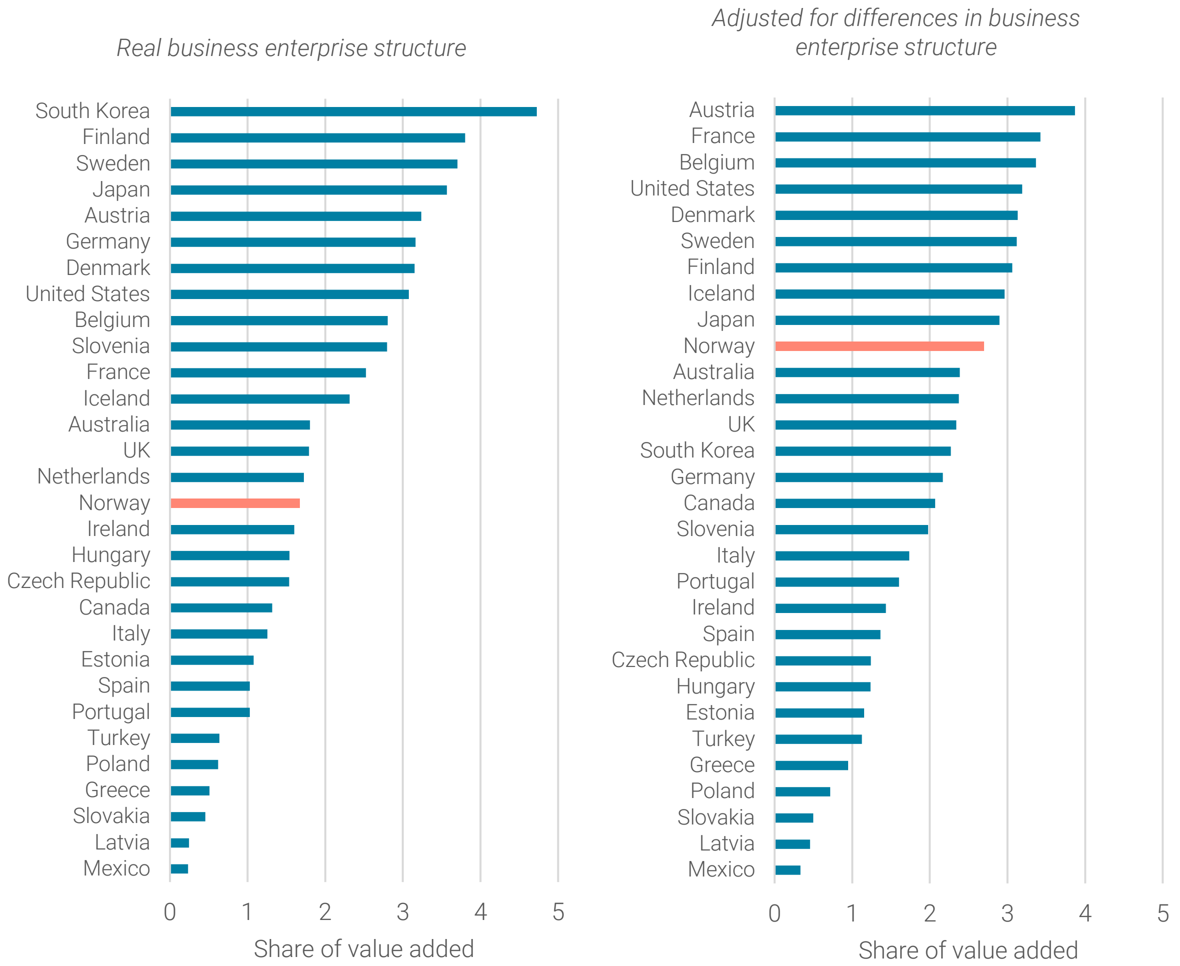


Figure 1.6: R&D expenditure in the business enterprise sector as a proportion of value added by real business enterprise structure (left) and adjusted for differences in business enterprise structure (right). 2015. Selected OECD countries.
Source: OECD/STI Scoreboard 2017

Differences in business enterprise structure are of great importance
Norway's moderate investment in total R&D as a share of GDP must be seen in the context of the country's generally high GDP level and the large number of resource-based industries. Both are closely related to the high revenue and high activity associated with the oil and gas industry in Norway. In such industries, value added is often high in relation to R&D investments. Canada, the Netherlands and Austria are similar to Norway, while Sweden and Finland are examples of countries with a strong concentration of industries that require a lot of research and development.

Since most of the R&D efforts are carried out by private companies, such structural differences will have a major impact on overall R&D efforts. The OECD has shown what the level would be if all countries had the same business structure as the average of the OECD countries. In such a comparison, R&D efforts in the Norwegian business enterprise sector would be higher than in South Korea, almost at the same level as Japan and closer to the other Nordic countries (see Figure 1.6).

R&D in the higher education sector

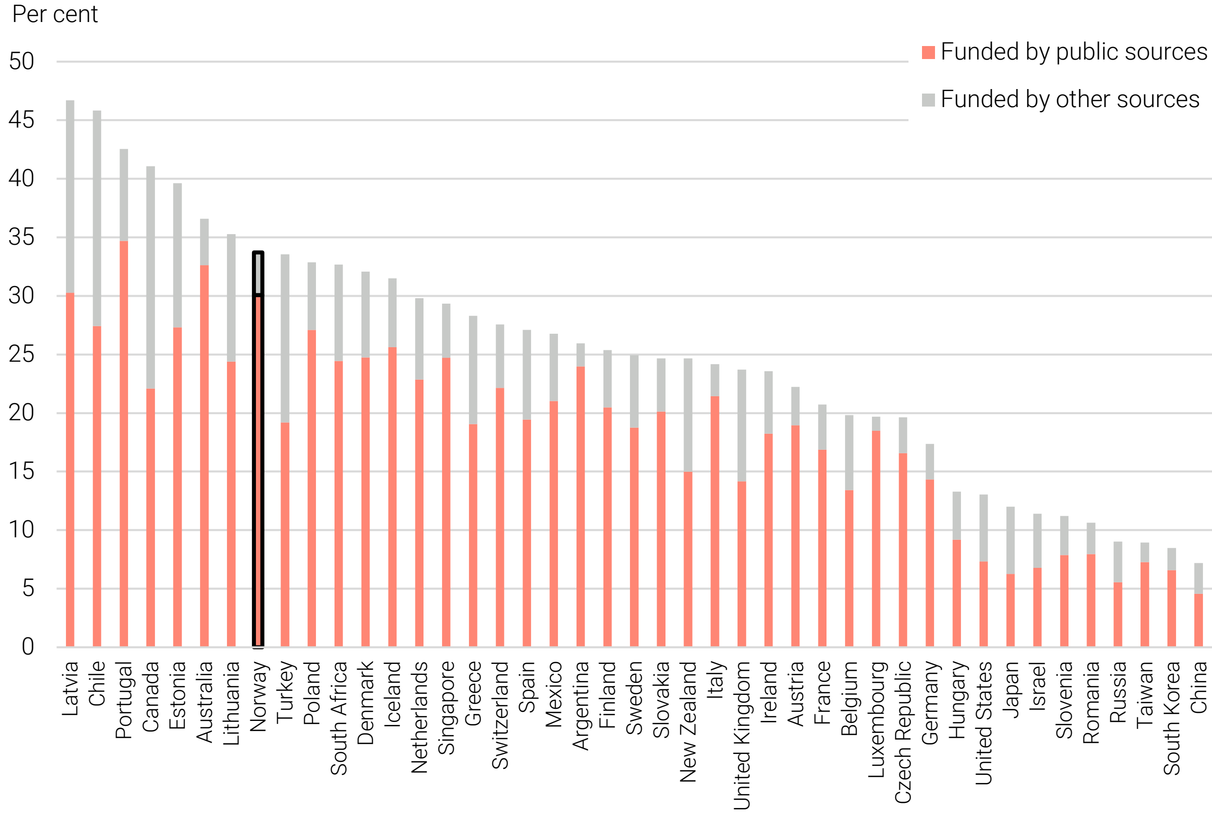


Figure 1.7: Proportion of R&D performed in the higher education sector funded by public sources and other sources.[1] Selected countries. 2017 or last available year.
Source: OECD / MSTI 2019–1

R&D in the higher education sector is mainly publicly funded

The higher education sector is the second largest R&D-performing sector in most countries. Nevertheless, there are major differences between several countries. In Norway the sector accounts for 34 per cent of total R&D. The higher education sector accounts for an even higher share with more than 40 per cent of the R&D expenditure in Latvia, Chile and Portugal, whereas the sector accounts for less than 10 per cent in China and South Korea.

Figure 1.7 illustrates that the R&D efforts in the higher education sector are mainly funded by public sources. There are, however, some exceptions. In countries such as Canada and the Baltic countries, the higher education sector plays a particularly important role. In Canada, the higher education institutions receive a significant amount of funding from student fees and other private funding, while the higher education sector in the Baltic countries obtains much of its funding from foreign sources, especially the EU Structural Funds and research programmes. The figure also shows that Norway is among the countries with the largest proportion of public funding in the higher education sector. In Europe only Portugal has a higher share than Norway.

[1] Other sources: own revenues at universities and research institutes; private foundations and gifts, loans, funds from NGOs and SkatteFUNN. SkatteFUNN is in principle public funding, but according to international guidelines (OECD Frascati manual) any tax incentive schemes are classified as own funding of the relevant sector. This is because the tax incentives are very different, and in many countries, there are period-related discrepancies between actual R&D activity and the associated tax benefits.

Chapter 2: R&D in the Norwegian system

Norwegian performing sectors for R&D

In Norway, national R&D statistics are categorised according to three basic sectors:

The industrial sector: Companies and enterprises aimed at commercial production of goods and services for sale at an economically significant price.
The institute sector: Private-non-profit research institutes mainly serving industry (the business enterprise sector in the OECD classification); research institutes and other R&D-performing institutes (other than higher education) mainly controlled by and funded by the government (government sector in the OECD classification) (PNP); and health trusts not conducting education and PNP hospitals.
The higher education sector: Units providing higher education; universities, specialised university institutions, state university colleges and university hospitals. To highlight the R&D activities in health trusts these are presented separately where appropriate and possible (data from 2007).

R&D expenditure in Norway by sector

NOK 73 billion spent on R&D in Norway
In 2017, Norway's total R&D expenditure amounted to NOK 69.2 billion, which equals a real growth of 7 per cent from the previous year. Preliminary figures for 2018 show that Norway spent NOK 73 billion on R&D. This equals a real growth of just over 2 per cent from 2017, slightly lower than the past ten years. Still, the growth is high compared with other Western countries.

Over time, an increasing proportion of Norwegian R&D has been carried out by the higher education sector. The proportion of R&D performed by the institute sector has decreased over time, while the share of R&D performed by health trusts has remained stable at 6 per cent. Preliminary figures for 2018 deviate somewhat from this trend: while R&D performed by the industrial sector has a real growth approaching zero in 2018, the higher education sector still has a real growth of more than 4 per cent. In the institute sector, the real growth is slightly above 3 per cent and just below 2 per cent for the health trusts.

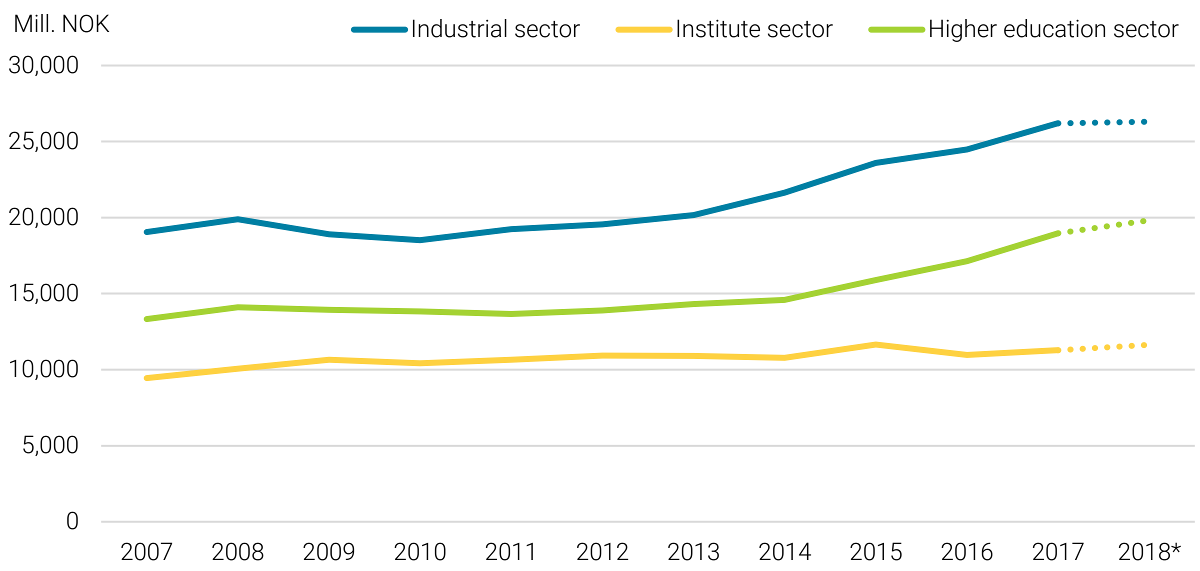


Figure 2.1: R&D expenditure in Norway by sector of performance. Health trusts are included in higher education sector and the institute sector. From 2007 to 2018. Fixed 2010 prices.
* Preliminary figures.
Source: Statistics Norway and NIFU, R&D statistics

ICT services and new buildings account for a large proportion of the growth

A large proportion of the R&D growth in the Norwegian industrial sector takes place within services, especially ICT services. Although the manufacturing industry's R&D expenditure has increased, expenditure within the services keeps increasing their proportion of the total R&D effort. On the other hand, the R&D expenditure in the oil and gas industry shows a downward trend, a steady decline since 2013. Preliminary figures for 2018 do not significantly change the main picture regarding the industrial sector. The growth in the higher education sector reflects a general expansion in the sector, but also driven by investment in new university buildings. In addition, the strong growth in the higher education sector from 2015 to 2017 is linked to the results of a new time-use survey. The survey shows that employees at the higher educational institutions spend a higher proportion of their working hours on R&D than previously measured. The growth in human resources is lower in 2018, compared with 2017, and primarily related to growth in fellows, postdoctoral fellows and researchers.

High R&D activity in small Norwegian companies

In Norway, small enterprises contribute more to total R&D expenditure than small enterprises in other, selected countries. While enterprises with 10–49 employees accounted for 26 per cent of R&D expenditure in Norway in 2015, the share was only 8 per cent in Sweden. Enterprises in Sweden with at least 500 employees accounted for three quarters of the sector's total R&D expenditure of EUR 8,200 million, while the largest R&D enterprises in Norway contributed two fifths.

Companies in Norway with 10–49 employees also had a higher number of R&D FTEs in 2015 than the other selected countries. See Figure 2.2. In Norway, enterprises in this group accounted for 26 per cent of the R&D FTEs in 2015, while the figure was below 20 per cent in all the other comparable countries. Norway had the fewest R&D FTEs in total – 15,000 in the industrial sector, compared with 25,000 FTEs in Denmark and 45,000 in Sweden.

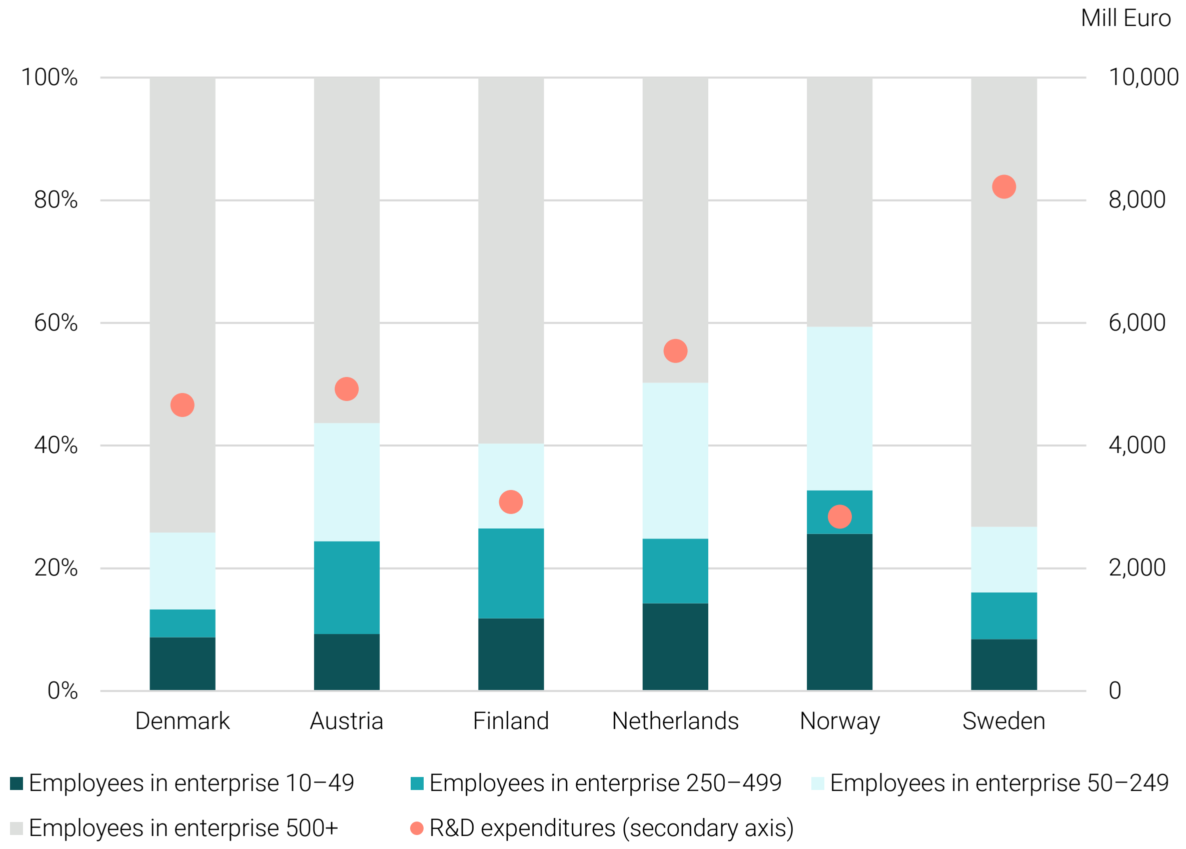


Figure 2.2: R&D costs and enterprise size in Norway and selected countries. 2015.
Source: Eurostat

R&D expenditure in Norway by funding source

Increasing share of public funding for R&D in Norway

In Norway, the funding of R&D activity has been roughly equally distributed between public sources and the industrial sector for a long time. In recent years, however, public funding has increased more than the funding from the industrial sector. In 2017, funding from public sources accounted for 46 per cent of total R&D, while the corresponding share from the industrial sector was below 40 per cent for the first time since 1981.

In addition to the direct public funding, there are various forms of indirect support. The most important scheme is the tax deduction for the industrial sector's R&D expenditure, SkatteFUNN, introduced in 2002. The scheme contributed to a total tax deduction of NOK 4.3 billion in 2018.

Declining share of R&D funding through the Research Council of Norway

Although public funding is increasing, there is a decline in the share of funding through the Research Council of Norway (RCN). In 2017, funding from the Research Council amounted to less than 10 per cent of total R&D. This is the lowest proportion since 1970, and a noticeable decline from 13 per cent in 2009. Some of the explanation may be that an increasing share of the Research Council's funding is received through projects where the Council's share may be difficult to identify for the respondents.

EU funding over NOK 1 billion for the first time

Funding from abroad has become increasingly important for Norwegian R&D. It amounted to about 3 per cent of the total funding until the 1990s, before gradually rising to the current level of about 9 per cent. Most of this expenditure stems from the industrial sector's funding from foreign enterprises in their own group. In 2017, funding from the EU research framework programmes amounted to more than NOK 1 billion. Increased funding has been a high priority in Norwegian research policy, and the growth may be a result of this mobilisation.

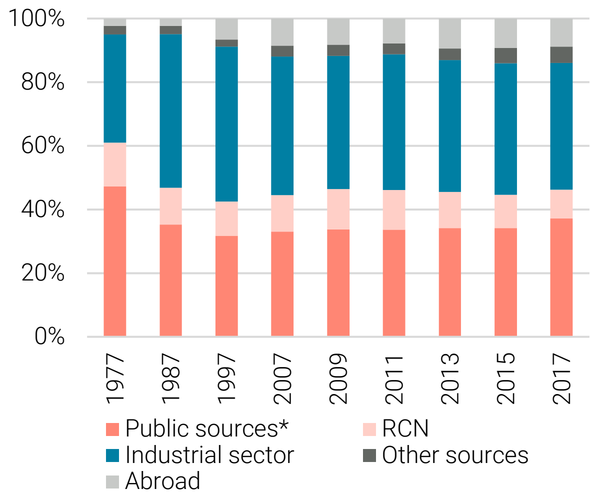


Figure 2.3: R&D expenditure by main source of funding. 1977, 1987, 1997 and 2007–2017.
* Excl. The Research Council of Norway (RCN).
Source: Statistics Norway and NIFU, R&D statistics.

Sector of performance	Total	Industrial sector	Public sources: Total	Public sources: Ministry, county, municipality	Public sources: The Research Council of Norway[2]	Other sources[3]	Abroad: Total	Abroad: Hereof The Eur. Commission
Industrial sector	31,990	24,504	1,403	670	733	2,020	4,063	180
Higher education sector	23,322	529	21,269	17,918	3,351	781	743	538
hereof university hospitals	*3455*	*55*	*3,128*	*2,843*	*285*	*238*	*33*	*17*
Institute sector	13,864	2,402	9,665	6,248	3,416	486	1312	420
hereof other hospitals	*922*	*35*	*843*	*818*	*25*	*44*	*1*	*1*
Total	69,176	27,435	32,336	24,836	7,500	3,287	6,118	1,139

Table 2.1: Total R&D expenditure by performing sector and funding source. Mill. NOK. 2017.

[1] Includes grants from Innovation Norway.
[2] The figures are based on tasks from performing units. This may differ from the funding source's tasks.
[3] Includes private gifts, foundations, own income and SkatteFUNN in the industrial sector.
Source: Statistics Norway and NIFU, R&D statistics

A closer look at Norway's R&D efforts – what are we researching?

NIFU's report *The R&D efforts within thematic areas in 2017*[2] (2019) maps areas anchored in the Government's long-term plan for research and higher education. The 10 thematic areas are energy, climate, environment, agriculture, fisheries, aquaculture, marine, maritime, welfare and education, as well as the technology area of biotechnology. By linking with the R&D survey, Norway has a rather unique dataset of thematic R&D areas.

The report shows the scope of resources, highlighted by R&D expenditure, by funding and research areas. In addition, some indicators for human resources are included. The 10 thematic areas make up 45 per cent of Norway's total R&D resources in 2017, in addition to biotechnology, which accounts for almost 8 per cent of total resources.

Public sources and the industrial sector finance an equal share, but dominate in various thematic areas

42 per cent of the thematic areas are funded by public sources. The same applies to the financing share from the industrial sector. Nevertheless, the distribution varies between the thematic areas. Public sources fund between 85 and 90 per cent of R&D efforts related to education and welfare, 73 per cent in marine R&D and 59 per cent in climate. The industrial sector finances 75 per cent of R&D efforts in maritime R&D, 58 per cent in energy, 55 per cent in aquaculture and 47 per cent in agriculture, environment and fisheries. Funding sources from abroad account for 8 per cent of the R&D efforts within the thematic areas, SkatteFUNN account for 3 per cent and other domestic sources account for 1 per cent.

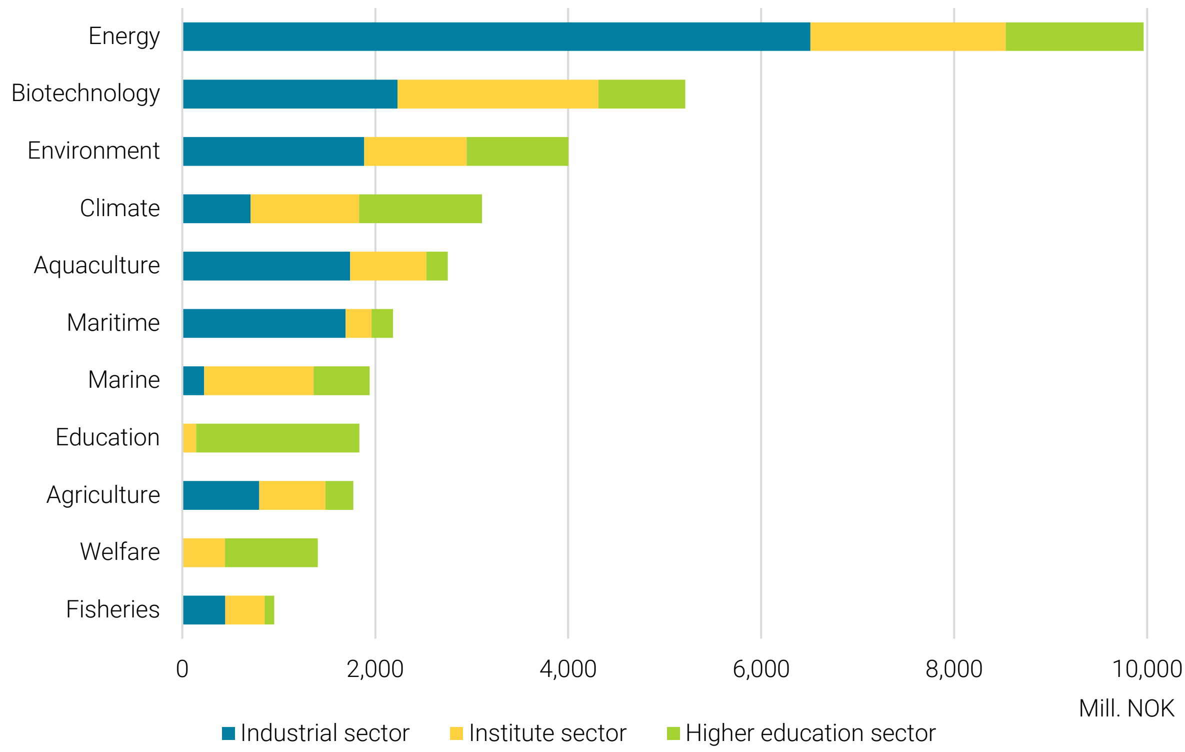


Figure 2.4: Current expenditures on R&D within the 10 thematic areas and biotechnology by performing sector.[1] *2017. Mill NOK.*

[1] Enterprises with 5 or more employees. Welfare and education are excluded from the industrial sector survey.
Source: Statistics Norway and NIFU, R&D statistics

[2] The report (in Norwegian): http://hdl.handle.net/11250/2619010

A slightly green shift in Norwegian research

Energy research accounts for 15 per cent of the total Norwegian R&D activity and is thus the largest mapped thematic area. Developments in recent years show a somewhat reduced scope of *petroleum research*, while *renewable energy* and *energy efficiency and conversion* are growing. Climate research had a real growth of 15 per cent in the period from 2015 to 2017, representing 4.6 per cent of total Norwegian R&D activity in 2017. The largest research area within climate research is *climate and environmental adaptations*, followed by *climate technology and other emission reductions* and *CO_2 management*. Environmental research also had real growth in the period from 2015 to 2017, equal to 20 per cent. In 2017, R&D activity related to environment accounted for 6 per cent of national activity, and *environmental technology* and *land-based environment and society* accounted for approximately equal parts of the activity.

Less R&D within agriculture, more in fisheries, aquaculture and marine

In 2017, research within agriculture accounted for 2.6 per cent of national R&D activity. Although more companies were included in the survey in 2015 and 2017 compared with 2007 and 2009, which changes the data base, we still see a real decline in R&D activity overall in the past ten years. The largest research areas within agricultural research in 2017 were *primary food production* and *nutrient/food processing*.

The R&D activity in fisheries, aquaculture and the marine sector had a real growth of 16 per cent in the period from 2015 to 2017. As of 2017, the three thematic areas make up a total of 8.5 per cent of total national R&D activity. Almost half of this activity takes place in aquaculture, which has grown in recent years, mainly due to an increase in R&D carried out in the industrial sector. The major research areas within aquaculture R&D are *health and disease* and *technology and equipment*.

Furthermore, R&D in the fisheries and marine sector accounts for 1.4 and 3 per cent of total R&D expenditure respectively. *Technology and equipment* is the largest research area within fisheries, while *marine ecosystems* is the largest within marine R&D.

More maritime research due to higher activity in the industrial sector

Maritime R&D accounted for 3.3 per cent of total R&D expenditure in Norway in 2017. Measured in fixed 2010 prices, average expenditure has increased by more than 6 per cent each year since 2009. The growth is mainly due to higher activity in the industrial sector. Two major research areas within maritime R&D, each of which accounts for more than 30 per cent of the activity in 2017, are *maritime transport* and *maritime operations within petroleum*.

Increasing R&D activity within welfare and education

R&D activity within two of the thematic areas largely funded by public sources, welfare and education, has increased in recent years. Despite a real decline of 7 per cent from 2013 to 2017, current expenditures within welfare R&D have had a real growth overall the past ten years. More than half of the current expenditures within welfare R&D in 2017 were related to *welfare services – public and private*, *family and upbringing* or *working life and the labour market*.

Educational research has grown steadily over the past ten years. Compared with 2007, the R&D expenditure is almost three times higher in 2017 (measured in fixed 2010 prices). More staff in first positions and research positions at universities and state universities in recent years, is one of the reasons why the R&D expenditure has grown. *Higher education* is the largest area of research within Norwegian educational research in 2017, followed by prim*ary school from 8th to 10th class* and p*rimary school from 1st to 7th class*. The largest theme within educational research is teaching, learning and development.

Biotechnology accounts for almost 8 percent of total national R&D expenditure

Overall, there has been a real growth in R&D expenditure within biotechnology every year since 2003, except for 2013. In 2017, biotechnology account for 7.8 per cent of total R&D expenditure in Norway. *Medical biotechnology* is by far the largest research area within biotechnology R&D, accounting for almost half of the current expenditure. Other large research areas within biotechnology are *marine*, *agricultural* and *industrial biotechnology*.

Chapter 3: Knowledge sharing and collaboration

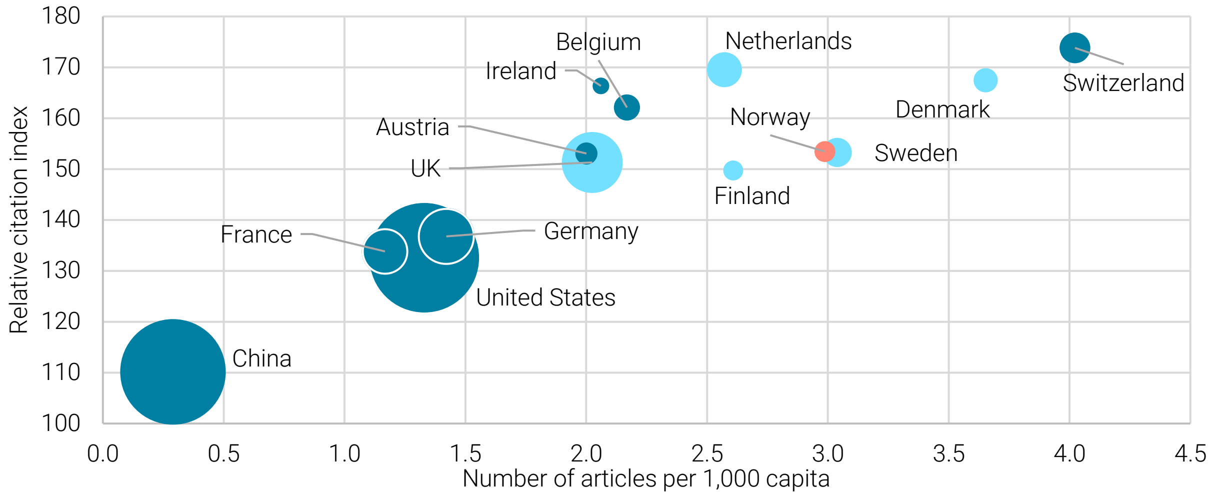


Figure 3.1: Number of scientific articles per 1,000 inhabitants (2018) and relative citation index (2016–2017) for selected Northern and Central European countries.
Source: NIFU, based on data from Web of Science

China's scientific publication is approaching the United States
Scientific publishing is a central part of the research. While there are several reservations related to the use of publishing figures to measure research, such data say a lot about production, dissemination and collaboration on research.

The United States has by far been the largest nation in terms of publishing scientific articles for a long time. Researchers in the United States published 430,000 scientific articles in 2018, accounting for nearly 18 per cent of the world's total scientific publishing. China has experienced tremendous growth and is now the world's second largest nation in this area. China's share of world production has increased from 7.3 per cent (2006–2008) to 16.4 per cent in the past ten years. Next are the UK and Germany.

What explains the growth in publishing?
There are several reasons that explain the growth in China's, and several other Asian countries', publishing figures. First, it is a sign of major expansion in knowledge production. Second, the number of journals included in the databases has grown, especially journals published in Latin America and Asia. Third, there is more collaboration on scientific publishing, which in turn causes more researchers to participate in more publications.

Norway has one of the highest number of articles per capita in the world
Norwegian researchers published 15,900 articles in 2018, ranking them as the world's 29th largest research nation measured in this way. The production of articles accounts for 0.65 per cent of the world production. When measuring the number of articles in relation to the population, Norway ranks as number four in the world. Only Switzerland, Denmark and Sweden have a higher scientific output per capita. Large research nations such as the United States, the United Kingdom and Germany have significantly lower relative publication volumes.

Switzerland at the top of the citation
While the number of publications is an expression of the scale of scientific production, citations express the influence of the research. The index in Figure 3.1 illustrates whether a country's publications are cited more or less than the world average, which is normalised to 100. With a citation index of 153, Norway ranks 7th in the world. Articles published by researchers from Switzerland and the Netherlands have the greatest scientific influence measured by the number of citations. These articles were cited 74 and 70 per cent more than the world average respectively. China, with a citation index of 110, scores significantly worse when it comes to citation frequency compared with publication volume.

Norway's publication and citation profile by discipline

Figure 3.2 shows Norway's scientific publications in 2018 distributed by discipline. The classification comprises five categories,[3] and includes all scientific publications registered in Cristin (NVI[4] publications). Publication points is a weighted expression of the volume of publishing, in which author shares, publication form, foreign co-authorship and the level of publishing channels are included as variables.

Medical and health sciences are the greatest

Medicine and health care accounts for 30 per cent of the publication points and 27 per cent of the publications in 2018. It is thus the largest discipline in Norway. Social medicine is the largest field within medicine and health care in terms of publication points. The largest field of study within natural sciences is geosciences. The same applies to pedagogy and education within social sciences, and computer technology and computer science within technology. The humanities is the smallest discipline (publication points 11%, publications 10%). The largest fields of study within the humanities are theology and religious science.

Medical research is also most cited

Articles within medicine and health sciences achieved the highest relative citation index, both in 2011–2013 and 2014–2016 (see Figure 3.3). On average, the articles were cited 42 and 43 per cent more than the world average, respectively. In 2014 to 2016, articles in the fields of sports medicine, surgical subjects and heart, vessels and respiratory tract were most cited within the discipline of medicine and health care.

The citation index for natural science was 133 in both periods, with geosciences having the highest citation index from 2014 to 2016. The other disciplines have lower figures, marginally above the world average. There is also less spread in the citation index between these disciplines. Thus, it is the fields of medicine and natural sciences that contribute to the overall citation index being well above the world average in Norway.

However, some disciplines are poorly covered by the database, especially regarding social sciences and the humanities. The calculation is based on a small part of what was published during the periods (6,300 and 1,700 articles, respectively). Articles in international journals are covered, while other important publications in these disciplines, such as publication in books and in Norwegian journals, are not included in these figures.

Calculation of the citation index

The citation index is based on articles published during the period 2011–2016. Only articles indexed in the Web of Science (Science Citation Index Expanded (SCIE), Social Science Citation Index (SSCI) and Arts and Humanities Citation Index (A & HCI) are included. Relative citation indexes and percentile calculations are based on the citations these articles have received from the time of publication until 2018.

A writer or institution gets full credit for an article, regardless of how many other contributors it may have. For the analyses in this chapter, we have chosen to omit articles with more than 100 authors. This mainly concerns "CERN articles" which may have hundreds or thousands of authors. The reason is that these significantly affect the Norwegian citation index for physics, although the Norwegian contribution within this discipline is quite marginal. Since this citation index is used to say something about the scientific influence of Norwegian research in various disciplines, there are good arguments for excluding these articles, although the limit on number of authors is debatable. The consequence would be a slightly lower national average for the citation index.

[3] The R&D statistical survey distinguishes between six fields of R&D. In this overview, the disciplines are a bit different: agricultural and fisheries are classified under natural sciences, while veterinary medicine is included in medicine and health. Also, psychology is included in medicine and health in the publication analysis, while the field is included in social science in the R&D statistics context.

[4] Norwegian scientific index.

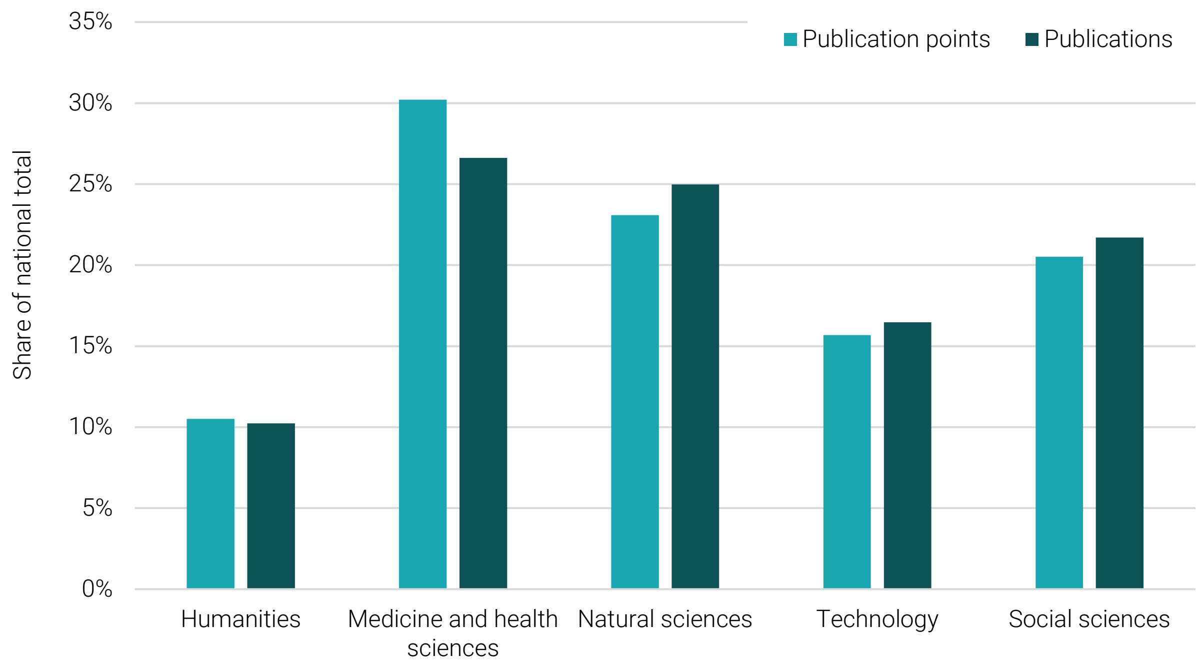


Figure 3.2: Norwegian scientific publication by discipline. Percentage of national total, publication points and publications. 2018.
Source: NIFU, based on data from Cristin

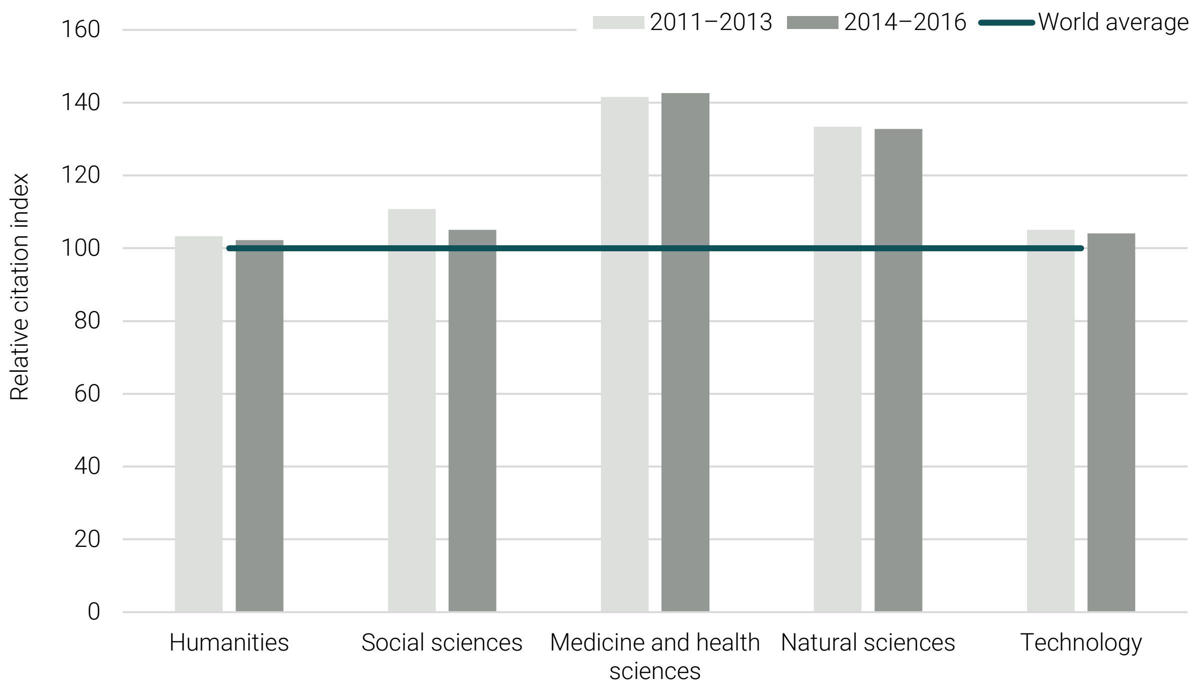


Figure 3.3: Relative citation index for Norway by discipline. 2011–2013 and 2014–2016.
Source: NIFU, based on data from Web of Science

Highly cited articles – a new indicator?

In general, the citation frequency of scientific articles is quite unevenly distributed. Most articles are little cited, or not cited at all, while a few achieve an extremely high number of citations. Over the past decade, there has been an increasing interest in using highly cited articles as an indicator in the research policy context due to the focus on "top research" or "scientific excellence" internationally. It is assumed that scientific publications are, to some extent, cited based on how much or little influence they have on further research. Highly cited articles thus represent particularly important scientific publications.

More highly cited articles in Norway

We have identified articles published by Norwegian researchers who are among the 1 per cent and 10 per cent most cited articles within their discipline. Most of them also have authors from other countries. Figure 3.4 shows the two indicators for the periods 2011–2013 and 2014–2016.

Both indicators show a positive trend. In the period 2011–2013, 13.1 per cent of Norwegian articles were among the 10 per cent most cited (3.1 percentage points higher than the world average). The share increased to 13.5 per cent in the period 2014–2016. The proportion within the 1 percentile increased from 1.9 per cent in the first period to 2.1 per cent in the second. Among the 10 per cent most cited articles in the period 2014 to 2016, articles within medical and health care dominated.

NIFU does not have access to data that make it possible to compare Norway with other countries. However, a similar 10 per cent indicator is published in the OECD's Science, Technology and Industry Scoreboard 2017 (based on the Scopus database and a slightly different methodology). Here, Norway ranks 16th out of 41 countries that are included in the analysis. In other words, Norway is behind the leading countries when it comes to publishing articles that are particularly highly cited.

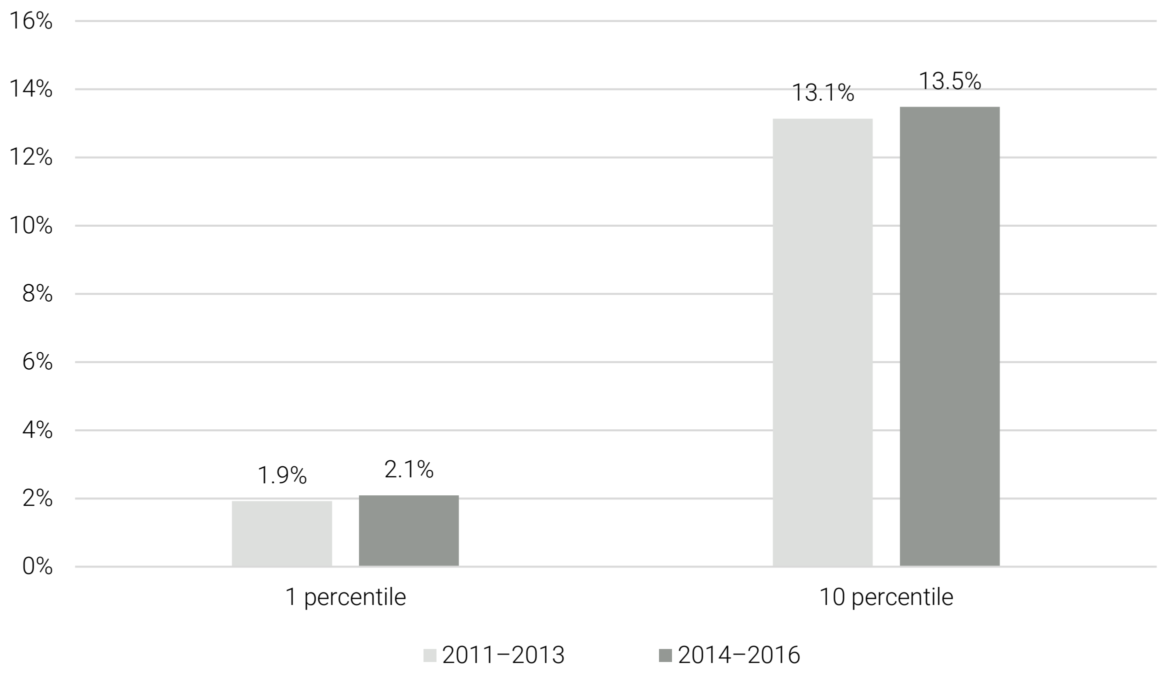


Figure 3.4: Highly cited articles, 1 and 10 percentiles for Norway. 2011–2013 and 2014–2016.
Source: NIFU, based on data from Web of Science

Scientific publication by sector and institution

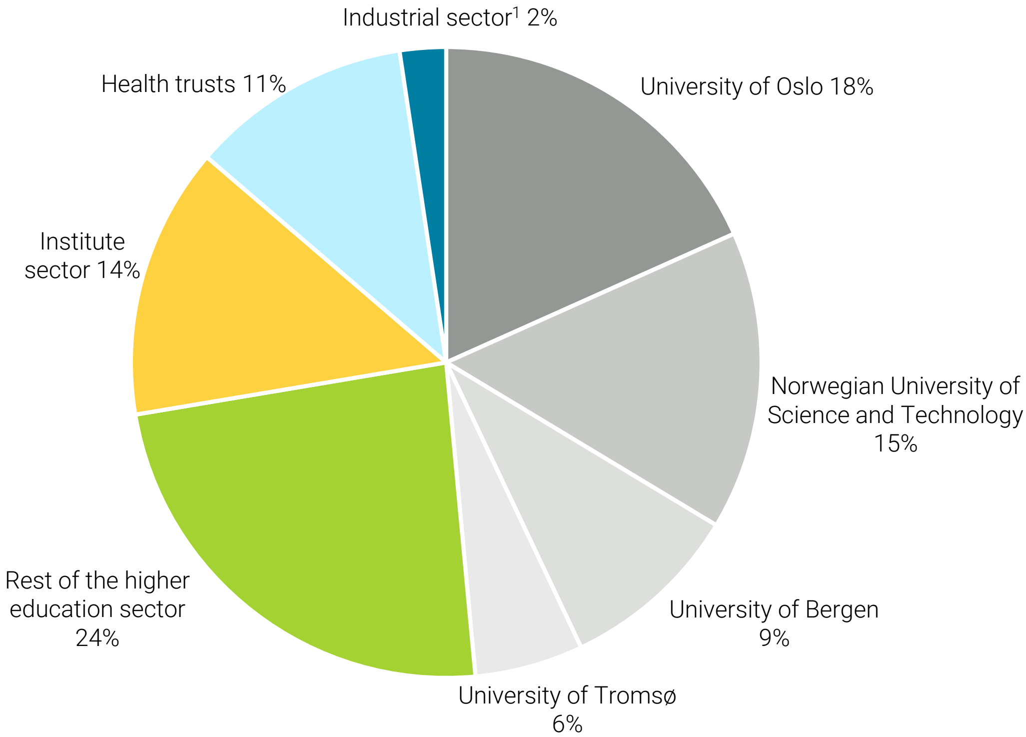


Figure 3.5: Scientific publication in Norway by institution, type of institution and sector.[5] Share publication points of national total. 2018.
[1]Estimated share for the industrial sector.
Source: NIFU, based on data from Cristin and Web of Science

Non-specialised higher educational institutions account for half of the publication
Figure 3.5 shows the scientific publication in 2018 for large, non-specialised universities and for other types of institutions and sectors in Norway. The analysis is based on approximately 27,000 scientific publications. The largest single institution is the University of Oslo with a share of 18 per cent of the national publication, followed by the Norwegian University of Science and Technology (NTNU) with a share of 15 per cent. The four universities highlighted in Figure 3.5 accounted for 48 per cent of the national publication in 2018, while other institutions in the higher education sector accounted for 24 per cent.

The institute sector accounted for 14 per cent of the publication, while the health trusts (university hospitals and other hospitals) accounted for 11 per cent of the national publication.

The industrial sector accounts for 2 per cent of national publication
While the industrial sector is by far the largest sector in terms of R&D efforts, little of this results in scientific publications. The industrial sector is not covered by the national measurement system for scientific publishing. Nevertheless, external co-authorship, for example with enterprises, is registered in Cristin. Complemented with data for the industrial sector from Web of Science, this makes it possible to include the sector in the national overview as well. In total, the industrial sector contributed to about 900 scientific publications in 2018, representing 2.4 per cent of the national total.

[5] Estimated share for the industrial sector.

Development in international co-publishing

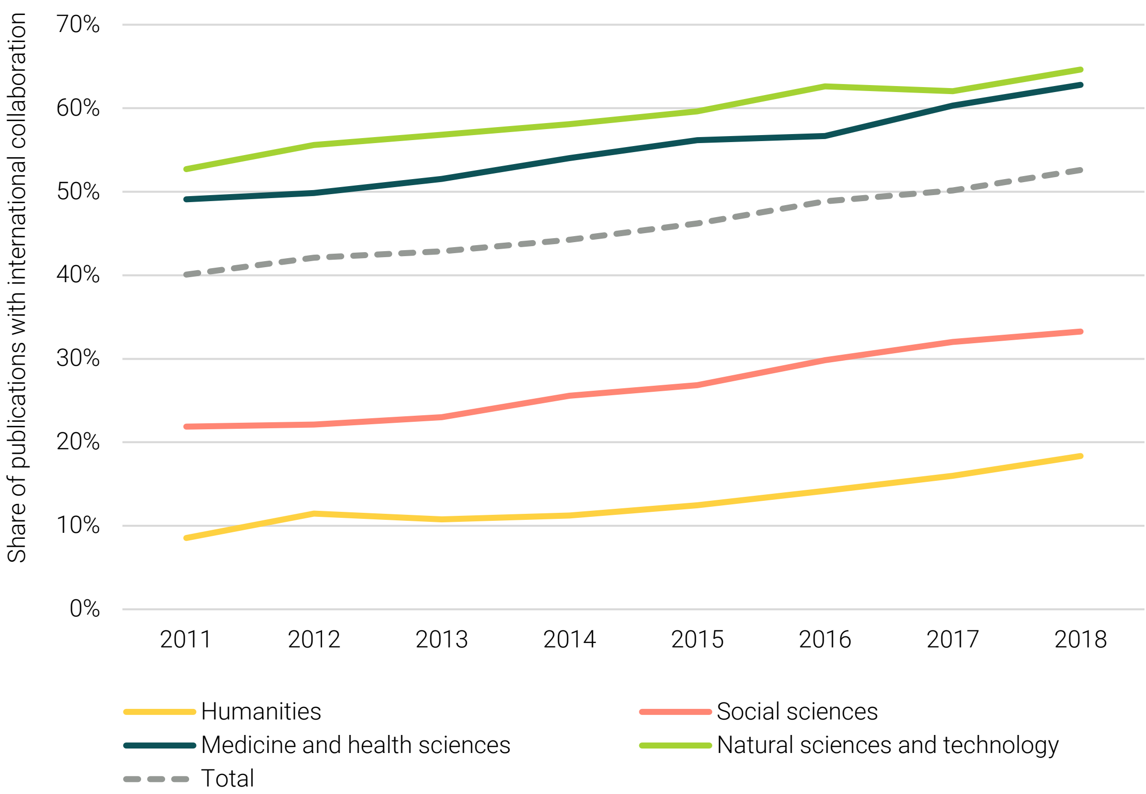


Figure 3.6: Proportion of Norwegian publications with international collaboration by discipline. 2011–2018.
Source: NIFU, based on data from Cristin

Large increase in international collaboration
Research increasingly involves international collaboration. This is reflected in the publication patterns. In the 1980s, only a small proportion of Norwegian scientific articles had co-authors from other countries. The proportion has risen year by year, and the scope of international collaboration is now considerable.

Furthermore, there are major differences between the disciplines regarding international collaboration. While the proportion of international co-authorship is 65 per cent in science and technology in 2018, it is only 18 per cent in the humanities. This is linked to different professional traditions regarding the practice of co-authorship and the degree of research collaboration in general. In the humanities, most publications are authored by only one person, while this occurs much less frequently in science, technology and medicine.

The United States is still the largest partner
Researchers from the United States have the most frequent publication collaboration with Norwegian researchers. However, this is not unique to Norway, as the United States is the world's largest research nation. In total, 13 per cent of the Norwegian scientific publications registered in the Current Research Information System in Norway (Cristin) had co-authors from the United States.

The collaboration with the UK, Sweden and Germany is also extensive. They each account for about 10 per cent of the publications. Norwegian scientific publications with co-authors from Denmark, France, Italy or the Netherlands account for 5 to 6 per cent each. International co-authorship varies from small bilateral projects between a Norwegian and a foreign researcher to large multilateral projects, involving many researchers from several different countries.

International collaboration and citation frequency

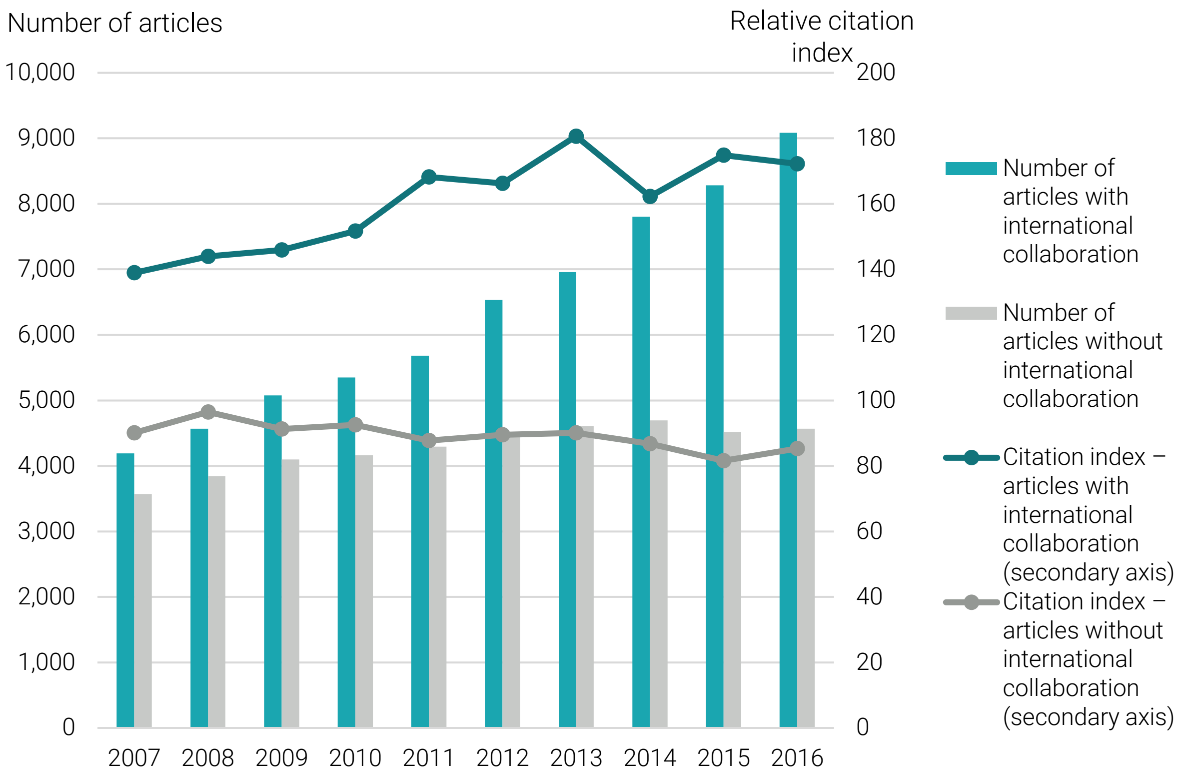


Figure 3.7: Citation index for Norwegian articles with and without international cooperation. Number of articles and relative citation index. 100 = world average. 2007–2016.
Source: NIFU, based on data from Web of Science

Articles with international collaboration are more cited

At an aggregate level, the citation frequency of articles involving international collaboration is markedly higher than for articles with authors only from one country. This is a general phenomenon that also applies to Norway. Figure 3.7 shows the citation index of the Norwegian articles that have co-authors from foreign institutions, and the articles that only have authors from institutions in Norway for the period 2007–2016. The analysis is limited to the Norwegian articles indexed in the Web of Science, since citation figures are not available for other publications.

The articles with international collaboration have been cited about 70 per cent more than the world average over the last couple of years. The citation index also shows a rising trend during the period. The articles, which only have contributors from Norwegian institutions, are cited slightly below the world average throughout the entire period. In the Report on Science & Technology Indicators for Norway 2018, citation indicators were calculated for the bilateral, trilateral and multilateral collaboration articles. The analysis showed that the multilateral collaboration articles are particularly widely cited.

More articles with international collaboration in Norway

The figure also shows the number of articles with and without international collaboration. The number of articles with co-authors from institutions in other countries has more than doubled during the period, while the number of articles that did not have such co-authorship shows a much weaker increase. Since articles with international collaboration make up a much larger proportion of the articles than before, these have an even greater impact on the national total. Hence this is an important reason why the Norwegian total citation index has increased a lot.

Open access publishing development

More Open Access Publishing
In recent years, there has been increasing attention to make publicly funded research openly available. The Research Council of Norway, together with several other research councils, launched the so-called "Plan S" in the autumn of 2018. This is an initiative to make publications funded by public funds openly available.

However, the development has been going on for a long time, and an increasing proportion of the publications are openly available today. Figure 3.8 illustrates that the number of Norwegian scientific articles with open access has more than doubled in the period 2013–2018. Measured as a proportion of publication, there is a significant increase, from 38 per cent in 2013 to 67 per cent in 2018.

What is Open Access Publishing?

Publications can be openly available in various ways: through pure open-access journals ("gold" open access), through self-archiving ("green" open access), or through "free-purchase" of articles in so-called hybrid journals.

Unlike subscription-based journals, the pure open-access journals are often based on the authors' paying a fee to have the articles published, or the publisher covering all the costs. By a hybrid scheme, both the subscriber and the author pay for the publications. The subscription scheme is maintained, while each author can "redeem" his or her article so that it is openly available.

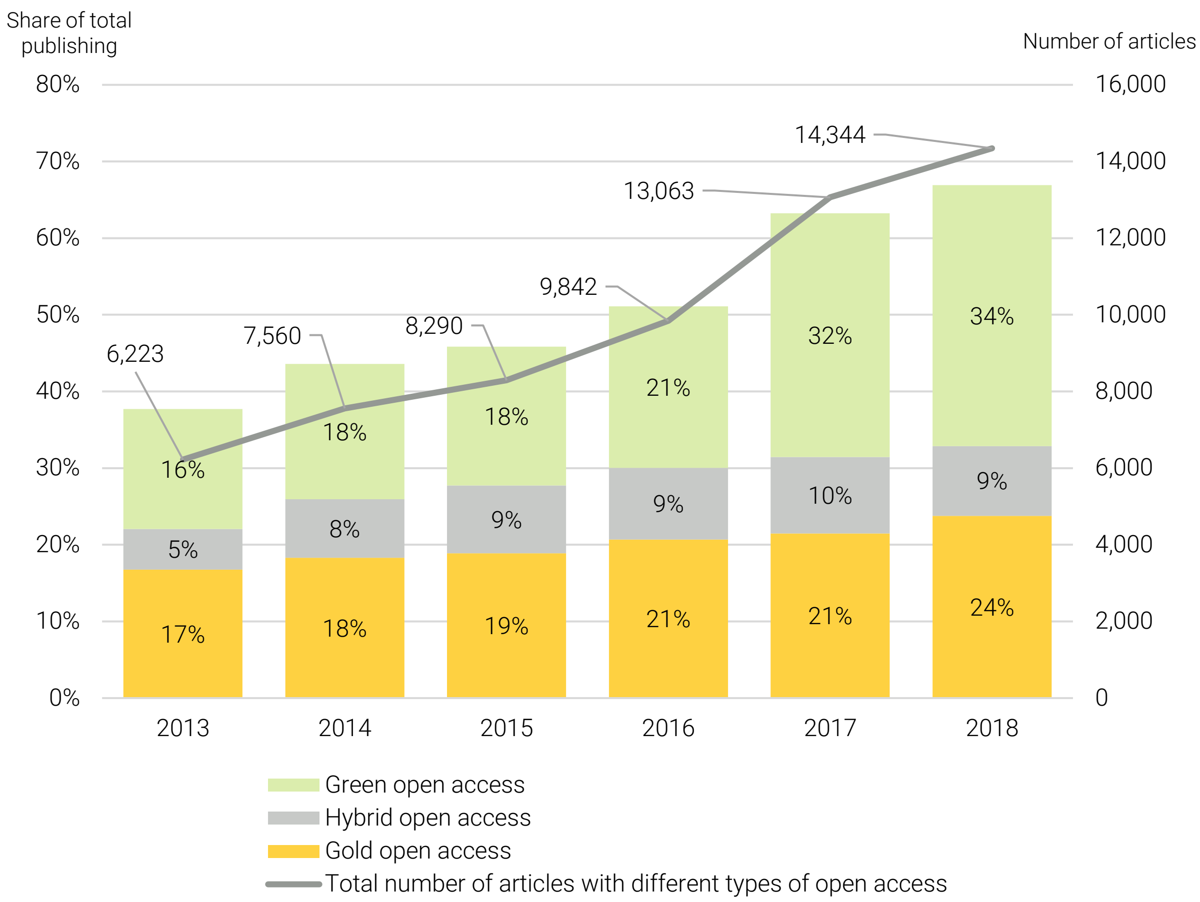


Figure 3.8 Norwegian scientific publication with different types of open access. Percentage of total Norwegian journal publishing. 2011–2018.
Source: Unit. Data: Cristin, Scopus, DOAJ, Unpaywall

Extramural R&D in the industrial sector

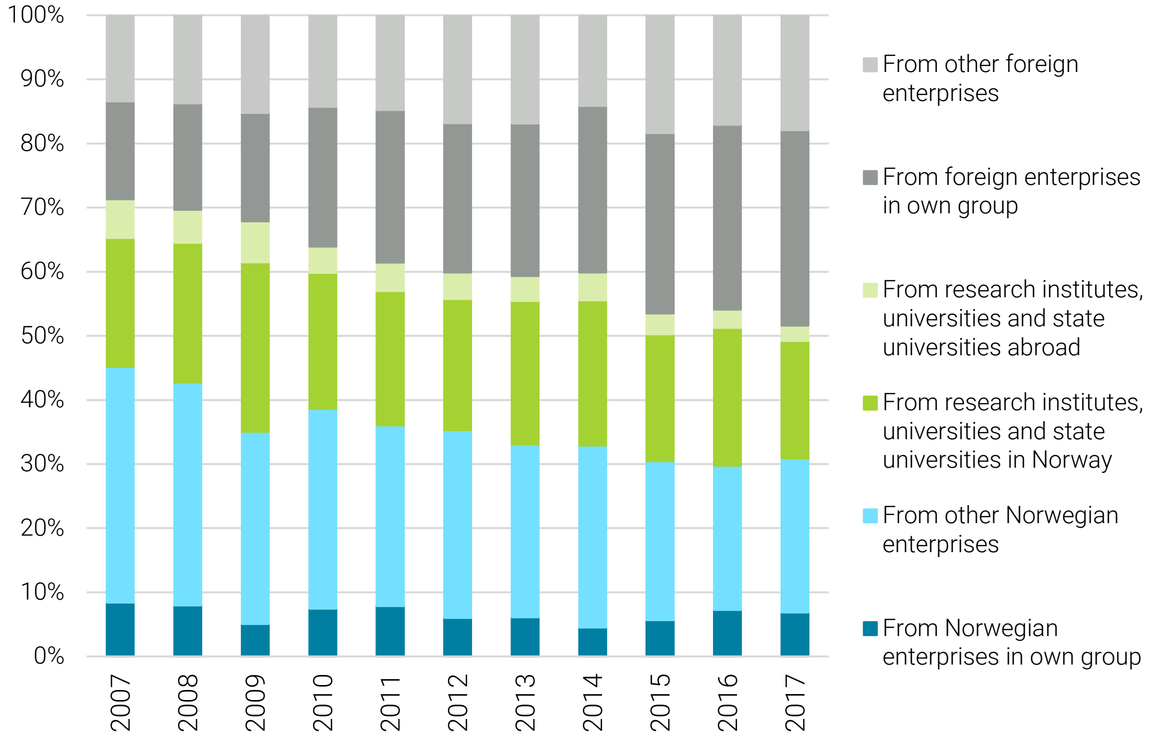


Figure 3.9: The industrial sector's purchase of R&D services by service provider. 2007–2017.
Source: Statistics Norway, R&D statistics

More purchases of R&D services from foreign enterprises

In addition to their own R&D, many enterprises in the industrial sector buy services from others (extramural R&D). The extent of such purchases is often seen as an expression of collaboration in the R&D and innovation system. There is also a lot of collaboration that does not result in transactions. In Norway, the industrial sector purchased R&D services for NOK 7.5 billion in 2017, an increase of 7 per cent from 2016. In addition, companies with 5–9 employees purchased R&D services for NOK 380 million.

Purchases from enterprises have increased over the past years. Figure 3.9 shows that over time there has been a twist towards more R&D purchases from foreign enterprises, especially from foreign enterprises in their own group.

Decrease of purchases from the institute and higher education sector

The industrial sector purchased R&D services from the institute and higher education sector amounting to almost NOK 1.4 billion in 2017. This is a decline of 9 per cent from 2016. Especially companies *extracting crude oil and natural gas*, in addition to *power supply,* declined this year. This is of great importance because the oil and gas industry accounts for a significant proportion of R&D purchases from the research communities. On the other hand, *the pharmaceutical industry* and *finance and insurance* are increasing their R&D purchases from Norwegian research communities.

Over the past decade, the industrial sector's purchase of R&D services from the higher education sector has had a certain real decline, while purchases from the institute sector are at about the same level as in 2007. This indicates that the scope of collaboration between the industrial sector and the higher education and institute sector has decreased somewhat over time, despite the stimulation of such collaboration through SkatteFUNN and other public innovation-oriented programmes.

Norway's participation in Horizon 2020

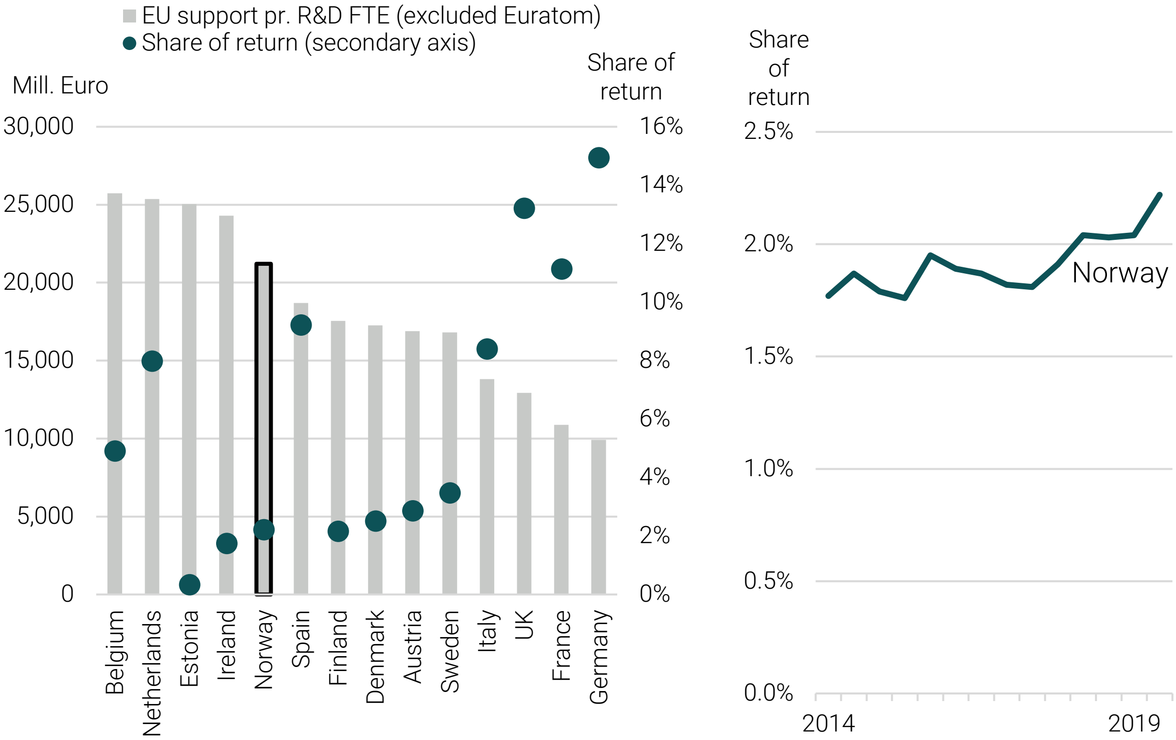


Figure 3.10: EU funding for approved projects by R&D FTEs by country and national share of total EU funding.
Source: The Research Council of Norway based on the European Commission, eCorda. March 2019

Horizon 2020 – the world's largest R&D and innovation programme
The EU programme Horizon 2020 is regarded as the world's largest programme for research and innovation with a total budget of about EUR 80 billion for the period 2014–2020. The programme is thus a central cooperation arena for European research and innovation. Norway has participated as a full member since 1994.

Norway receives more than 2 per cent of EU funds
The countries in Figure 3.10 have collected 85 per cent of total support from Horizon 2020. The largest countries naturally raise the most funds. So far, Norway has collected 2.2 per cent of total support in approved projects. This is above the agreed target for Norwegian research communities (2%). The target was reached in 2018, and the share has continued to increase. Norway is thus on a par with Finland, but behind Sweden and Denmark.

Looking at the overall support in relation to research full-time equivalents (FTEs), Norway is ahead of the other Nordic countries, but behind the Netherlands and Belgium.

Norwegian research environments succeed the most within societal challenges
Norway receives the most funding from projects under the programme section "social challenges", while the return share is somewhat lower for "outstanding research". Norway is also doing particularly well within the SME Innovation Programme and the Food Research Programme (FOOD). See table on the next page.

In addition to the funding itself, access to networks and partners is equally important. Looking at all the approved projects in which Norway participates, the total amount of funding is almost six times higher than the amount that accrues to Norwegian partners. This illustrates that the potential benefit from participation is far greater than the funds accruing to national research environments.

Programme	Norwegian EU funding for approved projects (mill. Euro)	Norwegian share of return (%)	Approved projects, Norway (number)	Norwegian success rate (%)	*Ranking Norwegian success rate over/under average (pp)*
Outstanding research	200	1.4	319	*11.3*	*-2.3*
ERC (European Research Council)	89	1.2	59	*10.1*	*-2.8*
FET (Future and Emerging Technologies)	15	1.1	18	*6.7*	*-0.6*
MSCA (Marie Skłodowska-Curie Actions)	68	1.7	183	*10.2*	*-4.1*
INFRA (Research infrastructure)	28	1.8	59	*47.2*	*11.9*
Industrial leadership	199	2.2	269	*15.8*	*6.2*
INDLEAD-CROSST (Industrial Leadership – Cross-theme)	0	2.9	1	*100.0*	
LEIT ADVMANU (The Leadership in Enabling and Industrial Technologies, Advanced manufacturing and processing)	24	2.3	21	*16.4*	*1.9*
LEIT ADVMAT (The Leadership in Enabling and Industrial Technologies, Advanced materials)	24	3.4	25	*36.8*	*7.2*
LEIT BIOTECH (Biotechnology)	7	2.3	12	*17.9*	*10.8*
LEIT ICT (Information and communication technology (ICT))	80	1.6	118	*14.9*	*6.6*
LEIT NMP (Nanotechnologies)	11	2.2	17	*15.5*	*8.1*
LEIT SPACE (Aerospace)	11	1.9	22	*23.9*	*7.9*
SME (Innovation in small and medium sized enterprises)	42	5.2	53	*11.9*	*1.6*
Societal challenges	489	3.0	558	*20.3*	*8.5*
HEALTH (Health, demographic changes and welfare)	75	2.0	74	*13.2*	*3.9*
FOOD (Food safety, agriculture and forestry, marine research, bio economy)	116	5.5	124	*26.8*	*14.4*
ENERGY (Safe, clean and efficient energy)	116	3.9	110	*21.1*	*8.7*
TPT (Smart, green and integrated transport)	70	1.6	90	*29.0*	*9.4*
ENV (Climate, environment, resource efficiency and raw materials)	72	3.9	78	*26.2*	*15.4*
SOCIETY (Europe in a changing world)	13	2.2	35	*11.0*	*5.0*
SECURITY (Secure societies)	28	2.8	47	*16.7*	*6.9*
Distribution of outstanding quality and broader participation	0	0.1	3	*4.5*	*-9.6*
SEAWP-CROSST (Distribution of outstanding quality and broader participation – Cross-theme)	0	0.7	1		
TWINING (Institution partnership)	0	0.3	2	*3.3*	*-6.1*
Science with and for society	8	2.8	26	*18.6*	*6.6*
CAREER (Attractive careers within research and technology for young people)	1	3.3	6	*17.1*	*8.1*
GENDEREQ (Ensure equality within research and innovation)	1	1.4	2	*16.7*	*4.6*
INEGSOC (Integrate society in research and innovation)	2	3.5	7	*18.4*	*8.7*
SCIENCE (Create a dialogue and engage society in research and innovation)	1	6.4	2	*10.0*	*2.2*
GOV (Governance for the promotion of responsible research and innovation)	2	2.5	7	*21.9*	*4.0*
IMPACT (Predict and assess potential effects on environment, health and safety)	0	f	1		
KNOWLEDGE (Better knowledge about research communication)	0	3.0	1		
FTI (Fast Track to Innovation)	9	2.8	9	*6.1*	*0.6*
EURATOM (The European Atomic Energy Community)	0		5	*29.4*	*-3.4*
Total	906	2.22	1,189	15.6	3.5

Table 3.1: Norwegian participation in Horizon 2020 - key figures. 2014–2018.

Source: The Research Council of Norway based on the European Commission, eCorda. March 2019

Chapter 4: Education and skills

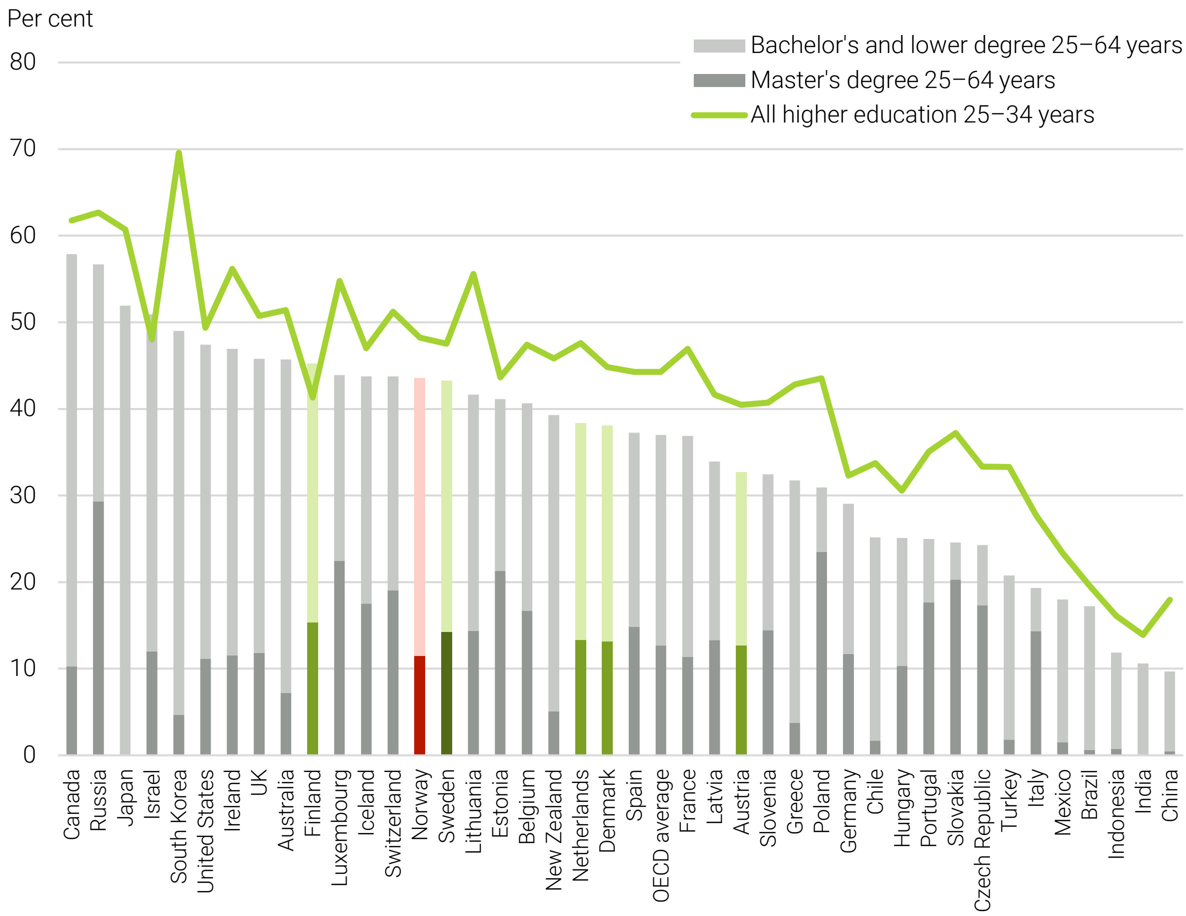


Figure 4.1: Proportion of the population with higher education by age group and level of education. Selected countries. 2017.
Source: OECD, Education at a Glance 2019

More people are completing higher education
The level of education is rising across large parts of the world. In 2017, 37 per cent of the total population in the OECD area had completed higher education. Just ten years ago, the share was 27 per cent. The level of education is generally higher in the younger part of the population (line above the columns), which means that the proportion of highly educated people in the entire population will increase further. This is also central to the UN Sustainability Goal 4, where equal access to higher education is one of the sub-goals.

High proportion of short higher education in Norway
As Figure 4.1 shows, Norway has a high proportion of highly educated people. This is primarily due to a high proportion of the population having *shorter* higher education (bachelor's and lower degree). The proportion of education at master's level in Norway is lower than the average in the EU, both for the whole population, and for those between 25 and 34 years old.

Signs of levelling
Another major trend is that the level of education is increasing a lot in some populous countries that have previously had a low proportion of highly educated. This applies to Turkey, Indonesia, India and China, among others. On the other hand, we see that the level of education flattens out in prominent knowledge nations such as Israel and Finland. Here, fewer in the younger population have completed higher education than in the population as a whole.

Weak economic return on education in Norway

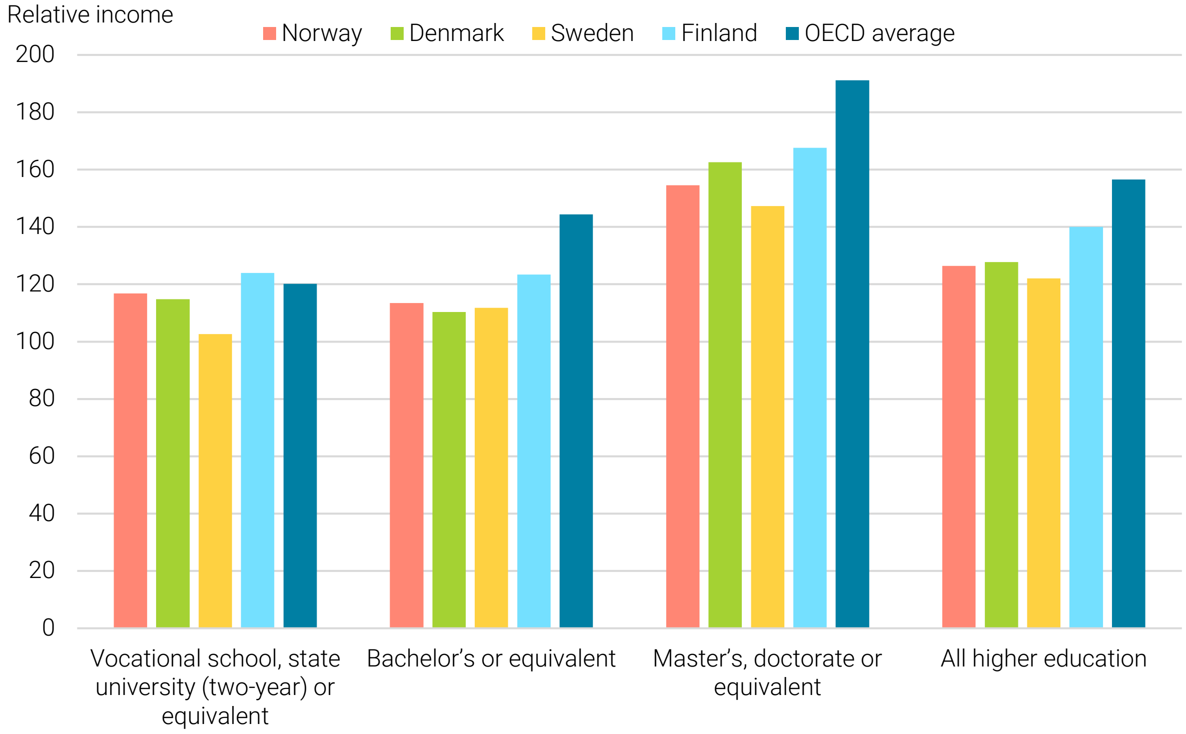


Figure 4.2 Relative income by educational level in Norway, Denmark, Sweden, Finland and the OECD average. High School or similar = 100. 2017.
Source: OECD Education at a Glance, 2019

The return on education in the form of salaries is relatively low in Norway compared with the average in the OECD countries. In 2017, the share of the population with higher education earned an average of 26 per cent more than the share with high school as their highest level of education.

The return on education was higher among those with a master's or doctoral degree (55 per cent higher income than those with high school as the highest level of education). In the OECD countries, people with a master's or doctorate earned, on average, 91 per cent more compared with people with the highest educational level equivalent to high school in 2017. The other Nordic countries were at a relatively similar level as Norway the same year, however somewhat higher in Finland.

Women still earn less than men – especially within higher education

The average income of women in Norway is lower than men's income. However, the difference has decreased somewhat from 2007 to 2017 (OECD Education at a Glance 2010 and 2019). The same applies to the average income difference between men and women in the OECD countries over the same period.

In 2017, the gender differences in annual income between full-time employees (25 to 64 years) in Norway were the least among those with primary education as their highest level of education. In this educational group, women's income corresponds to an average of 82 per cent of men's income. The income difference between men and women was greatest among those with higher education. Women with a higher education earned, on average, 75 per cent of the income of men with the same educational level. The income gap also varies somewhat with age. Women with higher education at the age of 55 to 64, are worst off.

Student numbers in Norway

65 per cent more students in Norway since 1994
In 2018, there was a total of 278,334 students in Norway, about as many as the year before (277,637). During the past 25 years, from the state university college reform in 1994, the number of students has increased by 65 per cent. There have been mainly two periods of growth: until the turn of the millennium, the number of students increased, and then levelled off. A new period of growth appears from 2009, which now seems to be flattening and moderately growing.

More students at the universities
In the first part of the period, up to 2005, the increase in student numbers took place largely at the state university colleges. However, in connection with the introduction of a political reform, the Quality Reform,[6] it became possible for state university colleges to apply to become a university. In addition, the Structural Reform in higher education was launched in 2015. Both have contributed to a more university-dominated higher education system. Today, Norway has 10 universities and 5 state university colleges, while there were 26 state university colleges and 4 universities right up to the mid-2000s.

High proportion of women, but uneven distribution by discipline
Ensuring women's access to education is part of the UN Sustainability Goals. In this area, Norway has been far ahead for a long time. The share of women among students in Norway passed 50 per cent in the 1980s. Increased influx of women was also an important driver of the student growth in the 1990s. Since 2000, the proportion of women has remained stable at about 60 per cent. Women are in the majority in most disciplines, except within natural sciences and technology, (34 per cent in 2018). There have been few changes in the gender distribution between disciplines the past years.

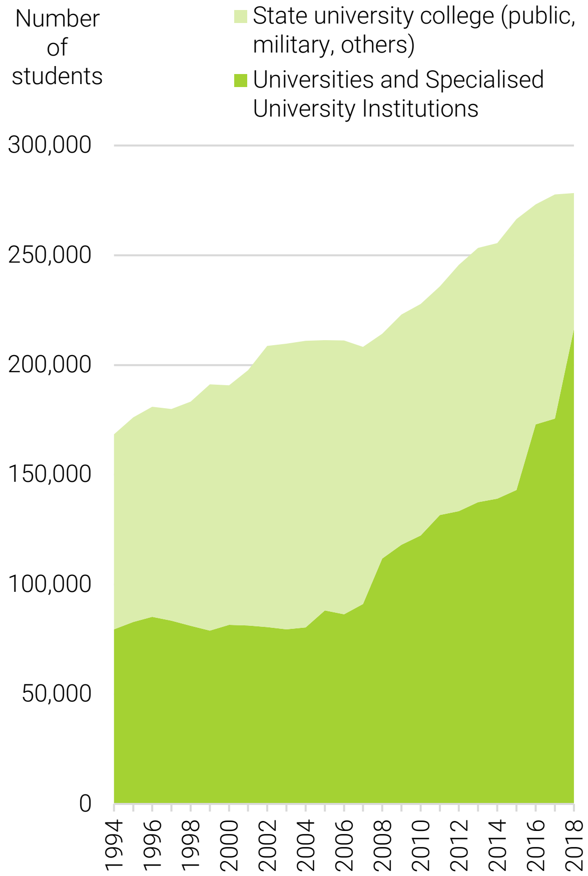


Figure 4.3: Number of students in higher education in Norway by type of educational institution.[7] 1994–2018.
Source: Statistics Norway

Goals of the Structural Reform of the Ministry of Research and Education

- Education and research of high quality
- Robust academic communities
- Good access to education and competence in the whole country
- Regional development
- World-leading academic communities
- Efficient use of resources

[6] The Quality Reform is a reform in the higher education sector. Important parts of the reform are the introduction of a new degree structure with bachelor's, master's and PhD degrees, and a diploma supplement, as well as the transition to the European Credit Transfer and Accumulation System (ECTS).

[7] In the Norwegian educational system, a Specialised University Institution is an institution at university level within narrower disciplines, with the same type of responsibilities and authorisations for education, research and research education.

The highly educated in working life

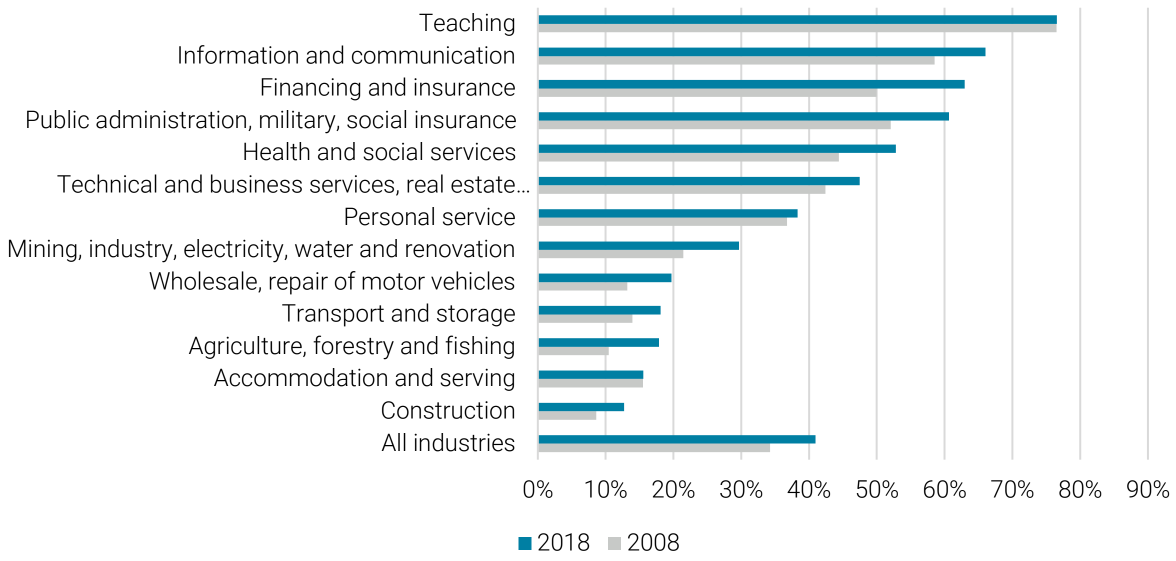


Figure 4.4: Industry distribution of the proportion of employed persons in Norway with higher education. 2008 and 2018.
Source: Statistics Norway

Large industry differences regarding the need of highly educated
Working life's need for highly educated skills varies considerably between industries, from teaching, where almost 80 per cent of employees have higher education, to construction, where the share is only 13 per cent.

Over the past ten years, the proportion of employed persons with higher education has increased from 34 per cent to 41 per cent. During this period, the level of education has increased within all industries. The exception is teaching, where the proportion of highly educated employees is almost at the same level as in 2008. However, this is by far the industry with the highest proportion of highly educated employees.

Future needs are closely related to today's level of education
A recent survey among Norwegian employers (see box) shows that there is a strong correlation between the industry's educational level today and what they respond in terms of future competence needs. The survey shows that the recruitment need for bachelor's degrees is high in areas such as *health and social sciences* and *public administration*. In these industries, more than six out of ten companies respond that they will have a great need to recruit people with a bachelor's degree. The need for people with a master's degree, on the other hand, is great in the fields of *professional, scientific and technical service*, *teaching*, *information and communication*, and *finance and insurance activities*. Within these industries, more than five out of ten companies respond that they will be in great need of recruiting employees with a master's degree over the next five years. The figures are based on a survey from 2017.

The employer survey was conducted by NIFU in 2017. The three-year project mapped employers' assessment of new employees relatively shortly after completing a master's degree, a bachelor's degree, a four-year teacher's education or a vocational school education. In addition to highlighting employers' experiences with the relevance and quality of the competence newly recruited had gained through their studies, recruitment needs were an important issue. The final report: https://www.nifu.no/publications/1684467/

R&D personnel in Norway

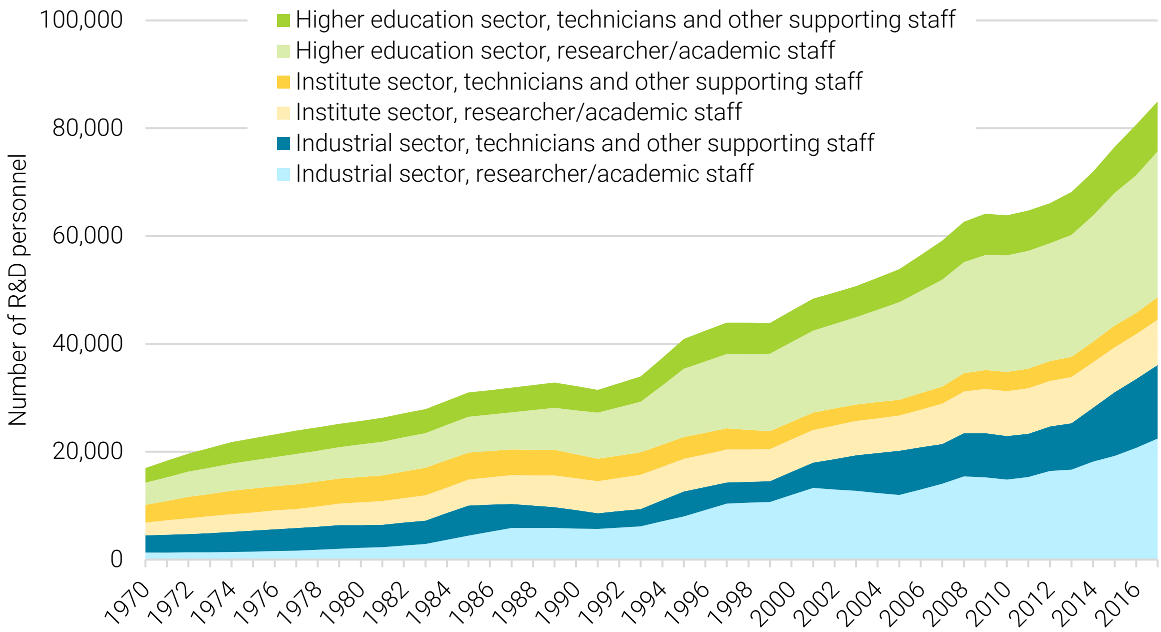


Figure 4.5: R&D personnel in Norway by performing sector. 1970–2017.
Source: Statistics Norway and NIFU, R&D statistics

Strong growth in the number of researchers and academic staff

From being a marginal part of the working life in the early 1970s, the number of people performing R&D in Norway has grown to become a "professional group" of importance. In 2017, a total of 85,000 people performed R&D in Norway. Of these, more than two-thirds were employed in professional positions such as researchers or academic staff, and the remaining third as technicians or other supporting staff.

The composition of the R&D personnel has changed over the past 50 years. In 1970, more personnel worked as technicians or other supporting staff compared with professional positions. The higher education sector has had the highest proportion of professional personnel during the entire period, from slightly more than half in the mid-1970s, to the current level of 75 per cent. In the institute sector, there has also been a shift from an overweight of technicians or other supporting staff to a majority of professional personnel. In the industrial sector, the proportion of professional personnel has long accounted for two-thirds of the positions, but from 2013 there has been a significant growth in technicians or other supporting staff.

Increased doctoral expertise among researchers in Norway

The increasing number of researchers coincides with a strong growth in the proportion of research staff with a doctorate. In the higher education sector, the proportion of doctorates has gone from below 30 per cent to nearly 50 per cent in the last 40 years.

In the same period, the share of doctorates in the institute sector has increased from just over 10 per cent to 54 per cent. Thus, there is a greater proportion of researchers with a doctorate in the institute sector than in the higher education sector. This is partly because much of the research performed in the higher education sector is carried out by staff in lecturer positions and fellows. In the industrial sector, the proportion of R&D personnel with a doctorate has long remained stable at about 10 per cent. Although the *number* of doctorates has increased in this sector as well, it is surprising that the *share* of doctorates has not increased, given the strong growth in the other sectors. One explanation may be that many employees in the industrial sector with a doctorate are not researchers but have other types of positions.

Gender balance and diversity among researchers in Norway

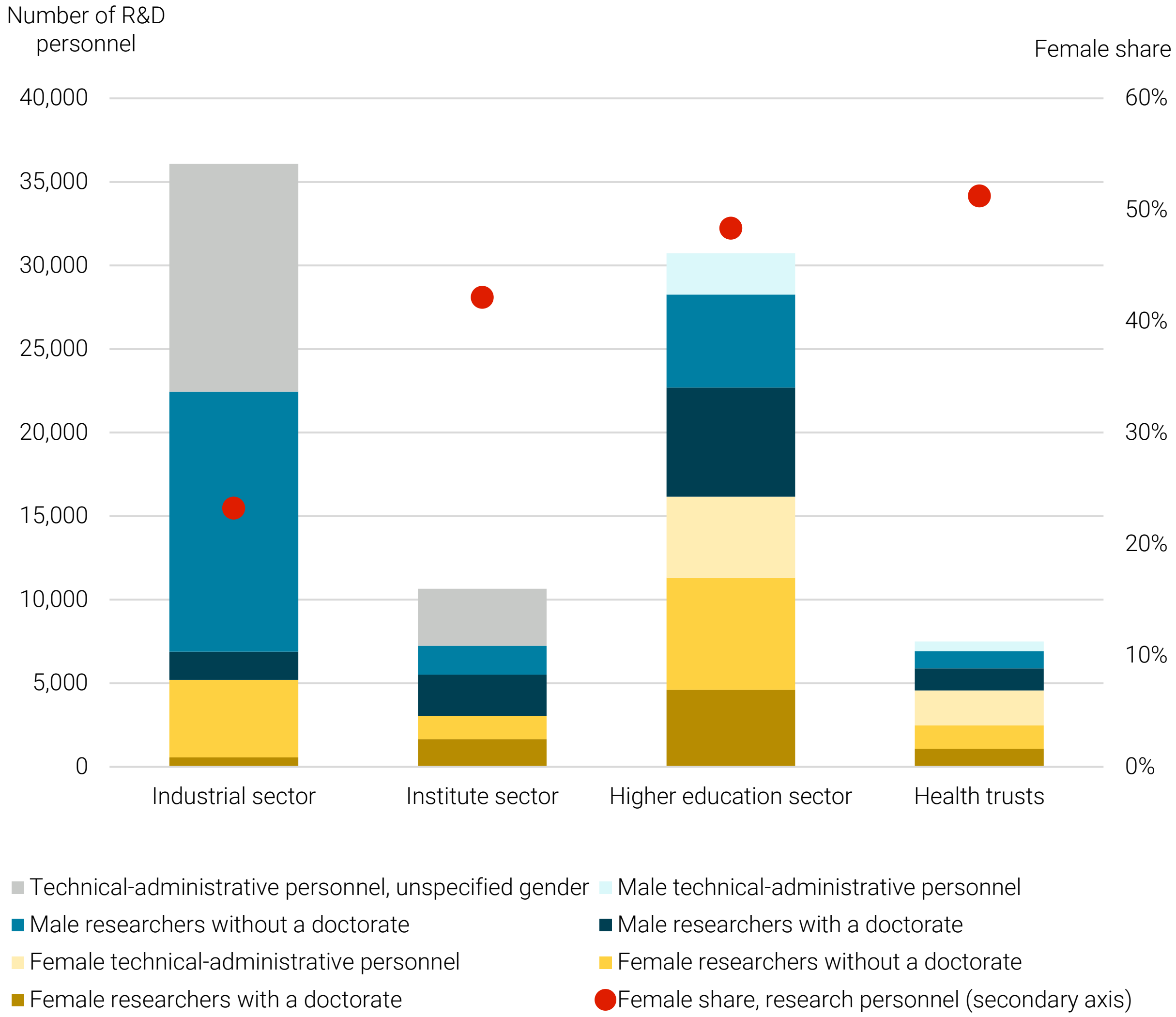


Figure 4.6: Women and men in Norwegian research in 2017 by sector and job level.
Source: Statistics Norway and NIFU, R&D statistics

Highest proportion of women in health trusts
Among researchers or academic staff who participated in R&D in 2017, 38 per cent were women. The health trusts had the highest proportion of women, 51 per cent. The proportion of women among researchers or academic staff in the higher education sector was 48 per cent, followed by 41 per cent in the institute sector. The industrial sector had the lowest proportion of women among researchers or academic staff, 23 per cent. There is a certain relationship between the size of an enterprise and the proportion of women. Larger enterprises generally have a somewhat higher proportion of women in their R&D staff.

Many male researchers in the industrial sector without a doctorate
Overall, the proportion of researchers or academic staff with a doctorate was somewhat higher for women (36%) than for men (33%). This is because many male researchers in the industrial sector do not have a doctorate. In other sectors, including health trusts, men have a higher doctoral share than women among researchers or academic staff.

Weak growth in the proportion of women at top level in Norwegian research

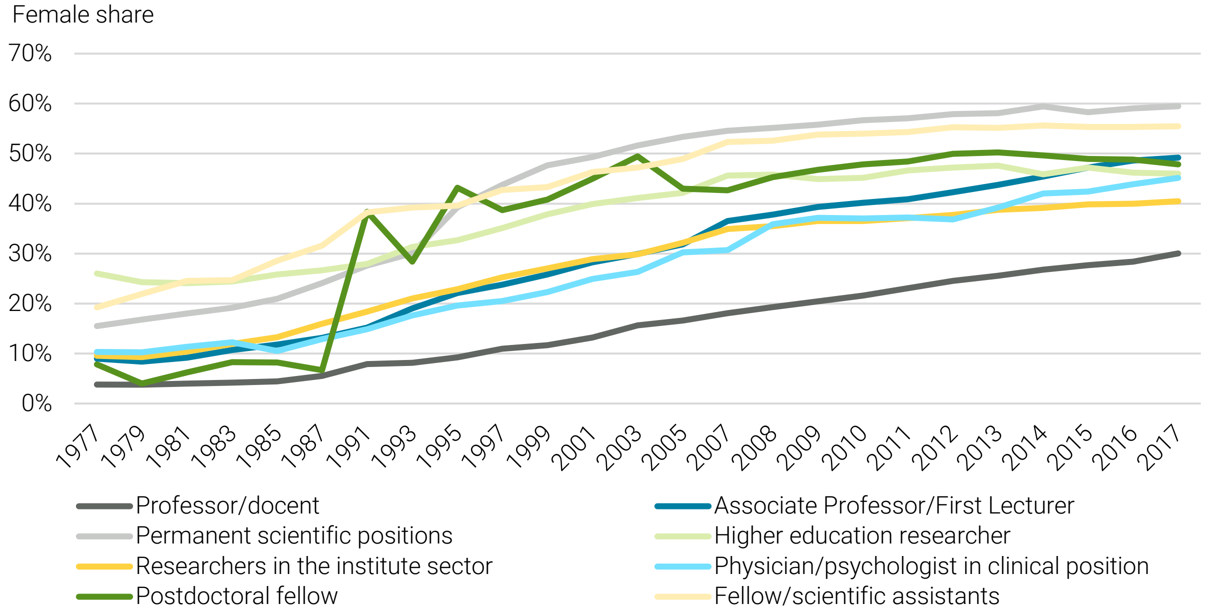


Figure 4.7 Female proportions of research staff at universities and state universities, health trusts and the institute sector by selected positions. 1977–2017.
Source: NIFU, Register of research personnel

The proportion of female professors remained stable until the early 1990s. In 2009, every fifth professor was a woman, and the proportion of women increased to 30 per cent by 2017. This represents a growth of 26 percentage points over the last forty years. In comparison, the proportion of women among associate professors and first lecturers has increased from 9 to 49 per cent, an increase of 40 percentage points, during the same period.

In 1977, less than 30 per cent of all academic positions at universities and state universities in Norway were held by women. By the mid-1990s, women accounted for more than 40 per cent of the fellows, scientific assistants and postdoctoral fellows.[8] Note that there were few postdoctoral fellows in Norway before the year 2000, only 265 in 1999 compared with close to 1,700 in 2017.

Following the state university reform[9] in 1994, the proportion of women in permanent scientific positions increased sharply, primarily among the state university lecturers. Women have accounted for more than half of the university and state university lecturer positions since 1999.

Looking at the research positions in the institute sector, the proportion of women was 10 per cent in 1977, roughly on a par with associate professor and senior lecturer. The proportion of female researchers in the institute sector was the same as for the associate professors until 2005, while in 2017, 40 per cent of the researchers in the institute sector were women, compared with 49 per cent of the associate professors.

The proportion of women among physicians and psychologists in clinical positions, was approximately the same as associate professors and researchers in the institute sector in 1977. Up to and including 2007, this category only includes the university hospitals. With the inclusion of health trusts without university hospital functions and private non-profit hospitals in the statistical basis in 2008, the proportion of women among doctors and psychologists in the clinical position increased noticeably.

[8] Until 2003, it was possible to earmark postdoctoral positions for women. A ruling in the EFTA Court in 2003 put an end to this, and the proportion of women among postdoctorals dropped significantly. By 2012, the proportion of women among postdoctorals were at the same level as in 2003.
[9] The process led to 98 smaller state universities being merged into 26 larger units in August 1994.

Doctoral degrees in Norway

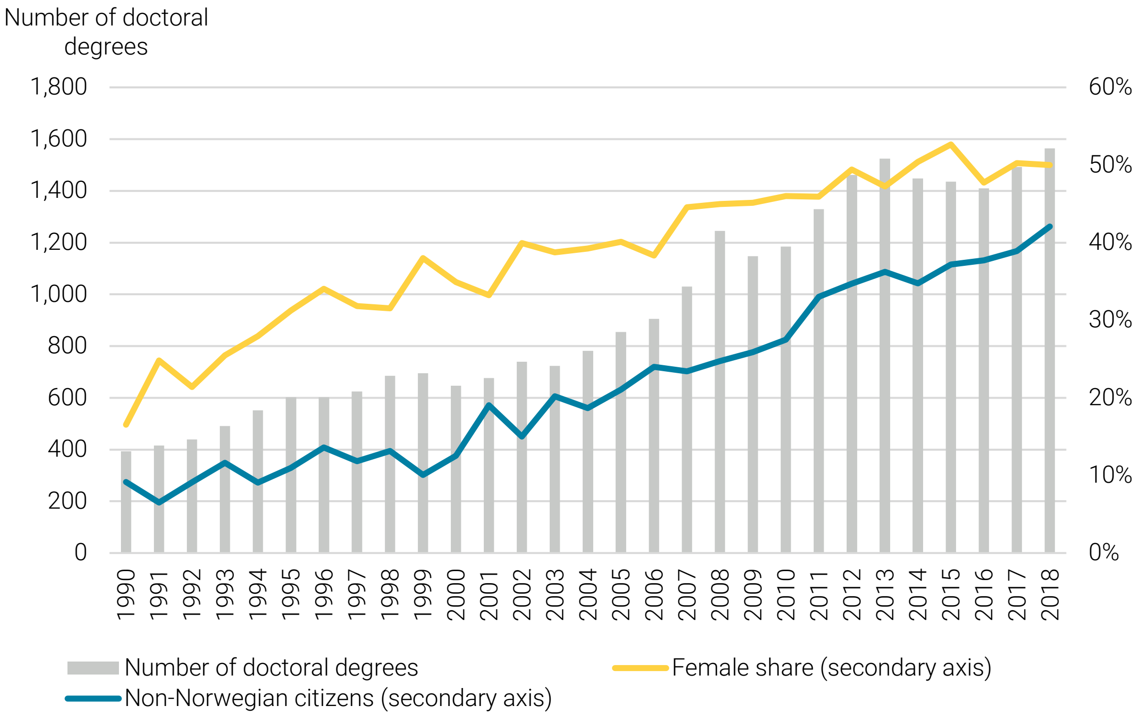


Figure 4.8: Number of doctoral degrees, and percentage of women and non-Norwegian citizens. 1990–2018.
Source: NIFU, Register of research personnel

Tripling of doctoral degrees in Norway over the past 25 years
The increase in researchers with a doctorate is related to a long-term and conscious political commitment to researcher recruitment in Norway. Several escalation plans have prioritised resources for recruitment positions. A higher number of researchers in the population is also one of the sub-goals of UN Sustainability Goal 9.

In Norway, the number of new doctorates has increased significantly over the past 25 years, from about 500 in the mid-1990s to over 1,500 in 2018. After stabilising at about 1,500 annually, we now see a new growth as a result of the recruitment positions in the Long-term Plan for Research and Higher Education from 2014. Due to the increase in the number of fellowship positions, there is reason to expect further growth in the coming years.

Equal gender balance among new doctorates
In recent decades, more and more women have completed their doctorate in Norway. At the beginning of the 2000s, about one third of the new doctorates were women. Since then, the proportion of women has increased sharply, and 2014 was the first year when more women than men defended their thesis in Norway. In 2018, there was an even gender balance. However, there are major differences between disciplines.

More non-Norwegian citizens among the doctoral candidates in Norway
Another key development is the increasing number of foreigners among doctoral candidates. In 2018, 658 people with foreign citizenship obtained a doctorate in Norway. This is the highest number so far, accounting for 42 per cent of the doctoral candidates the same year. By comparison, foreigners accounted for 10 per cent of the doctoral candidates in 1999. The proportion of foreign nationals among doctoral candidates is particularly high in science and technology. Among the foreign doctoral candidates in the past five years, about half of them have European citizenship, about one third are Asian, 12 per cent are affiliated with the African continent, while 7 per cent have US citizenship.

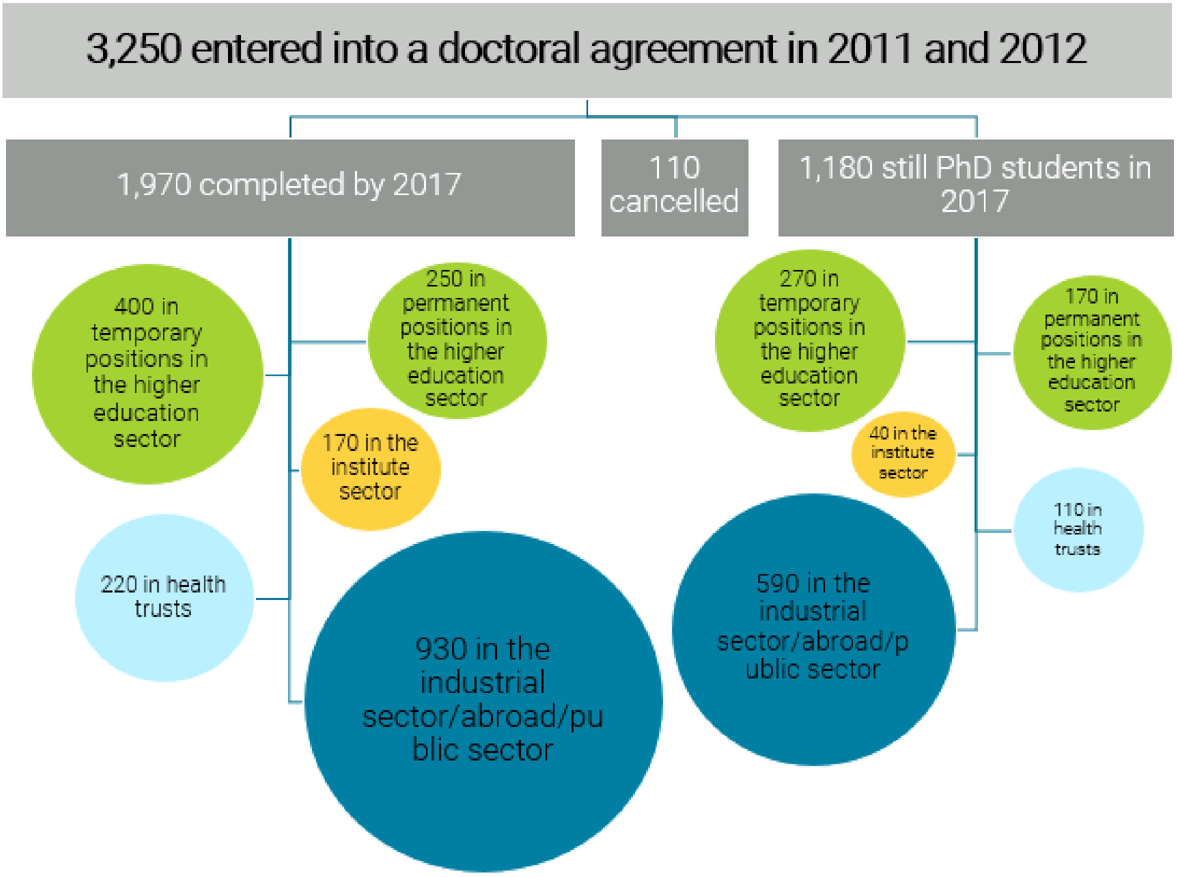


Figure 4.9: Status in 2017 for persons who entered into a doctoral agreement in Norway. 2011 and 2012.
Source: DBH and NIFU

Half of the doctoral candidates leave academia

The strong growth in doctoral candidates increases the need to examine their careers after having completed their thesis. If they pursue careers in academia, this is relatively easy to map. But in parallel with the growth of doctorates, the proportion who make careers outside academia is also increasing. These people need to be captured with other methods and data.

Figure 4.9 shows the first results of an ongoing project to map the doctoral candidates' careers in Norway (see box below). The results show that of all the 3,250 people who entered a doctoral agreement in Norway in 2011 and 2012, about half had left academia in 2017. This proportion has been stable for a long time.

Of those who had completed their dissertation, 20 per cent were employed in a temporary position (postdoctoral researcher or researcher) in a higher education institution, while 13 per cent had obtained a permanent position (associate professor or professor). 9 per cent worked in the institute sector, while 11 per cent worked at a health enterprise.

Monitoring system for researcher recruitment in Norway

In order to better follow the careers of doctoral candidates, a collaboration has been established between Statistics Norway, the Norwegian Centre for Research Data (NSD) and the Nordic Institute for Studies in Innovation, Research and Education (NIFU). The project will map and track the doctoral candidates' careers by connecting data from the following registers:

- NSD: Higher Education Database (DBH)
- NIFU: The Doctoral degree register and the Register of research personnel
- Statistics Norway: Labour market and employment statistics and System for personal data (SPF).

The project is in a pilot phase. After the pilot phase, annual data collection is planned.

Chapter 5: Innovation and digitisation in Norway

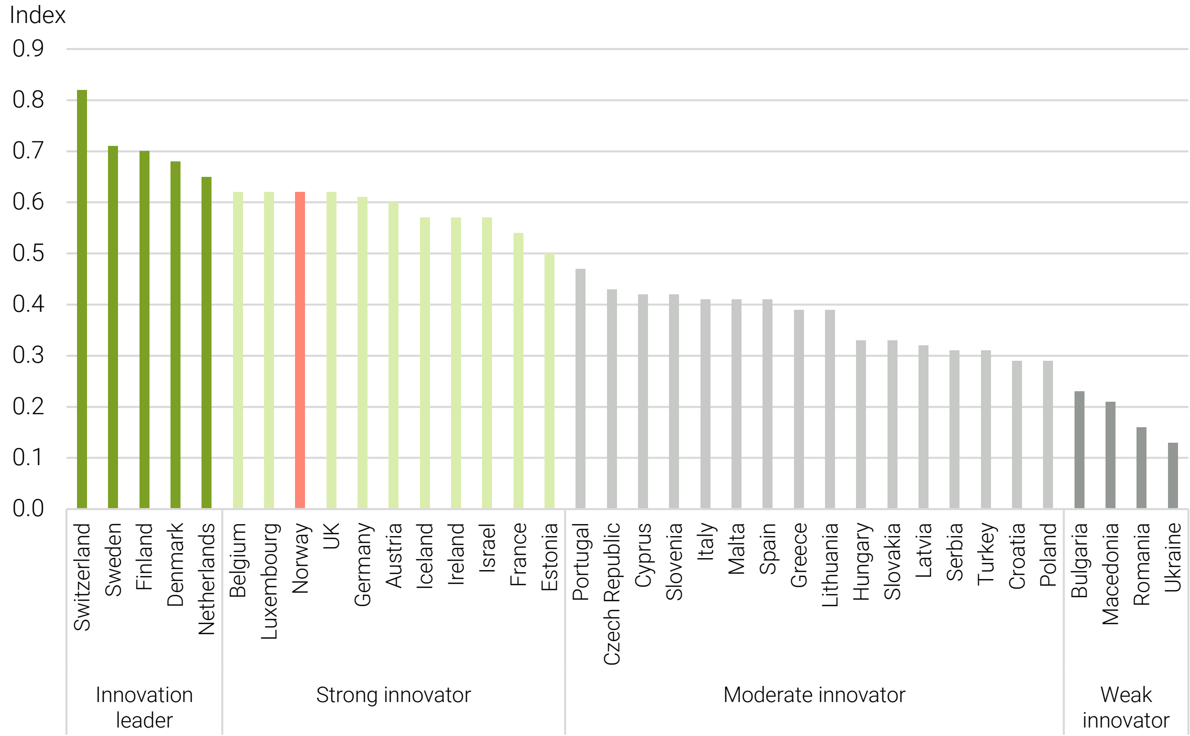


Figure 5.1: Ranking in the European Innovation Scoreboard 2019. By collection index.
Source: European Commission

For the first time, Norway is ranked among Europe's 10 most innovative countries
Since 2001, the European Commission has published an annual overview of key indicators of innovation in European countries, the European Innovation Scoreboard (EIS). The ranking covers 36 countries and includes 27 indicators. The purpose is to give a broad picture of innovation ability, framework conditions and results of innovation.

In the latest ranking of 2019, Switzerland, Sweden, Finland, Denmark and the Netherlands are regarded as the leading nations measured in this way. These countries belong to the group of "Innovation Leaders". Norway is ranked 8th in this issue, belonging to the group of "Strong innovators". This is significantly higher than Norway's previous results. The main explanation for Norway's progress is that the survey was turned into a separate survey in 2014, more in line with practice in most countries. As a result, the Norwegian Innovation Survey captured a significantly higher number of innovative enterprises.

Strongest at innovation in SME, weakest on high-tech exports
Looking at the various indicators and dimensions, Norway has relatively high values when it comes to human resources and research systems. Norway also has especially high values on indicators related to public R&D investment and degree of innovation in small and medium-sized enterprises (SME). Norway is also top of the line in business-related training in ICT.

The weakest areas for Norway are the indicators relating to patents, in addition to design and exports of high-tech products. The weak score related to exports of high-tech products is largely related to Norway's industrial structure and the way in which high technology is defined. In terms of exports of knowledge-intensive services, however, Norway is among the leading countries in the ranking.

	Number of indicators	Number of countries	Top 3	Norway's ranking					
				2018–2019	2017	2016	2015	2014	2005
Innovation									
Global Innovation Index 2019	80	126	1. Switzerland 2. Netherlands 3. Sweden	19 (2018)	19	19	20	14	25
Innovation indicator 2018	38	35	1. Singapore 2. Switzerland 3. Belgium	17 (2017)	14	14	14	7	..
European Innovation Scoreboard 2019	27	36	1. Switzerland 2. Sweden 3. Finland	8	12	12	16	16	16
Global Competitiveness Index 4.0 2018	114	144	1. USA 2. Singapore 3. Germany	16	11	11	11	11	6
World Competitiveness Scoreboard 2019	260	63	1. Singapore 2. Hong Kong 3. USA	11	12	11	9	7	15
Bloomberg Innovation Index 2019	7	60	1. South Korea 2. Germany 3. Finland	17	14	14	14	15	..
The World Bank, Doing Business 2019	11	190	1. New Zealand 2. Singapore 3. Denmark	7	6	6	9	6	6
The Global Talent Competitiveness Index 2019	65	125	1. Switzerland 2. Singapore 3. USA	4	10	10	8	11	6
The World Bank GDP per capita 2018	1	237	1. Luxembourg 2. Norway 3. Switzerland	2 (2018)	2	9	10	8	9
The human capital index (HCI) 2018	6	157	1. Singapore 2. Japan 3. South Korea	20	..	..	..	..	..
Living conditions									
UNDP Human Development Report 2019	4	195	1. Norway 2. Australia 3. Switzerland	1 (2017)	1	1	1	1	1
Sustainable Development Report 2019	244	162	1. Denmark 2. Sweden 3. Finland	8	4	3	2	..	..
OECD Better Life Index 2017	11	40	1. Norway 2. Australia 3. Iceland	1 (2017)	..	..	..	..	..
World Happiness Report 2019	6	156	1. Finland 2. Denmark 3. Norway	3	1	..	4	2	..

Table 5.1: Indicator system for innovation, competitiveness, level of education and living conditions. 2005–2019.

Innovation in Norwegian industrial sector

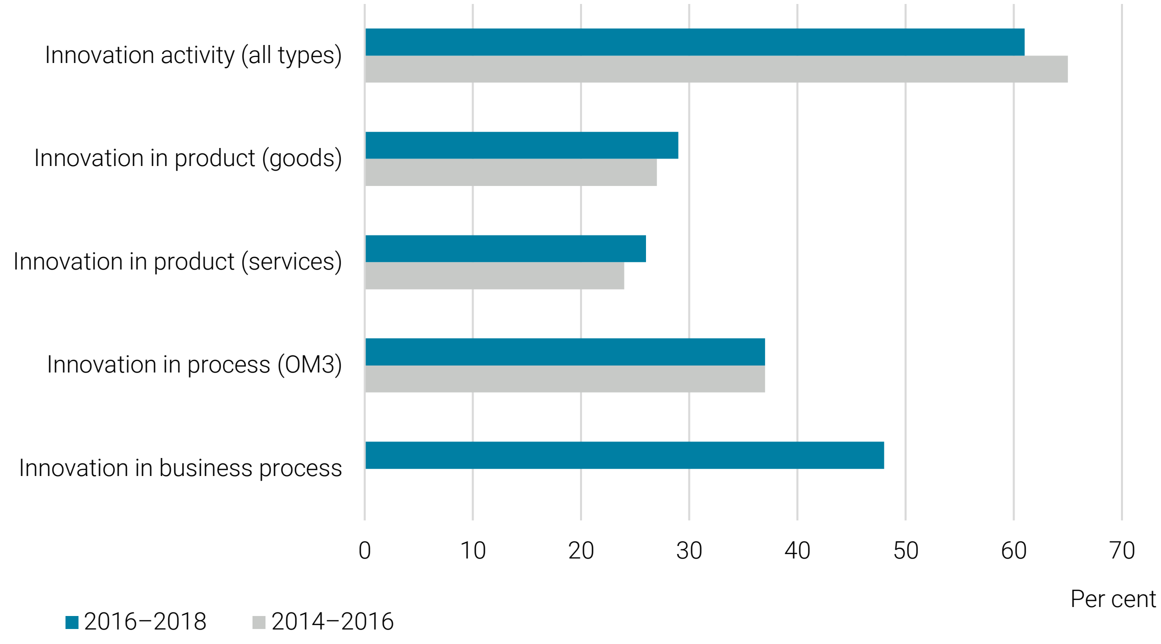


Figure 5.2: Proportion of innovative Norwegian enterprises by type of innovation. 2014–2016 and 2016–2018.
Source: Statistics Norway, Innovation survey 2014–2016 and 2016–2018

New and changed innovation survey
In the innovation survey, Norwegian enterprises answer several questions regarding change and renewal in their own business. The survey is closely related to the R&D surveys but has been conducted separately since 2014. The latest survey from 2018 is based on the very latest definitions of innovation, and is therefore not directly comparable with previous years, see text box below.

6 out of 10 Norwegian enterprises have innovation activity
For the period 2016–18, more than 60 per cent of Norwegian enterprises state that they have had some form of innovation activity. This is roughly the same share as reported in the previous two-year period. Furthermore, 55 per cent of the enterprises had innovation in goods or services, while 48 per cent had innovation in business processes. The latter type of innovation differs from the process innovation concept used in previous surveys, and now also includes certain activities that were previously referred to as organisational or market innovations.

Innovation investment of almost NOK 73 billion
In total, the enterprises reported spending nearly NOK 73 billion on innovation activities in 2018. Although R&D represents a significant part of this, the enterprises spend about as much resources on other innovation costs, such as personnel costs, services, materials, equipment and other capital goods.

New guidelines for mapping innovation:

The international guidelines for innovation statistics are given in the “Oslo Manual” published by the OECD. Since the previous innovation survey, these guidelines have been updated, including new definitions of different types of innovation. The latest innovation survey (2016–2018) also has several new questions that follow the new guidelines. Thus, in some areas it may be problematic to compare the latest figures with previous years.

Norwegian enterprises' planned innovation costs

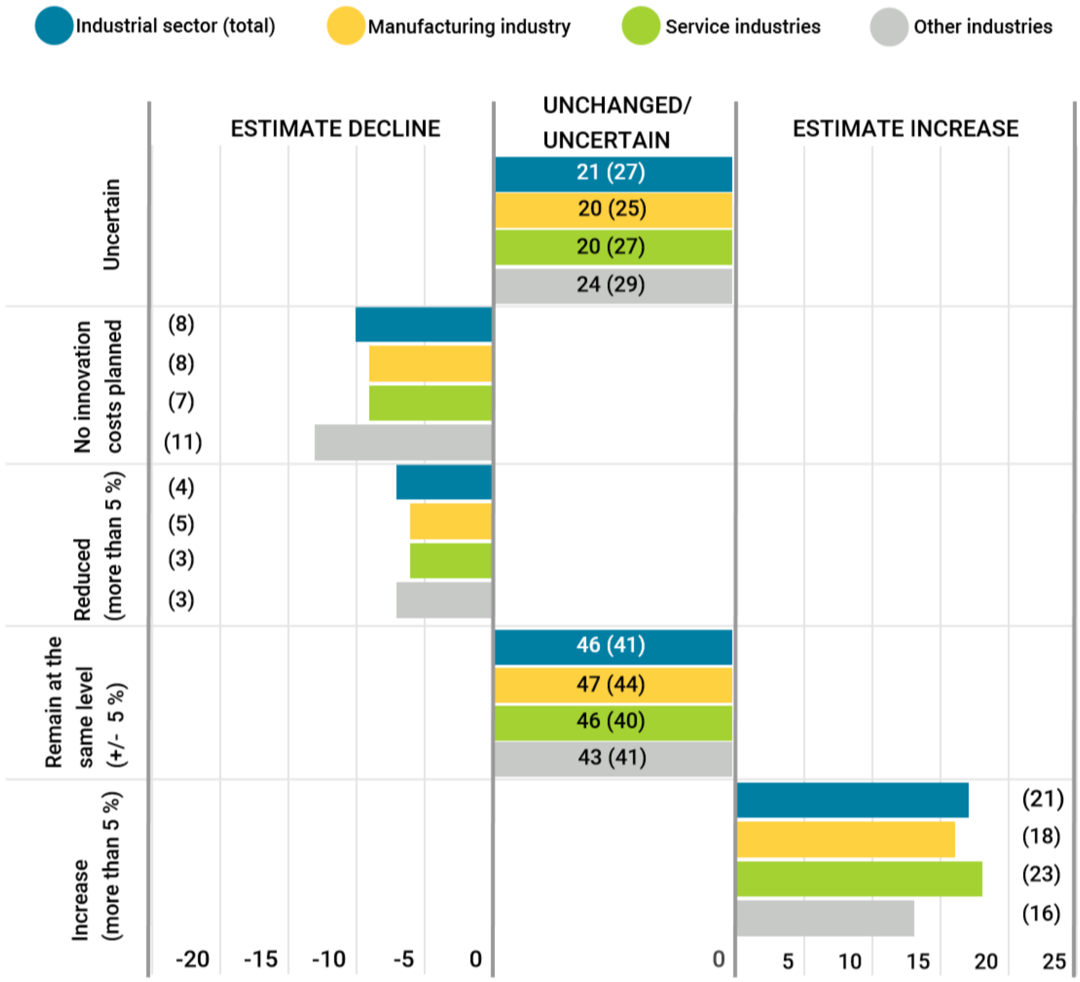


Figure 5.3: Enterprises' planned innovation costs in 2019 compared with 2018 (and in 2020 compared with 2019). Response as a proportion of enterprises with innovation activity, by industry.
Source: Statistics Norway, Innovation survey 2016–2018

60 per cent plan to maintain or increase innovation costs

In the latest innovation survey, enterprises are asked to state their planned innovation costs over the next two years, meaning changes from 2018 to 2019 and from 2019 to 2020. These are obviously uncertain estimates, and 20 per cent of enterprises answer "uncertain" to this question. Among those who make an estimate, most are clearly stating that they plan innovation investments at about the same level as in 2018. Some also estimate increased investments in 2020 compared with 2019. Although there is great uncertainty related to such estimates, the responses indicate a certain increase in innovation activities in Norwegian industrial sector up to and including 2020.

Stable innovation activity among large companies

Enterprises with more than 250 employees are more likely to respond that they plan to maintain innovation costs in the years ahead. This is probably because large enterprises have (to a greater extent than smaller ones) strategies and budgets for such investments several years ahead.

1 in 5 large manufacturing enterprises is planning to increase their innovation costs

Among the largest companies, 80–90 per cent plan innovation costs at the same or higher level over the next two years. For 2020, almost every fifth manufacturing enterprise with more than 200 employees plans innovation costs that are more than 5 per cent higher than the year before.

Innovation in the municipal sector

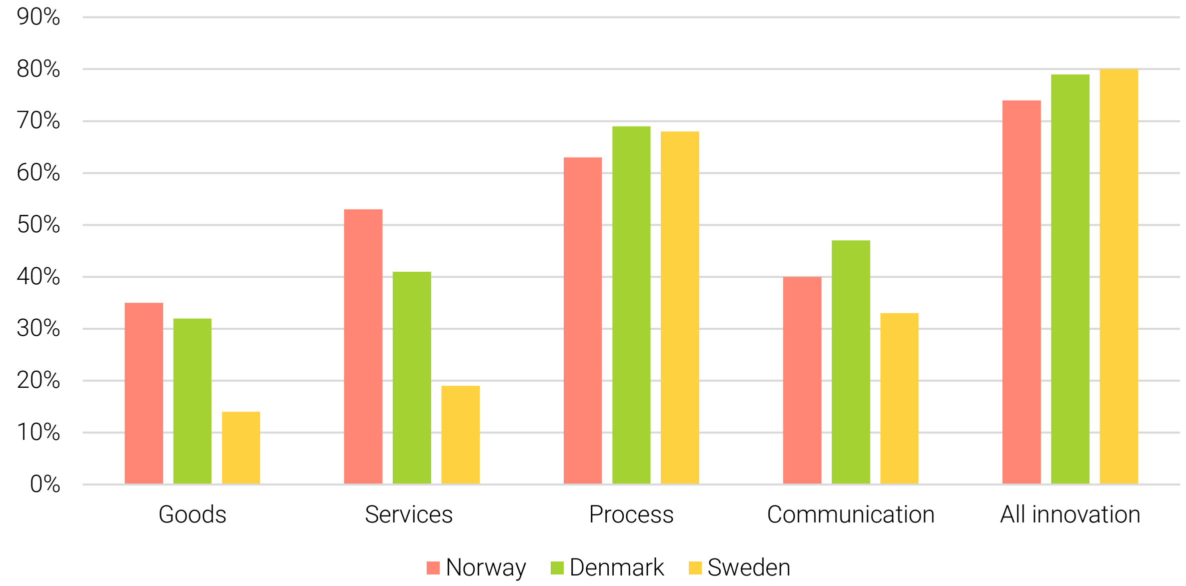


Figure 5.4: Proportion of innovative units in the municipal sector by type of innovation and country. 2016–2017.
Source: Municipal Sector Organisation, Centre for Public Innovation and Sweden's Municipalities and County Council

New surveys map innovation in the public sector
Innovation has traditionally been regarded as an activity taking place in the industrial sector. However, several studies have recently attempted to map innovation in the public sector, and Norwegian and Nordic environments have been among the driving forces for several years. The first full-scale public sector innovation survey was conducted in Denmark in 2017 under the auspices of the Centre for Public Innovation (COI). Since then, several other Nordic studies have mapped innovation in the public sector, based on the definition from COI.

70–80 per cent of municipal units in Scandinavia report innovation activity
The Municipal Sector Organisation (Kommunesektorens organisasjon) conducted the first public sector innovation survey of selected units in Norway in 2017. The results are basically comparable to similar surveys in Denmark and Sweden, as the questions are largely harmonised. A predominant majority of municipal units report having had some form of innovation activity: 74 per cent in Norway, 79 per cent in Denmark and 80 per cent in Sweden.

However, reservations about disparities in method and structural differences must be made. For example, there were 426 municipalities in Norway as of 2017, 98 in Denmark and 290 municipalities in Sweden. Such differences in municipality structure and size affect which tasks are addressed and the capacity to implement significant changes.

High degree of new products and services in the Norwegian municipal sector
Change in processes, meaning how public services are delivered, is the most common type of innovation in municipalities across the three Scandinavian countries. About two thirds of the units in the municipalities reported process innovation, slightly lower in Norway and slightly higher in Denmark and Sweden. There are greater differences in innovation related to new products and new services. The municipalities in Norway are introducing new products and services to a greater extent than in Denmark and Sweden. While 35 per cent in Norway have introduced new products, the corresponding figure is 32 per cent for Denmark and only 14 per cent for Sweden. There are similar strength relationships in innovation related to services.

Innovation in the state sector

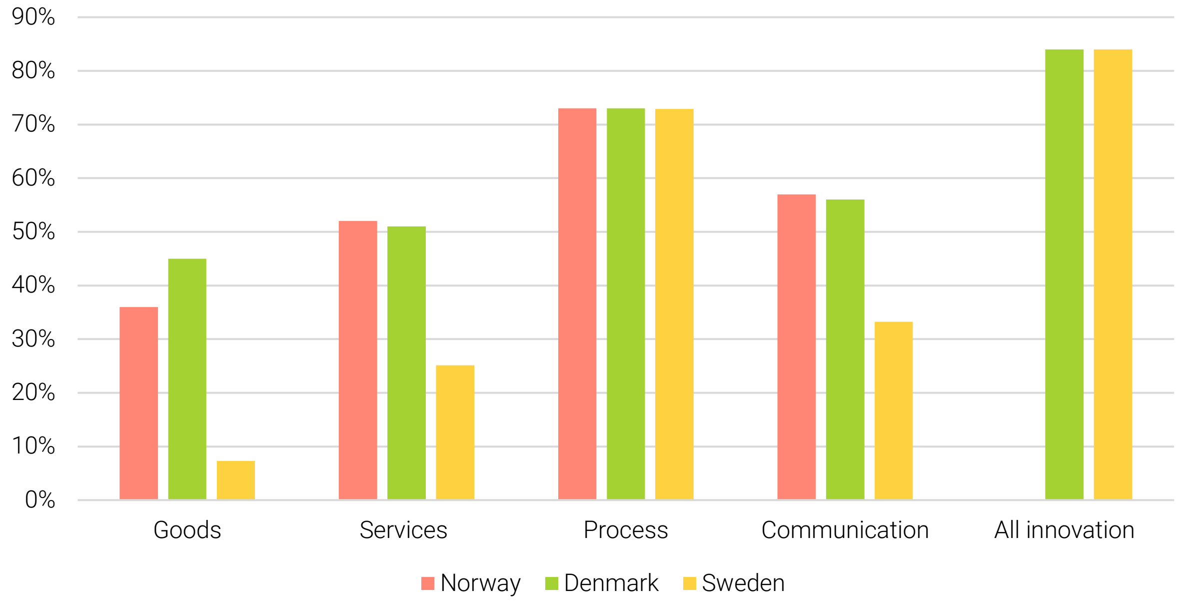


Figure 5.5: Proportion of innovative units in the state sector by type of innovation and country. 2016–2017.
Source: Norway: Difi (Directorate for Administration and ICT), Denmark: Centre for Public Innovation, Sweden: Sweden's Municipalities and County Council

Many similarities between innovation in state and municipal sector
As in the municipal sector, process innovation is the most common form of innovation for entities in the state sector as well. 73 per cent of state entities in all three Scandinavian countries state that they have introduced new or substantially changed processes. There is some more variation regarding innovation in products, services and communication. In these areas, there are far more innovative actors among Danish and Norwegian state actors, compared with the Swedish.

Overall, the pattern of types of innovation is relatively similar between the municipal and state sector in the three Scandinavian countries. The overall proportion of units that are innovative is also very similar across the three countries.

Technology is an important driver for innovation in the Norwegian public sector
Most often, it is the management that drives innovation in the municipal sector in Norway and Denmark. Secondly, the employees in the workplace: this corresponds to 35 per cent of respondents in the municipal sector in both Norway and Denmark.

New technology appears to be a more important driver for innovation in the Norwegian municipal sector compared with Denmark. In Norway, 18 per cent of the municipal units respond that new technology was an important driver, compared with only 11 per cent in Denmark. For the state sector, technology appears to be even more important. 28 per cent of the state units in Norway and 19 per cent in Denmark respond that new technology has been a driver for the innovation activity.

Economic pressure is a more important innovation driver in state than in municipal sector
In the Norwegian state sector, it seems that economic pressure is a more important driver of innovation compared with the municipalities. In the state sector, almost one third of the actors state that economic pressure has been important for innovation, compared with 11 per cent in the municipal sector. Furthermore, the proportion of entities in state sector that highlights economic pressure as an innovation driver is noticeably higher in Norway than in Denmark.

Digitisation in the public sector

The development of a digital public sector is a priority in Norway (The Digitisation Programme, 2012). The use of information and communication technology (ICT) and digitisation can make a positive contribution to economic growth and productivity, which is important to ensure a well-functioning welfare state in the future. In addition, it is a key tool for municipalities and state entities to achieve the goal of more coherent and user-oriented public services.

One third of Norwegian public entities lack a digitisation strategy

Under the theme of digital priority, the indicators show, among other things, that about one third of municipalities and state entities do not have an ICT/digitisation strategy. At the same time, one third of them have relatively extensive ICT projects. Furthermore, the indicators show that if a municipality or state entity has an ICT/digitisation strategy, the municipalities discuss more areas than the state entities. The municipalities have a relatively greater focus on increased quality of services, increased use of online self-service solutions and the establishment of new services in their ICT projects, while state entities have a relatively greater focus on efficiency (better interaction with other entities, restructuring and reduced staffing) in their ICT projects.

All in all, the composite indicator for digital priority shows that the municipalities have a relatively higher degree of digital priority than state entities as of 2018. This is because several of them have a more comprehensive ICT strategy and several have planned, or are in the process of implementing, ICT projects.

	Municipalities		State entities	
ICT strategies and ICT projects	Number	Share	Number	Share
0: Do not have an ICT strategy in place or ongoing ICT projects	34	9%	15	7%
1: Do have an ICT strategy or ongoing ICT projects, but few areas are affected	105	28%	111	53%
2: Comprehensive ICT strategy but few areas are affected by ICT projects	29	8%	9	4%
3: Comprehensive ICT projects but limited ICT strategy	110	29%	58	28%
4: Comprehensive ICT strategy and ICT projects	99	26%	17	8%
Total	377		210	

Table 5.2: Distribution of municipalities and state entities by degree of digital priority. 2018.
Source: Statistics Norway, *The use of ICT in public sector*

Measuring Norway's digital development

In order to create a better numerical basis for assessing whether Norway is on its way to achieve the main objectives, Statistics Norway expanded the survey "Use of ICT in the state" to "Use of ICT in the public sector" in 2018. In addition to state entities, the new survey includes municipalities and counties. The survey covers several areas such as ICT strategies and projects, digital procurement processes, use of cloud services, ICT security and ICT competence.

All indicators in the survey are grouped within three main themes to give the best possible overview of the level of digitisation: *digital priority*, *digital competence* and *digital activity*. It is important to be aware that these are constructed indicators, which only give an indication of the state of digitisation.

Because the survey has a high coverage rate and a high response rate, there is a very good data base to say something about the level of digitisation in public sector (covers 377 of 424 municipalities and 208 of 216 state-owned entities in 2018). There are several international and national surveys that address the state of digitisation in Norway (EU's Government Benchmark, Digital Economy and Society Index (DESI), UN eGovernment survey, Rambøll's "IT in practice"). However, these are based on a smaller selection of entities and therefore do not provide a full overview.

Lack of competence is a major challenge for digital development

The lack of competence is a major challenge for digital development in the public sector. 42 per cent of the municipalities state that the lack of competence to some extent or to a great extent is an obstacle to the development of the municipality's digital services. The challenge is somewhat less for the state. 28 per cent of state entities say that lack of competence is a major obstacle to their digital development.

Furthermore, as many as 70 per cent of the municipalities and 40 per cent of state entities who state that the lack of competence is a major obstacle to their digital development, have not tried to recruit ICT specialists. This indicates that several municipalities and state entities are facing either financial constraints or restrictions on the supply side in terms of relevant competence.

Great potential for further development of digital services

Municipalities and state entities use digital services to a much greater extent than they offer digital services themselves. At the same time, the scope of using digital services varies widely and there is still a high potential for efficiency improvement. This applies especially to services such as shipping and handling of orders for state entities, and services such as receiving, evaluating and assigning contracts for municipalities. The use of cloud services also has a great potential for development, where one third of the municipalities score "very low", and one quarter of state entities have no areas that are designed for the use of cloud services. There are also a small number of municipalities and state entities that offer advanced services digitally.

All in all, the composite indicator of digital activity shows that state entities have a relatively higher degree of digital activity compared with municipalities per 2018, mainly because several of them are more frequent users of digital services.

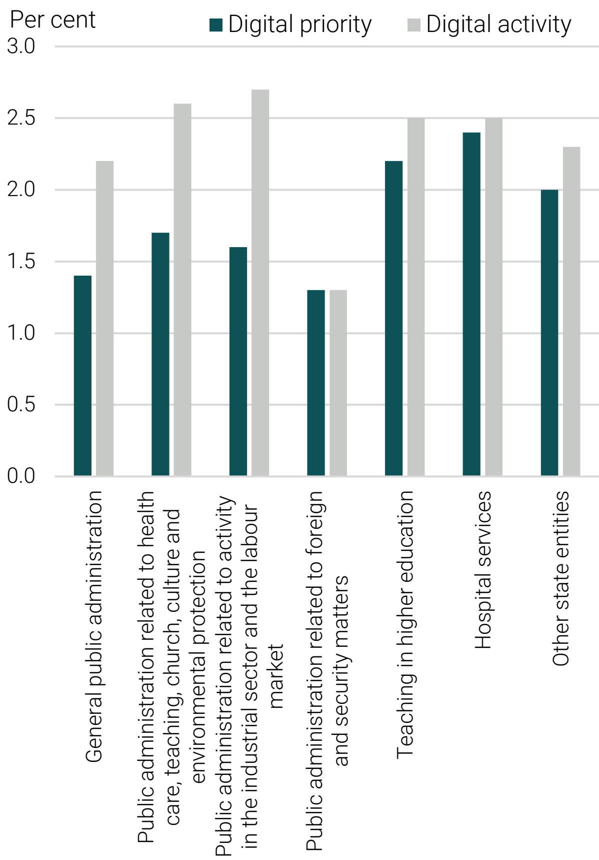


Figure 5.6: Average degree of digital priority and digital activity among state entities. 2018.
Source: Statistics Norway, *The use of ICT in public sector*

	Municipalities		State entities	
The use and offering of digital services	Number	Share	Number	Share
0: Very little digital activity	31	8%	21	10%
1: Relatively little digital activity	112	30%	16	8%
2: Use a lot of digital services, but offer it to a small extent to others	111	29%	105	50%
3: Offer a lot of digital services, but use it to a small extent themselves	37	10%	10	5%
4: Both use and offer digital services to a great extent	86	23%	58	28%
Total	377		210	

Table 5.3: Distribution of municipalities and state entities by degree of digital activity. 2018.
Source: Statistics Norway, *The use of ICT in public sector*

Chapter 6: Knowledge for sustainability

A new agenda for R&D and innovation
In the autumn of 2015, the UN member states adopted 17 goals for sustainable development (SDG) towards 2030. The goals have gradually gained a central position in national and international politics. In the area of knowledge, sustainability goals are increasingly used as a framework for strategy and priorities. The latest Long-term Plan for Research and Higher Education in Norway is closely linked to the sustainability goals. Several actors also incorporate the goals into their own strategies, priorities and projects.

Few direct links to R&D and innovation
Few of the 169 sub-goals related to the sustainability goals are explicitly about research, development and innovation. Some of the goals are related to education, but overall, the link between sustainability and the role of knowledge environments must be further developed and understood as a more indirect link. Another challenge is that the indicators measuring progress are not fully developed and to varying degrees comparable between countries and over time. In this chapter, we take a closer look at Norway's status of achievement of the SDG's and how figures from R&D statistics and other sources can be linked to the indicator set developed under the UN's sustainability goals.

Norway will not reach six of the seventeen sustainability goals with today's development
Like many other OECD countries, Norway, the rest of the Nordic countries, the Netherlands and Austria, have already achieved SDG 1 (no poverty). Norway has also achieved SDGs related to good health (SDG 3), gender equality (SDG 5), clean energy for all (SDG 7) and less inequality (SDG 10). Figure 6.1 illustrates Norway's status in 2019 for each of the 17 SDGs.

The SDG Index (Sachs et al., 2019) also shows that Norway is on track to achieve 10 out of 17 sustainability goals by 2030. The trend for five of the targets shows only a moderate improvement, not sufficient to reach the 2030 targets. These include hunger (SDG 2), clean water (SDG 6), innovation and infrastructure (SDG 9), sustainable cities and communities (SDG 11) and life under water (SDG 14). At the same time, progress regarding SDG 13 (climate action) is stagnating.

Sustainability indicators

The UN's 17 sustainability goals are composed of 169 sub-goals. Each sub-goal has one or more associated indicators enabling us to measure the current level and developments in time. These indicators are included in the UN Global Indicator List, which is a framework of 244 indicators for measuring, monitoring and prioritising the work towards Agenda 2030. Each indicator is categorised (tier I, II or III) according to whether an international methodology is established, standards are available and whether data are produced regularly for a certain proportion of countries. The indicator framework is used, among other things, to create the SDG (Sustainable Development Goal) Index and SDG Dashboards for the UN member countries.

Increasing inequality and negative trends related to climate change in many OECD countries
The OEDC has measured the distance to the SDGs for several years, focusing on the OECD countries. The latest report, Measuring Distance to the SDG Targets 2019, was published in May 2019. It is based on the UN Global Indicator List, with data from the UN database and the OECD's own database.

The figures show that the OECD countries generally outperform the rest of the world in the SDGs related to poverty (SDG 1), health (SDG 3), clean water (SDG 6) and clean energy (SDG 7). However, many face major challenges related to responsible consumption and production (SDG 12), stopping climate change (SDG 13), life underwater (SDG 14), land life (SDG 15) and no hunger (SDG 2).

The challenges associated with SDG 2 are mainly poor performance on indicators measuring sustainable and energy-intensive agriculture, sustainable diet among the population and overweight. Furthermore, inequalities seem to be increasing in most OEDC countries, both between the poorest and richest and between genders. In recent years, many OECD countries have also shown a negative development, or no improvement related to stopping climate change (SDG 13) and improving life underwater (SDG 14).

Figure 6.1: The status of Norway's achievement of the UN's sustainability goals in 2019 ranked in ascending order from: large challenges, significant challenges, challenges *and SDG* achieved.
Source: Sachs et al. (2019)

Sustainable development goals and R&D efforts

The Government in Norway has decided that the UN Sustainability Goals (SDGs) will be the basis for the work on regional, national and global challenges in Norway, including in research. Research affects the SDGs in several ways, both directly and indirectly. Directly through specific goals concerning R&D efforts and researcher recruitment, and indirectly by contributing to the development of new sustainable solutions and by bringing forth new knowledge as the basis for decisions and priorities.

Sustainable development goal 9 *Innovation and infrastructure*

Sub-goal 9.5:
Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.

Sustainability goal 9 *Innovation and infrastructure* concerns R&D efforts and researcher recruitment explicitly through sub-goal 9.5. Indicator 9.5.1 R&D expenditure as a share of GDP and 9.5.2 Number of researchers per inhabitants, are two concrete objectives related to research. Both indicators are measured in Norway.

As we have seen in Chapter 1, R&D expenditure as a share of GDP in Norway is relatively similar to the average for the OECD countries, but significantly below the international target (see Table 6.1). The number of researchers per million inhabitants is at a slightly lower level in Norway compared with the international target.

Indicator	Norway	OECD average	International target
9.5.1 R&D expenditure as a share of GDP	2.11%	2.16%	3.28%
9.5.2 Number of researchers per million inhabitants	6,513	3,810	6,845

Table 6.1: Values for indicator 9.5.1 and 9.5.2. 2017. International targets adopted by the UN Statistical Commission, March 2016.
Source: OECD (2019)

Is the research taking place in fields that bring us closer to goal achievement?
Research may also contribute indirectly to our achievement of the SDGs by developing new sustainable solutions and bringing forth new knowledge. In this context, it is relevant to take a closer look at some areas where Norway is preforming research.

In 2017, NOK 67 billion was spent on R&D in Norway. Almost half (about NOK 30 billion) was spent within 10 thematic research areas, all of which are rooted in the Government's Long-Term Plan for Research and Higher Education. The research areas include energy, climate, environment, agriculture, fisheries, aquaculture, marine, maritime, welfare and education. All areas are both directly and indirectly relevant to one or more of the UN's sustainability goals.

Energy research is particularly relevant for achieving SDG 12 (responsible consumption and production) and 13 (climate action), two of the SDGs where Norway is far away from goal achievement within 2030. Norwegian research on renewable energy, energy efficiency and restructuring has grown in recent years, while petroleum research has declined somewhat.

Environmental research is a broad thematic area affecting several of the SDGs in which Norway has major challenges. This includes research on land use and change in land, natural diversity and ecosystems.

Climate research is mostly directed at climate and climate adaptation (measured in R&D expenditures). Less funds are being spent on climate technology and other emissions reductions and CO_2 management, two areas that are particularly relevant to achieving SDG 12 (responsible consumption and production) and 13 (climate action).

Agricultural research is mostly directed at food-related agricultural research (primary food production and nutrient/food processing). This thematic area is especially relevant to achieving SDG 2 (zero hunger), 12 (responsible consumption and production) and 15 (life on land).

Fisheries, aquaculture and the marine environment particularly affect SDG 14 (life below water). Within fisheries, the largest sub-area is technology and equipment. Within aquaculture research, health and disease, feed, feed resources and nutrition, production biology as well as technology and equipment are the largest sub-areas in aquaculture measured in R&D expenditure. Within marine research, ecosystem is by far the largest sub-area (one-third), followed by ecosystem impact.

Welfare research affects, among others, SDG 9 (innovation and infrastructure) through gender balance within specific occupational groups. However, sub-areas that are closely related to SDG 9 and the challenges regarding gender balance, each constitutes a small part of the activity. The largest sub-area within welfare research is welfare services (public and private).

Appendix

Sector of performance	Total	Industry		Government		Other national sources[1]	Abroad	
		Total	Of which: Oil companies	Total	Of which: Research Council of Norway		Total	Of which: EU commission
Business enterprise sector	36,393	26,196	292	3,421	2,056	2,190	4,586	396
Of which: Industrial sector[1]	31,990	24,504	..	1,403	733	2,020	4,063	180
Institutions serving enterprises[2]	4,403	1,692	292	2,018	1,323	170	523	216
Government sector	9,462	710	89	7,647	2,094	316	789	204
Of which: Institutions serving government	8,539	675	89	6,804	2,068	272	788	203
Health trusts without university functions	922	35	..	843	25	44	1	1
Higher education sector	23,322	529	..	21,269	3,351	781	743	538
Of which: Universities and university colleges	19,867	474	..	18,141	3,066	543	710	521
University hospitals	3,455	55	..	3,128	285	238	34	17
Total Norway	**69,177**	**27,435**	**381**	**32,337**	**7,501**	**3,287**	**6,118**	**1,138**

Table 1: Total R&D expenditure in Norway by sector of performance and source of funds. 2017. Mill. NOK.

[1] Includes private funding, gifts and SkatteFUNN in the industrial sector.
[2] Includes private, non-profit hospitals operating on behalf of a regional health trust.
Source: NIFU and Statistics Norway, R&D statistics

Field of science	Total	Industrial sector	Institute sector	Higher education sector
Humanities	2,111	-	354	1,758
Social sciences	7,439	-	1,982	5,457
Natural sciences	6,392	-	2,761	3,631
Engineering and technology	6,773	-	4,181	2,593
Medical and health sciences	9,014	-	1,750	7,264
Agricultural sciences	2,495	-	2,097	399
Not elsewhere classified	30,318	30,318	-	-
Total	**64,542**	**30,318**	**13,124**	**21,100**

Table 2: Current expenditure on R&D by sector of performance and field of science. 2017. Mill. NOK.

Source: NIFU and Statistics Norway, R&D statistics.

Sector of performance		Total	Basic research	Applied research	Experimental development
Industrial sector	Million NOK	30,318	985	5,482	23,851
	Per cent	100	3	18	79
Institute sector	Million NOK	13,124	1,760	8,876	2,488
	Per cent	100	13	68	19
Higher education sector	Million NOK	21,100	8,688	9,814	2,599
	Per cent	100	41	47	12
Total	**Million NOK**	**64,543**	**11,433**	**24,172**	**28,938**
	Per cent	**100**	**18**	**37**	**45**

Table 3: Current expenditure on R&D by type of R&D and sector of performance. 2017. Mill. NOK and per cent.

Source: NIFU and Statistics Norway, R&D statistics

Year	Total			Industrial sector[1]			Institute sector			Higher education sector		
	Total	Current expenditure	Invest-ments	Total	Current expenditure	Invest-ments	Total	Current expenditure	Invest-ments	Total	Current expenditure	Invest-ments
1970	891	774	117	276	256	20	329	295	34	286	223	63
1972	1,236	1,095	142	355	335	20	459	417	42	421	342	79
1974	1,633	1,467	166	479	434	44	630	579	51	525	454	71
1977	2,716	2,356	360	850	747	103	959	860	99	907	749	158
1979	3,265	2,952	313	1,027	942	85	1,230	1,135	95	1,009	876	133
1981	4,268	3,865	403	1,334	1,210	125	1,713	1,570	144	1,220	1,086	134
1983	5,765	5,207	557	1,886	1,738	149	2,405	2,142	263	1,474	1,328	146
1985	8,203	7,362	841	3,574	3,249	325	2,826	2,494	333	1,803	1,619	183
1987	10,319	9,216	1,103	4,549	4,037	512	3,605	3,232	373	2,166	1,947	219
1989	11,662	10,314	1,349	4,590	4,057	534	4,301	3,839	461	2,771	2,418	354
1991	12,744	11,285	1,459	4,980	4,463	517	4,405	4,024	381	3,359	2,798	561
1993	14,336	12,668	1,668	5,631	4,907	724	4,811	4,338	473	3,894	3,423	471
1995[2]	15,970	14,389	1,581	7,341	6,438	903	4,491	4,272	219	4,139	3,680	459
1997	18,244	16,485	1,759	8,572	7,742	830	4,827	4,519	308	4,846	4,225	621
1999	20,347	18,441	1,905	9,540	8,772	768	4,987	4,753	234	5,819	4,916	903
2001	24,469	22,305	2,164	12,614	11,349	1,265	5,582	5,337	244	6,274	5,619	655
2003	27,246	24,813	2,433	13,391	12,077	1,314	6,360	6,075	285	7,495	6,661	834
2004	27,553	25,281	2,272	12,708	11,736	972	6,620	6,320	300	8,225	7,225	1,000
2005	29,515	27,443	2,072	13,512	12,591	920	6,907	6,661	246	9,096	8,190	906
2006	32,275	29,845	2,430	14,735	13,615	1,120	7,650	7,350	300	9,890	8,880	1,010
2007	36,788	33,956	2,832	16,755	15,482	1,274	8,310	7,942	368	11,723	10,533	1,190
2008	40,545	37,354	3,191	18,295	16,929	1,366	9,267	8,813	454	12,984	11,613	1,371
2009[3]	41,885	39,062	2,823	18,202	17,180	1,022	10,262	9,794	468	13,420	12,087	1,333
2010	42,759	40,001	2,759	18,514	17,264	1,250	10,415	10,051	364	13,830	12,685	1,145
2011	45,440	42,578	2,863	20,066	18,533	1,533	11,115	10,657	458	14,259	13,388	872
2012	48,044	45,140	2,903	21,176	19,718	1,458	11,828	11,238	590	15,039	14,184	855
2013	50,748	47,818	2,931	22,557	21,059	1,498	12,190	11,689	501	16,001	15,070	932
2014	53,867	50,895	2,972	24,802	23,336	1,466	12,345	11,911	434	16,720	15,648	1,072
2015	60,209	56,087	4,122	27,782	26,035	1,748	13,718	12,812	906	18,709	17,241	1,468
2016	63,345	59,299	4,046	29,489	27,689	1,801	13,220	12,738	482	20,636	18,872	1,764
2017	69,176	64,542	4,634	31,990	30,318	1,672	13,864	13,124	740	23,322	21,100	2,222
2018	73,182	67,393	5,790	33,216	31,066	2,151	14,765	13,625	1,140	25,201	22,702	2,499

Table 4: R&D expenditure in Norway by sector of performance and type of cost. 1970–2018. Million NOK. Current prices.

[1] Due to new information from important R&D units in the industrial sector, R&D statistics from 2001 till 2007 have been corrected.
[2] Data from 1995 is not directly comparable with the previous years due to an extension in the data coverage in the Industrial sector, as well as the transfer of state commercial enterprises from the institute sector to the Industrial sector.
[3] In 2009 some research units were reclassified, mainly from the higher education sector to the institute sector.
Source: NIFU and Statistics Norway, R&D statistics

Year	Total			Industrial sector[1]			Institute sector			Higher education sector		
	Total	Researchers[2]		Total	Researchers[2]		Total	Researchers[2]		Total	Researchers[2]	
		Total	Women (%)		Total	Women (%)		Total	Women (%)		Total	Women (%)
1974	21,820	9,756	..	5,152	1,419	..	7,599	3,286	9	9,069	5,051	12
1977	23,952	10,818	..	5,851	1,688	..	8,108	3,517	9	9,993	5,613	14
1979	25,154	11,851	..	6,402	2,017	..	8,605	3,982	9	10,147	5,852	14
1981	26,297	12,939	..	6,473	2,316	..	9,138	4,376	12	10,686	6,247	15
1983	27,930	14,002	..	7,254	2,909	..	9,793	4,663	11	10,883	6,430	16
1985	30,979	15,923	..	10,041	4,475	..	9,818	4,792	13	11,120	6,656	18
1987	31,898	18,128	..	10,332	5,897	..	10,077	5,343	16	11,489	6,888	19
1989	32,871	19,515	18	9,734	5,861	13	10,639	5,882	19	12,498	7,772	22
1991	31,473	20,118	20	8,634	5,671	14	10,094	5,909	20	12,745	8,538	24
1993	33,979	21,879	22	9,402	6,192	16	10,514	6,339	24	14,063	9,348	25
1995[3]	40,915	26,712	23	12,631	8,012	15	10,092	6,048	26	18,192	12,652	29
1997	43,972	30,280	26	14,326	10,377	18	9,998	6,118	28	19,648	13,785	32
1999	43,893	30,994	28	14,545	10,710	19	9,279	5,920	29	20,069	14,364	34
2001	48,394	34,549	29	17,995	13,308	19	9,285	6,077	31	21,114	15,164	36
2003	50,728	35,307	29	19,356	12,741	17	9,411	6,350	32	21,961	16,216	38
2005	53,845	36,570	32	20,215	11,999	19	9,425	6,484	34	24,205	18,087	39
2007	59,156	41,347	34	21,464	14,068	20	10,618	7,467	37	27,074	19,812	42
2008	62,675	43,715	34	23,472	15,412	20	11,111	7,713	38	28,092	20,590	43
2009[4]	64,126	44,762	35	23,468	15,249	21	11,716	8,198	39	28,942	21,315	44
2010	63,876	44,774	36	22,939	14,854	21	11,854	8,277	40	29,083	21,643	44
2011	64,717	45,578	36	23,317	15,332	22	12,106	8,434	41	29,294	21,812	45
2012	66,085	46,747	..	24,730	16,460	..	12,079	8,386	41	29,276	21,901	46
2013	68,204	47,795	36	25,324	16,667	19	12,297	8,540	42	30,583	22,588	47
2014	71,947	50,024	37	28,153	18,180	22	12,265	8,440	42	31,529	23,404	47
2015	76,557	52,181	37	31,068	19,236	22	12,323	8,341	43	33,166	24,604	48
2016	80,684	54,601	38	33,495	20,729	22	12,241	8,334	43	34,948	25,538	48
2017	85,335	57,934	32	36,087	22,451	23	12,582	8,390	..	36,666	27,093	49

Table 5: R&D personnel (head count) in Norway by sector of performance and gender. 1974–2017.

[1] Due to new information from important R&D units in the industrial sector, R&D statistics from 2001 till 2007 have been corrected.
[2] Personnel with a higher education degree (ISCED-level 5A and 6). Only academic staff are included in the higher education sector.
[3] Data from 1995 is not directly comparable with the previous years due to an extension in the data coverage in the Industrial sector,
as well as the transfer of state commercial enterprises from the Institute sector to the Industrial sector.
[4] In 2009 some research units were reclassified, mainly from the higher education sector to the institute sector.
Source: NIFU and Statistics Norway, R&D statistics

Year	Total			Industrial sector[1]			Institute sector			Higher education sector		
	Total	Researchers[2]	Others	Total	Researchers[2]	Others	Total	Researchers[2]	Others	Total	Researchers[2]	Others
1970	9,857	4,317	5,540	3,067	867	2,200	3,820	1,663	2,157	2,970	1,787	1,183
1972	11,395	5,115	6,280	3,395	976	2,419	4,400	1,992	2,408	3,600	2,147	1,453
1974	12,459	5,630	6,829	3,460	1,011	2,449	5,007	2,309	2,698	3,992	2,310	1,682
1977	13,860	6,358	7,502	4,003	1,202	2,801	5,333	2,556	2,777	4,524	2,600	1,924
1979	14,810	7,112	7,698	4,390	1,390	3,000	5,638	2,906	2,732	4,782	2,816	1,966
1981	15,025	7,548	7,477	4,201	1,524	2,677	5,885	3,125	2,760	4,939	2,899	2,040
1983	16,188	8,350	7,838	4,409	1,821	2,588	6,801	3,544	3,257	4,978	2,985	1,993
1985	19,036	9,767	9,269	6,687	2,995	3,692	7,095	3,605	3,490	5,254	3,167	2,087
1987	20,140	11,557	8,583	7,187	4,102	3,085	7,619	4,181	3,438	5,334	3,274	2,060
1989	20,471	12,256	8,215	6,579	3,862	2,717	8,108	4,725	3,383	5,784	3,669	2,115
1991	20,530	13,570	6,960	6,747	4,599	2,148	7,810	4,817	2,993	5,973	4,154	1,819
1993	22,166	14,803	7,363	7,482	5,021	2,461	8,026	5,045	2,981	6,658	4,737	1,921
1995[3]	24,003	15,964	8,039	9,437	6,169	3,268	7,611	4,802	2,809	6,955	4,993	1,962
1997	24,935	17,520	7,415	10,410	7,662	2,748	7,463	4,767	2,696	7,062	5,091	1,971
1999	25,444	18,319	7,125	10,995	8,080	2,915	7,136	4,718	2,418	7,313	5,521	1,792
2001	26,745	19,714	7,031	12,273	9,321	2,952	6,988	4,723	2,265	7,484	5,670	1,814
2003	28,546	20,581	7,965	13,390	9,368	4,022	7,238	4,962	2,276	7,918	6,251	1,667
2005	29,984	21,216	8,768	13,288	8,617	4,671	7,276	5,088	2,188	9,420	7,511	1,909
2006	31,251	22,600	8,651	13,881	9,530	4,351	7,500	5,200	2,300	9,870	7,870	2,000
2007	33,655	24,369	9,286	14,848	10,372	4,476	7,796	5,523	2,273	11,011	8,474	2,537
2008	35,502	25,593	9,909	15,996	11,027	4,969	8,165	5,796	2,369	11,341	8,770	2,571
2009[4]	36,091	26,273	9,818	15,673	10,783	4,890	8,763	6,328	2,435	11,655	9,162	2,493
2010	36,121	26,450	9,671	15,321	10,622	4,699	8,832	6,360	2,472	11,968	9,468	2,500
2011	36,950	27,228	9,722	15,545	10,925	4,620	9,123	6,543	2,580	12,282	9,760	2,522
2012	37,707	27,841	9,866	16,062	11,375	4,687	9,232	6,611	2,621	12,413	9,855	2,558
2013	38,534	28,311	10,223	16,371	11,508	4,863	9,449	6,749	2,700	12,714	10,054	2,660
2014	40,297	29,237	11,060	17,932	12,284	5,648	9,355	6,657	2,698	13,010	10,296	2,714
2015	42,409	30,632	11,778	19,087	13,000	6,087	9,370	6,656	2,715	13,952	10,976	2,976
2016	43,918	31,913	12,005	19,616	13,396	6,220	9,365	6,722	2,643	14,937	11,795	3,142
2017	46,761	33,983	12,778	21,205	14,432	6,773	9,335	6,652	2,683	16,221	12,899	3,322

Table 6: R&D personnel (FTE) in Norway by sector of performance. 1970–2017.

[1] Due to new information from important R&D units in the industrial sector, R&D statistics from 2001 till 2007 have been corrected.
[2] Personnel with a higher education degree (ISCED-level 5A and 6). Only academic staff are included in the higher education sector.
[3] Data from 1995 is not directly comparable with the previous years due to an extension in the data coverage in the Industrial sector,
as well as the transfer of state commercial enterprises from the Institute sector to the Industrial sector.
[4] In 2009 some research units were reclassified, mainly from the higher education sector to the institute sector.
Source: NIFU/Statistics Norway, R&D statistics

County	Percentage of employees with a higher education	R&D expenditure in the higher education sector per capita (NOK)	Percentage of R&D expenditure in the industrial sector	Percentage of Innovation activity financed by Innovation Norway[1]	Percentage of publicly financed R&D	Percentage of funding from Research council of Norway[2]
Norway	11	4,440	46	100	46	100
Østfold	7	567	57	4	30	1
Akershus	14	2,937	57	4	36	13
Oslo	22	12,347	41	7	50	28
Hedmark	6	1,092	33	5	69	1
Oppland	6	1,075	63	5	39	1
Buskerud	8	586	90	4	16	1
Vestfold	8	493	81	4	21	1
Telemark	7	1,247	74	3	28	0
Agder counties	8	1,687	57	7	43	2
Rogaland	11	1,819	70	8	27	3
Hordaland	11	6,863	30	10	62	13
Sogn og Fjordane	6	839	77	6	26	0
Møre og Romsdal	6	1,003	75	8	26	1
Trøndelag	11	9,477	34	14	49	26
Nordland	6	1,849	48	6	51	1
Troms	11	12,329	15	4	79	7
Finnmark	7	1,341	35	2	63	0

Table 7: R&D and innovation indicators in 2017 per county.

[1] 2018.
Source: NIFU/Statistics Norway, R&D statistics

EU innovation scoreboard 2018		EU 28	Belgium	Denmark	Estonia	Finland	France	Germany	Iceland	Ireland	Italy	The Nether-lands	Norway	Poland	Portugal	Slovenia	Spain	Sweden	Switzer-land	Czech Republic	United Kingdom
	Composite Innovation index[1]	0.525	0.618	0.680	0.500	0.704	0.535	0.612	0.573	0.567	0.410	0.651	0.616	0.295	0.471	0.423	0.409	0.713	0.823	0.431	0.616
	EU=100 (SI)	100	118	130	95	134	102	117	109	108	78	124	117	56	90	81	78	136	157	82	117
1	ENABLERS																				
1.1	Human resources																				
1.1.1	New doctorate graduates	2.1	2.0	3.2	1.3	2.6	1.7	2.7	0.9	2.2	1.4	2.2	2.1	0.5	1.8	1.9	2.6	2.7	3.4	1.7	3.1
1.1.2	Population completed tertiary education	39.8	46.7	46.7	43.7	40.2	46.3	32.1	47.3	55.3	27.7	47.5	48.6	43.5	34.5	41.2	43.6	47.7	50.5	33.6	48.2
1.1.3	Youth with upper secondary level education	10.9	8.5	26.8	17.2	27.4	18.7	8.4	23.6	9.0	7.9	19.1	19.9	4.0	9.8	12.0	9.9	30.4	31.2	9.8	14.3
1.2	Attractive research systems																				
1.2.1	International scientific co-publications	1,070	1,835	2,929	1,488	2,100	914	995	3,507	1,686	831	1,990	2,455	393	1,235	1,492	914	2,464	3,492	980	1,542
1.2.2	Scientific publications among top 10% most cited	11.50	13.10	15.80	10.00	12.70	10.10	11.80	9.60	12.70	12.40	15.70	12.00	5.70	9.90	7.80	9.70	13.50	15.60	5.90	14.60
1.2.3	Foreign doctorate students	20.30	37.90	35.20	12.90	21.90	39.50	9.70	35.70	27.00	14.20	39.90	20.60	2.00	25.00	8.90	12.00	35.10	55.30	15.90	43.20
1.3	Innovation-friendly environment																				
1.3.1	Broadband penetration	18	29	46	16	32	12	17	n/a	21	9	31	25	21	37	19	28	45	n/a	13	16
1.3.2	Opportunity-driven entrepreneurship	3.60	1.60	11.10	3.00	9.70	4.00	3.80	10.00	2.60	3.00	7.00	6.30	5.40	2.70	2.40	1.80	7.40	6.40	2.70	4.00
2	INVESTMENTS																				
2.1	Finance and support																				
2.1.1	Public R&D expenditure as a percentage of GDP (%)	0.68	0.83	1.07	0.66	0.94	0.73	0.93	0.75	0.31	0.50	0.82	1.00	0.36	0.64	0.47	0.54	0.97	0.93	0.66	0.50
2.1.2	Venture capital as a percentage of GDP (%)	0.149	0.133	0.073	0.122	0.120	0.212	0.086	n/a	0.166	0.065	0.163	0.111	0.054	0.092	0.006	0.116	0.100	0.181	0.007	0.202
2.1	Firm investments																				
2.2.1	R&D expenditure in the business sector	1.36	1.76	1.97	0.61	1.80	1.42	2.09	1.35	0.74	0.83	1.17	1.10	0.67	0.67	1.39	0.66	2.42	2.39	1.13	1.12
2.2.2	Non-R&D innovation expenditure	0.86	0.49	0.35	1.92	0.74	0.51	1.33	n/a	0.49	0.69	0.16	0.68	1.11	1.02	0.69	0.42	0.77	2.01	0.74	0.67
2.2.3	Enterprises providing ICT training	23	36	28	13	36	19	30	24	30	17	26	42	13	19	29	21	24	n/a	25	28
3	INNOVATION ACTIVITIES																				
3.1	Innovators																				
3.1.1	SMEs with product or process innovations	34.30	47.30	33.30	41.40	54.20	38.00	41.00	44.50	37.70	40.70	48.50	55.60	14.80	56.00	25.90	18.20	38.30	44.80	33.00	38.00
3.1.2	SMEs with marketing or organisational innovations	35.60	45.10	39.20	20.40	44.80	45.20	45.60	39.10	48.60	38.90	31.60	54.00	11.10	47.40	27.00	27.20	36.30	58.40	31.30	40.20

3.1.3	SMEs innovating in-house	28.10	39.80	23.60	38.40	48.50	33.80	36.80	n/a	34.50	38.80	35.00	47.90	12.10	51.20	22.40	14.50	33.50	36.90	30.60	24.00
3.2	Linkages																				
3.2.1	Innovative SMEs collaborating with others	11.80	22.10	12.90	24.60	21.30	13.40	8.50	22.90	11.60	5.70	14.50	21.70	4.50	9.70	12.20	6.40	13.20	9.70	12.60	30.60
3.2.2	Public-private co-publications	81.70	120.00	267.60	53.10	162.50	64.30	137.30	232.50	111.20	63.30	150.60	182.40	20.90	32.90	95.30	38.50	251.40	388.50	60.30	116.70
3.2.3	Private co-funding of public R&D expenditures	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
3.3	Intellectual Assets																				
3.3.1	PCT patent applications	3.53	3.46	6.17	1.29	7.73	3.75	6.27	2.36	1.94	2.12	5.52	3.60	0.52	0.91	1.86	1.40	9.57	6.74	0.82	3.04
3.3.2	Trademark applications	7.85	8.31	12.55	20.02	11.88	6.12	9.44	6.57	4.93	8.57	9.64	4.23	5.25	8.68	10.79	8.88	11.33	18.51	5.13	6.76
3.3.3	Design applications	4.17	2.76	7.22	6.38	4.06	2.89	6.32	1.35	1.41	5.65	4.09	0.58	5.15	3.82	2.69	2.70	4.18	5.94	4.17	2.93
4	IMPACTS																				
4.1	Employment impacts																				
4.1.1	Employment in knowledge-intensive activities	14.20	15.60	15.10	13.50	16.20	14.50	14.80	19.30	20.80	13.70	17.10	15.40	10.30	10.60	13.70	12.50	18.50	21.40	12.90	18.50
4.1.2	Employment fast-growing firms innovative sectors	5.20	2.80	4.90	2.80	2.80	4.20	4.80	n/a	8.50	3.30	5.10	3.10	6.20	4.90	3.90	5.30	6.20	3.20	7.20	7.10
4.2	Economic effects																				
4.2.1	Medium and high-tech product exports	56.30	48.40	48.60	39.30	44.00	58.30	68.30	8.70	56.20	52.20	49.70	14.30	48.60	40.10	57.30	46.30	54.40	52.00	67.10	53.50
4.2.2	Knowledge-intensive services exports	68.40	68.70	74.90	50.00	71.70	62.00	75.50	51.70	94.00	51.00	78.00	76.20	40.80	38.50	36.50	33.80	71.50	69.70	42.70	82.10
4.2.3	Sales of new to market and new to firm innovations	12.96	15.61	5.47	11.15	11.30	9.85	14.04	6.07	16.96	12.40	10.41	7.25	6.28	9.77	8.68	19.32	8.70	19.62	12.96	15.53

Table 8: EU indicators for science, technology and innovation. Indicators for benchmarking in selected countries in latest year for available data.

[1] The innovation index is composed of 29 different variables ranging from 0 (lowest) to 1 (highest).
Source: DG Enterprise

The Research Council of Norway (RCN) (Norges forskningsråd)

The Research Council of Norway plays a vital role in developing and implementing the national research strategy. The Council acts as an advisory body to the government, identifying present and future needs for knowledge and research. In addition, it is a funding agency for independent research programmes and projects, strategic programmes at research institutes, and Norwegian participation in international research programmes; it is also a co-ordinator, initiating networks and promoting co-operation between R&D institutions, ministries, business and industry, public agencies and enterprises, other sources of funding, and users of research.

The RCN's role as an adviser includes strengthening the knowledge basis for the research and innovation policy. The national R&D and innovation statistics are a part of this responsibility.

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Statistics Norway (SSB)

Statistics Norway is the national agency for collection, processing and dissemination of official Norwegian statistics. Statistics Norway has a special responsibility to identify and place in order of priority the needs for official statistics, for coordination, for development of statistical methods, and for providing the statistics for the benefit of analysis and research. Official statistics shall meet the needs of the general public, businesses and the authorities for information about the structure, the development and the functioning of the Norwegian society.

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Science & Technology Indicators for Norway 2019

A national report of research and innovation indicators for Norway has been published regularly since 1997 and annually from 2009. This is an English version of the 2019 report, consisting of selected parts of the full Norwegian report. Data and analysis are based upon the results from the national 2017 statistical survey on resources devoted to research and experimental development (R&D) and Innovation survey as well as other statistics and studies. Time-series and international data are also included.

The purpose of the report is to present an overall description for non-Norwegian readers of Norway's performance and activity within science, technology and innovation. The data and analysis are structured around six chapters: the first chapter describes Norwegian R&D in an international context. The second chapter focuses on R&D in the Norwegian system. Chapter three discusses knowledge sharing and collaboration within research and development, while chapter four address education level and skills, especially regarding R&D personnel and doctorates. Chapter four presents indicators for innovation in the Norwegian industrial and public sector, as well as digitisation in the public sector. The sixth and final chapter discuss the status and challenges related to UN's Sustainable Development Goals (SDGs), especially for Norway, and examines the link between the SDGs and research areas prioritized by the Norwegian Government in the Long-Term Plan for Research and Higher Education.

The title and reference for the original report in Norwegian is: Det norske forsknings- og innovasjonssystemet – statistikk og indikatorer 2019, (ISBN 978-82-12-03810-3), published in Oslo, November 2019, by the Research Council of Norway. The report is the result of a collaboration between NIFU, Statistics Norway and the Research Council of Norway, where NIFU has the main editorial responsibility. Editors of the original report in Norwegian was Espen Solberg and Kaja Wendt, with Mona Nedberg Østby as editorial secretary. All of the above are from NIFU. Other members of the editorial committee were Svein Olav Nås and Tom Skyrud from the Research Council of Norway, Erik Fjærli, Kristine Langhoff and Lars Wilhelmsen from Statistics Norway, Knut Senneseth from Innovation Norway, Beate Rotefoss from SIVA and Magnus Otto Rønningen from the University of Oslo. The English version has been prepared by Frøydis Sæbø Steine (NIFU) and proofread by Chris Allinson at Allinson Editorial.

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