



Norwegian Ministry
of Education and Research

Meld. St. 5 (2022–2023) Report to the Storting (white paper)

Long-term plan for research and higher education 2023–2032

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Long-term plan for research and higher education 2023–2032

*Recommendation from the Ministry of Education and Research of 23 September 2022,
approved by the Council of State on the same date.
(The Støre Government)*

Part I
Objectives and priorities

1 The Government's policy for research and higher education

1.1 The Government's ambitions

The Government's objective is a democratic, sustainable society with high value creation, equitable distribution, a high degree of trust among the population and good public services all over Norway. Society should be based on a sound security policy. Participation in education and working life are the keys to fairer distribution, less exclusion, stronger civic engagement and personal liberation. Climate and nature considerations shall underlie all policies.

The Stoltenberg II Government took the initiative for the first long-term plan for research and higher education. The present long-term plan, the third of its kind, is published under circumstances that are very different from those surrounding the publication of its two predecessors. In 2022, we have a war in Europe, society is emerging from two years of coronavirus pandemic, there is an energy shortage and high energy prices, and the financial outlook is uncertain. At the same time, the major challenges that have been facing society for some time have become even more urgent. This concerns the climate and environmental crisis in particular, but also the demographic development with an aging population and centralisation trends that lead to a shortage of skills and expertise in parts of the country. These challenges intensify the need to restructure the economy, for example by promoting new business and industry.

In the present situation, the Government considers research and higher education to be more important than ever. We depend on research-based knowledge and expertise to understand and resolve the challenges facing society. The development of new knowledge through research, not least long-term basic research, provides much of the foundation we rely on in our management of challenges and crises. Norway's participation in international education and research collaboration is an important part of this.

The Government sets out three overall objectives and six thematic priorities for Norwegian research and education during the period 2023–2032.

The overall objectives are:

- enhancing competitiveness and innovation capacity
- environmental, social and economic sustainability
- high quality and accessibility in research and higher education

The thematic priorities are:

- oceans and coastal areas
- health
- climate, the environment and energy
- enabling and industrial technologies
- societal security and civil preparedness
- trust and community

Together, these objectives and priorities cover the areas where the Government sees the greatest need for knowledge development in the years ahead.

It is not enough simply to develop the knowledge, however. It must also be made available and applied in business and industry as well as in the public sector and in civil society. A lot of work remains to be done in that context. There has been an explosive growth in the amount of research published over the past decades, but society's ability to absorb the knowledge produced has not kept up.¹ When society does not adapt as necessary as quickly as we want it to, one of the reasons for this is that research and expertise are not sufficiently closely linked to the areas where they are needed. A recurring point in the present long-term plan is therefore that knowledge must be applied in society.

Among other things, more must be done to enable business and industry to apply research

¹ See e.g. Bornmann and Mutz (2015) and Mazzucato (2013).

and development, both to increase value creation and to resolve important societal challenges. The business and industry sector in Norway currently invests less in R&D than in many other countries. The Government has therefore announced that it will prepare a strategy for how to increase R&D investments to 2 per cent of GDP by 2030. An important question in this connection will be what the public sector can do to encourage business and industry to invest more in research and research-driven innovation.

In the present long-term plan, the Government is also launching a new policy instrument in the Norwegian research system to promote the practical application of research-based knowledge: *missions*. Missions are innovative and ambitious projects which combine research and other policy instruments to solve a concrete problem by a deadline. Norway is already taking part in the EU missions, and the Government is now also launching two national missions focusing on areas of priority:

- sustainable feed
- including more children and young people in education, employment and society

See Chapter 6 for a more detailed discussion of missions as a policy instrument. The two national missions are described in sections 3.3 and 3.6.

One of the crucial conditions for research-based knowledge being applied in society is that it enjoys a high level of trust. The general level of trust in research has been high in Norway for a long time, and it rose somewhat during the coronavirus pandemic.² However, we also see trends that give cause for concern. Academic freedom of expression comes under threat in certain contexts from different forms of pressure to conform. Incidents of harassment, threats and attempted cancellation have been reported, and it is sometimes questioned whether research is independent of political and financial interests.³ The widespread use of temporary employment in academic positions, for example, could lead to self-censorship and a tendency to conformity in academic communities.⁴ We also see that excessive pressure to publish and a quest for sensational findings, when combined with inadequate sharing of data, could result in findings that cannot be reproduced by others.⁵ Many of these challenges must be tack-

led by the academic communities themselves. However, trust in research is so vital to society that the Government wants to draw attention to the matter. See Chapter 7 for more details.

1.2 Challenges and trends

The long-term plan has a ten-year time horizon, but is revised every four years to take account of political and societal change. The world has undergone fundamental changes since the first two long-term plans were published. Five areas in which developments have had a major impact on this long-term plan are briefly described below.

1.2.1 Security

Norway should be a safe country to live in. The coronavirus pandemic had major consequences for society as a whole, and Russia's war against Ukraine and other geopolitical developments, such as the ascent of China, have given rise to lasting changes in the international system, both in terms of security policy and economics. Terrorism, cyberattacks, supply disruptions and serious natural events resulting from climate change are all part of the known range of threats we must continue to protect ourselves against. We must also prepare for unknown and complex threats and crises.

1.2.2 Climate and loss of natural diversity

The climate is becoming increasingly unpredictable, nature is disappearing, extreme weather events are occurring more frequently, and biodiversity is under threat. These are all consequences of society's overconsumption of natural resources. We urgently need to find good and effective solutions to cut greenhouse gas emissions and adapt to climate change. We need to ensure an equitable transition with legitimacy among the population to a low-emission society where we preserve ecosystems and natural diversity. Norway is in a unique position to tackle the climate and nature crisis because of the country's abundant natural resources and other environmental assets both on land and at sea, high level of expertise in technology development and other fields, and excellent preconditions for developing emission-free production industry. We must seize these opportunities.

² Research Council of Norway (2022a).

³ Thue et al. (2022).

⁴ Ibid.

⁵ See e.g. Baker (2015).

1.2.3 Energy

Norway is an energy nation. The energy industries – the petroleum and renewable energy industries – are Norway’s biggest industries, as they have been for decades. However, the period since the publication of the last long-term plan has been characterised by more volatile energy markets, and the Russian invasion of Ukraine has exacerbated these challenges. The economic, social and political consequences are significant. Europe is facing a massive energy transition in order to achieve its climate targets, and the EU aims to become independent of gas imports from Russia. Access to clean, reasonably priced renewable energy has long been a competitive advantage for Norwegian industry and a boon to Norwegian households. The Norwegian continental shelf will be a stable long-term supplier of oil and gas to Europe during an extremely demanding time. The development of new industries such as offshore wind power, hydrogen and carbon capture and storage can build on and develop expertise and technology from the already established industries.

1.2.4 Trust

Trust is the glue that holds society together. When people feel that they can trust each other and the authorities, they develop a sense of community, solidarity, good democratic processes and high value creation. If the level of trust drops, major problems will soon ensue. Distrust can easily trigger demands for control measures to be implemented, and considerable resources will then be required to manage the resulting tension and conflict on a continuous basis. The high transaction costs of societies characterised by low levels of trust inhibit engagement, willingness to invest and optimism for the future.⁶ Over the past decade, we have seen worrying tendencies towards polarisation and declining trust in different parts of the world, including Western countries. The general level of trust is high in Norway, but even here we see a certain tension in some areas.⁷ The Government’s view is that we should be on our guard against such tension and tendencies towards polarisation being allowed to develop. The key is timely prevention, particularly because declining trust can be self-reinforcing.

⁶ Fukuyama (1996).

⁷ OECD (2022a).

1.2.5 Demographics

Falling birth rates in combination with higher life expectancies have gradually changed the composition of the Norwegian population. This development is reflected in many other countries. On average, populations are aging and the proportion who are of working age is falling. We spend longer time on our education, and the period of retirement has grown considerably. On the other hand, the Pension Reform and higher level of education have contributed to elderly people continuing to work for longer than they did a couple of decades ago. This is not enough to make up for the shifting composition of the population and the increase in life expectancy, however.

In combination with other factors, these demographic changes have resulted in a shortage of labour, not least of highly qualified labour.⁸ A high employment rate is desirable, but a shortage of labour will significantly restrict society’s value creation. This shortage is most keenly felt in rural areas where the recruitment base is smaller, but it will eventually affect more central areas as well.⁹ The capacity in higher education will have to be adapted to take account of these changes.

In addition to the five trends mentioned here, there is constant development in other important areas of society, not least the economy and technology, where digitalisation is a key feature.

1.3 More about the objectives and priorities

The Government’s assessment of social development, in particular the trends mentioned above, form an important background to the new long-term plan. The long-term plan is also based on extensive rounds of input and a knowledge base prepared by the following, among others: the Research Council of Norway (the Research Council), the Norwegian Directorate for Higher Education and Skills (HK-dir), the Norwegian Agency for Quality Assurance in Education – NOKUT, the Sikt – Norwegian Agency for Shared Services in Education and Research, the OECD and several Norwegian research communities. A lot of inter-departmental work has gone into defining the knowledge needs. Several ministries have their own research or knowledge strategies that have been used. Based on the above, the Government

⁸ Official Norwegian Report (NOU) 2020: 2.

⁹ Official Norwegian Report (NOU) 2020: 12.

has set the new overall objectives and priorities for the long-term plan.

The objectives are set at an overarching level and are intended to be long-term objectives. There is a high degree of continuity from previous long-term plans, but some adjustments have been made. The objective of *enhancing competitiveness and innovation capacity* is vital in enabling Norway to succeed in the transitions facing us, and has been retained unchanged. This objective encompasses broad generic initiatives and priorities in the field of research and higher education. The previous wording of ‘tackling major societal challenges’ has been replaced by the objective of *environmental, social and economic sustainability*. The long-term plan thus emphasises the sustainability perspective and also links it to Norway’s international work. The objective of *high quality and accessibility in research and higher education* still involves an ambition for more ‘academic and research communities of outstanding quality’, which was the wording of the previous objective. More and more Norwegian research communities are holding their own at the international top level and succeeding in international competition. It is the Government’s ambition to increase the number of outstanding academic and research communities, and it will facilitate policy instruments that help them to keep up the good work. The wording of this objective also signals that the Government has ambitions to make improvements across Norwegian and Sami research and higher education. The objectives are discussed in more detail in Chapter 2.

The thematic priorities in the long-term plan are areas where the Government considers it particularly important for Norway to invest in research and higher education in the years ahead. Two of the priorities – *climate, the environment and energy* and *enabling and industrial technologies* – have been carried over from the previous plans. However, there have also been some changes. *Societal security and civil preparedness* and *health* have come to the fore as areas of particular importance in our time, and they have been made separate priorities. We have added *coastal areas* so that *oceans and coastal areas* are seen in conjunction with each other. The priority *trust and community* is new and represents a continuation of several elements from previous plans, including research and expertise on the public sector, and gears them towards two traditionally strong aspects of Norwegian society that the Government considers it vital to secure through research and higher education in the years ahead. Each of

the priorities’ knowledge needs and measures are described in more detail in Chapter 3.

1.4 A well-functioning knowledge system

We depend on a well-functioning research and higher education sector in order to follow up the objectives and priorities in the long-term plan. In Norway, we are lucky enough to live in a society that has stepped up its investments in research, development and higher education over many years of economic growth and with broad political support. In recent years, there has been a significant increase in expenditure on higher education measured as a percentage of GDP, see Figure 1.1, which shows the most recent OECD figures available from 2018.

Figure 1.2 shows that Norway’s level of public funding for research and development (R&D) is among the highest in the world. In 2019, the year before the coronavirus pandemic, South Korea was the only country to use more public funds than Norway as a percentage of GDP on research and development.

The Government’s view is that Norway should continue a high level of investment in research and higher education. Moreover, intensified efforts are required in several areas. We will have less financial scope of action in the coming years, however, so these investments must be accommodated within the applicable budget. This situation makes it even more crucial than before to get the highest – and best – possible return on society’s investments in the form of research and higher education. This long-term plan therefore places greater emphasis on the workings of the knowledge system than the previous plans did.

Overall responsibility for the Norwegian knowledge system for research and higher education rests with the Ministry of Education and Research.¹⁰ The sector principle for research means that each ministry is responsible for research funding within its areas of responsibility, while the Ministry of Education and Research is responsible for coordinating research policy and also has a particular responsibility for basic research and cross-sector research. See Figures 1.3 and 1.4 for an overview of the ministries’ R&D allocations. The Ministry of Education and

¹⁰ The term ‘knowledge system’ is also used in other contexts. In the present long-term plan, it is used to refer to research and higher education.

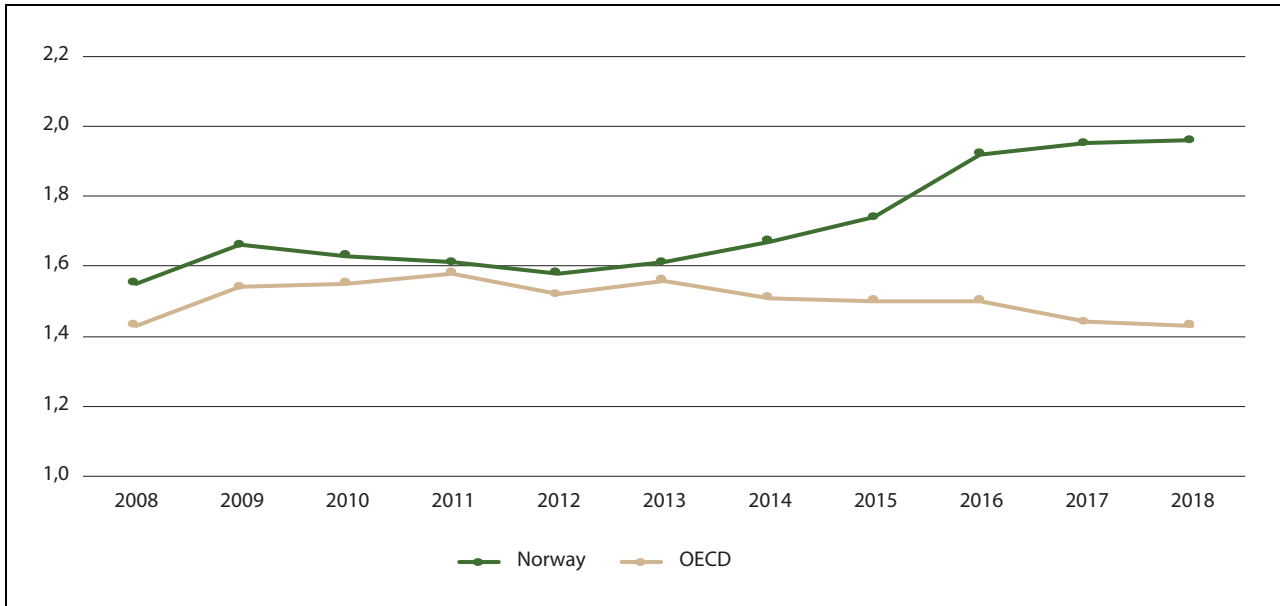


Figure 1.1 Expenditure on higher education as percentages of GDP during the period 2008–2018.

Source: OECD

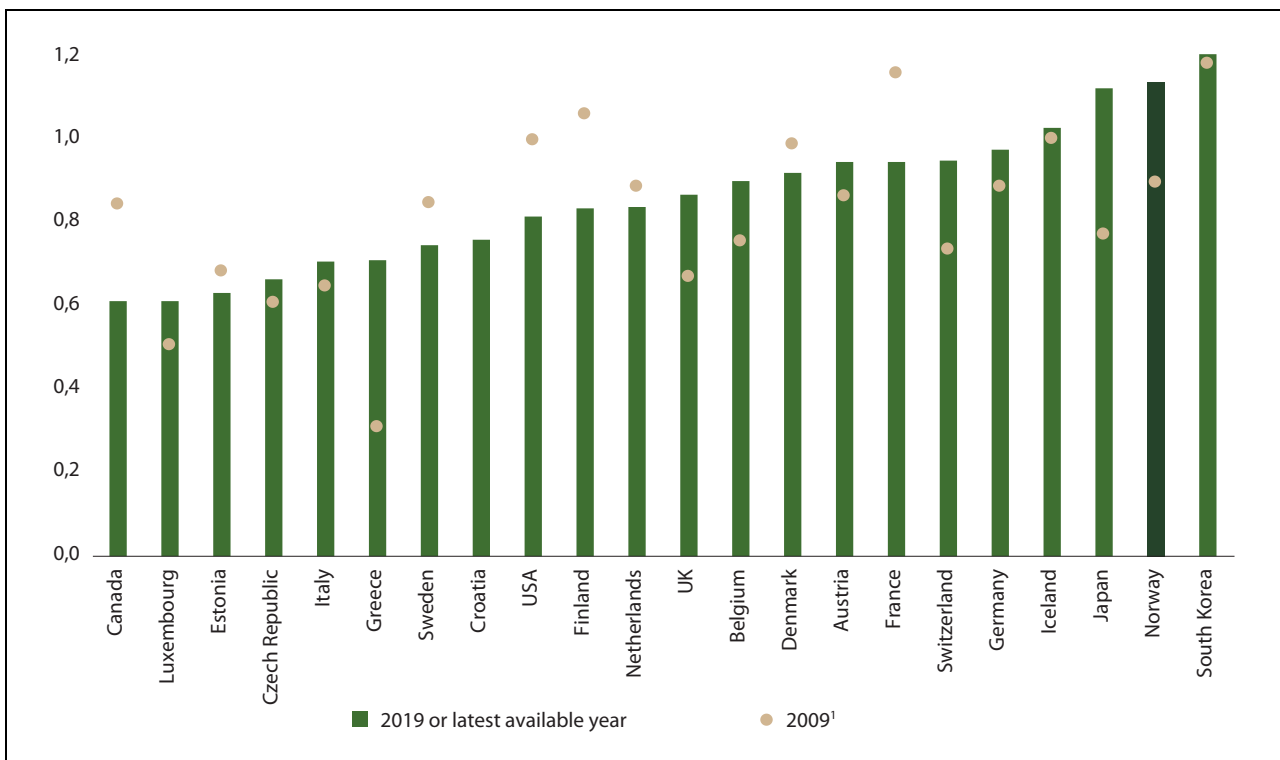


Figure 1.2 Public R&D funding, including tax incentives for enterprise R&D, 2009 and 2019. Per cent of GDP.

¹ For Greece and Switzerland, 2010 figures were used as the basis for comparison.

Source: OECD

Research has overall responsibility for higher education and tertiary vocational education (vocational colleges), but which skills are needed in the different sectors of society is also an important consideration in this context.

As well as the research and higher education institutions, the Research Council of Norway, HK-dir, NOKUT and Sikt are also key strategic parties to the implementation of the long-term plan. As regards the state universities and university col-

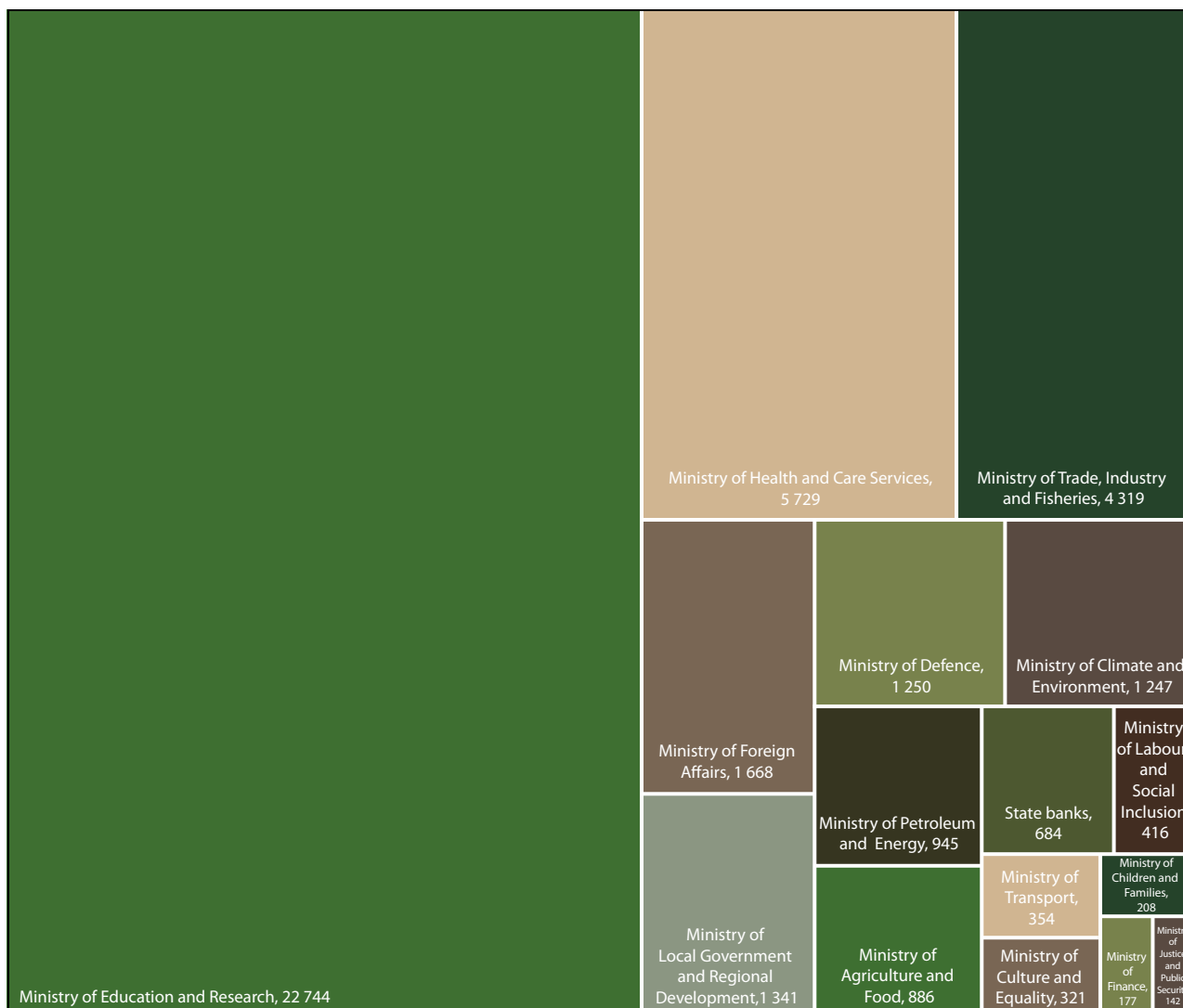


Figure 1.3 Research and development in the national budget for 2022 by ministry (in NOK million)

Source: National budget analysis/Statistics Norway

leges, they have been given new sector objectives that match the objectives set out in the long-term plan. Development agreements between the Ministry of Education and Research and the state universities and university colleges are intended to help the sector to follow up areas that are strategically important when it comes to achieving the sector objectives and the long-term plan's priorities. See Chapter 5 for details. The institute sector possesses vital expertise on how to resolve the major challenges facing society. This gives the institutes a key role in the follow-up of the plan.

The long-term plan's overall objectives and thematic priorities tally well with the priorities of the European research collaboration facilitated by the EU. It is important to ensure that the policy instruments in the Norwegian research system are coordinated with those in the European sys-

tem so that we can get the most out of the resources invested. Research and higher education have both become international activities, and more use should be made of the opportunities for international cooperation, whether through European or Nordic forums, through bilateral collaboration, or under the auspices of international organisations such as the UN or the OECD.

The Norwegian knowledge system has many strong sides, including a sound public funding foundation, but it also has its challenges and some room for improvement. This long-term plan therefore contains a separate Part 2 on the knowledge system in which the Government discusses the need and plans for a new research and higher education policy based on, among other things, the need to ensure that resources are utilised more efficiently. We need to put measures in place to

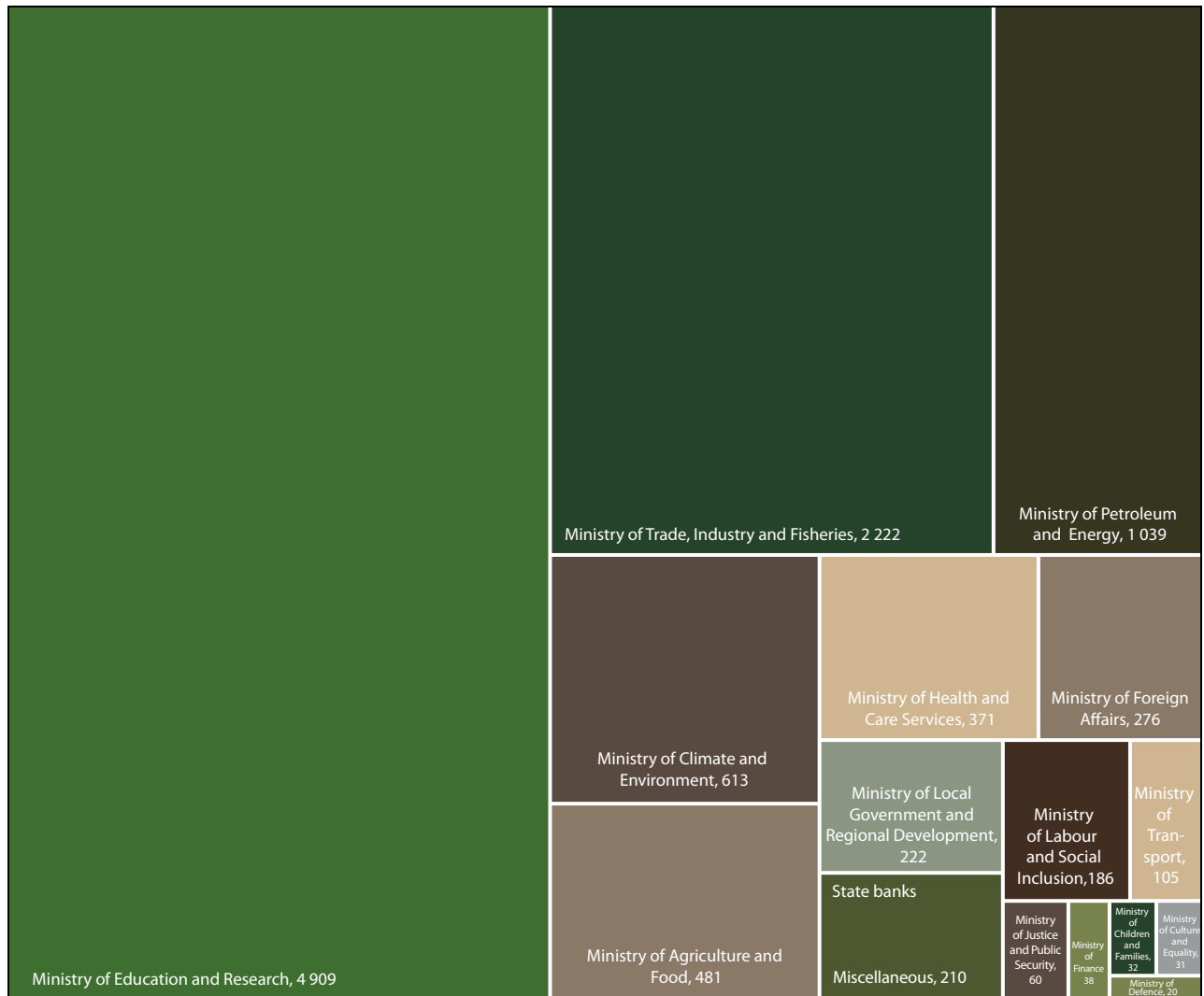


Figure 1.4 Allocations to the Research Council of Norway in 2022 by ministry (in NOK million)

Source: National budget analysis/Statistics Norway

ensure that the R&D system functions better and that dimensioning of higher education takes more account of society's needs. We also need better policy instruments for applying the knowledge (including missions) and good, resource-efficient data infrastructure and building solutions.

1.5 Follow-up of the new long-term plan

Since there will be less financial room for manoeuvre in public sector budgets in the time ahead, more of the follow-up of the long-term plan than before will have to be done using existing resources and reordering priorities. The Government expects the ministries, policy agencies and publicly funded research and higher education

institutions to follow up the objectives and priorities of the long-term plan using the resources available to them at all times, considering their capabilities and areas of responsibility. The Government will consider the need for further follow-up in the annual national budgets.

It has long been a political goal for R&D investment to equal 3 per cent of GDP, and for the public sector to cover 1 per cent, while business and industry should cover 2 per cent. These goals remain unchanged. At the same time, goal achievement should be considered over a longer period and based on a normal situation. Exceptional situations such as the coronavirus crisis or the present war in Ukraine can have a significant positive or negative impact that does not provide a fair picture of goal achievement in the longer term.

1.6 Reporting on the previous long-term plan

The Long-term Plan for Research and Higher Education 2019–2028 was published in autumn 2018. During the period 2019–2022, the plan was followed up with funding in the amount of approx. NOK 3.3 billion. This includes both new allocations proposed by the Government, additional funding allocated during the Storting's consideration of the budget and funds reallocated within the budgets. Just under NOK 1.6 billion of these funds were allocated to the follow-up of the three escalation plans for *technology initiative*, *R&D on renewal and restructuring in the business sector* and *enhanced quality in higher education*.

Figure 1.5 shows how the objectives and long-term priorities were followed up during the period. When we consider follow-up in both education and research, the priorities that experienced the greatest growth were *enabling and industrial technologies* and *public sector renewal and better public services* and *public sector renewal and better public services*. *Climate, the environment and clean energy* and *better public services*. *Climate, the environment*

and *clean energy* was the priority with the greatest growth in research investments. *Societal security and social cohesion in a globalised world* was the priority that received the least follow-up in the form of increased allocations.

About NOK 1.8 billion of the funding was spent on escalation in research, while NOK 1.4 billion were spent on education. A significant proportion of the funds spent on follow-up in the education sector went to student places and increasing the number of places in the following years.

In total, the R&D allocations increased by NOK 4.3 billion during the four-year period. Some of the increase was related to the coronavirus pandemic and growing expenses associated with Norway's participation in Horizon Europe. The total R&D allocations include funding for research and development in subordinate agencies and construction projects in the university and university college sector, as well as fees for Norway's participation in international basic research organisations and Horizon Europe.

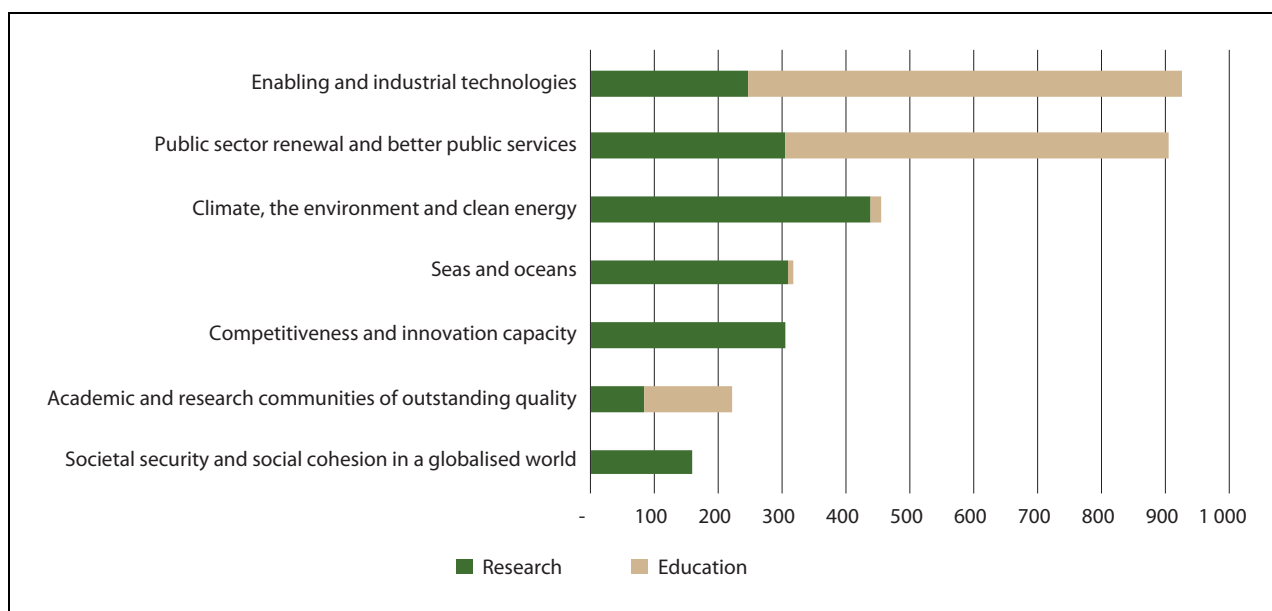


Figure 1.5 Follow-up of objectives and long-term priorities in the long-term plan for research and higher education during the period 2019–2022. NOK million.

2 Overall objectives

This chapter provides a more detailed description of the three overall objectives set out in the long-term plan. The objectives apply to Norwegian and Sami research and higher education throughout the plan period and to all subject areas, including the six thematic priorities described in more detail in the following chapter.

2.1 Enhancing competitiveness and innovation capacity

Research, development, innovation and higher education are crucial to society's value creation, not least now that the economy and society are undergoing a green and digital transition. In the years ahead, the Government will therefore do more to enable business and industry as well as the public sector to explore and implement knowledge and technology.

Research-driven innovation is an important source of transformation and absolutely vital to ensure future value creation and resolve the challenges facing society. Strong research and knowledge communities and well-developed international knowledge collaboration are key factors in this work. The Government bases its policy on a broad understanding of the concept of innovation. The term is understood to cover innovation in goods, services, processes, organisational models and communication, be it in the private or public sector or social innovation in civil society. Innovation work requires sound and relevant expertise, dialogue about knowledge development and effective regulatory frameworks. Innovation takes place in an interaction between different parties that is stimulated by cooperation, sharing and competition. Relevant parties will often be customers, suppliers, competitors, financial institutions, knowledge institutions, consultants, public authorities and social entrepreneurs. The public sector is to be developed by means of targeted, relevant measures and services to citizens and users based on research and knowledge, efficient resource utilisation and a high level of trust. To this end, dialogue with the population on chal-

lenges and knowledge-based solutions will be strengthened.

More research and development in business and industry and in the public sector

The ability to develop and apply new knowledge is a key to transition in existing industries and a basis for new ones. That is why this ability is one of Norwegian business and industry's most important competitive factors. R&D investment in the business sector has seen a positive development in recent years. However, Norwegian business and industry continue to invest less overall in R&D than the average for the OECD countries.¹

Public allocations to business and industry's own R&D projects often trigger R&D investments from the business community. The Government will therefore prioritise supporting business and industry's own R&D projects. The Government will also facilitate commercialisation and research-based start-ups in public knowledge communities. The commercialisation will help new knowledge-intensive enterprises to emerge in established as well as new industries.

Knowledge-based innovation and development in the public sector are crucial in order to protect democracy, ensure a sustainable welfare society and contribute to the green transition. The public sector accounts for more than half the economy, making it both a major market and an important partner for the private sector. An innovative public sector, both at central government and local level, is therefore important to the economy of society as a whole, including to competitiveness in the private sector.

Research is an important driver for innovation and public sector development, but the current scope is not enough to meet the needs or take full advantage of the assumed potential. Research on, in and with the public sector is important to the outcome of innovation work as well as to the Government's trust reform. Indicators show that public sector innovation that takes place in coopera-

¹ Research Council of Norway (2022b).

tion with the research sector has better effects in the form of higher quality, increased employee satisfaction, better political goal achievement, increased user participation and greater efficiency.² It is also important to mobilise the municipal sector to intensify its research efforts.

There is great potential for more cooperation on research-driven innovation both in the private and in the public sector. Many research institutions and communities can contribute here. The institute sector, for example, has long experience of providing a high level of research expertise of relevance to enterprises' concrete needs.

Green and digital transition

Norway shall be a low-emission society by 2050, and the Government aims to reduce Norway's emissions by 55 per cent by 2030. These are highly ambitious goals, and business and industry as well as the public sector have an important role to play in the green transition. A parallel digitalisation initiative will support and enable the transition. In addition to the national knowledge initiatives, Norway is participating in a major green and digital transition initiative through Horizon Europe, the European Research Area (ERA), Erasmus+ and the European Education Area. Our participation in European collaborative efforts and our own national efforts must be seen in conjunction with each other to support goal achievement.

Norwegian business and industry are in a good position to contribute to the green transition. The Norwegian labour force is well educated, the capital markets largely function well, and healthy competition contributes to innovation and high efficiency. These factors help to make change processes easier and reduce the costs of transition. Norway also has an abundance of renewable biological resources that can form a basis for new green business and industry and climate-friendly products.

The public sector can continue to use its significant purchasing power to procure green and sustainable solutions, for example through schemes such as innovation partnerships, pre-commercial procurements and other innovative forms of procurement. Efforts to promote more climate and environmentally friendly business and industry activities will help to boost green competitiveness, which can be a plus for Norwegian business and

industry in national as well as global markets as more and more importance is attached to environmental considerations.

The Government wants to facilitate a general shift towards more climate and environmentally friendly solutions throughout Norway in Norwegian business and industry's research and innovation activities. Green transition and a more efficient and circular economy with more reuse can contribute to the creation of new industry and new jobs, as well as reduce pressure on our natural resources. The Government will prioritise green innovation projects in order to stimulate a green transition in business and industry. Green transition and competitiveness are guiding principles of the targeted schemes Green Platform Initiative and green growth loans, among other things.

The Government will introduce the principle that projects that receive funding from business-oriented policy instruments shall have a place in the process towards the 2030 transition target and that Norway shall be a low-emission society by 2050. This principle covers both projects with neutral effect and projects with a positive effect on the green transition and is thus no obstacle to supporting good projects for example in the petroleum industry. The policy instruments are to mobilise good projects that contribute to the green transition or address other important purposes, including in relation to the areas mentioned in the Government's roadmap to the Green Industrial Initiative.

Digitalisation will strengthen the competitiveness of business and industry and make society more productive through the green transition. Research-based knowledge, technology and ICT skills will help to change or create new products, production methods and business models. Digitalisation is moving fast and leaving its mark on the business sector in general and industrial development in particular, which presents great opportunities for many sectors.

Although the Norwegian public sector is among the most digitalised in the world, there is still room for improvement. Several public sector bodies are already using solutions based on artificial intelligence to provide more targeted and user-oriented services, increase the benefit of their activities to society, rationalise operations and work processes, and reduce risks. The use of artificial intelligence will probably continue to increase in future, which means that Norway will need more people with expertise on artificial intelligence and machine learning, among other things. Keeping up with these developments is

² National Centre for Public-Private Sector Innovation (2022).

hard, particularly for many of the small enterprises, and both specialised and more flexible study programmes will be required in this area.

Huge amounts of data are generated as a result of increased digitalisation, more use of sensors and more digital value chains. These data could be a highly valuable resource for future innovation and value creation, in marketing and in automated production. Public sector bodies also generate large quantities of data. Norway has good register data for many areas of society and good systems for sharing data. Good data management facilitates business development as well as a more efficient and user-centred public sector. Better data utilisation will also help Norway to succeed with its transition to a more sustainable society and a greener economy. Report No 22 to the Storting (2020–2021) *Data as a resource – The data-driven economy and innovation*, which was considered by the Storting in spring 2021, highlights the ambition for data to increase value creation throughout Norway. The goals and measures described in this report are intended to help to ensure that society as a whole can benefit from the value of the data and that they are used in a responsible and trustworthy manner. See also Chapter 8 on infrastructure and data sharing.

High quality in research and higher education as well as sound and relevant expertise are important in order to succeed with the green and digital transition, but more is required. In order to suc-

ceed with research-driven innovation in this field, it is also necessary to ensure good framework conditions and facilitate the interaction between Norwegian and international knowledge communities, business and industry, and the public sector. The partnership and missions in Horizon Europe and the national missions are important arenas for such interaction.

2.1.1 Measures

The Government will:

- present a strategy setting out that research and development in business and industry shall amount to 2 per cent of GDP by 2030
- prioritise supporting business and industry's own R&D projects
- continue to make education more work-relevant based on regional and national needs by facilitating more systematic dialogue and interaction
- use research and higher education to promote competitive green industries all over Norway
- ensure good Norwegian participation in EU knowledge initiatives for green and digital transition in Europe
- strengthen the knowledge base of research and innovation policy for the private and public sectors

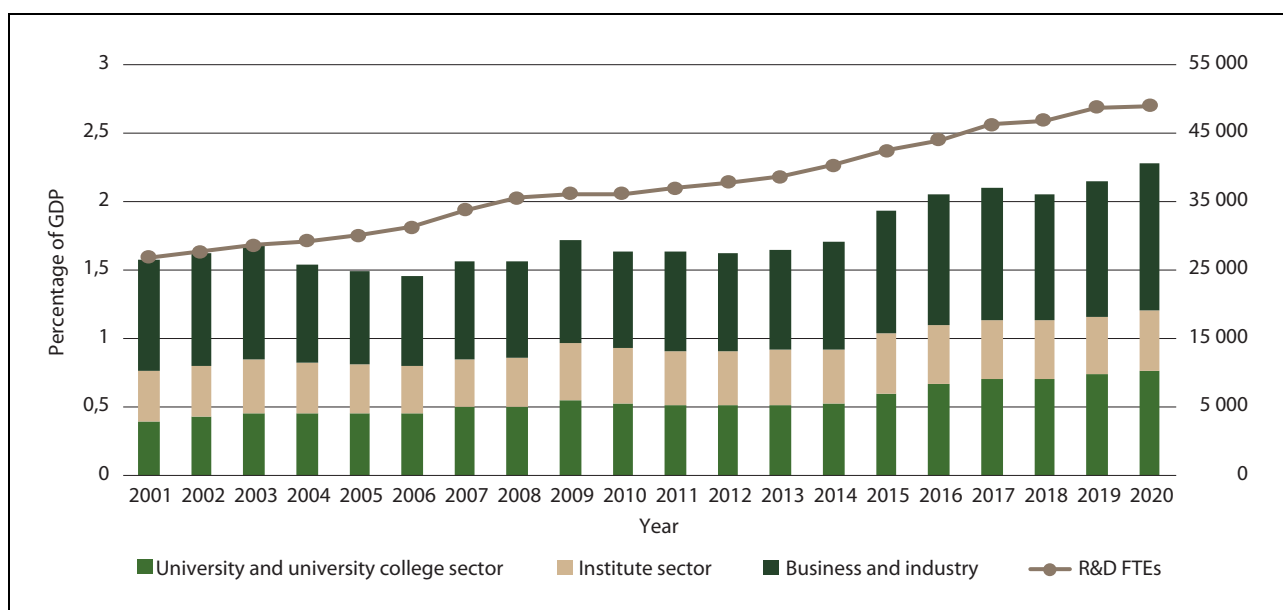


Figure 2.1 Total R&D expenditure as a proportion of GDP by sector and development in R&D full-time equivalents 2001–2020. Percentages and numbers.

In the R&D statistics, health trusts and regional health authorities are included under the university and university college sector (university hospitals) and the institute sector (other health trusts and private non-profit hospitals).

Source: Statistics Norway/NIFU, R&D statistics

- mobilise more actors from the full range of Norwegian business and industry as well as from the public sector, including the municipal sector, to participate and invest more in research and development

2.2 Environmental, social and economic sustainability

The Brundtland Commission put sustainable development on the global political agenda in 1987. Its ideas were based on research-based knowledge that the complex systems that we humans depend on must be balanced to be able to develop well over time. These systems include the ecosystems as well as economic and social systems. If the systems are pushed beyond a sustainable level, we risk not only gradually weakening the systems, but also triggering self-reinforcing mechanisms that will eventually cause them to break down.

This way of thinking about sustainability formed the backdrop when the UN in 2015 adopted what is known as the 2030 Agenda, which is a global action plan for sustainable development. The 2030 Agenda for Sustainable Development has been put into more concrete terms in the form of 17 Sustainable Development Goals and 169 sub-goals aimed at achieving sustainable development along three dimensions: economic, social and environmental.

Report No 40 to the Storting (2020–2021) *Mål med mening* ('Meaningful goals' – in Norwegian only) is an action plan for Norway's efforts to

achieve the Sustainable Development Goals. This white paper describes how the Sustainable Development Goals can be understood in a Norwegian context and based on Norway's political goals. The white paper was considered by the Storting in April 2022, see Recommendation No 218 to the Storting (2021–2022). The Government has delegated responsibility for the 17 Sustainable Development Goals and pertaining sub-goals to the relevant sector ministries, which will follow up the measures adopted by the Storting.

We need even more knowledge about how to address considerations for society, the environment and the economy in the ongoing green transition. Change and development in one sector can have major, and sometimes unintended, consequences in other sectors of society. A comprehensive approach is therefore required. As emphasised in much of the feedback on the long-term plan, we need more interdisciplinary, cross-sectoral and international collaboration.

The great challenges facing society are global and cross-sectoral in nature, but at the same time they have local roots. This sometimes means that there are difficult decisions to be made when different interests must be weighed against each other, for example considerations for global greenhouse gas emissions on the one hand and local nature or indigenous people's traditional livelihoods on the other. The knowledge base underlying such balancing acts must be as good and consensual as possible.

The European Green Deal is intended to transform the EU into a resource-efficient and competitive economy, and it is an important part of the EU



Figure 2.2 The Sustainable Development Goals

Source: www.regjeringen.no

strategy for implementing the UN 2030 Agenda and the Sustainable Development Goals. Norway supports the vision of the European Green Deal and will be a partner in this work.

Environmental sustainability

Environmental sustainability means taking care of the climate, nature and other environmental assets for future generations. However, several major global knowledge reports show that the climate is changing, that the environment and natural diversity are under threat, and that developments are heading in the wrong direction.³ The most recent reports from the UN Intergovernmental Panel on Climate Change conclude that our very existence is at stake, and that those who are most vulnerable will suffer the most. These challenges can only be resolved through fundamental changes to society, and we do not have much time to act to ensure a sustainable future.

Ambitious emissions targets and preservation of natural diversity must be balanced against sustainable use and management of land and environmental resources. A prerequisite for restructuring the Norwegian economy is that it must be done within the limits defined by the Paris Agreement and consideration for sustainable resource use. Norway must reduce its global footprint and help to reduce greenhouse gas emissions and the pressure on nature.

The state of Norwegian ecosystems is good overall, but we also have challenges associated with loss of natural diversity in Norway. The most important threats to species and types of nature are man-made changes in land use. However, the most economically important fish stocks are sustainably managed, and petroleum production is subject to strict environmental requirements.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service (IPBES) points out that nature can be preserved, restored and used in a sustainable manner without coming into conflict with other societal goals, but that new and better solutions require new knowledge in many areas. We need knowledge about nature, the climate and sustainable management, and we also need knowledge about human behaviour if we are to succeed in achieving fair and effective restructuring. What knowledge and skills will be needed in the time ahead and the Government's priorities in the areas of *oceans and*

coastal areas and climate, the environment and energy are explored in more detail in sections 3.1 and 3.3.

Social sustainability

Modern society is developing at a rapid pace, and the continuous process of social, cultural, demographic and technological change is impacting on the way we live. At the same time, the social contract between individuals and society rests on respect for certain fundamental values, such as justice, equality and freedom for individuals. Social sustainability is about people and the conditions that allow them to enjoy good health and quality of life. It is also about society developing in the right direction with equitable distribution of benefits and burdens. As we have seen in other countries, injustice and exclusion, regional conflicts and tension between urban and rural areas can lead to polarisation and tendencies towards social dissolution. Political instability will in turn make it more difficult to achieve the environmental sustainability goals.

We are in a good position to maintain social sustainability in Norway, but there are nevertheless some trends that give grounds for concern. The knowledge needs in the time ahead and the Government's priorities relating to *trust and community* are explored in more detail in section 3.6.

Economic sustainability

Economically sustainable development is about ensuring the financial security of people and societies within the bounds of what the planet can tolerate. Report No 14 to the Storting (2020–2021) *Long-Term Perspectives on the Norwegian Economy 2021* notes that there will be fewer people of working age to support each retiree in the time ahead. The state's expenditure on pensions and health and care services will increase, while the growth in tax revenues will slow down in step with the growth in the number of people in employment. These challenges will apply all over Norway, but will impact rural areas hardest. Compared to other countries, Norway is in a good position to deal with these challenges and undertake the necessary restructuring, however.

Development and innovation has contributed to Norway becoming the modern welfare state it is today. Going forward, we must facilitate change within sustainable economic limits. Sustainable welfare requires knowledge and prioritisation. A

³ IPCC (2022), IPBES (2019), UN Environment (2021), UN Environment (2019).

good education system and extensive research and development efforts will support innovation and fresh thinking. The Government will work to promote sound economic development throughout Norway.

2.3 High quality and accessibility in research and higher education

Norwegian research and higher education must be of high quality and accessible to those who need it if we are to achieve the competitiveness, innovation capacity and sustainability goals described above. It is also a goal in itself for Norway as a knowledge nation to have academically strong and well developed research and higher education systems. We shall have world-leading expert communities in certain areas and ensure high quality across the full range of research and higher education. The Government will lay a sound foundation for developing more outstanding academic and research communities and raise the quality of research and education. The Government will also ensure good access to research and education throughout Norway and fulfil its obligations in relation to Sami research and higher education. Good conditions will be put in place both for long-term basic research and thematic research. Moreover, Norway's education and research collaboration with the rest of Europe and priority partner countries outside the EU will be continued and developed.⁴ Norway must also contribute to international knowledge cooperation on shared challenges, particularly in the areas that fall within the scope of the objectives and priorities described in the present long-term plan.

Quality and accessibility in research

The quality assurance systems used by the research communities themselves, such as peer review of publications, projects and appointments, are key tools for promoting and measuring quality of research. Systematic subject evaluations also generate important knowledge about the status in the field. On the basis of this knowledge, the OECD concludes that the quality of Norwegian research has improved in recent years and that the challenge going forward is to maintain quality

at this level and keep up policy instruments for excellence in research, while doing more to facilitate application of the knowledge generated.⁵ Many institutions now have top communities with a very high level of expertise that they can use in their own strategic as well as academic development work going forward.

The most important task for decision-makers in the knowledge system is to contribute to well-functioning systems, structures, policy instruments and regulatory frameworks that will enable the research communities to produce research of the highest possible quality. The goal should be to become world-leading in areas with such potential. In any case, research must be conducted in a professionally and methodically satisfactory manner and be of consistently high quality. It must also be ensured that the quality does not drop below a critical limit that could reduce confidence in research. The Government would therefore like to include in the present long-term plan an overall discussion of some aspects of the research system that would benefit from further development. See Chapter 5 for more details.

Generally speaking, good quality of research depends on a well-functioning R&D system. This means good interaction between researcher-initiated and user-initiated research, between basic and applied research, innovation and commercialisation, and between different institutions engaged in research, such as universities, university colleges, institutes, health trusts and regional health authorities, and enterprises. It is important that these institutions have a long-term perspective, strategic priorities, modern infrastructure and the required expertise. Also, researchers must be guaranteed good working conditions and sufficient operating funds for their research activities. All these factors must be in place to enable the expert communities to work on complex and ambitious ideas and thus be attractive partners for Norwegian and international partners inside and outside academia. As the challenges facing society become more and more complex, research approaches must become increasingly interdisciplinary. It is often not enough to study technical factors in isolation. It may also be necessary to consider the social and cultural aspects of, for example, climate measures or public services. As a rule, all relevant disciplines, such as social sciences, the humanities and law, should therefore be involved in all interdisciplinary projects.

⁴ Ministry of Education and Research (2021a), Ministry of Education and Research (2021e), Report No 7 to the Storting (2020–2021), Ministry of Education and Research (2021f).

⁵ Larrue and Santos (2022).

Research-based teaching is another factor that strengthens quality of research. Such teaching allows students to contribute innovative and fresh perspectives, which is important in enabling future researchers to develop their skills already during their studies.

Together, the research institutions should contribute the knowledge and skills required by the different sectors of society. A high degree of accessibility in the Norwegian research system means that research-based knowledge should be easily accessible to both the general public and enterprises of all sizes across Norway. This can be achieved by means of open access to publications, evidence syntheses, research dissemination via the media or direct contact with researchers, for example through contract research, citizen participation or other forms of cooperation.

Quality and accessibility in higher education

Quality in higher education covers students' learning outcomes, completion rates and the labour market relevance of study programmes. The Norwegian universities and university colleges have seen a positive quality development in recent years. A lot of work has gone into ensuring coherence and cohesion in study programmes, developing more student-active learning methods and introducing digital tools. Results in some areas remain inadequate, however.⁶

Universities and university colleges educate graduates who should be able to meet the current skills needs as well as new needs triggered by social and technological change. Those who are students today will be involved in developing the labour market of the future with their professional

expertise and generic skills such as critical and analytical thinking, information processing, and innovation and entrepreneurship. Institutions that cooperate well with the labour market and other stakeholders gain good insight into which skills are needed. Cooperation will thus make it easier to create attractive and relevant study programmes throughout Norway.

Higher education is also a means of personal development and liberation and should promote civic engagement, taking control of one's own life and contributing to the development of society. Higher education offers students the opportunity to realise their potential, both in a personal and social sense, by acquiring sound academic knowledge and practising fact-based argumentation, among other skills. The classic academic goal of formative education will remain a key focus of higher education in Norway. See also Chapter 7 on academic freedom and trust in research.

Norway falls below the average for OECD countries in terms of growth in the proportion of the population that has completed higher education. The reasons for this are complex.⁷ If development continues at the same pace as over the past ten years, the proportion of the population aged 25–34 that has completed higher education will fall below the average for OECD countries in 2033. However, educational propensity has increased somewhat in recent years, particularly in 2020. This is linked to the coronavirus pandemic, among other things. In 2022, 11.8 per cent of qualified applicants had not been offered a place after the supplementary admission round.⁸

Educational capacity is dimensioned with a view to covering student demand for education and the labour market's need for qualified labour

⁶ Report No 16 to the Storting (2020–2021), HK-dir (2022b), NOKUT (2022), NOKUT (2021).

⁷ OECD (2019), OECD (2021).

⁸ Norwegian Universities and Colleges Admission Service (2022).

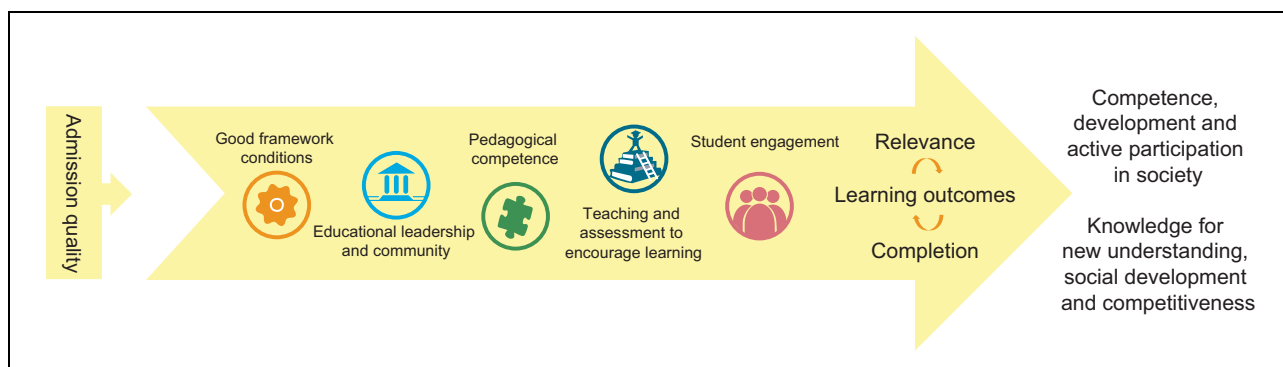


Figure 2.3 Factors of significance to quality in higher education

Source: Report No 16 to the Storting (2016–2017) *Quality Culture in Higher Education* (white paper on quality in higher education)

throughout Norway. The institutions are responsible for adjusting their capacity accordingly. This means that they need to know the skills needs of the different regional labour markets. To that end, they must be in dialogue with regional authorities and parties that know of skills needs and shortages of qualified labour. It will not be possible to fund future growth in educational capacity in priority areas based on increased allocations alone. The institutions themselves will contribute by reordering priorities within their own budgets as required. See Chapter 4 for a more detailed discussion of educational capacity.

The Government will maintain a decentralised structure and contribute to better quality of education and lifelong learning. Services throughout Norway must be based on high-quality research and education. A closer connection between programmes of education and local enterprises will help to make the programmes more relevant. According to the demographics committee behind Official Norwegian Report NOU 2020: 15 *Det*

handler om Norge – Utredning om konsekvenser av demografiutfordringer i distriktene ('It's about Norway – report on the consequences of demographic challenges in rural areas' – in Norwegian only), the availability of local expertise is the most important factor in the establishment of local knowledge enterprises.

The Government is working to improve access to flexible study programmes that can be taken as further or continuing education in combination with employment. Lifelong learning and flexible and decentralised studies form an important part of the institutions' social mission. Digital technology and digital teaching methods must be used to adapt study programmes to regional and local needs to make both the study programmes and skills more accessible.⁹

⁹ Ministry of Education and Research (2021b) and Ministry of Education and Research (2021c).

3 Thematic priorities

The six thematic priorities presented in this chapter are areas in which the Government considers it particularly important for Norway to make strategic investments in research and higher education in the years ahead. For each priority, we describe the associated challenges and knowledge needs going forward, before concluding by describing planned measures and follow-up.

3.1 Oceans and coastal areas

The oceans and coastal areas of the world provide us with food, energy, jobs, natural and cultural experiences, and they are the key to achieving several of the UN Sustainable Development Goals. The oceans cover 70 per cent of the Earth's surface and are home to a wealth of species and ecosystems with a wide range of natural assets. Ocean currents connect the oceans, we share fish stocks with neighbouring countries, and maritime transport links continents. Transport by sea is important to the ocean-based industries and contributes to the national and international flow of goods. The oceans play a very important role in the climate system, as they provide about half the world's oxygen production and absorb about 25–30 per cent of our annual CO₂ emissions. At the same time, our oceans are under pressure from climate change, pollution, overconsumption of harvestable resources and loss of natural diversity. Norwegian ocean areas are also under pressure, but with the exception of some coastal areas, the general state of Norwegian waters is good. Conditions vary more in other countries' waters and in international waters. Different ocean areas are facing different challenges, which highlights the importance of targeted knowledge and expertise adapted to different oceans and coastal areas as well as different purposes.

The oceans present great opportunities for fulfilling the world's food, energy and transport needs in a sustainable manner. Norway has a particular management responsibility in the Arctic and Antarctic regions, and our ocean-based industries are world-leading in the fields of petroleum

production, shipping, fisheries and aquaculture. Norway is home to very strong research communities in all of these areas, and we have sound educational institutions that contribute to a high level of expertise across this range of industries. These communities and institutions also contribute to the understanding and management of the oceans and coastal areas. The education programmes need to impart specific as well as generic knowledge and skills, and it is important that people already in employment have the chance to update their knowledge and skills.

The projects that receive support under the Research Council's Oceans research portfolio are deemed to be of high quality and relevance. Norway is also achieving excellent results in the competition for European research funding, and we play a key role in developing and coordinating important initiatives and partnerships. We also engage in extensive research collaboration with countries outside Europe.¹ Based on the above, it is natural that we should have ambitions to further develop our knowledge about ecological relationships in the sea going forward. We should also make research results more accessible and applicable, for example by devoting more attention to data sharing and standardisation of systems.

The UN Decade of Ocean Science for Sustainable Development (2021–2030) forms an important context for work on the thematic priority of oceans and coastal areas. Norway's contribution to this effort aims to strengthen national as well as international expertise in the field. Norway's participation in the EU mission 'Restore our Ocean and Waters by 2030' will also be important for achieving the goal of a healthier ocean where greenhouse gas emissions and marine litter are reduced. The opportunity to utilise marine resources in a sustainable manner is closely linked to a good environmental status. The High Level Panel for a Sustainable Ocean Economy (the Ocean Panel), chaired by Norway and Palau, have pointed out the link between the ocean economy, good ocean management and abundant and

¹ Research Council of Norway (2022d).

clean oceans. An important part of Norway's development cooperation policy is to promote sustainable oceans, and knowledge and research must contribute to making our efforts as effective as possible.

3.1.1 Main challenges and knowledge needs

3.1.1.1 Oceans, climate and the environment

Integrated ocean management

The management of Norway's ocean areas is based on sound knowledge. However, many aspects of the ocean and coastal environments are poorly understood, and we must continue to build knowledge and expertise. Further developing our understanding of the ocean and coastal areas is vital to managing marine ecosystems in a sustainable manner.

The oceans play an important role in regulating the climate and slowing down global warming by absorbing excess heat and CO₂. However, excessive absorption of heat and CO₂ from the atmosphere has a detrimental effect on marine life. Under an ecosystem-based ocean and coastal area management regime, we have to consider the consequences of climate change in conjunction with other impact factors. We must also adapt and strengthen the management regime when climate and environmental conditions change. Climate change poses new challenges when it comes to ensuring that the overall management and resource utilisation are sustainable. At the same time, the existing knowledge base must be further developed to support our ocean management.

Growing challenges related to ocean and climate, including loss of natural diversity, ocean acidification, environmental toxins, plastic pollution and other impact factors, affect the dynamics and function of ecosystems, and must be met with measures to keep marine ecosystems robust and productive. We need more knowledge about and a better understanding of how the ecosystems function and interact, as well as how they are affected by the sum of different impact factors. Norway emphasises a knowledge-based, integrated and responsible ocean and coastal management regime that builds on a sound knowledge base obtained through mapping, research and environmental monitoring.

We also need better methods for monitoring changes and assessing the overall pressure and impact on marine ecosystems. Efficient data collection will enable us to obtain better knowledge more quickly about the status of and changes in

the ocean. Increased digitalisation and use of artificial intelligence are important to make efficient use of large quantities of data. We can also use more data from environmental monitoring in research.

It is important to make active use of existing knowledge and make it accessible and understandable to relevant users. Using the knowledge in ocean management systems is useful because it introduces new approaches and drives further knowledge development. In some fields, using knowledge syntheses can provide new insight and benefit management. International management brings together different states, organisations and political cultures. This triggers a need to see different disciplines in conjunction with each other. We need to develop more knowledge about the integrated management of oceans and coastal areas through research in social sciences, the humanities and law, among other disciplines.

Oceans and climate

Marine nature conservation is important for building robust marine ecosystems and ensuring natural diversity, biological production capacity and a basis for harvesting. This will require us to further develop our knowledge about conservation measures and sustainable use of marine nature. Knowledge about oceans and climate is especially relevant in this context, particularly considering how climate change affects the oceans and ecosystems and how they absorb greenhouse gases. This knowledge is important for assessing nature-based carbon capture and storage solutions. Seaweed, kelp and eelgrass are often referred to as the 'blue forest'. Along with other plants and phytoplankton in the sea, the blue forest is valuable from a climate perspective because it absorbs and stores CO₂. Seawater and marine plants account for about half of all CO₂ absorption. Marine plants and phytoplankton also produce half the Earth's oxygen. Increased knowledge about the significance of the blue forest in the climate context and sustainable seaweed management and cultivation could contribute to carbon capture as well as to the development of new business activities. The interaction between the climate and the environment is an important topic in the Decade of Ocean Science. Understanding how the blue forest is impacted by and impacts the ecosystem, carbon budget and human activity is important to understanding this interaction. Another relevant topic is ecosystem accounting, which entails putting a

value on marine ecosystems and ecosystem services.

Increasing ocean acidification resulting from CO₂ absorption is one of the consequences of greenhouse gas emissions, and we therefore need more knowledge about its effects on marine life. The importance of conservation and restoration measures to restore functions and make marine ecosystems robust to climate impacts is a key area of research when it comes to developing ocean management. Preventing damage by alien organisms is a topic that requires sound knowledge of the dispersal routes and ecological impact of such species, including under changed climatic conditions.

Ocean warming leads to changes in marine ecosystems. Arctic species are pushed further north, while Atlantic species have expanded their geographical range. In Norwegian waters, these changes are particularly evident in the northernmost areas and the Arctic Ocean. There has been a rapid decline in sea ice levels in recent decades, both in terms of extent and thickness, and open ocean is becoming increasingly dominant. We therefore need knowledge about how the ocean currents, carbon cycle and fish migrations develop in the Arctic Ocean when it is only covered in ice during winter. This fundamental knowledge is needed in order to understand and manage the consequences of climate and ecosystem-related changes for fisheries and society.

Carbon storage in sediments on the seabed is attracting more and more attention, but we still do not know enough about the implications of such processes. More knowledge is needed about carbon storage in the seabed and about the emission impact of activities that affect the seabed.

Many circumstances combine to create a great demand for critical metals and rare earth elements: the green transition, electrification, digitalisation, batteries and renewable energy sources. Many of the minerals and metals needed for such purposes can be found on the seabed. Research and technology development is required to make commercial extraction of seabed minerals a reality, and to enable such activities to be carried out in a sustainable manner.

Environmental toxins and pollution

Limiting marine pollution is important to safeguard ocean health, ensure safe food production and conserve marine ecosystems. Knowledge documenting the prevalence and effects of harmful chemical substances in the environment leads

to new substances constantly being identified as environmental toxins. Environmental monitoring and documentation of toxicological effects and overall ecosystem impacts form an important basis for good international regulation of environmental toxins.

The term ‘plastic pollution’ covers plastic waste of all sizes, all the way down to microplastics and nanoplastics, that has ended up in the environment. Plastic production and the quantities that end up in the oceans are increasing rapidly. Plastics are not easily broken down in nature, and they pose a threat to marine life, living resources, safe seafood and human use of the sea in many different ways. There is also concern about how microplastics and nanoplastics affect humans and animals. The international community has adopted a process and a mandate for negotiating a global treaty to end plastic pollution through the United Nations Environment Assembly. The treaty text is scheduled to be completed in 2024. Consensual knowledge and application of knowledge will be crucial to such a treaty, among other things in relation to measurement methods, indicators, reporting and statistics on environmental status and discharges. Other relevant topics include the spread and impact of plastics in the environment, the link to environmental toxins and alien organisms, and the health effects of plastics. We also need knowledge about sustainable alternatives to plastics, the consequences of replacing plastics with other materials and effective measures to prevent plastic pollution. The Norwegian Plastics Strategy, published in June 2021, describes several knowledge needs that will be prioritised in the time ahead. Plastic pollution is an area where measures and knowledge are developing at a rapid pace. Any research initiatives must therefore be sufficiently flexible to accommodate this.

Environmental monitoring technology

New technologies and methods for environmental monitoring of ocean areas can lead to huge leaps in development in terms of data material, data quantities and knowledge production, not least in relation to environmental conditions that are changing under the influence of climate change. New technologies and methods can also lead to more effective knowledge production. Surveying and environmental monitoring also provide data that can form a basis for research. Monitoring of how human activity impacts the marine environment, and what effects this impact is having, must

be further developed. We also need to further develop our understanding of what is caused by the impact of activities in ocean areas or adjoining coastal and land areas, what is caused by climate change and other extensive changes, and what is caused by natural processes and variation in the oceans. Ocean surveying and monitoring is also a field where we need to develop better and more cost-effective methods. If Norwegian actors develop new environmental monitoring methods and technologies, this could give them an advantage and an opportunity to supply an international market.

3.1.1.2 *Increasing value creation by means of sustainable management of ocean-based industries*

Ocean-based industries account for a significant proportion of Norway's value creation and employment. The ocean-based industries contributed a total of NOK 680.9 billion in value added in 2019, which accounts for about 19 per cent of the total economy. Fisheries and aquaculture alone were responsible for export value of approx. NOK 120.8 billion in 2021. We are not alone at sea, however – these resources are managed in cooperation with other countries.

The ocean connects us to the rest of the world

Pollution and environmental toxins from emissions on land and at sea spread over large areas. If we are to safeguard and strengthen the oceans' function as a source of food, fundamental ecosystem services, value creation and employment, we must manage them in a sustainable manner and ensure sustainable business and industry both on land and at sea. We have undertaken through the Ocean Panel to ensure sustainable management of all our waters by 2025.

There is a continuous need for research on and development of management regimes, national as well as international ones. It is important to take a comprehensive perspective on how we impact the oceans and the marine environment, as well as on how industries impact each other. The management systems and regulatory frameworks of the future should be developed in such a way as to stimulate innovation and encourage the industries' value chains to build systems for efficient utilisation of resources and a more circular economy that can help to keep our footprints within acceptable limits. Many of the ocean-based value chains are currently international and involve multinational commercial enterprises, which makes international cooperation on research and framework conditions

Box 3.1 Ocean Space Centre

If Norway is to continue to be a leading nation in ocean-based industries, it is important to have laboratories to help these industries to continue to develop.

The Norwegian University of Science and Technology's (NTNU) current marine technology laboratories at Tyholt in Trondheim is the largest facility in Europe for teaching, research and equipment development in its field. The research facility is used for teaching, basic research, commissioned research and innovation. The upgrading of NTNU's marine technology laboratories is the most important national knowledge investment in future value creation in ocean-based industries.

The new facility at Tyholt, Ocean Space Centre (OSC), will secure value creation for Norway by ensuring competitive ocean space industries. The OSC will make Norwegian ocean space industries more productive by means of:

- knowledge and technology development
- knowledge externalities
- a world-leading educational environment
- contributions to restructuring in business and industry

The OSC will be an important knowledge, research and educational environment for Trondheim and for Norway as a whole. The centre will also be an important part of the European research infrastructure.

The OSC will include machinery and marine structures laboratories, two basins (an ocean laboratory and an ocean basin laboratory), and a fjord laboratory (comprising three hubs: in the Trondheimsfjord, off the islands Hitra/Frøya and off Ålesund). The centre will also have teaching rooms, student laboratories and offices. NTNU will manage the centre and run it in collaboration with Sintef. The budget for the project is just over NOK 8 billion.

for the management of marine resources absolutely vital.

Education, research and innovation all have important parts to play in relation to our oceans. Education programmes must incorporate the continuous flow of new and relevant knowledge about sustainability, and the knowledge must be shared and exchanged with other countries. Research and innovation are particularly important when it comes to finding and developing solutions that lower the overall environmental impact, but without excessive implications for the costs of business and industry and our welfare. These solutions comprise both technology and better ways of working that address the circular economy. It is also important that research on the Law of the Sea and important management mechanisms contributes forward-looking insights. The management systems must be adapted to the context in which they are to function, which also requires perspectives from the humanities and social sciences. This makes research and education in these disciplines important, too. Furthermore, the management of oceans and coastal areas must consider the coexistence of different industries at sea and along the coast. This research requires costly high-quality infrastructure that must be used as efficiently as possible. This applies to research vessels, instruments and equipment, research stations, satellites etc.

Coexistence in our ocean and coastal areas

Developing sustainable ocean-based industries is very challenging. The needs of existing industries such as fisheries, aquaculture, transport and the petroleum industry must be addressed while new industries are established. Examples of new industries include offshore wind power, offshore aquaculture, subsea storage of CO₂, deep-sea mining for minerals, crab fishing in the Barents Sea, harvesting of the plankton species *Calanus finmarchicus* and new mesopelagic species and cultivation of seaweed, molluscs and tunicates. Successful coexistence between industries and sustainable management are required in order to utilise the ocean's full commercial potential. We therefore need to know more about how existing and new industries impact each other and the ecosystems. Climate change is currently having a significant impact on our ocean, coastal and fjord systems, and our management of ocean-based industries will have to take this impact into account. Fisheries are affected by fish stocks changing their migration patterns, and increased tempera-

ture and run-off affect the situation in the aquaculture industry. This requires the continuous development of research on fish stocks as well as aquaculture. We also need more knowledge about seabed conditions in relevant areas and about the effects of offshore wind power and deep-sea mineral mining on marine resources, nature and other industries. An up-to-date survey and overview of important spawning grounds will be one of many important knowledge tools.

Large areas are required to cultivate seaweed, kelp, tunicates etc., and this makes it challenging for such activities to coexist with recreational outdoor pursuits as well as with other industries. More research should therefore be conducted on the effects of this industry and on possibilities for good and effective area allocation in the coastal zone. Further research would also be welcome on possible ways of combining seaweed and mollusc production with different forms of aquaculture and offshore wind power.

In addition to research on the technological and scientific aspects, we also need input from social science research to ensure that the regulatory framework is designed in a good manner. Among other things, we need to know what effect digitalisation and new technology will have on the risks associated with different business activities. Efficient coexistence between sectors depends on them sharing data with each other and coordinating digitalisation efforts, for example by using common data standards.

Safeguarding the ocean as a source of food – sustainable growth in fisheries and aquaculture

Food from the sea will be crucial to ensuring a sufficient food supply for the growing global population. Seafood is also beneficial from a nutritional and health perspective, as well as from a climate perspective. Better use can be made of marine food production, both for animal and human consumption, by harvesting and cultivating marine species at a lower trophic level. However, a number of challenges must be resolved in order to ensure that products are safe and healthy. We must ensure continuous monitoring of the content of nutrients and contaminants in seafood, and new knowledge and new innovations are required to make optimum use of these resources.

We also need new knowledge about the combined public health effects of contaminants and nutrients in fish and other seafood. More knowledge of causal connections is needed in order to

minimise the risk of excessive amounts of contaminants in food and feed.

It is important to develop technologies and methods to monitor and detect toxic algae, environmental toxins and plastic pollution. At the same time, it is important to generate knowledge that can help us to find and eliminate the sources of, and develop technologies that can remove, harmful components from food and feed. We also need to understand how seafood value chains impact the climate and how big their footprints are. Knowledge about the importance of sustainable seafood production in a national and global food safety and nutrition perspective must be strengthened.

Sustainable fisheries depend on good research on stocks and resources in the ocean, along the coast and in the fjords, and these are priority areas in marine research. The basis for this research is the plans for growth in aquaculture through new forms of operation. New knowledge about sustainability and fish welfare is crucial to the success of this ambition. We need to know more about how to get robust fish with a high survival rate. New marine business opportunities that could provide more food and feed include cultivating seaweed, kelp, tunicates etc. Any excess nutrient salts will be absorbed in the course of such production.

Sustainable marine food production depends on the availability of feed with low greenhouse gas emissions. High-quality feed must be developed that ensures food that is safe for consumers and that is good for the environment. Feed production from more local sources must be increased, and resources must be utilised in a more efficient and circular manner. New and innovative solutions for more advanced processing will be important in developing this industry in Norway. Increased sustainable feed production in Norway will open up possibilities for employment and export of technology. The mission of sustainable feed for farmed fish and livestock is discussed under the priority *climate, the environment and energy*.

3.1.1.3 *Climate and environmentally friendly maritime transport*

Norway is a leading maritime nation, and Norwegian shipping companies operate in a global market. It is our ambition to halve emissions from domestic shipping and fishing vessels by 2030 compared with the 2005 level. This means encouraging the use of zero-emission and low-emission solutions in all vessel categories, cf. Report No 13

to the Storting (2020–2021) *Norway's Climate Action Plan for 2021–2030*.

Norwegian shipping must be restructured in order to meet national and international climate commitments, and its decarbonisation is only just beginning.² Zero-emission vessels make up about 1 per cent of all Norwegian ships, while 23 per cent have hybrid electric propulsion systems, run on liquefied natural gas (LNG) or use other low-emission solutions, for example diesel-electric engines on offshore vessels.

The Government expects the maritime policy to contribute to the development of world-leading Norwegian industrial and expert communities. The authorities will, in cooperation with the industry, ensure that zero-emission and low-emission shipping becomes an important Norwegian contribution to reducing global emissions. Investing in green shipping will also contribute to value creation and employment in Norway.

The national research and innovation strategy Maritim21 recommends intensifying efforts to digitalise the maritime sector, developing low-emission and zero-emission solutions and working across maritime value chains. Norway is participating in the Zero-Emission Shipping Mission, which is a public-private innovation alliance under the global initiative Mission Innovation. The target is for at least 5 per cent of the global deep sea fleet to run on zero-emission fuels by 2030. Norway has also signed the Clydebank Declaration along with 21 other countries.³ The 22 signatories will work together to establish at least six green corridors by the middle of the present decade.

This development towards climate and environmentally friendly maritime transport requires new energy carriers and propulsion systems, solutions to improve energy efficiency, cleaning technologies to prevent emissions to air and discharges to sea, and digital solutions to rationalise shipping. This transition also requires zero-emission solutions to be developed and demonstrated for large vessels that cover long distances.

Cooperation across disciplines and operational expertise on safe use of new technology are also needed. The decarbonisation of the Norwegian and international fleets of vessels depends on access to new energy carriers and infrastructure in ports where ships call and refuel, and on green products and services throughout the maritime value chain.

² Menon Economics (2022).

³ UN Climate Change Conference UK (2021).

3.1.1.4 Reliable energy supply from the sea

The oil and gas industry is Norway's biggest single industry measured by value creation, central government revenue, investment and export value, and it contributes to economic activity all over Norway. The Government will continue to invest in energy and petroleum research, among other things in order to achieve the goals of reduced greenhouse gas emissions in Norway by 2030 and zero emissions by 2050. Energy and petroleum research is also expected to help Norway to achieve its goals for transition, new green industries and increased export revenues. Investments in petroleum research are intended to help the further development of the industry and ensure that it remains profitable in the future. The Government emphasises that exploration and recovery activities on the Norwegian continental shelf should be based on Norwegian world-leading technology that addresses weighty considerations for health, safety and the environment as well as coexistence with other industries.

Emissions from the continental shelf is to be reduced, and the Government's policy will actively support green a transition based on using expertise from the oil and gas industry in new industries. The authorities will, in cooperation with the petroleum industry, work to reduce emissions from oil and gas production on the Norwegian continental shelf by 50 per cent by 2030 and to net zero in 2050. Current knowledge indicates that reducing emissions by 50 per cent by 2030 will require investments in the order of tens of billions of Norwegian kroner. However, research and development will play an important role in work to reduce costs and find good solutions for emission reduction and restructuring.

Norway will continue to be a stable long-term supplier of oil and gas to Europe during an extremely demanding time. However, the Norwegian continental shelf has entered the mature phase and is set to gradually decrease production. About 50 per cent of the estimated total recoverable resources (including areas that have not been opened for petroleum activities) have already been produced. Research on geology and subsurface understanding is therefore important to increase value creation and recover the remaining resources on the Norwegian continental shelf. Such expertise also has transfer value to other industries and sectors of society.

Digitalisation will be important, as will the development of digital tools in order to enable better resource utilisation and contribute to energy

savings, lower greenhouse gas emissions and reduce risk during drilling. At the same time, it can be challenging to carry out overall assessments of the potential health and working environment consequences of changes that concern an increasing number of automated processes.

The petroleum and supplier industries have close links to strong research environments as well as expertise, knowledge and technology that will be needed in industrial development towards the green transition both on land and at sea. This expertise could thus be important to the Norwegian economy long after oil and gas production has come to an end. It will be important, however, to ensure that other and new industries make use of the expertise and technology possessed by the petroleum industry. For example, the Government is very ambitious when it comes to offshore wind power and other new industries, such as extraction of seabed minerals, carbon capture and storage, and blue hydrogen. These industries will also benefit greatly from the petroleum and supplier industries' expertise. The development of new sources of energy and new technology for the green transition is discussed in more detail under the priority *climate, the environment and energy*.

3.1.2 Measures and follow-up

The Government expects universities, university colleges, hospital trusts, regional health authorities and research institutes that receive public basic funding to follow up the thematic prioritisation of oceans and coastal areas and help to meet the knowledge and skills needs described above within their capabilities and areas of responsibility.

The Government will:

- give particular priority to the following areas of research and research-driven innovation:
 - technology and other solutions to increase the value of industries in ocean and coastal areas and on the continental shelf
 - coexistence between ocean-based industries and sound management of ecosystems and resources in ocean and coastal areas
 - the impact of climate change and the role of the ocean in the climate system, including in the Arctic Ocean
 - nature-based solutions for carbon capture and storage in the sea
 - clean and productive seas and healthy and safe seafood

- energy and petroleum research that contributes to green transition and low emissions and further develops the industry so that it remains profitable in future
- climate and environmentally friendly maritime transport based on the priorities of the Maritim21 strategy
- give particular priority to the following areas in higher education and skills:
 - relevant programmes of professional study and discipline programmes for ocean-based industries and the management and understanding of oceans and coastal areas
 - decentralised and flexible education
- launch a mission for the purpose of ensuring that all feed for farmed fish and livestock should come from sustainable sources (see the priority *climate, the environment and energy* for details)
- consider measures to make better use of large quantities of data, for example in connection with ocean management
- facilitate efficient utilisation of research vessels and other research infrastructure

3.2 Health

Good health and quality of life are prerequisites for a good life and for being able to contribute to and participate in society. This forms the basis for UN Sustainable Development Goal 3. There are several reasons why health is a separate priority in this long-term plan. The coronavirus pandemic and how it has been managed have demonstrated how important health is for society and for the economy, in addition to the purely health-related impact. The pandemic has also demonstrated the importance of basic research as well as how research and innovation actors play a crucial role in providing the knowledge required to deal with a health crisis.

Good public health is a prerequisite for the sustainable development of society. Social and gender inequities in health, demographic changes, development of the burden of disease with a high proportion of non-communicable diseases, growing health expenditure and a falling rate of employment all bring a more pressing need for knowledge-based public health work.

Public health, animal health, plant health, food production and our surrounding environment are closely linked, and this forms the basis for the concept of One Health. Throughout history, people have been able to overcome many serious

infectious diseases – including through measures targeting the environment. Climate change, globalisation, urbanisation and population growth mean that we must expect infectious diseases to spread more quickly and to more people worldwide. Complex health challenges cannot be resolved unless different disciplines, methods and ideas come together to form a greater whole. Such a scientific convergence must take account of these connections on a scale that we have hitherto not have succeeded in achieving.

Norway will have sustainable health and care services in the years ahead. However, a growing number of elderly people and changes in the burden of disease will increase pressure on these services going forward. Health and social service personnel are the most important input factor in the health and care services, and account for about two-thirds of the specialist health service expenditure. Projections indicate that, if the current use of personnel continues, the number of full-time equivalents needed will increase by about 35 per cent over the next 15 years.⁴ The capacity to train health and social service personnel and their expertise must correspond to the needs of the services and be organised in accordance with developments in demographics, burden of disease, the way in which services are organised and the development of new, knowledge-based treatment methods. At the same time, we cannot staff our way out of the consequences of demographic developments. The need for services can be reduced by placing greater emphasis on prevention and empowerment.

Health and care is the biggest thematic research area in Norway and the second largest area of education measured by student numbers. Norway is home to a growing health industry and big research and expert communities in life sciences, the study of cancer and neuroscience. Research is one of our hospitals' four main tasks, and the universities, university colleges and hospital trusts collaborate closely on health and care research. It is a goal to increase research in and on services at municipal and county authority level, as well as on factors that have a bearing on public health. Better use of public health data and health and register data through research can help to improve the quality of services, give us better overview of public health risk and impact factors, and help us to develop new and effective treatments. Using such data in cooperation with business and industry could increase Norway's

⁴ Hjemås et al. (2019).

value creation while also improving health. Sufficient capacity in the education system is another input factor required to strengthen research capacity.

Health as a priority in the long-term plan will promote measures in research and higher education that help to improve our ability to succeed in resolving the health and care challenges. The measures are intended to provide more knowledge, innovation, business development and skills development, a more interdisciplinary approach and better cooperation. Good interaction between policy instruments in several sectors is needed to resolve challenges and promote good human, animal, plant and environmental health. Prevention and ongoing efforts are important in preventing and dealing with crises. Crisis preparedness and management are discussed under the priority *societal security and civil preparedness*. Inclusive societies characterised by good childhoods, participation and employment are very important to health, and are primarily discussed under the priority *trust and community*.

3.2.1 Main challenges and knowledge needs

3.2.1.1 Public health challenges

Public health is crucial to the population's state of health and to the development of people's health and quality of life. Our health is influenced by society, and good health is primarily developed outside of the health and care services. The way in which society is organised and facilitates good health choices over the course of a life is crucial to public health. The social distribution of determinants for health development is also important.

Mental health issues and mental disorders are among our biggest public health challenges. More knowledge is needed about what is causing the increasing prevalence of mental health issues and mental disorders among young people, the consequences of this development and what action can be taken. It is also necessary to strengthen mental health literacy in the population to promote good mental health and prevent mental health problems. The long-term public health research efforts have two main priorities. The first is to obtain better public health data, including data on the burden of disease and how it is influenced by demographic trends. Among other things, research needs to become more representative of different population groups and make better use of links to register data. The second main priority is research on measures and

their health benefits, cost efficiency and any unintended consequences. The Norwegian programme for municipal public health work 2017–2027 is considered as a platform for developing a knowledge system for public health in the municipalities. Social sciences make significant contributions to research on prevention and has great potential for bolstering the success of public health efforts.

A good shared knowledge base requires good cooperation across different sectors as well as with business and industry. A knowledge system can give Norway a shared public health knowledge base that puts us in the best possible position to achieve national and international public health goals towards 2030. The content of the public health knowledge system will be described in more detail in the white paper on public health that is scheduled to be submitted in 2023.

Health issues may explain why many people are not in employment or education, not least mental health issues and disorders and musculoskeletal disorders. Despite having a relatively healthy population, Norway has a higher proportion of the population receiving health-related benefits than any other OECD country.⁵ We know a lot about the use of health-related benefits, but less about why the proportion is higher than in comparable countries. Research is still needed to elucidate links between health, the labour market and employment, as well as on the reasons why such a high proportion of the population is receiving health-related benefits.

The working environment can have a positive as well as a negative effect on the health of employees. In order to ensure a sustainable working life in future, it is vital to continue to develop knowledge about the working environment factors that promote health and those that constitute a potential risk of ill health and work-related sickness absence and dropout. We also need knowledge about what it takes to prevent ill health and its consequences.

Vulnerable children and young people are particularly at risk of developing ill health. For example, we know that children who are subject to child welfare service measures often also have a great need for health and care services. We need more knowledge about vulnerable children and young people, including risk factors, the effect of preventive measures and measures to counteract exclusion, marginalisation and mental and physical issues and illness. See the priority *trust and*

⁵ Report No 14 to the Storting (2020–2021).

community for more information about vulnerable children and young people.

Gender is a factor in health and health issues. We have to ensure that everyone who lives in Norway, regardless of gender, are given equal opportunities for the best possible health and receive safe, good health and care services when they need them. More research is needed on gender-related health differences and their causes. We also need more knowledge about trends that can cause undesirable gender inequities in health, with a particular focus on women's health.

In order to understand how changes to the climate and environment may impact public health in Norway, we need to facilitate cross-sector cooperation and a strong expert community that works in a comprehensive and systematic manner. This is also important in order to participate in health collaboration in the Horizon Europe programme.

The Government wants to fight infectious diseases and contribute to the funding, development and equitable distribution of vaccines and other technology that the market will not provide on its own. A global health project via the Research Council will fund research that can contribute to lasting improvement in the health of vulnerable groups in low-income and lower-middle-income countries. The project is also intended to contribute to ensuring that the knowledge is relevant for policy formation and practical use. Moreover, it will help to fulfil Norway's obligations under a new global health partnership in Horizon Europe, EU-Africa Global Health Partnership.

3.2.1.2 *The One Health approach*

The coronavirus pandemic has proven that animal and human health are interconnected. There is a great need for knowledge about the links between public health, animal health, plant health, food production and the environment (One Health). Transfer of diseases between animals and humans, either directly or via food, feed, water etc., could pose a threat to our health and welfare. The majority of new infectious diseases that occur in humans are diseases that have been transferred from animals (zoonoses).⁶ That is why we need knowledge that helps us to understand how and why pathogenic microorganisms are transferred between animals, humans and the environment on land, at the coast and in the sea. Such knowledge is important to enable us to monitor,

predict and prevent future disease outbreaks, and not least reduce the scale of consequences of such outbreaks. It is crucial that such knowledge is based on an interdisciplinary, cross-sector and comprehensive One Health approach.

A comprehensive approach is also vital in building robust, safe and sustainable food systems,⁷ which in turn are important to ensure good public health, animal and fish health and plant health, as well as safe food production and a safe environment. In order to continue to produce healthy and safe food in future, we need knowledge about the effects of climate change on Norway's food production and different production systems, among other things. We also need to know what effect climate change has on the use of new food and feed resources, new technology and new packaging solutions. Furthermore, we need more knowledge about the accumulation of environmental toxins and other contaminants in organisms and food chains, exposure to such substances and their potential harmful effects on health and the environment.

The fight against antimicrobial resistance (AMR), which is one of the greatest threats to global health, food safety and modern medicine, must also be based on an interdisciplinary and comprehensive approach to health. Incorrect use and overuse of antibiotics mean that more infections, both in humans and animals, are becoming increasingly difficult to treat, and this could in turn lead to longer hospital stays, increased health and care expenses, increased mortality and poorer animal health and animal welfare. Therefore, we need to know more about how we can reduce the need for and use of antibiotics and how to prevent resistant bacteria from spreading. We also need more knowledge about alternatives to antibiotics, infection control measures and vaccines in preventive work among animals as well as humans, and measures to limit the spread of infections. Research is also sorely needed on the role the environment plays in the development and spread of resistant bacteria and resistant genes, and how they are transferred in and between the land and the sea, including humans, domesticated and wild animals. New knowledge in these areas will help to prevent major outbreaks of disease and reduce the use of antibiotics and other pharmaceuticals. The knowledge will also ensure that we use medication in the correct way to deal with and minimise the challenges posed by resistance.

⁶ IPBES (2020).

⁷ See UN (2012).

3.2.1.3 Sustainability of services under pressure

A lack of qualified personnel is a challenge that several parts of the health and care services is already facing, particularly in rural areas.⁸ The needs for health and social service personnel will follow developments in the burden of disease, which is influenced by demographic trends such as increasing life expectancy, lower birth rates and certain migration patterns. At the same time, the demographic trends will also affect the availability of personnel. This comes on top of growth in the use of health and care services among younger users, which increases pressure on health and care services. Mental health and substance abuse services in particular are seeing growing demand. Priority will therefore be given to health and social service personnel who specialise in this area during the present plan period. The content of the study programmes that educate the health personnel Norway needs must also meet the needs of a health and care sector undergoing rapid development. The overall composition of skills and personnel will therefore vary over time. New personnel groups will be required, and some of the traditional ones will become less important. The Government has appointed the Health Personnel Commission for the purpose of establishing a knowledge base and proposing targeted measures for the years ahead to educate, recruit and retain qualified personnel in health and care services all over Norway. The intention is to address the short-term and long-term challenges facing the health and care services.

The National Curriculum Regulations for Norwegian Health and Welfare Education (RETHOS) project is developing national guidelines for health and social work education programmes. RETHOS is based on cooperation between the university and university college sector, the service sector and students to produce graduates whose skills meets the services' needs. The project will be evaluated during the period 2023–2025. The systems that are to estimate the overall need for health and social service personnel and the need for different groups of personnel, including any new types of personnel, must be developed to meet the service needs. The content and capacity of the health and social work programmes must also be organised to meet the service needs. Decentralised education models could improve local recruitment and form important elements of

the efforts to recruit health and social service personnel to rural areas.⁹

If health-related tasks are carried out in the same way and using the same composition of personnel in future as they are today, simply increasing the educational capacity and staffing of health and care services will not be sustainable. Changes in society mean that services must be provided in new ways. Innovation and cooperation with business and industry will be key factors in creating sustainable health and care services all over Norway.

However, changes to the organisation, task-sharing and use of labour-saving innovations require health and social service personnel to take part in development and innovation work and in the implementation of the solutions arrived at. We also need knowledge communities that can help to evaluate the effects as new innovations are implemented and spread. Among other things, they can make systematic use of health data to assess effects. These communities must therefore include health sciences such as medicine and life science, but it will also be relevant to involve the humanities and social sciences in these knowledge communities. Contributions from the humanities and social sciences can be important to ensure that the sector implements knowledge and measures, and in connection with cooperation and ethical user participation.

Clinical training plays a vital part in achieving the learning outcomes for many study programmes that educate healthcare professionals, and a lack of clinical training places is often the factor that limits the possibility to increase educational capacity. This requires closer, more dynamic and binding local cooperation between educational institutions and the health and care services to ensure that all relevant learning arenas are used. Improving quality and increasing capacity in clinical training placements in the municipalities are crucial if we are to educate a sufficient number of qualified staff for the health and welfare services. The Government has therefore entered into a bilateral cooperation agreement with the Norwegian Association of Local and Regional Authorities (KS) to raise quality and capacity in practical and clinical training placements for health and social work students. It will also be necessary to make the most of the scope for using other solutions, such as simulation, to boost capacity and quality in clinical training.

⁸ Official Norwegian Report (NOU) 2020: 15.

⁹ Official Norwegian Report (NOU) 2020: 15.

Box 3.2 Health Pilot

Health Pilot contributes to sustainability in health and care services and value creation in the Norwegian health industry. In Health Pilot, the public sector works with enterprises to create innovation based on the needs of patients, the population or the public health services. The goal is to bring new solutions to the patients and populations sooner. The Research Council of Norway is leading the work in close collaboration with the regional health authorities, the Norwegian Association of Local and Regional Authorities (KS), represented by the organisation's strategic research agency (KSF), and Industrial Development Corporation of Norway (SIVA) on the calls for proposals and subsequent evaluations. Innovation Norway is also contributing to the work. The cooperation is organised through a reference group that helps to ensure that the scheme addresses clear needs, own strategies and that the actors take responsibility for mobilisation and the further development of the scheme. Health Pilot has already contributed to more dialogue and interaction between the health industry and health services and mobilised applicants for this and other relevant schemes. Health Pilot will achieve multiple goals at the same time because the scheme facilitates big collaborative projects aimed at resolving concrete challenges by mobilising across several services levels, disciplines and sectors.

3.2.1.4 Research is insufficiently integrated into services

Evidence-based practice is based on clinical and practice-based research. Moreover, participation in research and discipline development is important in order to recruit and retain all groups of health personnel across service levels, in somatic as well as mental health and substance abuse services. The Government wants discipline development and research to be a realistic possibility and career path for all professions in the health and care services.

Clinical studies are not sufficiently integrated into clinical practice and patient treatment, and one of the ways in which this becomes evident is that the systems used for treatment purposes are

not compatible with research needs. National and local medical quality registers and research registers are used in some of the clinical research carried out in hospitals. In this context, better correspondence between definitions of variables, more automated reporting and better data sharing procedures and cooperation are required. Clinical research will become a more integral part of patient treatment as part of the follow-up of the *National Action Plan for Clinical Trials 2021–2025*.

Increased use of personalised medicine will make advanced decision support tools and analysis and interpretation of register data part of the patient treatment. Research trials as part of the patient care pathway represent a great potential for developing new diagnostic and treatment methods. However, broader application of personalised medicine within different disciplines and areas of technology will require expertise, infrastructure, better ICT solutions, cross-sector collaboration and better integration of research and treatment. The Ministry of Health and Care Services will therefore present a new national strategy for personalised medicine in the course of 2022.

Better knowledge through research is key to developing the health and care services of the future. However, there is a great need for knowledge in municipal health and care services and the county dental health services. The amount of research in and for the municipal health and care services and county dental health services is not proportional to the need for knowledge and collaboration in the increasingly complex municipal services. A stronger knowledge base will help to improve municipal planning and development and achieve better prioritisation as well as new, good solutions in the health and care services. More research will thus strengthen the quality of services, which is required to tackle long-term challenges such as new user groups and the growing elderly population. General practitioners (GPs) and other health and social service personnel working in GP practices play an important role in health-promotion and preventive work. Research on the role of the GP service in this work should therefore be facilitated. Closer cooperation between the GP service and universities and university colleges could contribute to more research being conducted in the municipal health and care services. The Health&Care21 Advisory Board took the initiative to a study by the Norwegian Association of Local and Regional Authorities' (KS) strategic research agency (KSF) in order to facilitate

Box 3.3 Unikom

Unikom is a network for all parties with an interest in how the municipal sector, universities, research institutes and other organisations can cooperate to arrive at good, research-based solutions for the municipalities. There are currently 16 contract-based collaborations/partnerships between municipalities and academia. One of these is TRD3.0, which is a partnership between Trondheim municipality and the Norwegian University of Science and Technology (NTNU). In 2021, Trondheim municipality reached out to see whether anybody was interested in establishing contact between parties involved in or interested in such collaboration. This initiative developed into what is now referred to as the Unikom network. In collaboration with the Norwegian Association of Local and Regional

Authorities (KS), an overview of partnerships has been prepared and results and experience collated.

The municipalities that take a leading role in the municipality-university partnerships/municipal clusters are often big urban municipalities, but there are exceptions to this rule. The number of municipalities and academic institutions taking part in the partnerships vary from a single municipality collaborating with one university to *Kunnskapskommunen HelseOmsorg Vest*, where nine municipalities are taking part in a cluster collaboration with a total of seven different knowledge institutions, with Bergen acting as the engine among the municipalities involved.

more and better organised research relevant to the municipalities' knowledge needs.¹⁰ It is an important precondition for more research in and for the municipal health and care services that the municipalities themselves prioritise dedicating resources to this purpose and take steps to put a good structure in place.

Research-based knowledge output on mental health and substance abuse over the past 20 years has been considerable. However, further research is needed both on prevention and on the actual patient groups. For some mental disorders, we also lack knowledge about which treatment is most effective. There is a potential for improving implementation of evidence-based practice throughout the services, as well as for strengthening cross-service collaboration in mental health and substance abuse services. The Government will present an escalation plan for mental health and a substance abuse prevention and treatment reform where evidence-based practice will be a key aspect.

3.2.1.5 Better use of health data

Access to collated information about large populations across health registers and biobanks facilitates epidemiological research, allows for exploratory analysis and could make it easier to identify

appropriate patient groups for clinical studies. However, gaining access to health data for research purposes can require a lot of time and resources, particularly when it comes to aligning data from several sources. We nevertheless need to facilitate utilisation of the wide range of health data sources available, such as central health registers, medical quality registers and population-based health surveys etc. SAMINOR, The Population-based Study on Health and Living Conditions in Regions with Sami and Norwegian Populations, is one example. Health data also need to be made available for research through quality-assured data products and flexible analysis services. In some areas, for example mental health, we also need more and better quality indicators and better management data.

The Government will help to make Norway's large quantities of valuable health data more easily available for research, innovation and business development in the best interests of patients and the general population. The Health Data Service will therefore be further developed as a national solution to achieve an overall solution for overview of and access to public health data. The Ministry of Health and Care Services has distributed for consultation a proposal to give the Health Data Service decision-making powers to help to make the processing of applications simpler and more efficient. The Health Data Service is already contributing to the processing of applications and

¹⁰ Kommunenes strategiske forskningsorgan (2019).

their case processing by providing information about registers and the application process, a common application form, a variable explorer, a file transfer service, a common application receipt service and an application guide. Work to consider alternatives to the Health Analysis Platform is under way. This includes making use of existing infrastructure in the university and university college sector, with the Health Data Service filling a national access control and data disclosure function, whereby data can be transferred directly from the registers to researchers' analysis spaces in the infrastructures.

The Health&Care21 Monitor is a system for following up the previous long-term plan for research and higher education, and it could be an important aid in seeing the links between research topics and burden of disease. The monitor can be further developed to provide an overview and form a basis for analysing priorities, for example in the field of public health.

3.2.1.6 *More value creation from investments in life sciences and health research*

Health research and life sciences provide a foundation for better understanding life, ecosystems and animal, plant and human health. More knowledge can lead to innovation and business development, allowing expert communities to create new and profitable knowledge-based jobs all over Norway. At the same time, industrial and business development depends on good cooperation between a broad range of actors across sectors, disciplines and national borders. Education and research are important parts of this cooperation. Innovation and business development processes are often time-consuming and capital-intensive, as strict requirements must be met to document that products are safe and effective.

Expertise and necessary facilities should be available to start-up enterprises that embark on test production and upscaling both in and outside the public research institutions. We could miss out on industrialisation and value creation at home if enterprises choose to move away from Norway to start their production.

The international health industry invests heavily in research and innovation.¹¹ The Government wants to attract international capital and expertise and will therefore facilitate industry-funded clinical trials, for example through the NorTrials partnership. Moreover, Norwegian business and

industry and Norwegian research communities must use the opportunities offered by the EU Health Programme, EU4Health, and relevant Horizon Europe partnerships and projects. Our research and innovation communities in the fields of health and life sciences must become more attractive partners for Norwegian and international business and industry players.

3.2.2 **Measures and follow-up**

The Government expects universities, university colleges, hospital trusts, regional health authorities and research institutes that receive public basic funding to follow up the thematic prioritisation of health and help to meet the knowledge and skills needs described above within their capabilities and areas of responsibility.

The Government will:

- give particular priority to the following areas of research and research-driven innovation:
 - sustainable health services, for example through Health Pilot
 - life sciences
 - personalised medicine
 - gender differences in health with a particular focus on women's health
 - interdisciplinary research in a One Health perspective
 - cross-sector research focusing on aging
 - sustainable food systems, including the mutual influence in different links of and across value chains, taking account of the One Health perspective
 - research on, in and about the municipal health and care services
- give particular priority to the following areas in higher education and skills:
 - work to improve quality and increase capacity in clinical training placements in the municipalities, among other things through follow-up of the bilateral cooperation agreement between the Government and the Norwegian Association of Local and Regional Authorities (KS)
 - professional disciplines with a bearing on personnel challenges in the health and care services, particular in the fields of mental health and substance abuse services
 - decentralised and flexible education
- give particular priority to the following areas in infrastructure and digitalisation:

¹¹ See for example the European Commission (2022).

- further develop the Health Data Service as a national function for application processing and access to health data, while reusing existing analysis services
- consider the need for data about groups and risk factors, obtaining and linking data from population studies and health registers, and further developing the use of burden of disease analyses
- biobanks and population studies
- present a new national strategy for personalised medicine in the course of 2022
- describe the content and way forward for a public health knowledge system in the 2023 white paper on public health
- continue to develop research infrastructure for municipal health and care services as part of the work on the national health and cooperation plan

3.3 Climate, the environment and energy

We have to develop new climate and environmentally friendly solutions to ensure a sustainable future. The UN Intergovernmental Panel on Climate Change concluded that we must act now if we are to have any hope of meeting our obligations under the Paris Agreement. Rapid and significant emission reductions, more clean energy, better resource utilisation and climate adaptation require us to develop and test a broad range of climate measures and technologies across all sectors, while conserving our ecosystems at the same time.¹² Over time, Norway has pursued a policy that has contributed to economic progress while also addressing conservation of natural resources and ecosystems. According to the OECD, Norway is on track to achieve most of the Sustainable Development Goals by 2030.

Norway is well positioned to carry out necessary restructuring while also stimulating new value creation and sustainable business development. We have strong research and innovation communities, abundant natural and environmental resources and a trust-based society that make an equitable transition possible. We must make better use of these advantages than we are doing at present if we are to achieve our climate and environmental goals. To come up with the best possible solutions, we must base our efforts on

knowledge and skills, higher education and high-quality research.

Sustainable and equitable transition is not only a question of new knowledge about resources, technology and natural diversity. Climate challenges must also be tackled using knowledge about how people understand their cultural and natural environment and make decisions based on the cultural, societal, linguistic and historical conditions under which they live. This requires a comprehensive and integrated approach where social sciences, the humanities and other relevant disciplines must be included in research and education of relevance to climate and environmental issues. In order to address diversity, equality, consideration for indigenous peoples, social justice and good health, we need more knowledge about the social and economic consequences of activities and measures intended to resolve climate and natural challenges. Then we can ensure that the green transition is both effective and fair.

3.3.1 Main challenges and knowledge needs

3.3.1.1 *Integrated management on the environment's terms*

The need for a comprehensive and rapid transition to a sustainable future requires policy instruments and measures in different parts of society to be seen in conjunction with each other. We need to know what the ecosystems can withstand, what consequences different restructuring measures will have, and what changes we must prepare for in future. Research-based scenarios and projections showing probable developments in the state of the climate and environment are a key factor in this work. Such scenarios and projections are developed for the climate, but are inadequate and fragmented when it comes to natural diversity, ecosystems and other environmental resources.

We need to develop more knowledge about nature-based solutions and measures that benefit the climate as well as nature. We also need to know what we can do to limit harmful activity in nature and restore damaged nature. National natural capital accounts developed in line with the UN standard for natural capital accounting will be used to systematise knowledge about the extent and status of nature and ecosystem services and help us to make better decisions to promote sustainable development.

Sustainable natural and environmental management requires knowledge about the financial and cultural value of nature and the environment

¹² IPCC (2022).

for society. Indigenous peoples, local communities and business and industry must all be taken into consideration. Mountain areas, outlands fields and the sea are subject to different forms of development, among other things relating to energy production, mineral extraction, aquaculture facilities, nature-based tourism and building of holiday cabins. New knowledge is important to find future solutions for sustainable land use that takes account of the environment, business and industry, and the people affected.

3.3.1.2 *Effective and fair transition to a sustainable low-emission society*

Norway is well positioned for the transition to a low-emission society. We have abundant access to renewable land and marine resources. We have industrial and technological expertise, access to critical raw materials and infrastructure, and decades of experience of energy production and processing. While we are in a favourable position, there is still a long way to go before we achieve the climate goals. Knowledge and skills, research and technology development are key factors in achieving climate and environmental goals and ensuring a fair transition, as well as in contributing to business development and increased value creation for society. Knowledge development, innovation and education are therefore key features of the Government's Green Industrial Initiative published in 2022.¹³

The recent energy situation in Norway and Europe illustrates how important it is to increase the amount of renewable energy available. Norway has large offshore areas with good wind resources that have the potential to become an important source of renewable energy for Norway and the rest of Europe. Many of these areas are only suitable for floating wind turbines. Unlike bottom fixed wind turbines, which represent an established technology, floating wind turbines are still an immature and significantly more expensive technology. The Government will facilitate large-scale investments in offshore wind power to help to provide power to people and enterprises all over Norway. A great deal of research is needed in relation to the industrialisation and commercialisation of the value chain for offshore wind power, integration of offshore wind power plants in the power system and offshore area management. We also need knowledge about the environmental effects of offshore wind power and coexistence

with fisheries. The general knowledge base on offshore wind power also needs strengthening.

The oil and gas sector is responsible for more than a quarter of Norway's greenhouse gas emissions and is the country's second greatest source of emissions, second only to the transport sector. The Government will, in cooperation with the industry, work to reduce emissions from oil and gas production on the Norwegian continental shelf by 50 per cent by 2030 and to net zero in 2050. In order to reach these targets, the industry will have to use solutions with high abatement costs. However, research on and development of emission-reduction technologies and solutions will help to reduce these costs. At the same time, petroleum-related supplier industries and related strong research communities possess expertise, knowledge and technology that will be required in business development in connection with the green transition. Research and development related to the petroleum industry are discussed in more detail under the thematic priority *oceans and coastal areas*.

Hydrogen can help to reduce greenhouse gas emissions significantly as well as increase value creation and employment in Norway. The Government will contribute to building a coherent value chain for hydrogen produced with low or no emissions, where production, distribution and use are developed in parallel. In order to succeed, we need research and technology development to reduce costs and increase energy efficiency throughout the value chain for hydrogen in line with the Government's ambitions for a Green Industrial Initiative.¹⁴ We need research and development relating to safety, integration of hydrogen into the existing energy system and framework conditions. International research collaboration and participation in the EU's research and innovation programmes are key aspects of this work.

Different forms of bioenergy account for an important part of the energy sector's potential for global emission cuts. Norway has significant unutilised bioresources that can be used for energy purposes while at the same time increasing value creation and employment. It is important to generate knowledge about where these resources can be used to maximise the environmental benefit.

About 15 per cent of greenhouse gas emissions in Norway come from the building and construction industry, which is also the country's number one source of waste. There is also a con-

¹³ Ministry of Trade, Industry and Fisheries (2022).

¹⁴ Ministry of Trade, Industry and Fisheries (2022).

siderable potential for improving energy efficiency, particularly in existing buildings. The building and construction industry therefore has an important role to play if we are to achieve our climate and environmental goals. We need knowledge about effective ways of reducing this industry's climate and environmental footprint and its energy requirements.

Batteries are considered a core technology in the transition to renewable energy, particularly in the transport sector. Batteries are also important to stabilise the power grid, energy supply and energy storage, which also represents industrial opportunities for Norway. European and other international battery initiatives set important guidelines for Norway's national battery strategy, which was presented in June 2022. A key strategic objective for the EU is to develop a battery industry of its own. Norwegian industrial enterprises are already producing input factors, products and services for several parts of the complex battery value chain, and knowledge of materials has been developed over decades in close cooperation between the processing industry and academia. Norwegian expert environments are now building on this knowledge to develop state-of-the-art battery materials. The planned growth in the Norwegian battery industry means that major long-term investments are needed in expertise throughout the education system, from craft certificates to higher education and research.¹⁵

The Government will continue its work to promote carbon capture, utilisation and storage (CCUS) as an important contribution to achieving the climate target, establishing a new green industry and exporting technology. It is essential in order to make CCUS a cost-effective climate measure to engage in research and demonstrations to reduce the technology costs of CCUS and make the technologies for capture, transport, utilisation and storage of CO₂ more competitive. New technology will support the Norwegian full-scale demonstration project Longship, which involves carbon capture from cement production (Norcem) and waste incineration (Hafslund Oslo Celsio), as well as transport and storage of CO₂ in subsea geological formations (Northern Lights). CO₂ can also be used as an input factor in industry by contributing to the inclusion of products containing carbon in the circular economy, thus cutting emissions and creating new industrial activity

at the same time. The need for CCUS research relates to the development of new technologies and upscaling to commercial value chains, new business models, market models, and framework conditions for carbon capture, utilisation and storage. More knowledge about society and the environment is also required in connection with CCUS.

Norway's CCS investments mostly concern the Longship project, Technology Centre Mongstad (TCM), which tests and qualifies new carbon capture technologies, and the research and demonstration programme CLIMIT. Commercial projects are also facilitated by offering storage. Since 2021, the CLIMIT programme has also covered direct air capture of CO₂, which may become necessary to reduce the CO₂ content in the atmosphere in the long term. A summary of the current knowledge status is needed in connection with direct air capture, including energy requirements, possibilities for improving energy efficiency and land use. Robust methods must be developed for life-cycle analyses that can show the climate effect of capturing and reusing CO₂. Research is also needed on policy instruments and to identify barriers to creating a well-functioning market.

Everything from building and construction work to climate adaptation, natural capital accounting and climate projections depend on accurate and accessible geodata. Research and development is essential in the further development of methods for collecting, processing and facilitating the use of our shared geographical information. The UN estimates that as much as 80 per cent of all data can be linked to a geographical location. There is considerable potential for better and more efficient use of these data.

Satellites play a crucial role in establishing a factual basis for knowledge-based climate and environmental policies. Many of the essential climate variables described in the UN Intergovernmental Panel on Climate Change's reports are largely based on satellite measurements. International cooperation is the cornerstone of the Government's focus on space-related activities. Environmental crime, the Government's Climate and Forest Initiative, fisheries crime and the Government's Blue Justice Initiative are examples of areas where Norway has taken a leading role internationally and where satellite data are an important tool. At the same time, small satellite technology is opening up new possibilities for solutions at the national level.

¹⁵ Federation of Norwegian Industries (2021).

Box 3.4 EU missions in the field of climate, the environment and energy

Norwegian research communities are taking part in the full range of EU missions, and four of the five EU missions are closely linked to challenges in the field of climate, the environment and energy. The four missions ‘Climate-Neutral and Smart Cities’, ‘Adaptation to Climate Change’, ‘A Soil Deal for Europe’ and ‘Restore our Ocean and Waters’ are intended to resolve ambitious, demanding and complex environmental challenges by 2030. The missions will trigger broad engagement, receive funding from different sectors and interact with changes to regulatory regimes, legislation and policies. Furthermore, these complex challenges cannot be resolved without interdisciplinary knowledge development. This will require the involvement of a broad range of actors, including research

communities, educational institutions, business and industry, the public sector, the voluntary sector and the population at large. The relevant ministries can contribute to regulatory and policy development that support the objectives. It is important that the population participates, as new knowledge and technology are set to be introduced. It is a prerequisite for achieving our goal that the population trusts research results and is willing to contribute to the green transition by changing their behaviour. It is also important that Norwegian efforts are well coordinated in order to ensure good cooperation between communities, and that national and EU policy instruments supplement and reinforce each other.

3.3.1.3 Zero-emission transport and comprehensive land use planning

Well-functioning transport systems are needed to transport people and goods in a safe and efficient manner, and they are crucial to the competitiveness of business and industry.¹⁶ At the same time, a significant share of emission cuts in the time ahead will have to be made in the transport sector. Development, operations and maintenance of transport infrastructure occupy large areas and have negative consequences for the climate and the environment. Norway has come a long way in the electrification of its passenger car fleet. Norwegian industry and the public sector are nevertheless facing demanding restructuring, particularly in freight transport and aviation where technology development is still in an early stage.

Research and innovation are crucial if we are to succeed in achieving a quick and cost-efficient transition to zero-emission solutions for all forms of transport. Public administration and business and industry both depend on new knowledge and a rapid transition to new transport technology that can produce better vehicles, contribute to efficient use of zero-emission solutions and make better use of the existing transport infrastructure. We also need the costs and environmental impact of

maintenance and infrastructure development to be as low as possible. Moreover, we depend on behavioural change, for example when it comes to using transport solutions such as public transport, efficient logistics and shared mobility.

Transport21 is a strategy for research, development and innovation in the transport sector. Important research topics that can help to speed up the transition to emission-free transport of people and cargo have been identified in connection with this strategy. These topics include infrastructure for zero-emission solutions, energy efficiency, biofuel and hydrogen use for transport purposes, logistics hubs, smart delivery and shared solutions. We also need new knowledge and technology for more environmentally friendly and integrated transport planning, such as simulation tools and new methods for optimising and utilising capacity. Risk mitigation, piloting of late-stage technology development and innovative public procurements are crucial to speed up technology development and contribute to early market introduction. Enova, PILOT-E and PILOT-T have been among the key policy instruments in this context. Further developing the supplier industry is crucial if we are to succeed nationally, but also to be able to take advantage of the opportunities for value creation represented by the growing international market for innovative mobility solutions. According to Transport21, Norway is well positioned to succeed in develop-

¹⁶ Maritime transport is discussed in section 3.1 under the priority *oceans and coastal areas*.

ing new integrated digital management systems at system levels (integrated ITS), artificial intelligence, big data, the internet of things and autonomous systems.

Close cooperation between research communities, the authorities and businesses is important in order to take advantage of the opportunities and succeed in gearing efforts to areas where Norway has competitive advantages and particular needs.

At the same time, it is important that the policy instruments help to increase the number of new graduates with expertise in technology relevant to the transport sector, as such expertise will be in considerable demand in the years ahead.

The majority of the Norwegian population live in towns and cities. The purpose of developing ‘smart cities’ is often to improve inhabitants’ quality of life, make optimum use of shared resources and reduce the cities’ climate and environmental problems. Urban climate and environmental problems may relate to energy, mobility, operations and maintenance, development of public services and business development. Urban densification and transformation of areas heralds a need for new knowledge to ensure environmentally friendly urban development that also safeguards the population’s health and quality of life. New technology and knowledge can help to reduce greenhouse gas emissions through increased resource utilisation, a circular economy where it is possible to reuse materials, more environmentally friendly mobility and delivery of goods, and adaptation to climate change. In towns and cities all over the world, technology is tested and put to use in various public and private services. There are pavements and roads made from solar cell panels, waste bins that send alerts when they need emptying, air quality monitoring, new transport solutions that reduce the need for passenger cars and vans, food is grown in hydroponic systems or on rooftops, and meat can be industrially manufactured. The continued development of national research and innovation must be seen in conjunction with the Horizon Europe partnership Driving Urban Transitions and the EU mission for climate-neutral and smart cities.

A comprehensive land use and societal planning process should promote good living conditions for people and help to make cities, towns and locations attractive. Cities need more green spaces with trees and open watercourses, known as blue-green infrastructure, to deal with the increases in drought, heat and surface water that climate change will bring. We therefore need

knowledge about methods for establishing and preserving green areas and important cultural history environments, Urban agriculture can help to develop the towns and cities of the future in a more circular and sustainable direction in accordance with the UN Sustainable Development Goals.

3.3.1.4 *We have to adapt to a changing climate*

Climate change poses challenges across sectors, actors and areas of society, and has an impact on all the Sustainable Development Goals.¹⁷ The UN Intergovernmental Panel on Climate Change now believes that climate change has a greater and more far-reaching impact on nature than previously assumed.¹⁸ It is therefore more urgent than ever to facilitate climate resilient development, which means to combine strategies to adapt to climate change with action to reduce greenhouse gas emissions and increase carbon absorption in order to support sustainable development.

In Norway, climate change will require us to adapt our land use, energy production, transport, agriculture, cultural environment and nature management, among other things. It is important to have a good knowledge base on the overall consequences of climate change when planning solutions to reduce emissions as well as risk and vulnerability. We have to obtain and facilitate a good scientific knowledge base of climate data and develop robust climate projections and risk assessments.

3.3.1.5 *Sustainable and climate-adapted agriculture*

The most important function of agriculture is to ensure sustainable production of healthy and safe food in sufficient quantities based on Norway’s natural resources. We must therefore preserve the arable soil and ecosystems on which our agriculture depends. At the same time, we need to reduce greenhouse gas emissions and increase carbon absorption. Technology development and new knowledge play an important role in the further development of a forward-looking climate and environmentally friendly agricultural sector and will make important contributions to reducing greenhouse gas emissions from agriculture and

¹⁷ How to deal with major natural events resulting from climate change is discussed under the priority *societal security and preparedness*.

¹⁸ IPCC (2022).

increasing the amount of carbon that is absorbed and bound in soil and forest.

Agriculture accounts for about 9 per cent of Norway's total emissions. Knowledge is needed about how to cut emissions while improving food security. More knowledge is also needed about forms of operation that promote biological diversity, soil health and carbon storage in the soil. Good soil health means that the physical, chemical and biological soil components work together in an optimal manner, both in terms of production and other soil functions. It is important to consider soil health when the climate is changing. Norway is one of the few countries in Europe to have a dedicated soil health programme that sets out a proposed implementation plan.¹⁹

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service estimates that forests and other ecosystems on land can contribute more than a third of the emission cuts necessary to achieve the 2-degree target by 2030 if they are sustainably managed. New knowledge can shed light on how we can exploit the potential for increased CO₂ absorption and carbon storage and how we can use raw materials from Norwegian forests in the most climate-friendly manner possible, not least in order to compensate for emissions from other sectors.

Norway has huge forest resources and a potential for increased logging. However, this must take place within the limits of sustainability and in a manner that safeguards endangered species and addresses other important environmental considerations. At the same time, forest-based value chains can make a significantly higher contribution to the Norwegian economy than is the case at present if we increase the profitable processing of these resources here in Norway.

A high level of research and innovation is important to make the forest and wood industry more competitive and develop a forest industry that makes a positive contribution to the climate by processing renewable and residual raw materials. New knowledge will form the basis for further developing sustainable and profitable forestry that strikes a good, knowledge-based balance between forestry activities and climate and environmental considerations.

Climate change directly impacts agriculture, which must therefore be prepared to deal with a climate that is changing towards higher temperatures, significantly longer periods without frost, extreme precipitation, drought and changes in

biodiversity. Climate change can pose challenges such as new plant and animal diseases, new and harmful alien species, fewer pollinators, more frequent and extensive forest fires, floods and generally more demanding production conditions, including highly demanding conditions for reindeer husbandry and grazing. On the other hand, a warmer climate and longer growing season also brings a potential for increased production and new plants. Nature-based solutions may help to prepare agriculture for climate change, for example by protecting and restoring bogs and wetland and opening up streams and rivers. New technology, digitalisation and development of climate-adapted plants, animal husbandry, and knowledge of agronomy and new forms of operation are some of the factors that will be crucial to climate adaptation of agriculture and forestry.

A changing agriculture and forestry industry will also mean a growing need to improve access to relevant expertise by strengthening recruitment to agricultural studies and further developing relevant study programmes at all levels.

3.3.1.6 *Increased circularity and sustainable bioeconomy*

A more sustainable economy will require us to utilise resources and secondary raw materials far more efficiently than we do at present. By changing to a more circular economy, we will help to reduce the loss of natural and environmental resources and prevent weakening of the natural resource base. Using more secondary raw materials will help to improve resource utilisation throughout the value chain. It is also essential to the transition to a circular economy that environmental toxins and hazardous substances are removed from circulation. The circular economy can be divided into two material cycles: one for non-renewable resources and one for renewable biological resources.

Products, components and materials whose characteristics make them suited for re-use and easy to repair, modernise or recycle circulate in the cycle for non-renewable resources. We need research we can use as a basis for organising legal and industrial policy instruments in an expedient manner. Research and innovation in the circular economy must extend their perspective from isolated to integrated approaches, from the linear to the circular, from waste to secondary raw materials, and from fossil to renewable solutions. It is therefore important that the policy agencies develop the green circular economy as a focus

¹⁹ Norwegian Agriculture Agency (2020).

Box 3.5 Sustainable feed mission

Our food security is under pressure due to population growth, increasing pressure on areas and resources, climate change and less reliable supply lines. At the same time, the need to reduce greenhouse gas emissions increases demand for renewable biomass and products that provide climate and environmental benefits. More efficient and circular systems offer a great potential for strengthening Norway's food production and improving resource utilisation while also reducing greenhouse gas emissions and our environmental footprint. However, this will require new knowledge, better coordination across sectors, and a common, targeted effort to apply the new knowledge.

In the present long-term plan, the Government is launching two missions. This represents a brand new research policy instrument in a Norwegian context (see Chapter 6 for a more detailed discussion). The goal for this mission is that all feed for farmed fish and livestock shall

come from sustainable sources, thus reducing greenhouse gas emissions from food systems. The Ministry of Trade, Industry and Fisheries, the Ministry of Agriculture and Food, the Ministry of Climate and Environment, the Ministry of Health and Care Services and the Ministry of Education and Research will be among the ministries involved.

A sustainable feed mission is intended to contribute to new innovations and technological solutions being implemented. This mission will be an important contribution to achieving the targets Norway has set itself for the climate, environment, food production, employment and value creation. It will also support the common European goal of increased self-sufficiency and sustainable food systems in Europe. The final wording of the main objective, quantification and further developing the sub-goals will take place during the design and implementation phase.

area across disciplines and sectors, build a common knowledge base with business and industry organisations and other stakeholders, and cooperate on coordinating their efforts.

Increased use of renewable biological resources at the expense of fossil carbon in the renewable resource cycle will help to reduce greenhouse gas emissions. The development of new knowledge and technology in the fields of biotechnology and industrial processing technology, among other areas, will make it possible to exploit more of the many renewable biological resources, including those considered waste today, safely and effectively. However, we need to know more about how to recover materials more efficiently while also removing environmental toxins and hazardous substances from circulation.

There is a great potential for increasing utilisation of various biological residual raw materials and side streams. Everything from fertiliser and sludge to production waste and food waste can potentially be reintroduced into the food chain as food, feed, fertiliser and soil improvement agents – provided that the substances are safe. Several of these resources are also well suited as raw materials for bioenergy purposes. Research, innovation and technology development are therefore

needed to exploit the potential for nutrients, energy products and other valuable biochemical components from bioresources.

We also see industrial communities based on complementary collaboration emerging. The enterprises collaborate to utilise each other's residual materials, waste streams, excess heat or other resources, thus contributing to reducing greenhouse gas emissions and environmental impact. Targeted knowledge development will link the value chains for renewable resources in industrial communities more closely with the value chains for material cycles, for example by producing algae or other microorganisms that bind carbon and utilise residual heat released from processing industries.

3.3.1.7 Prevent emission and spread of substances harmful to the environment

We need more knowledge about how substances harmful to health and the environment are dispersed in the environment, including the significance of different sources and routes of dispersion. We also need more knowledge about the cocktail effect of substances harmful to health and the environment and how these substances affect

individuals, populations and ecosystems, both in isolation and in combination with other impact factors such as climate change. There is a lot we do not know about the prevalence of substances harmful to health and the environment in the Norwegian population. In particular, we need knowledge about the extent to which different groups are exposed to such substances, including children, the elderly, pregnant women and different social classes. International research cooperation and knowledge about conditions in other parts of the world will be important in this work.

We also need more knowledge about the effects of exposure to substances harmful to health and the environment, including how environmental toxins accumulate in the body, illness and quality of life. It is also important to consider how different groups in the population are affected by these effects.

3.3.1.8 *More knowledge about climate change in the polar regions*

Knowledge about climate change and environmental impact in the polar regions is strategically important to managing an environment in rapid change, and it is vital to society's development, climate adaptation and contingency planning in the High North. Climate change is progressing particularly quickly in the Arctic. Research on polar ecosystems will thus yield valuable knowledge about future development in other areas. That is why we need efficient surveying and environmental monitoring. We also need management-oriented knowledge about the environmental consequences of commercial activities in the High North. Moreover, we need more knowledge about the effects of environmental toxins, ocean acidification and the sea ice decline in combination with increasing human activity in the polar regions, as well as about their overall impact on ecosystems.

Svalbard has great geopolitical importance, in addition to being an important platform for research and higher education and for international cooperation. Norway should remain a strong polar research nation, and there is a particular potential for more Norwegian research activities in Ny-Ålesund. Svalbard is also an important starting point for research in the Barents Sea and the Arctic Ocean.

The rapid changes in Arctic ecosystems on land may have significant consequences for how nature is used in the High North, not least for reindeer husbandry, but also for forestry, hunting and fishing, tourism and outdoor pursuits. Good

management of Arctic areas in future will require good knowledge and projections of development to provide a good basis for societal planning. It will also be important to know how the management system can safeguard the relevant interests of the current users of nature in polar areas.

The Antarctic has a key position in the global climate system, not least when it comes to rising sea levels. Intensified research efforts and more observation data will be crucial in improving our understanding of climate change in the Antarctic. The Norwegian research station Troll at Queen Maud Land in the Antarctic constitutes a unique platform for developing such knowledge and puts Norway in a good position to contribute to the collective international effort to generate knowledge about the Antarctic.

3.3.2 **Measures and follow-up**

The Government expects universities, university colleges, hospital trusts, regional health authorities and research institutes that receive public basic funding to follow up the thematic prioritisation of climate, the environment and energy and help to meet the knowledge and skills needs described above within their capabilities and areas of responsibility.

The Government will:

- give particular priority to the following areas of research and research-driven innovation:
 - green and fair transition to sustainable and forward-looking agriculture, business and industry, and civil society
 - social and cultural sustainability in the green transition
 - ecosystems in Norway, including nature's tolerance, potential tipping points, the value of nature and sustainable land management
 - renewable energy solutions, low-emission technology and carbon capture and storage, including piloting
 - circular solutions and safe use of bioresources across industries, sectors and disciplines
 - the High North, Arctic and Antarctic
- give particular priority to the following areas in higher education and skills:
 - relevant programmes of professional study and discipline programmes in the field of climate, the environment and energy
 - decentralised and flexible education

- interdisciplinarity and humanist perspectives in higher education of relevance to climate, the environment and energy
- give particular priority to the following areas in infrastructure and digitalisation:
 - further development of an efficient and accessible environmental data system for research and management
- launch a mission for the purpose of ensuring that all feed for farmed fish and livestock comes from sustainable sources

3.4 Enabling and industrial technologies

Enabling and industrial technologies have a transformative power to help to make a sustainable society a reality through green and digital transition. The Government will therefore prioritise these areas of technology.

Enabling technologies are basic, advanced areas of technology that enable the development of more efficient, profitable and sustainable solutions, products and processes. Examples of such enabling technology areas include information and communications technology (ICT), nanotechnology and biotechnology. These technologies comprise a number of narrower areas, such as artificial intelligence, sensor technology and gene technology. Enabling technologies improve our

understanding and use of basic elements of natural and man-made materials and systems. The knowledge gained influences how we produce food and medicines, how we process natural raw materials into suitable and more environmentally friendly materials, and how we can understand, safeguard and use large quantities of data and complex systems.

Industrial technologies are advanced, generic technology platforms that build on and make use of enabling technologies. The platforms make it possible to develop advanced materials, production processes and components, for example through robotisation, 3D printing, biorefining, biocatalysis and industrial fermentation. High-cost countries such as Norway have to manufacture goods more efficiently than countries where cheap labour is readily available. In order to be cost-efficient and competitive, production must become increasingly automated and flexible.

Basic research on enabling and industrial technologies paves the way for concrete application in the long-term plan's other priority areas. Such application of technologies, and the introduction of mature technologies, are largely integrated into the long-term plan's other priorities and objectives. The pace of technological development is very fast, and research institutions must therefore cooperate closely with business and industry.

Box 3.6 From basic research to a new product at record speed

The Covid-19 pandemic had taken hold in Norway by 20 March 2020, when Professor Magnar Bjørås at the Norwegian University of Science and Technology (NTNU) received a troubling message from St. Olavs Hospital. The hospital was running out of coronavirus tests, and it was impossible to get hold of more. They asked Professor Bjørås if he could help them.

Bjørås contacted Associate Professor Sulalit Bandyopadhyay. They had never worked together before, but within a week, the two scientists had developed a new RNA isolation kit, and pilot production was up and running. St. Olavs Hospital received the reagents, which proved to work well. Production was quickly scaled up, and the test was soon approved and taken into use by many Norwegian hospitals.

The success story of the coronavirus test was enabled by decades of basic molecular biology research at NTNU and Oslo University Hospital (OUS)/the University of Oslo. Research on related disciplines, such as nanoparticle technology and virology, and proximity to diagnostic units at St. Olavs and OUS were other critical factors in the quick development of this test.

The coronavirus test is a good example of how long-term basic research and interdisciplinary collaboration can quickly produce an innovation of great importance to the population, the health service and society when the need is great and clearly formulated. This innovation is also a good example of how strong basic research communities represent an important part of our contingency planning for unknown events.

3.4.1 Main challenges and knowledge needs

3.4.1.1 Developing technologies to increase value creation and sustainability

Information and communications technology (ICT)

ICT is no longer merely a technology. It is as much a transformative driving force that forms the basis for new business models and applications in all areas of society. ICT is a necessary element in most new technologies. Business and industry invest by far the most R&D in ICT, and they emphasise development activities. There is a potential for the top ICT research communities to make even better use of the EU framework programmes.

Biotechnology

Biotechnology has in many ways become a mature technology, and it has been introduced in many areas of application. The public R&D communities account for more than half of all R&D activities in the biotechnology area. The health trusts and regional health authorities are very

active in biotechnology research, while the level of activity is low in the institute sector. The links between universities, university colleges, institutes, health trusts, regional health authorities, and business and industry could also have been better. There are strong ties and a strong institute sector in the fields of marine industries, agriculture and the food industry, but basic research should be strengthened. Biotechnology is a separate discipline, but disciplines such as medicine, biology, physics and chemistry are also well placed to engage in biotechnology. The biotechnology field enjoys good recruitment. Both biotechnology and life sciences have large, strong research communities that do relatively well in the competition for research funding at the national level, but they could have made better use of the opportunities offered by the EU framework programmes. Infrastructure investments are vital to success.

Nanotechnology

Nanotechnology and related innovation are becoming increasingly commercialised, often via small and medium-sized research-intensive enterprises. There are often close links between public R&D communities and enterprises, and a lot of radical innovation is taking place. At the national level, the universities, university colleges and institutes are driving forces in basic technology development, in interaction with and influenced by international expert communities and trends. These sectors also have great capacity to utilise research funding from national and international sources. National investment in nanotechnology infrastructure is important to maintain a high level of activity. Business and industry are responsible for more than half of all R&D in the nanotechnology area.

New advanced materials make for simpler and more efficient energy storage, which can improve access to affordable renewable energy in sufficient quantities to achieve a green transition. For example, advanced nanomaterials could help to reduce the use of pesticides and biocides in agriculture, while advanced biomaterials could contribute to more sustainable use of plastics.

Advanced industrial technologies

The Covid-19 pandemic demonstrated how complex and vulnerable the global value chains had become. A more flexible technology capable of dealing with the vulnerabilities that arise when

Box 3.7 Centre for Computational and Data Science

The sustainable development of society increasingly depends on knowledge obtained from data and large quantities of data. That is why the University of Oslo established the Centre for Computational and Data Science.

The centre is intended to strengthen the university's scientific standing and position Norway on the international arena by bringing together expert communities from different departments and disciplines. The centre will contribute to better and more efficient use of data in public management and business development through research on areas such as artificial intelligence, language technology, statistical methodology, machine learning and deep learning. In addition to facilitating development and use of digital resources in research, business and industry, the centre will operate meeting places and develop cooperation between research communities in academia, business and industry, and public sector entities.

Kilde: The University of Oslo (UiO)

global value chains are disrupted must be developed.

Digitalisation and automation of production processes, in combination with advanced monitoring and sensor technology, will be important drivers for cutting emissions and increasing reuse of resources. 3D printing makes it possible to tailor products, thereby using less materials.

Technological convergence

The merging of different enabling technologies has revealed a need for more expertise on responsible technological development among technologists as well as in the humanities and social sciences.

Examples of relevant emerging and converging areas of technology include quantum technology and neurotechnology. Advances in *neurotechnology* have the potential to improve the diagnosis and

treatment of brain disorders and thus improve our health and welfare. The emergence of neurotechnology also brings ethical, legal and social challenges, however, these challenges must be taken into account when designing research efforts. The possibility to manipulate and control quantum effects at an increasingly detailed level by means of *quantum technology* offers new opportunities in communication, measurements and sensor, simulation and computer science. The development of quantum computing is expected to revolutionise the digital world and could impact global communication networks and internet security.

3.4.1.2 *Responsible technology development*

Socially responsible technology development

Rapid technological change can entail negative consequences and risks for individuals, society

Box 3.8 Areas of technology in the Research Council of Norway

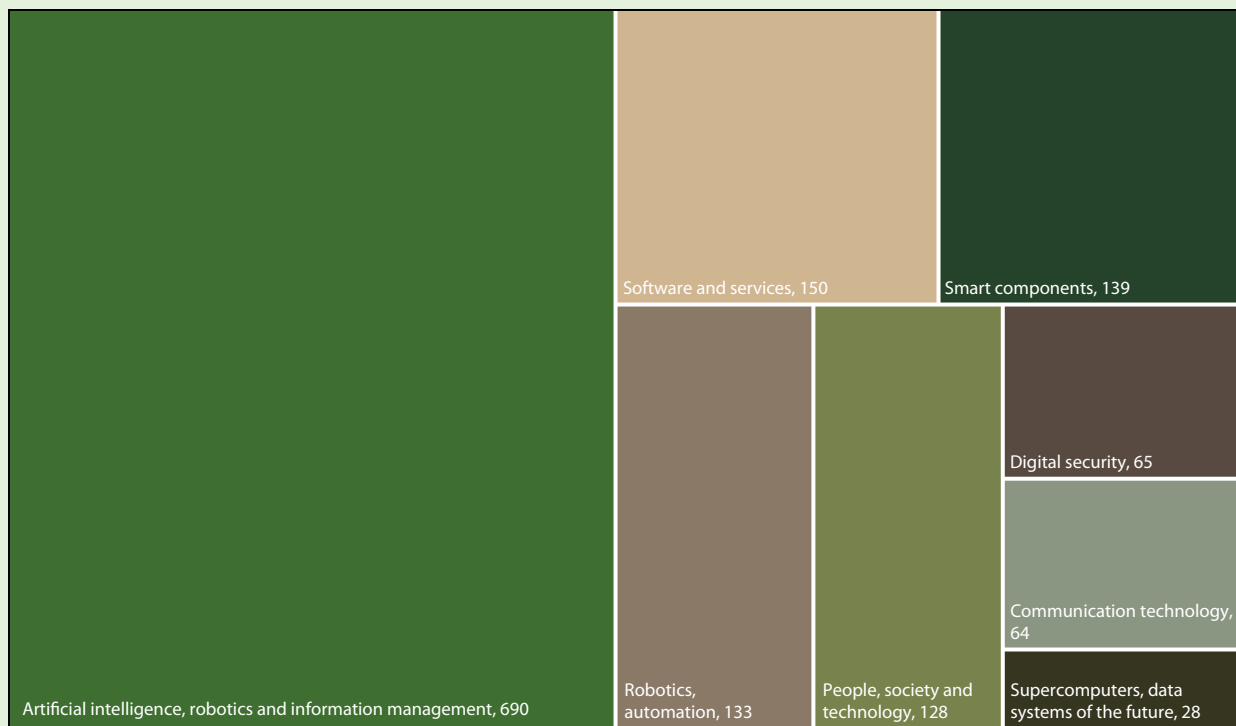


Figure 3.1 The Research Council’s 2021 R&D spending broken down by area of technology, in NOK million
 Source: The Research Council of Norway

The Research Council does not have a separate programme dedicated to artificial intelligence (AI), but AI has been a key priority in its ICT programme, IKTPLUS. Calculations from 2021

show that nearly 50 per cent of the funds the Research Council allocated to ICT went to projects on AI, robotics and information management.

and the environment and contribute to social distancing, inequality and threats to security and human rights. A significant challenge going forward is how to enjoy the benefits of new technology while dealing with its potentially negative or excluding effects. This will require a broad, interdisciplinary approach that includes legal, ethical, societal and cultural perspectives.

Health, safety and the environment – ethical, legal and social aspects

Considerations for health, safety and the environment (HSE) and ethical, legal and social aspects (ELSA) are well integrated into the management of the Research Council of Norway's portfolio for enabling technology, both through funding for dedicated projects and through requirements for their integration into technology development projects.

A key HSE policy in the development of advanced chemicals and materials is that they should be safe and sustainable by design. The European Commission is working on a framework to be used to define criteria for evaluating whether

Box 3.9 Norwegian research centre for artificial intelligence innovation

A new centre for research on artificial intelligence and big data has been established. The centre is named Nemonoor and will be led by NTNU and SINTEF Digital. The centre's objective is to develop ground-breaking theories, methods and technologies for using artificial intelligence in innovative industrial solutions in an effective and responsible manner.

Among other things, the centre will be working on:

- challenges related to intelligent data platforms
- analysis of large-scale sensor data
- personalisation
- massive language models for Scandinavian languages
- the relationship between physical and digital systems

Kilde: NTNU

Box 3.10 Norwegian-American artificial intelligence collaboration

Artificial intelligence can contribute to carbon capture and storage, smarter energy systems, better climate modelling and more personalised medicine. Norway has signed an agreement with the US Department of Energy to work more closely on research, innovation, education and ethical issues in the field.

The agreement facilitates collaboration in the form of common research and innovation projects, scientist and student exchanges, sharing of technology and equipment, joint education programmes and further development of ethical and responsible application of technology. In order to protect privacy, legal and technical solutions will ensure that data are shared in a responsible manner.

Large quantities of data and new types of supercomputers are now making it possible to use advanced artificial intelligence methods to carry out tasks that were previously impossible. This could contribute to breakthroughs in a number of areas, including carbon capture and storage, weather and climate supermodelling, development of new pharmaceuticals and personalised medicine.

chemicals and materials can be deemed to be safe and sustainable by design. This framework can be used in the early stages of technology development projects' design phase.

The National Strategy for Artificial Intelligence states that Norway shall lead the way in developing and using AI with respect for individual rights and freedoms.²⁰ Artificial intelligence in Norway should be built on ethical principles, respect for privacy and good cyber security.

The work to ensure ethical and responsible development of artificial intelligence depends on international agreement and cooperation. The Norwegian principles harmonise with corresponding principles in the EU, OECD and UN.

²⁰ Ministry of Local Government and Regional Development (2020).

3.4.1.3 *Better preconditions for developing and using technologies*

Expertise

Too few upper secondary pupils in Norway choose to specialise in natural science subjects and technology. The proportion of students in tertiary education who study natural sciences and technology is below the OECD average.²¹

The demand for labour with ICT skills is higher than the supply. Employers want employees with digital skills suitable for the occupation they are to enter, as well as people with specialised technology expertise.

In order to ensure that society's need for expertise on artificial intelligence is met, higher education must offer programmes that provide the advanced artificial intelligence expertise that the different sectors need, as well as knowledge and skills in fundamental disciplines such as statistics, mathematics and informatics.

We see an increase in the use of foreign contract labour and outsourcing of ICT services to providers abroad to meet Norway's need for digital expertise. This is often a sensible solution and the only way to obtain the capacity required. However, it can also make us more vulnerable and weaken our ability to safeguard our own security interests.

In a world where digital and hybrid threats are becoming increasingly common, digital security expertise is also vital. Surveys carried out by the Norwegian National Security Authority show that many enterprises have considerable room for improvement when it comes to awareness of and expertise on security.

Two-thirds of graduates from Norwegian PhD programmes are foreign nationals, and many of them may not be able to obtain security clearance. That means that they cannot work with classified information in enterprises that safeguard national security interests. The consequence of this is an increasing need to strengthen the education programmes and recruitment of personnel who can be granted security clearance in the enabling technologies in general and in digital security and cryptology in particular.

Infrastructure

Norwegian research communities need access to necessary research infrastructure to be able to use the enabling technologies. The general needs

for research infrastructure are discussed in Chapter 8. As far as enabling and industrial technologies are concerned, it is particularly important to have access to high-performance computing capacity. Most disciplines that use enabling technologies have a large and growing need for data storage and computing power.

In light of international developments, the Government deems it necessary to make a critical assessment of how the Norwegian technology infrastructure depends on systems and components manufactured and operated in societies whose transparency standards differ from those of Norway.

Regulatory framework and security

Clear legal framework conditions are important if Norway is to be able to contribute at the forefront of research in enabling and industrial technologies. Biotechnology and gene technology research is regulated at the national level by the Biotechnology Act and the Gene Technology Act and through international conventions.

Biotechnology and gene technology have gained much broader areas of application over the past 20 years, while the legal framework has largely remained the same. However, the Storting adopted a new Biotechnology Act in May 2020 that facilitates research and the introduction of gene therapy. Special Norwegian rules on trials of pharmaceutical products that contain genetically modified organisms have made Norway unattractive for research on gene therapies and technologies such as CRISPR and mRNA vaccines.

The Government therefore appointed a committee in November 2020 and tasked it with conducting a broad scientific review of the status, possibilities and regulatory framework for gene technology. The committee will submit its report by 1 December 2022. Its remit includes evaluating the Norwegian practice for evaluation and approval of GMO pharmaceuticals for clinical testing and, if relevant, propose amendments based on the evaluation.

The regulatory framework governing personal data imposes limitations on machine learning research. Consent is the most common way of obtaining legal access to personal data for use in artificial intelligence (AI). When personal data are collected based on a particular statutory provision, there is little scope for using the data for anything other than their original purpose. The exception to this rule is if there is a legal basis for the new use. Public sector bodies therefore have

²¹ OECD (2022b).

Box 3.11 A breakthrough since the previous long-term plan

Proteins are essential to all life, and the shape of a protein determines its function. Experiments to determine the structure of proteins have previously been very difficult, and thus also expensive, to carry out. It is not uncommon for the advanced methods to take as long as a year, and it has normally cost as much as NOK 1 million to find a protein structure through experimental methods.

In 2020, however, something remarkable happened. The company DeepMind developed the AI algorithm AlphaFold, which can quickly predict the shape of new proteins on the basis of data from the Protein Data Bank. The algorithm had soon mapped all the proteins in the human

body, and the process is now being repeated species by species.

In 2021, the journal *Nature* named AlphaFold the Method of the Year. DeepMind, which is a British company, made the algorithm openly available. The algorithms were soon installed on Norwegian infrastructure and made available to Norwegian research communities at the initiative of NORA (Norwegian Artificial Intelligence Research Consortium), the University of Oslo's University Center for Information Technology (USIT) and Sigma2. The programme is available to the entire research community and can be used to develop pharmaceuticals, among other things.

little opportunity to use the data they collect to analyse their own activities using AI. However, the EU's upcoming Data Governance Act will allow the use of depersonalised data, subject to certain conditions, for research through the Health Analysis Platform and similar tools. This will allow us to meet the needs of research without compromising privacy.

3.4.2 Measures and follow-up

The Government expects universities, university colleges, hospital trusts, regional health authorities and research institutes that receive public basic funding to follow up the thematic prioritisation of enabling and industrial technologies and help to meet the knowledge and skills needs described above within their capabilities and areas of responsibility.

The Government will:

- give particular priority to the following areas of research and research-driven innovation:
 - basic research in areas necessary to the development of enabling and industrial technologies
 - artificial intelligence, quantum technology and neurotechnology
- give particular priority to the following areas in higher education and skills:
 - necessary specialist expertise in emerging and converging technologies of particular strategic importance

- more students from Norwegian education institutions taking doctoral degree programmes in technology
- decentralised and flexible education
- consider the follow-up of recommendations in the coming Official Norwegian Report from the gene technology committee on research and innovation activities
- consider whether there are regulatory obstacles to the expedient and desirable use of artificial intelligence in the public and private sector

3.5 Societal security and civil preparedness

As mentioned in Chapter 1, we live in uncertain times with great changes taking place in society. Therefore, the Government wants to strengthen work on societal security and civil preparedness also through research, innovation and education. Societal security and civil preparedness is about society's ability to prevent and deal with events that threaten fundamental values and functions and pose a risk to life and health.²² The best way to deal with a crisis is to have robust systems in place under normal conditions that can be upscaled in a crisis, and to have resources available all over the country. Crisis management must moreover be based on clear structures, division of responsibility and a regulatory framework, as well

²² Ministry of Education and Research (2021g).

as sufficient knowledge and skills at all levels.²³ In addition, we must follow up crises with research aimed at preventing further crises.²⁴

Events that threaten fundamental values and functions can be triggered by natural disasters, pandemics, conflict and war, technical faults, human error or intentional actions. As the climate becomes warmer, unpredictable weather patterns develop where serious natural events will become more frequent. This challenges societal security and threatens food security and access to critical natural resources. Climate change in combination with increasing globalisation will also increase the risk of infectious diseases spreading. Changes to the world's power systems in a situation where the global economy is closely interconnected and value chains are vulnerable increase the risk of conflict, and the consequences of conflicts become considerably more serious. This could have major consequences for societal security and civil preparedness. The population's confidence that the supply systems for food, water, medication, vaccines and energy are robust and will function well in any situation is a prerequisite for societal security and for society's social and political stability. In a time of crisis, the outcome will be determined by the resources and responses of the population and the public administration, business and industry, and civil society actors. Therefore, we need insight into how we can mobilise these parties in a crisis. We also need to know how we can communicate effectively with different groups of society and make them aware that they are part of our emergency response organisation.

New technology is being developed and introduced at a rapid pace. This opens opportunities, but can also pose challenges to national security and public security, as well as to the population's fundamental right to protection of privacy. It is important that we introduce new technology in a secure manner, that the technology developed is secure, and that it is possible to prevent and prosecute crimes committed by means of new technologies. These digital security needs are growing rapidly as society's critical infrastructure becomes increasingly reliant on digital value chains.

In recent decades, different threats have attracted our attention, including terrorism, pandemics, cyberattacks, war and serious natural

events caused by climate change. We will continue to protect ourselves against these and other known threats. However, we must also make contingency plans to prepare for unknown and complex threats and crises, and build knowledge about how we can deal with a situation and put things right after a crisis. Societal security and civil preparedness is a complex field, characterised by a complex overall situation involving a number of risks and actors. A crisis can beget new crises or be closely linked to crises in other sectors, as the climate crisis has consequences for food security, migration and energy and security policies. Research and education play a crucial role in this context. We need to map the status of crises. We also need knowledge about how threats and crises develop and about the effects of different measures. Not least, we need to educate graduates to meet the needs of the future. Work on societal security and civil preparedness involves many disciplines and subject areas that must be seen in conjunction with each other. Strengthening trust in society, i.e. that people trust each other and the authorities, and that groups with different cultural backgrounds and affiliations join forces, is an important aspect of societal security and civil preparedness. An interdisciplinary approach must therefore also include perspectives from social sciences and the humanities. Norway is participating in societal security and civil preparedness collaboration under Horizon Europe and associated programmes. We also collaborate and share experience with the EU in our work on national guidelines for responsible international collaboration. We need interdisciplinarity and global cooperation in research as well as education to prepare for known and unknown threats.

3.5.1 Main challenges and knowledge needs

3.5.1.1 Global health threats

Antimicrobial resistance (AMR) is one of the greatest threats to global health, food safety and modern medicine, as discussed under the priority *health*. Global trends such as population growth, urbanisation and increased travel could also make pandemics a more frequent occurrence, and this will in turn have consequences for societal security and civil preparedness. The interaction between public health, animal health, plant health, food production and the environment (the One Health approach) is a key aspect both of pandemics and of combating antibiotic resistance.

²³ Ministry of Justice and Public Security (2022).

²⁴ The Directorate for Civil Protection regularly analyses crisis scenarios and proposes relevant measures to prevent and deal with crises. We need to clarify our research needs in terms of prevention.

Action taken to limit pandemics can affect all sectors of society. We must therefore prepare to face pandemics by implementing knowledge-based measures with as limited negative effects as possible. This will require us to develop and improve knowledge systems that yield new knowledge in a crisis more quickly. The Coronavirus Commission²⁵ and the Holden Committee²⁶ have both pointed out that we need to invest in more knowledge and better digital solutions. They also emphasise that we have to strengthen global health preparedness to enable the world to prevent, identify at an early stage and respond quickly to developing resistance and new or persistent threats posed by infectious diseases. This also requires sufficient capacity in education in the field, as we pointed out under the priority *health*. The Norwegian Institute of Public Health's report on antibiotic resistance and pertaining knowledge gaps, challenges and relevant measures pointed out that we lack knowledge about the role of the environment in the development and spread of antibiotic resistance in Norway as well as in the global context.²⁷ To prevent resistance, we need global research collaboration and more knowledge about infection control in the health service. Good infection control can prevent both infection and the spread of resistant microbes. Preventive work outside institutions and good animal health are also crucial factors in limiting the spread of infection, thus keeping the use of antibiotics by humans and animals low. The Norwegian Institute of Public Health proposed a number of measures in its report, including more research on prevention in and outside the services.

3.5.1.2 Food security, drinking water and supply risk

Food security in Norway is addressed by domestic food production and by safeguarding our production base. We utilise our soil resources well and protect cultivated soil. International trade also ensures our food security. Even though Norway has good food security, climate change and more extreme weather events can make crop failure a more frequent occurrence. Climate change and international conflicts can both disrupt the value chain and make supply security more challenging. Any strengthening of our contingency planning by increasing Norway's food production must be

based on sustainable management and more circular use of resources, in combination with strong protection of cultivated soil. The protection of cultivated soil must be balanced against other needs of society, however. Food security and drinking water supply depend on good ecosystem conditions and ecosystem services such as water supply and purification. The challenges of the future require an integrated approach to society's different needs.

The global trade and food systems are also changing. Population growth, climate change, natural resources under pressure, water shortages, the coronavirus pandemic and the security policy crisis caused by the war in Ukraine all contribute to putting food security high on the national as well as the international agenda. Other major environmental degradation, security policy crises and unforeseen events such as pandemics could also disrupt the value chains.

We need knowledge that will help to increase the national self-sufficiency rate within the limits inherent in nature, and also about risk management and more robust trade systems at the national as well as international level. We have to improve our understanding of risk, mutual dependence and vulnerability to disruption in a global production system. We also have to improve our knowledge about how we can build preparedness systems to prevent poverty, food shortages and famine as a result of failure in food production and food distribution.

A secure supply of safe drinking water is vital for society to function. A sufficient number of skilled workers, engineers and graduate engineers in the fields of water, sewage and the environment must be trained and employed to enable municipalities to ensure clean and safe water to the entire population of Norway. It is also important to develop and introduce new technology in the municipalities to ensure effective, cost-efficient and sustainable water and sewage solutions.

3.5.1.3 Energy security

In recent years, Europe has set itself ambitious goals for cutting greenhouse gas emissions and restructuring the energy markets. A significant production capacity has been developed for variable renewable energy, while much of the controllable production capacity has been phased out. This will have a bearing on energy prices in Europe in the time ahead. Increased demand for clean energy in combination with low inflow in Norway's hydropower system and high gas, coal

²⁵ Official Norwegian Report (NOU) 2021: 6.

²⁶ Norwegian Directorate of Health (2021).

²⁷ Steinbakk et al. (2014).

and CO₂ prices have had a significant impact on energy prices in Norway as well. The Norwegian power grid has become more closely integrated with that of other European countries through a number of electricity interconnectors. When the European energy market changes because of the growth in variable renewable energy, we are also affected.

New knowledge and new technologies and solutions must be developed to manage, transmit and use energy in a good and appropriate manner. This is also important to make the energy system more secure, robust and flexible. We need power market models to help us to understand the connections in the power markets going forward, and knowledge about how Norwegian society depends on a secure energy supply. We also need knowledge about the consequences of our overall energy policy for different groups in society, as well as about its implications for wealth distribution and welfare policies. Energy security is a particularly important national responsibility, which means that the expert communities and tools we need to ensure security of supply must be in place. Large-scale investment in offshore wind power intensifies the need for more knowledge and up-to-date models that can manage energy and power market analyses.

3.5.1.4 *Serious natural events*

Damage caused by floods, landslides and avalanches, storms and wind has always been one of the major challenges facing Norway. We have to expect more extreme weather events and greater impact from such natural events in the time ahead, particularly in connection with dramatic changes to precipitation patterns. More extreme precipitation means that landslides could occur in areas that have so far been spared. Changes to the climate also increase the probability of more droughts. Droughts can lead to lower hydroelectric power production, increased risk of forest fire, crop failure, a limited drinking water supply and damage to ecosystems.²⁸ Ice loss leads to an increased level of human activity in areas that were previously inaccessible. This activity makes nature more vulnerable, which increases the risk of negative impacts.

Extreme weather events and infrastructure damage will also cause considerable indirect costs, for example reduced sense of security and disruption of business activities. Failure of func-

tions critical to society is one potential consequence. This will increase pressure on the authorities, municipalities and enterprises' capacity to prevent and deal with crises and carry out rescue operations. In light of climate change, we therefore need to identify new research areas to prevent natural hazards.

We also need to develop a better understanding of the impact of natural damage on nature, society, migration and the economy. Such events could have a detrimental effect on food production, settlement, water supply and other infrastructure. At the same time, much of Norway is characterised by demanding topographical conditions and very long distances. We therefore need knowledge about how the risk of damage related to climate and weather conditions and major incidents develop in and vary between different parts of Norway, and about what measures can be implemented to reduce the risk of damage and incidents. We also need innovation in rescue technology and more highly skilled rescue and emergency response personnel.

3.5.1.5 *Nuclear safety and preparedness*

Nuclear research in Norway has given us knowledge and expertise in areas such as radiation protection, nuclear safety and preparedness, radioactive pollution and radioecology as well as radiopharmacy. Norway has no nuclear reactors for electricity production, but nearby countries do have nuclear power production and plan to develop more facilities. We therefore need expert communities capable of dealing with incidents where radioactive substances spread and could affect Norway. As part of this effort, we will continue to contribute financially to the European Atomic Energy Community's (Euratom) Euratom Research and Training Programme (2021–2025), although Euratom's research programmes do not fall within the scope of the EEA Agreement and Norway is not a member of Euratom. The areas of research that are most relevant to Norway are radiation protection, the effect of radioactive pollution on the environment and in the food chain, and waste management, and we have therefore given priority to these areas.

The closure of our research reactors at Kjeller and in Halden means that we need knowledge and expertise on treatment, storage and final disposal of radioactive waste, and on safe decommissioning of nuclear facilities. This work will probably go on for decades. The Norwegian radiation protection community is a small one, and lack of exper-

²⁸ Report No 5 to the Storting (2020–2021).

tise could make it challenging to decommission the nuclear facilities in a safe manner. We have a tradition of bringing in international experts, but expertise in this field is now in short supply internationally, as several countries are planning to decommission facilities. We must therefore strengthen the research communities that carry out basic research and offer research-based education in the nuclear field. The Government has already initiated this work, cf. Proposition No 115 (Resolution) (2021–2022) and Recommendation No 450 (Resolution) (2021–2022).

3.5.1.6 Security policy changes and responsible international knowledge cooperation

Russia's war against Ukraine has had material political and economic consequences on a global scale and given rise to lasting change in the international system, both in the economy and security policy. At the same time, more intense rivalry between the global powers and the interconnected global economy will continue to affect and intensify the consequences of potential future conflicts. The Government will continue its work to develop and strengthen Norwegian research communities with expertise on security policy changes and trends at the regional European level as well as on global power shifts and the potential for conflict. The dynamics of the relationship between the USA, the EU, Russia and China and these dynamics' implications for Norway and our national security are of particular interest. The UN's role and function form part of this picture.

The Government considers it particularly important to strengthen cooperation with the EU and other closely related partners and allies on security policy research, but also considers it important to strengthen cooperation with other international partners with research expertise on foreign policy and security policy. We need interdisciplinary knowledge about the political development and security policy priorities of individual countries, as well as about what this means for Norway's scope of action in security policy matters. It is important, both in the Norwegian context and from a more general perspective, to identify and understand policy instruments that can be effective in efforts to reduce and deal with national and international conflict. We need to understand how we can develop an institutional and legal framework suited to deal with international political conflicts and their consequences in the years to come.

Geopolitical developments also have a bearing on the framework conditions for international higher education and research cooperation. The Government considers it important for Norwegian higher education and research institutions to be well equipped to protect the assets they manage, including knowledge about and expertise on critical and potentially sensitive areas, in their interaction with foreign partners. International cooperation is a precondition for Norway's further development as a knowledge nation and for finding good solutions to global challenges. This also includes cooperation with institutions and individual scientists from countries that Norway has no cooperation with on security policy-related matters. Several such countries possess strong expert communities in areas of importance to the development of knowledge and expertise that Norway needs, including areas of security policy-related importance.

The Government wants to strike a good balance between maintaining an open and internationally oriented knowledge sector and the need to exercise greater caution as global tension and polarisation are mounting. HK-dir and the Research Council of Norway have been tasked with developing national guidelines for responsible international collaboration in order to facilitate goal-oriented collaboration that addresses both established values and standards for academic collaboration and national interests in a broader sense. These guidelines, which are scheduled to be ready in the first half of 2023, are intended as a contribution to increasing knowledge and raising awareness among Norwegian higher education and research institutions about the opportunities as well as the challenges associated with international knowledge cooperation.

The framework conditions for Norway's security are influenced by the opportunities available to developing countries when it comes to positive economic, social and political change. Interdisciplinary research that provides deeper and broader insight into how the development of these countries can be supported therefore adds to the knowledge base on which Norway's development policy efforts are based.

3.5.1.7 Technology and societal security

Norway has a world-class digital foundation that facilitates digitalisation and innovation. More and more services that are important or even critical to society are built on this foundation. Society's growing dependence on digital services increases

our need for knowledge about risks and what can be done to reduce the vulnerability of value chains in the economy and critical societal functions and information systems. Among other things, we need knowledge about developments in traditional and social media. The rapid development of new and ground-breaking enabling technologies, which are discussed in more detail under the priority *enabling and industrial technologies*, will have a bearing on security and data protection in Norway in the years ahead. Examples of such technologies include big data, artificial intelligence, the internet of things, autonomy, space technology and quantum technology. These technologies can help to keep society and the population safe. Moreover, they can give us better possibilities for prevention, rescue operations, fire response and crisis management, but they could also pose major new challenges in terms of security and protection of privacy.

The threat posed by organised crime is increasingly digital. We therefore need to understand mutual dependencies in a global, digital economy and social development. We also need to understand how criminals and states can influence and threaten society and national security by digital means. Moreover, we have to develop knowledge and methods to fight internet crime and different forms of influence operations and disinformation. We must also become less dependent on technology supplied by authoritarian states. We therefore need to strengthen education in ICT security and increase the number of employees who have expertise on digital security and the ability to manage digital risks. It is important that security and data protection are prerequisites in the development of all new products and systems, so that society does not need to spend a lot of resources on remedying security flaws once the products and systems are in use.

Technology development is an integral part of our security policy development and total defence. Technology development both in the military and civil sector will have significant influence over the development of new capacities of importance to defensive capability and civil-military cooperation. We need strong research communities rooted in a Norwegian context that are capable of cooperating to strengthen the defence sector's and civil sector's ability to understand and make use of new and ground-breaking technology, including in an operational setting.

3.5.1.8 Knowledge in a crisis

A crisis is a situation that differs from the normal situation and that has caused or could easily cause loss of life, injury or damage to the environment and material assets. A crisis is an extraordinary situation where an urgent need arises that cannot be met by ordinary resources and responsibilities. A reorganisation or additional resources will therefore be required to resolve a crisis. The coronavirus pandemic has demonstrated the weaknesses of the current knowledge system and made it evident that we need better contingency plans to deal with the knowledge needs that arise during a crisis, including psychosocial emergency response.²⁹ Good crisis management depends on good assessments of which expert communities to involve at which stage of the crisis. Societal security is characterised by a complex overall situation involving a number of risks and actors. Overall knowledge development is needed to elucidate connections and assess the effects of different forms of preparedness and crisis management measures.

Quick access to existing statistics and data is needed to support knowledge-based crisis management. New statistics and data must also be developed and opportunities provided for ensuring that good research and analysis communities from different disciplines have access to the data. Among other things, it is important that they can quickly produce quality-assured evidence syntheses on which politicians can base their decisions. Furthermore, we need knowledge about effective communication in a crisis situation.

We also need to consider how the existing regulatory framework is practised and if there are any ways of making case processing more efficient. It is important to be able to collect data quickly, and we therefore need to simplify the regulatory framework and the way in which it is practised. Among other things, we have to consider the rules for and ethical aspects of randomised studies and other methods to identify causal connections. We also need to have a basic infrastructure for data sharing and computing power that has sufficient capacity regardless of where a crisis strikes.

3.5.2 Measures and follow-up

The Government expects universities, university colleges, hospital trusts, regional health authori-

²⁹ Official Norwegian Report (NOU) 2021: 6.

ties and research institutes that receive public basic funding to follow up the thematic prioritisation of societal security and civil preparedness and help to meet the knowledge and skills needs described above within their capabilities and areas of responsibility.

The Government will:

- give particular priority to the following areas of research and research-driven innovation:
 - effects of infection control measures and antibiotic resistance
 - international research collaboration on climate-smart agriculture and global food security
 - development of energy security models and analysis tools
 - mutual dependencies and trade systems in a global, digital economy and social development
 - strengthen Norway’s research capacity on geopolitical dynamics, particularly regarding political, security policy-related and financial changes at the global scale
 - consequences of security policy developments and changes in the threat situation for Norway’s national security
 - effective measures to combat internet crime and different forms of influence operations and disinformation
 - strengthen synergies in utilisation of technology and improve the ability to manage complex rescue operations and deal with new and complex threats
 - facilitate research for the decommissioning of Norway’s nuclear facilities
- give particular priority to the following areas in higher education and skills:
 - facilitate the education of more engineers, graduate engineers and graduates with interdisciplinary expertise on societal security
 - facilitate the education of more PhD candidates who can be granted security clearance
 - strengthen nuclear expert communities and study programmes
 - facilitate the strengthening of digital security expertise in key disciplines
 - decentralised and flexible education
- give particular priority to the following areas in data infrastructure and digitalisation:
 - infrastructure capable of processing large quantities of data to strengthen contin-

gency planning, prevent crises and manage them when they do occur

- investment to make us less dependent on technology supplied by authoritarian states
- face new and complex threats by strengthening cooperation in research, innovation and skills development across sectors and through interdisciplinary perspectives
- develop models and analysis tools and strengthen expertise and understanding of the water cycle, energy security and prevention of damage caused by droughts, floods and landslides/ avalanches
- establish better preparedness to deal with knowledge needs and upscale systems when a crisis occurs, and highlight research needs for crisis prevention
- strengthen the knowledge base on disciplines that require particular caution in cooperation with foreign actors
- establish a research centre that focuses on geopolitical issues

3.6 Trust and community

The Norwegian welfare state is built on a high level of trust between people and widespread use of collective solutions. The high level of trust, both between individuals and groups in the population, between the people and the authorities and between urban and rural areas, has long historical roots, and is linked to people’s sense of community and cultural identity.³⁰ The development of common welfare schemes and other social institutions has made it possible for the Norwegian social model to combine a sense of social security with high value creation.³¹ Long-term efforts have been undertaken to promote parity of living conditions between regions and between densely and sparsely populated areas.

Today, the level of trust in Norwegian society is among the highest in the OECD area. According to the OECD, contributing factors include a strong welfare system, equalisation of income through taxation, petroleum revenues to the state, tripartite collaboration in the labour market, low corruption and a high level of integrity in the public sector.³²

In an age of rapid transition, the Government believes that we must strengthen trust and com-

³⁰ Bergh and Bjørnskov (2011).

³¹ Sejersted (2005).

³² OECD (2022a).

munity to ensure the Norwegian social model is sustainable. This means that we must reduce financial, social and regional differences, prevent exclusion, protect jobs, counter trends of polarisation and a sense of powerlessness, bolster democratic participation and combat hate speech and discrimination. We must also strengthen trust in civil society and trust in public services and authorities. Furthermore, we must secure the financial foundation for our welfare schemes. The responsibility for all of the above does not rest with one single sector of society. To succeed, we must be able to see the connections between many areas of society and policy, and do so with a long-term perspective. This requires insight into what has shaped society over a long period of time and the challenges we now face.

The Government emphasises three main challenges with respect to trust and community. We need a better knowledge base to 1) ensure participation and diversity in common arenas, 2) prevent exclusion, and 3) develop an innovative and efficient public sector that provides good services to its users. These topics require an interdisciplinary approach, particularly from the humanities, social sciences and professional disciplines. Trust in research-based knowledge is discussed in more detail in Chapter 7.

3.6.1 Main challenges and knowledge needs

3.6.1.1 Ensure participation and diversity in common arenas

A vibrant democratic society is based on the active participation of its citizens. Social and cultural arenas must therefore be geared to motivating participation in a diverse population. This applies in public discourse, political parties and elected bodies, in education and the labour market and in other common arenas. Encouraging broad participation also serves to prevent exclusion. We are not succeeding in this area today, as discussed in the section below on preventing exclusion.

Democracy and public life

The central government authorities have a constitutional responsibility to promote open and informed public discourse. The development and renewal of democracy requires critical discussion and a diversity of perspectives. The challenges facing society must be addressed on the basis of objective debate and respect for democratic pro-

cesses. Protecting democracy is a key responsibility in all sectors.

The fabric of public discourse and common arenas has changed over the past decades. New technology enables a diversity of voices to participate in public debate. At the same time, we see that democratic processes and public debate are now under pressure from, among other things, troll factories, fake news, various forms of manipulation through digital media and the emergence of echo chambers. This could undermine democracy and threaten societal security (discussed in more detail in section 3.5). We also see that cancel culture, self-censorship and harassment on new platforms can deter people from participating in public debate, especially in relation to contentious issues. There is also tension between urban and rural areas. Overall, this leads to a polarisation of society. Some of the same challenges are also evident in academia (see discussion in Chapter 7).

We need research on the drivers that impact public discourse today and on what bolsters or undermines objective debate and democratic processes. This research should look at political, technological, cultural, social, regional and legal aspects. We also need research on what promotes and, if applicable, impedes our development of democratic competence – regardless of background – in education, working life and civil society. The research should also have a regional perspective that captures the similarities and differences between different regions, parts of the country, rural and urban areas, and the specific challenges facing rural Norway. Ensuring research is performed by research communities based in different parts of Norway will increase the likelihood of a diverse range of regional perspectives being represented. There is a lot to be gained in these areas from international research collaboration, including through the Horizon Europe programme. Inclusion and diversity and young people's participation in democracy are also important priorities in Erasmus+ and the European Education Area.

The culture sector, civil society, voluntary organisations, the media and the education system all play a key role in protecting democracy. We therefore need research on how the current policy in these fields is able to deal with new challenges relating to language, social conventions and culture of free speech. Examples of relevant issues include global technology giants' dominance as content providers, political influence via new media, rights issues and the significance of new, digital cultural meeting places and forms of

Box 3.12 Freedom of Expression Commission

The Freedom of Expression Commission was appointed in 2020 to study the social, technological, legal and financial framework for freedom of expression in Norway today. The Commission has been tasked with mapping existing knowledge about the status of freedom of expression and assessing the need for more research in this area, among other things. The Commission's Report, Official Norwegian Report (NOU) 2022: 9 *En åpen og opplyst offentlig samtale* ('Open and informed public discourse' – in Norwegian only), was presented in August 2022. The Commission finds that the overall public discourse situation in Norway is good, and refers to how the internet has made a huge contribution to democratising freedom of expression and information, among other things. However, the Commission also highlights a number of challenges.

Although the Commission recommends several amendments to the law in this area, it believes that a viable democracy is best achieved by other means. The Commission points out that the development of an inclusive culture of free speech is a shared responsibility,

and that rhetorical citizenship and broad expression preparedness are developed jointly. Public discourse in Norway today is based on an active and diverse civil society. The Commission recommends several concrete measures to stimulate this development, including education and training in the use of freedom of speech at school.

The Commission also sees a continuous need for up-to-date research in various areas, particularly those facing challenges. Examples of such areas are use and experience of freedom of speech in various groups, including Sami, sexual minorities and disabled people. Other areas include the large platform companies' impact on Norwegian society, the scope and harmful effects of misinformation and disinformation, and the status and experience of freedom of speech in the arts and culture.

The report will be submitted for broad consultation before the Government considers its recommendations. See also discussion of the Kierulf Committee's report on academic freedom of expression in Chapter 7.

communication. How increased digitalisation impacts people with poor digital literacy should also be investigated.

Participation in education and working life

Participation in kindergartens and schools and other educational arenas leads to personal growth, is conducive to health and opens doors for participation in working life, civil society and democratic processes. The Norwegian education system is a community arena that fosters a sense of belonging and bolsters trust in society by giving everyone access to learning and development based on common values. We need knowledge about how we can ensure a learning environment that helps everyone to complete basic education and develop the skills they need to actively participate in society.

Work is a source of income, financial security and self-realisation. Participating in working life counteracts differences in living conditions, helps to prevent and combat poverty, and plays a huge role in social inclusion. Work is by and large con-

ducive to health, but for some, work and the working environment can also cause health problems and lead to sickness absence and exit from working life. We need knowledge about how to promote a productive, diverse and inclusive working life.

Belonging and participation

A sense of community requires us to identify with, include and accept each other despite our differences. An inclusive society also requires that both majority and minority groups have a sense of social belonging and identity. We need research on cultural and identity issues, including their historical and religious aspects. The Norwegian research system has a particular responsibility to generate sound research on Norwegian and Sami language, culture, history, economy and other aspects of society, including research on regional issues.

Children and young people have a right to participation. Growing up in a digital age entails opportunities, but also considerable risks. The

Norwegian Committee for the protection of children and young people against harmful media effects, which presented its report in March 2021, recommends more research on children's use of media and media content, especially relating to sexualised content, hate speech, digital bullying and extreme content.³³

We also need knowledge about what role participating in cultural and leisure activities plays for the individual, and how important these types of local community arenas are for public health, including research on how the barriers to participating in such activities can be broken down for adults and children alike.

Research is also needed on the opportunities indigenous peoples, national minorities and other minority groups have to safeguard their cultural heritage and practise their own cultural traditions across borders and in relation to the majority society. Cultural practices being shaped in contact with each other and new ones arising is often seen as enabling broader inclusion. Research is needed on these dynamics and their role in safeguarding both community and trust.

Equality, non-discrimination and diversity

The Government's ambition to achieve greater equality, less discrimination and more diversity

³³ Official Norwegian Report NOU 2021: 3.

covers many arenas of society and will improve the lives of many. The Equality and Anti-Discrimination Act has, moreover, recently been extended to cover more forms of discrimination.

However, the Research Council describes this policy area as being 'weak' in terms of research. The Ministry of Culture and Equality has therefore established a collaboration with the Research Council with a view to presenting a cross-sector R&D strategy in 2023. A new report from the Nordic Institute for Studies in Innovation, Research and Education (NIFU) particularly recommends strengthening research on bases for and forms of discrimination that have so far not been studied to any great extent, and on the discrimination challenges that are most serious for individuals and society.³⁴

The forthcoming R&D strategy will strengthen the knowledge base for equality efforts in a range of sectors and arenas in the years to come. The knowledge needs that are identified will form the basis for the choice of direction and priorities. Research communities, sector authorities, special interest organisations etc. will be involved in the development work.

3.6.1.2 Prevent exclusion

Exclusion is a complex and persistent problem for society. Being excluded from the social communi-

³⁴ NIFU (2021).

Box 3.13 Mission to include more children and young people in education, employment and society

Exclusion of young people is a major challenge in society and entails significant costs for the individual and society. Many different areas of society are involved in the work to reduce exclusion. Unified and coordinated efforts where knowledge is used to create real change are needed to tackle this challenge. Close collaboration between research, higher education and services geared towards children and young people who are struggling is vital to ensuring they have a good childhood and go on to have good lives as adults. Exclusion among young adults often stems from experiences in childhood and adolescence. In the present long-term plan, the Government presents two missions. This represents a fresh research policy instrument in a Norwegian context. See Chapter 6 for

a more detailed discussion. Through this mission, the Government aims to reduce the proportion of young people not in education or work or taking part in society through cross-sectoral and targeted efforts geared towards impact factors for a good childhood. The Ministry of Children and Families, the Ministry of Health and Care Services, and the Ministry of Education and Research will be among the ministries involved. The final wording of the main objective, quantification and further development of the sub-goals geared towards education and qualification, health, quality of life, coping, participation and inclusion, will be developed during the design and implementation phase. Consideration will also be given during this phase to whether the mission will cover young adults.

ties that others participate and find meaning in, be it school, working life, leisure activities or cultural arenas, is one of the most difficult things anyone can experience. There are often multifaceted reasons, and exclusion from one context often leads to other forms of exclusion. It gives rise to a long list of negative consequences at group and society level, and costs a great deal in terms of human and financial resources. The battle against exclusion requires considerable efforts from various actors and services, both individually and collectively.

Understanding the reasons is essential to preventing exclusion, not least how different risk factors are interlinked and often reinforce each other. The key challenges and knowledge needs linked to specific groups or topics are set out in brief below. The cross-cutting knowledge needed to develop better and more efficient public services are discussed at the end of the chapter.

Vulnerable children and young people

Vulnerable children and young people are a heterogeneous group. Some may struggle for a short time, while others may have persistent and complex needs. This group includes children who experience neglect, violence and abuse, or who live in families with a low income or other living condition challenges. It also includes children and young people with disabilities or mental health issues. We also find juvenile offenders and those who have dropped out of school or have learning difficulties in this group. Children who come from immigrant backgrounds or have been adopted are other groups that may be particularly vulnerable. Many of these vulnerable children and adolescents have complex problems. Children and young people who receive inadequate care, learning and experience to prepare them for adult life have a heightened risk of permanent exclusion.

The research and innovation strategy Barne- og Ungdomsdepartementet 2021 shows that research in this area is based on a poor foundation, sectorised and has a short-term perspective. It also highlights the need for sound and forward-looking development of knowledge about what makes children and young people feel secure and included and what promotes their development.³⁵ A united research effort will contribute to covering knowledge gaps, particularly with respect to the cross-sector challenges. The strategy highlights the need for better access to, use and alignment of data as a basis for

research-based analyses of children and young people's lives and their complex needs. We need a knowledge base that provides better, more research-based education, more targeted services and that lays a better foundation for developing policy. The programmes of professional study should be seen in a cross-sector perspective, both to link research and practice closer together and to holistically address the needs of children and families. Research is needed on the causes of exclusion and about the course it takes and its consequences, and, not least, on how measures to prevent and reduce exclusion among children and young people work.

Working life and exclusion

Employment policy, along with overall policy, shall ensure high employment and low unemployment rates. Those who have the capacity to work shall have the opportunity to do so, to ensure sustainable welfare schemes, even out social differences and combat poverty.

However, many people of working age are not in employment and receive public benefits. The use of health-related benefits is moreover high compared to other OECD countries (see section 3.2 on health). Certain groups are over-represented among those who struggle to find or keep jobs: young people, some groups of immigrants and people with poor qualifications or health issues. The fact that the proportion of young people who receive health-related benefits has increased over time gives cause for concern. The Employment Committee has proposed several measures to counter this trend.³⁶ At the same time, we must combat irresponsibility in working life and work-related crime.

The need for research that can contribute to a more inclusive working life is complex. Firstly, we need research with a long-term perspective on how working life and the labour market develop, and the trends and development features identified. This research will provide a knowledge base on which to adapt policy and priorities, and enable us to design good, targeted measures.

Secondly, it is important that research generates knowledge on how the authorities' efforts help to increase work inclusion, and on alternative ways forward. The research must both have a socio-economic macro perspective and a micro perspective looking at the support given to par-

³⁵ Research Council of Norway (2021a).

³⁶ Official Norwegian Report (NOU) 2019: 7 and Official Norwegian Report (NOU) 2021: 2.

ticularly vulnerable groups. It is important that the work and welfare sector, the health sector and the education sector work together to include particularly vulnerable groups in working life, or prevent them from dropping out. We need research that reflects these connections. This kind of research can set out how policy can be designed, e.g. how work-related follow-up can be provided at the same time as healthcare.

Integration

Integration policy cuts across sectors and is built on collaboration between central government and the municipalities, the social partners, civil society and private actors. The Act relating to integration through training, education and work (the Integration Act) is intended to contribute to more immigrants joining the workforce, thus enabling them to support themselves and their families, contribute to a financially sustainable welfare state and become part of Norwegian society.

Research shows that the rate of employment among immigrants is lower than in the population as a whole at all levels of education. This may be due to multiple factors, and there are differences between immigrant groups. There is a significantly higher employment rate among immigrants who have taken an education in Norway than among those who have taken the same level of education abroad.³⁷ There are also considerable differences between e.g. refugees and labour immigrants. Other factors may also have an impact on employment. For example, stigmatisation and discrimination may also lead to marginalisation and act as a barrier to inclusion in society and working life.

We have seen recently how acute crises have forced large numbers of people to flee, which has posed a challenge for national authorities' ability to coordinate collaboration across borders. This has also challenged Norwegian response efforts relating to the receipt, settlement and integration of newly arrived refugees in local communities.

Integration policy must be supported by research that generates knowledge about what works when it comes to different groups of immigrants being included and participating in Norwegian society and working life, and that contributes to developing equitable education and welfare services for a diverse population.

Crime prevention

Strengthening participation in common arenas is an indirect, but very effective means of preventing crime. Reducing the dropout rate from upper secondary school and increasing participation in working life are examples of measures that will reduce crime in the longer term.

Previous research has shown that there is a preponderance of young men in the crime statistics, and that low socio-economic status is a known risk factor. The immigrant population is a group over-represented in crime statistics, which is linked to, among other things, the fact that this group has a lower average age and poorer living conditions than the rest of the population. Young people and immigrants are also more at risk of being the victims of crime, particularly crimes involving violence and sexual abuse. These are the crimes that cost society the most. Crimes of relevance to societal security are discussed in more detail in section 3.5.

We need research on concrete causal relationships and on measures with a documented effect to be able to prioritise and get the policy right. For example, we do not know whether poor living conditions lead to crime, whether crime leads to poor living conditions or whether both are due to a common underlying cause. The same applies to the connection between crime and other factors, such as mental health, alcohol and drug abuse, and participation in working life or education. Nor do we know enough about which penal sanctions and other sanctions are most effective at preventing crime. In this research area, Norway should exploit the comparative advantage it has over many other countries of being able to link data about individuals from multiple registers, enabling us to identify connections and prove effects.

3.6.1.3 An innovative and efficient public sector that provides good services to its citizens

A knowledge-based public sector that enjoys the broad trust of the population is fundamental to the Norwegian welfare model. If we are going to maintain this welfare model during a period marked by less financial scope of action, while maintaining the trust of society, we need to think differently about the structure of the public sector and its measures and services. If the public sector is to be able to develop its efficiency, quality and trust-based governance systems, it is vital that the sector has the ability to initiate, participate and use research to that end. In the face of demo-

³⁷ Official Norwegian Report NOU 2017: 2.

graphic changes, we need to develop public services that meet user needs in a relevant and efficient manner, also across sectors. We need, not least, to develop better services for users with different and complex needs. The Government will implement a trust reform in the public sector to ensure that its employees get the freedom of action they need to provide good services (see box 3.14).

Report No 30 to the Storting (2019–2020) *An innovative public sector* confirms the need to increase research efforts on and involving innovation in the public sector. Surveys also show that innovation is more effective in the public sector when combined with research and higher education. The effects include higher quality, improved employee satisfaction and political goal achievement, more user participation and higher efficiency.³⁸ However, the same surveys show that only 24 per cent of the innovation takes place in a collaboration with research and higher education.

The research-based knowledge base is weak in parts of the public sector. More and better research is needed in a number of areas in relation to the content of the services themselves, the structures they are part of, how they work together as an integrated set of services for users, and their effect. This applies to both central government and municipal measures. One example of this is the practice-based research conducted on labour and welfare services, where the research efforts are rather weak. More and better knowledge about what works for whom will be helpful to case officers working in labour and welfare administration and partners in the health sector, the education sector and the labour market.

Another example is the child welfare service, which is tasked with taking care of some of the most vulnerable children and families in our society. We need research on the challenges children and their parents face, and the help they need across the spectrum of services. We particularly need to look at the assistance measures provided by municipalities, and whether they achieve the results they set out to. We also lack knowledge about what constitutes good care and treatment in a child welfare institution, and how we can ensure that children who live in institutions and foster homes are not moved around more than necessary. Child welfare service employees administer some of the welfare state's most invasive measures. They thus need a high level of expertise and

continuity in the professional community to be able to provide high-quality services while safeguarding children's and parents' due process protection. We need to prioritise master's degree programmes in child welfare until the qualification requirements are implemented in full in the sector in 2031.

We need good basic data and high-quality research on the entire course of education and training with respect to kindergartens and schools. More must be done to that end to enable reuse and further use of data, including for research purposes, while safeguarding protection of privacy at the same time. Research must provide an insight into cause and effect between different phenomena of significance to children and young people's well-being, learning, education choices and inclusion in a longer perspective. We need research on what works for whom and why, and research that develops theory and methodology.

As well as research in individual sectors, we need to strengthen cross-sectoral research and research on this type of collaboration. Silo thinking places too many limits on collaboration between sectors and levels of authority, and is an obstacle to the development of good services for citizens who need help and assistance from multiple service providers or sectors. We also need better and more dynamic collaboration between research, education programmes and different professions in the field of practice. The municipal sector has a key role here. Research and education programmes must be of relevance to individual municipalities, mobilising them as valuable actors in education and research. In that connection, we must develop better collaboration models for research *with* the municipalities, and not just on and for them. This is particularly important now that major demographic changes are taking place. One relevant collaboration measure may be to develop population data at county and municipality level into public health profiles, which could provide knowledge about the effect of measures. This type of knowledge could be used as a basis for measures in the social element of municipal master plans.³⁹

More knowledge is also needed about interaction and collaboration between the public sector, especially the municipalities, and voluntary organisations in several welfare policy areas, such as education, the conditions under which children and young people grow up, integration of immi-

³⁸ National Centre for Public-Private Sector Innovation (2022).

³⁹ Norwegian Institute of Public Health (2020).

grants, care for the elderly, public health and civil preparedness. Foundations and non-profit organisations play an important role here.

The Research Council's funding instruments have recently been increased to build capacity and help to ensure that research and innovation improves quality, skills and efficiency in public health and care services (see section 3.2 on health), labour and welfare services, the education sector, and child and family welfare services. The object is to strengthen practice-based research in communities that are responsible for programmes of professional study, ensure qualified professionals for the field of practice and help to increase collaboration on innovation between researchers, professionals, service providers and users. These efforts will continue. Participation in international collaboration, not least Horizon Europe and Erasmus+, is also a means of developing better public services.

Since the budgets for public expenditure generally look set to become tighter going forward, also in research, it will become increasingly important to prioritise good causes. Knowledge about which measures work, gained e.g. through trials, is important for prioritising research. The effects of measures and services must be documented to a greater extent, for example through effectiveness research. This must also be followed up with formative research by using e.g. register data, to ensure that measures provide the individual with the right help while also being sustainable for society. New graduates, evidence syntheses and more use of research results, by, for example, drawing up guidelines, are important channels for having the knowledge quickly implemented in the services.

As well as having to further develop the public services available, we also need knowledge about how we can ensure that people continue to have a high level of trust in the public authorities and in the governance tools used by the public administration. This is made evident by various trends. The increasing complexity of society leads to more juridification, when, for example, regulatory instruments are used to tackle the challenges facing society. More research and expertise is therefore needed about legislation as a governance tool. We need research on the quality of and compliance with regulations, on the social function of legislation, the use of new technology and how it relates to fundamental rights.

What has become known as the EEA case and the pertaining Official Norwegian Report (NOU)

2020: 9 *Blindsonen – Granskning av feilpraktiseringen av folketrygdlovens oppholdskrav ved reiser i EØS-området* ('The blind zone – investigation of incorrect application of the requirement to stay in Norway set out in the National Insurance Act in connection with travel in the EEA area' – in Norwegian only), shows that there is a great risk of making mistakes when it comes to implementing and practising the EEA regulations that are incorporated into Norwegian law. These mistakes can have serious consequences for individuals. Incorrect application of the law also impacts people's trust in the authorities and the public administration. We therefore need more legal research that can form a knowledge base for legal practice and for the public administration's work on regulatory development and application.

In the wake of the coronavirus pandemic, we also need knowledge about the population's trust in the advice given by the authorities during health crises. We need to conduct research on communication with different population groups and the importance of being open about the knowledge on which the advice is based, among other things.

Box 3.14 The trust reform

The trust reform is a joint project for the whole Government. The object of the reform is to provide more welfare and better services for citizens by increasing trust within the public sector. This will be achieved by:

- a. increasing the professional freedom of first-line staff
- b. reducing reporting and documentation requirements
- c. increasing scope of action for municipal and county authorities
- d. increasing co-determination and opportunities for involving employee unions
- e. improving governance, organisation and coordination
- f. increasing use of trust-based management

To strengthen the basis for the trust reform, we need research-based knowledge about the factors that enhance targeted and trust-based governance in the public sector, at different levels and within different fields.

3.6.2 Measures and follow-up

The Government expects universities, university colleges, hospital trusts, regional health authorities and research institutes that receive public basic funding to follow up the thematic prioritisation of trust and community, and help to meet the knowledge and skills needs described above within their capabilities and areas of responsibility.

The Government will:

- give particular priority to the following areas of research and research-driven innovation:
 - strengthen trust, community and diversity, including research on democracy as a governance system and way of life, democratic participation, civil society, equality, regional factors and digital exclusion.
 - combat exclusion, including research on violence, abuse and hate crime, and research on children and young people
 - strengthen the public sector’s innovation capabilities and efficiency, including more
 - use of formative research and effectiveness research.
- give particular priority to the following areas in higher education and skills:
 - relevant programmes of professional study in areas with insufficient capacity, particularly in child welfare, teachers in rural areas and teachers with Sami language skills
 - decentralised and flexible education
- implement a mission to include more children and young people in education, employment and society
- assess the recommendations made by the Freedom of Expression Commission
- develop models for collaboration between research and fields of practice that are in line with the public sectors’ future knowledge and innovation needs
- draw up and implement a cross-sectoral R&D strategy to strengthen the knowledge base for the efforts to achieve equality, non-discrimination and diversity

Part II
The knowledge system

Introduction

To be able to follow up the objectives and priorities set out in this long-term plan, we need a well-functioning knowledge system. This means that academic communities at research and higher education institutions must be equipped to efficiently deliver high quality and sufficient capacity. The knowledge and skills developed in these academic communities must be relevant to the different sectors of society and meet the needs across Norway. This applies to both Norwegian and Sami research and education. The research and education institutions must also work well with the Research Council of Norway, the Norwegian Directorate for Higher Education and Skills (HK-dir), the Norwegian Agency for Quality Assurance in Education (NOKUT), Sikt – Norwegian Agency for Shared Services in Education and Research, and other parts of the policy instrument system, as well as with the Ministry of Education and Research and the rest of the central government administration.

Several analyses conducted in recent years demonstrate that the Norwegian knowledge system has many strengths, but that improvements are also needed in a number of areas.¹ This has

¹ See for example Lekve (2022).

been confirmed through the work on this long-term plan and the wealth of input the Ministry of Education and Research has received in that connection. The Government would therefore like to use Part II of this long-term plan to set out some of the most important challenges and signal measures where necessary.

Chapter 4 discusses the policy for higher education and skills, and reference is made to the ongoing work on two white papers in the field of education. Chapter 5 sets out the status and challenges in the research system, which the Government intends to follow up through, among other things, a dedicated white paper on the research system. Chapter 6 then sets out the missions, launched in this long-term plan as a new policy instrument in Norway, in greater detail. Chapter 7 discusses academic freedom and trust in research, which are basic preconditions for a well-functioning knowledge system. It provides an account of, among other things, the Government's follow-up of the Kierulf Committee's report on academic freedom of expression. Chapter 8 sets out the policy on open research and discusses the value of data, while Chapter 9 provides a brief account of the work on university and university college buildings.

OECD report provides knowledge base for the long-term plan

On assignment for the Ministry of Education and Research, the OECD has prepared a report that will form part of the knowledge base for the work on the long-term plan for the period 2023–2032 – *Towards a new stage in Norway's science, technology and innovation system*.¹ The report is based on the recommendations made in *OECD Reviews of Innovation Policy: Norway 2017*.² The report, which was published in 2022, is not as extensive as the 2017 report, and does not provide a full review with pertaining recommendations, but presents analyses based on extensive interview and data material and a set of options for action:

- Balancing and linking excellence and relevance to maximise the economic and societal impact of high-quality research
- Institutionalising and systemising innovation at the universities to enhance capacity at all levels

- Extending the traditional boundaries of the research landscape between universities/university colleges and research institutes
- Exploiting the research institutes' full potential to tackle economic and societal challenges
- Improving the different types of thematic innovation centres
- Jointly designing and performing bigger and more transformative national missions with a high level of legitimacy and coordination
- Continuing to develop and improve challenge-driven and commissioned research schemes in cooperation with the policy agencies
- Improving the content and process of the long-term plan to increase its impact on priorities and ensure holistic coordination of the research and innovation system

¹ Larrue and Santos (2022).

² OECD (2017).

4 Higher education and skills needs

4.1 Quality and capacity in higher education

High-quality higher education is a fundamental precondition for Norway's further development as a democratic and sustainable knowledge society. The universities and university colleges play an essential role in society by educating highly skilled graduates who can fill important roles in society. Higher education also has a great bearing on individuals' personal and career development.

Developing the capacity of higher education must accommodate the needs of society and the demand among applicants. Student demand is influenced by labour market prospects and is a good indicator, along with analyses of future skills needs, for developing the capacity of education programmes. The universities and university colleges have an independent responsibility to develop the capacity of their programmes in line with the skills needed in different areas of the labour market. Education institutions must also now, to a greater extent than before, gear their activities towards enabling people to update and supplement their skills. As set out in Report No 19 to the Storting (2020–2021) *Styring av statlige universiteter og høyskoler* ('Governance of state universities and university colleges' – in Norwegian only), the actors involved in developing the capacity of higher education – the institutions, applicants and the authorities – need better access to updated information and good analyses of the regional and national skills needs in the different areas of education. It is on this background that responsibility for analysis and information work concerning skills needs has been assigned to the Directorate for Higher Education and Skills.

More than 100,000 people apply for higher education every year, and there is reason to believe that this number will increase going forward. Choosing an education is one of the most important decisions we make in life. In 2021, the Ministry of Education and Research appointed a committee, chaired by Marianne Aasen, to review and assess the regulations relating to admission to higher education. The Committee will submit its

report (Official Norwegian Report) on 1 December 2022. Norwegian students make up one of the oldest student populations in the world, and it is important that the system does not hinder young people from starting an education. The Government will therefore consider changing the rules on admission to higher education.

The Ministry of Education and Research wishes to improve its cooperation with other ministries with respect to the skills needs in different sectors. The Ministry also wishes to raise awareness in other sectors of how it works on developing policy on skills and higher education. The Ministry is therefore preparing a guide for ministries' work on skills needs, and plans to hold meetings with the other ministries on this topic every six months.

Education policy is important for enhancing innovation and development in all sectors. Research-based education is an important cornerstone, both for ensuring positions in the public and private sector are filled with people who possess the right qualifications, and for enhancing research and innovation and thus ensuring that the knowledge is used. Doctoral degree programmes are an important link between the world of education and the world of research, which help to meet research communities' and the labour market's needs for qualified researcher personnel. If more researchers can find positions outside academia after they graduate, this may lead Norwegian companies and public enterprises to apply research to a greater extent.

Society is currently undergoing a rapid digital transition, which has consequences for higher education policy. We will all need ICT and technology skills to a greater or lesser extent. The digital transition is far from over – rather it appears to be gathering speed. The large majority of employees will therefore need a certain level of digital skills to keep up in future. There is a lack of highly-skilled ICT personnel in Norway, as well as in the rest of the world. This trend means that highly-skilled and specialised ICT personnel are in demand, and that people in general need a higher level of ICT skills to be able to participate in the

labour market. The Government expects the education institutions to continue addressing the consequences of the digital transition, so that they can meet society's need for knowledge and skills. The education institutions must adapt the skills they impart to candidates as well as how they provide and implement education programmes.

HK-dir has established a national competition arena for education quality to stimulate knowledge, skills and innovative work on education. Norwegian participation in Erasmus+ also enables Norwegian universities and university colleges to participate in international collaboration projects that aim to develop the field of education. The Government expects the universities and university colleges to use the different schemes available to them in their quality development work, and also expects the institutions – irrespective of external funding – to work systematically to develop student-active teaching and assessment methods that promote learning.

4.2 Flexible and accessible education

Norwegian and Sami higher education should also be accessible off campus, close to where people live. It should be possible for people in all stages of life to take higher education and top up their knowledge and skills by taking courses and further and continuing education. More should therefore be done to facilitate high-quality decentralised and online education. Establishing new education institutions or more campuses are not necessarily the answer to bringing education closer to the people. The universities and university colleges can use technology and digital aids and collaborate with local communities and employers. Experience gained during e.g. the coronavirus pandemic can form a basis for developing better solutions whereby digital tools can be used in a well thought-out educational manner. This will provide a good point of departure for accessible courses and programmes that are adapted to local and regional labour needs and learning needs.

The campus structure we have in Norway makes up the core of the provision of decentralised education. The study centre model is suited to providing education and mobilising skills development in more locations off campus, and it serves as a good supplement to the campus structure. The study centre model is based on education institutions collaborating with local authorities and social actors to organise session-based

courses and programmes with digital teaching and supervision. This method of teaching allows higher education to be more easily and flexibly combined with work and other commitments. Online education and hybrid solutions thus lower the threshold for taking courses and education.

However, accessible higher education is not just about session-based or online programmes. It is important that education institutions offer first-degree programmes all over Norway to ensure that people who want to study full-time do not have too far to travel.

In spring 2023, the Government will present a white paper to the Storting on the labour market's skills needs in the short and long term. The paper's overall objective is to cover the most important skills needs in the labour market and society going forward, and ensure that people across Norway have access to education. A shortage of labour and an aging population make it even more important to prioritise education that is in demand among students and as well as in the labour market, and that provide the skills Norwegian society needs going forward.

The Government has also announced that it will present a white paper to the Storting on programmes of professional study. The emphasis in this paper will be on teacher training programmes, engineering programmes and health and social care programmes. The professional disciplines are very important for the welfare state. High-quality programmes of professional study provide skills that will secure good public services for people all over Norway. The programmes of professional study also contribute to professional innovation and development in schools, health and care institutions and other organisations. The white paper on programmes of professional study will address perspectives such as quality and capacity.

4.3 Tertiary vocational education

Society's skills needs are not met by universities and university colleges alone, and the skills policy must therefore look at the education system as a whole. Tertiary vocational education will be important in the years to come. The three biggest fields here are technical subjects, health and welfare, and economics and business administration. Some vocational colleges collaborate with Norwegian university colleges and universities to enable students to use their tertiary vocational education

as the basis for a bachelor's or, if relevant, master's degree.

Tertiary vocational education is a sector in growth. A total of 10,897 students graduated from 61 vocational colleges in 2021. This is an increase of about 31 per cent compared with 2020 and 62 per cent compared with 2019.² In its input to the long-term plan, HK-dir estimated that the labour market's need for vocational college graduates was large and growing. Tertiary vocational education is the most important bottleneck in a number of industries and regions. The vocational colleges have good local support and offer more flexible programmes that can be taken in combination with other commitments. The Government would therefore like to emphasise the important role vocational colleges play in the knowledge system, not least as suppliers of sorely needed vocational

qualifications in the labour market in the years to come.

4.4 Measures

The Government will:

- present a white paper to the Storting on the labour market's skills needs in the short and long term
- present a white paper to the Storting on programmes of professional study
- develop an analysis and information system on national and regional skills needs in HK-dir
- consider making changes to the admission system to higher education
- systemise the ministries' work on skills needs by means of a guide and hold regular meetings with the ministries every six months

² Norwegian Directorate for Higher Education and Skills (2022a).

5 A well balanced research system

To what extent the Norwegian research system is well balanced is the subject of constant debate. There are a lot of different views on what ‘well balanced’ means and whether the system is now in a state of ‘imbalance’, and there are as many views on what areas should be better balanced than they are today. The debated issues include the ratio between basic and applied research, between the amount of research carried out in the different sectors, between international and national research funding, between basic allocations and competition-based funding, and between investments in research and tools for research such as infrastructure. There are thus many answers to what constitutes ‘well balanced’ in these matters, and the answers will vary depending on one’s point of view. The Government believes that it is time to review the research system to assess whether changes are needed that can make an optimal contribution to achieving research policy objectives.

There are also a number of individual topics that are ripe for action already before the broad review of the research system. This applies to international collaboration, Norwegian academic language, research and development in business and industry, coordination of research policy and the universities’ and university colleges’ career policies.

5.1 Background

Around 90,000 people work in research and development in Norway, broken down into three research-performing sectors: the universities and university colleges, the institute sector and business and industry.¹ These sectors have emerged and developed over a long period of time in mutual exchange with each other, with political authorities and with the needs of society. The university and university college sector has tradition-

¹ In this breakdown, the research carried out by university hospitals is included in the university and university college sector.

ally emphasised basic research and research linked to their areas of education. The institute sector, which is the smallest of the three sectors, has largely focused on applied research. Business and industry, which is the biggest R&D sector measured in terms of investment, has largely engaged in development work and invested less in research compared with many other countries.

R&D allocations have increased more and more regularly than in most comparable countries over the past 20 years. The internationalisation that was wanted and planned has taken place. Overall, research quality is good. Norway is ranked number 10 in the world’s 43 top nations measured in publication volume. Norway’s researchers do very well in the EU. The Research Council’s added value is well documented by systematic surveys in a range of areas, for example surveys showing the added value generated by the funding the Research Council allocates to business and industry.

In other words, the growth and the focus of the R&D allocations have served us well in many respects. Nevertheless, it is now time to devote special attention to the research system because of the significant changes that have taken place over the past 10–15 years.

5.2 Changes in the research system

Significant changes have taken place in the research system, both within and between the three research-performing sectors, and the breakdown of R&D activities has also changed between them. A number of universities and university colleges have merged, and more institutions have been awarded university status. The university and university college sector has also grown considerably. From 2015 to 2019, the sector’s R&D expenses increased by 27 per cent, while R&D staff increased by 17 per cent.² Student numbers increased by 9 per cent during the same period.³

² NIFU Statistics bank.

³ Database for Statistics on Higher Education (DBH)

The changes have led some of the universities and university colleges to focus more on applied research and innovation, and the biggest institutions in particular obtain more external funding than previously. The proportion of basic research at universities and university colleges has dropped from 48 to 38 per cent in the past 20 years, and applied research now accounts for almost half of the activity in this sector. In absolute figures, basic research has also grown considerably during the period.

Changes have also taken place in the institute sector. Changes in the university and university college sector, among other things, have reduced the institute sector's access to funding from the Research Council. Several institutes have also merged with other institutes or been amalgamated into universities or university colleges. The first Norwegian institute policy strategy was presented in 2020.⁴ The strategy has resulted in a joint Research Council follow-up regime for the public administrative institutes, together with the institutes that receive basic funding and SIMULA. The Government also revised the guidelines for state basic allocations to the institutes in 2021.

Research publication has increased in both the university and university college sector and in the institute sector, and an ever growing proportion of this publication takes place in open channels.

There has been a positive development in business and industry's share of national R&D over the past 10 years, and it now makes up around 47.5 per cent of Norway's total R&D expenditure. Extraordinarily large public grants in 2020 due to the pandemic contributed to the increase that year. R&D in business and industry nevertheless saw a real growth of almost 50 per cent during the period 2010 to 2020. This growth coincides with the growth in public grants to research, development and innovation in business and industry. This funding doubled during the period 2012–2017.⁵ The grants were reduced in 2018 and 2019, and accounted in 2019 for around 30 per cent of the R&D expenses of business and industry.

Compared with many other countries, R&D activity in Norwegian business and industry is still low. This is due, among other things, to the fact that the structure of Norwegian business and industry has a high level of specialisation in industries with relatively low R&D intensity and a large proportion of small and medium-sized enterprises. Most of the R&D work that is carried out

in business and industry takes place in the service industries, which is also where the highest growth is seen. The Government has expressed its ambition for R&D in business and industry to equal 2 per cent of GDP.

One of the most noticeable changes over the past 10–15 years is the marked internationalisation of research and the Norwegian research system. The proportion of researchers with a foreign background at Norwegian universities, university colleges, hospital trusts, regional health authorities and research institutes has risen from 18 per cent in 2007 to 29 per cent in 2018. Around 80 per cent of researchers with a foreign background are internationally mobile researchers. In 2018, almost half of the employees in temporary positions at universities and university colleges had foreign backgrounds, compared to around 20 per cent of the permanent staff.⁶ The proportion of foreign doctoral students was 44 per cent in 2021, and around 60 per cent in mathematics, science and technology.⁷ The proportion of foreign applicants to research fellowships and postdoctoral researcher positions was around 80 per cent.⁸

The EU's research policy and policy instruments have become increasingly important at the national level. Participation in Horizon 2020 was successful, with a strong increase in the number of applications granted over the programme period. The Government has even higher ambitions for participation in Horizon Europe, including the new missions, for the period 2021–2027.

Norway now also participates actively in the European Research Area (ERA) – an internal market for research, innovation and technology. Participation provides access to new knowledge, important networks and impulses for policy development in, among other areas, green and digital transition, researcher careers, academic freedom, data infrastructure and open knowledge sharing. The collaboration is based on a set of common values and principles for research and innovation adopted in the EU.

Fewer structural changes have taken place at the strategic and political level in Norway, but changes have nevertheless taken place within a stable external framework. The main structure based on one research council has remained largely unchanged. The Research Council is the funding channel and quality assurance mecha-

⁴ Ministry of Education and Research (2020).

⁵ Statistics Norway (2019).

⁶ Nordic Institute for Studies in Innovation, Research and Education (2020).

⁷ Statistics Norway (2022).

⁸ Frølich et al. (2019).

nism for research projects, and has an important strategic role in addressing national priorities, contributing to the development of strong research communities and cultivating talented young researchers. The Research Council also serves as a research policy adviser for the authorities. Application processing was reorganised under portfolio management in 2019, and the Council's use of programme boards was changed accordingly. The Research Council was last evaluated in 2012.⁹ Two area reviews have been conducted more recently that have included the Research Council, without major changes being made to the Research Council's areas of responsibility or roles.¹⁰ Changes in the research-performing sectors impact the Research Council and its interaction with the sectors, which can cause certain challenges as described below. The Research Council's difficult economic situation, which came to light in spring 2022, comes in addition to this, cf. mention in Proposition No 1 to the Storting (Resolution) (2022–2023) for the Ministry of Education and Research. The situation shows the important role the Research Council plays in the research system and the importance of the research funding awarded via the competition arenas for Norwegian research communities.

At the political level, the sector principle and the Ministry's responsibility for coordinating research policy remain constants. This principle, which means that all the ministries are responsible for research in their sector, has advantages and disadvantages. On the one hand, it ensures the entire government system has an awareness and knowledge of the significance of research. On the other hand, this division of labour demands a clear understanding of responsibility and effective coordination. The Ministry of Education and Research prepared a *Veileder for sektoransvaret for forskning* ('Guide for sector responsibility for research' – in Norwegian only) in 2017, in cooperation with the other ministries.¹¹ Although this guide clarifies what sector responsibility entails, to what extent coordination is effective enough can be questioned, given the ever growing need for cross-sector cooperation.

5.3 Challenges and issues

Many of the changes discussed above have brought about improvements, both in terms of quality and capacity, and they are based on major restructuring efforts in many organisations. There are nevertheless numerous challenges in the research system. Researchers, research institutions and various special interest organisations highlight difficulties and pending issues that also seem to be inter-related to a certain extent.

Several key actors feel that the division of roles and responsibilities between the three research-performing sectors has become too unclear. Now that universities and university colleges are developing differentiated academic profiles, sometimes through development agreements with the Ministry of Education and Research, a tricky balance must be struck in several areas. Determining what priority should be given to basic research in relation to other areas, such as innovation and developing professional disciplines, must be carefully considered in and across institutions. The institutions have a strategic responsibility for their own priorities and should be allowed to develop based on their strengths. At the same time, the university and university college sector as a whole must safeguard national and regional societal needs, participate in international collaboration and succeed in the international competition for research funding.

The institute sector, on its part, finds that the research landscape has changed in a way that makes it difficult for many institutes to secure adequate project funding, largely due to increased competition from universities and university colleges.

Business and industry may find it difficult to reach the Government target of R&D investments in the sector accounting for 2 per cent of GDP by 2030. Public R&D funding aims to encourage business and industry to invest more in this area than it otherwise would have done.

SkatteFUNN is a tax break scheme that aims to support research and development in business and industry. Several analyses have found that the SkatteFUNN scheme addresses several objectives, particularly for small and medium-sized enterprises, but that the majority of tax breaks under this scheme go to development projects rather than research. Efforts are needed to find out how the authorities can best go about increasing research and development in business and industry.

⁹ Technopolis (2012).

¹⁰ Ministry of Education and Research (2017a) and Deloitte (2019).

¹¹ Ministry of Education and Research (2017b).

Some of the challenges described above are linked to the Research Council's roles and instruments. For example, it appears that university and university college researchers' increased dependence on funding from external sources such as the Research Council is linked to the increase in the number of academic staff. If correct, this may indicate that the institutions do not have a strong enough culture or capacity to distribute resources in a manner that safeguards prioritised research tasks. The causal connections here are complicated, however, and these questions should therefore be studied in more detail.

Competition-based schemes managed by the Research Council are important for ensuring high quality and for gearing research towards the knowledge needs in different sectors of society. This applies to all three research-performing sectors. The very low percentage of successful applications seen in some calls for proposals in recent years, and maybe especially under the open competition arena Ground-breaking research, have led some to question whether the transaction costs linked to preparing an application and administration are proportionate to the benefits. The increasing number of rejections is challenging trust in the system and leading to debate on time expenditure, assessment criteria, application processing and the Research Council's feedback to applicants.

Another challenge is that a great deal of the project funding the universities and university colleges receive from the Research Council go to research fellow, postdoctoral and other research positions on temporary contracts, which will require strong and continuous growth in the permanent research staff if it is not to exacerbate the problem of temporary positions. Given the limited financial scope of action referred to in Chapter 1, further growth in allocations to fund more academic staff members cannot be expected.

There is also good reason to look at the effects of the sector principle in Norwegian research. The OECD has highlighted the danger of silo thinking and fragmented backing for policy development in the area of research and innovation in several reports. This is becoming ever more pressing given the urgent need to solve the challenges facing society, for example in the areas of climate change and health. In its input to the work on the long-term plan, the OECD suggests establishing stronger coordination mechanisms at a high level.

One topic that has long been discussed is the unintended and undesired consequences of the

indicators that have been used since 2003 in the performance-based funding of research at state universities and university colleges, in large parts of the institute sector and hospitals.¹² There is much to indicate that the incentive effect of these indicators has contributed to the significant growth in the volume of publication. The use of these indicators has also had unfortunate consequences, such as an exaggerated focus on quantity rather than quality in research, and detrimental pressure to publish, particularly among young researchers, which may have taken precedence over other important tasks.

The high proportion of academic staff in temporary positions in the university and university college sector has also been a problem over time. This is unfortunate, particularly for young researchers, who do not get the job security they need, but also for the research system, which is marked by short-term perspectives and ad hoc solutions rather than holistic strategies where recruitment, career paths and academic profiles are developed together. Despite prolonged discussions and a number of political initiatives, there has only been a small decrease in the proportion of employees in temporary positions, from 16.7 per cent in 2016 to 12.7 per cent in 2021, while the corresponding figure for the labour market in general is 8 per cent and under 1 per cent for the institute sector.¹³

The internationalisation of the Norwegian research system described above has, among other things, helped to improve the quality of Norwegian research, and there is reason to believe that the strong growth in the proportion of foreign researchers has also made a positive contribution here. Several debates in recent years have also shown that the rapid changes have created challenges, linked for example to protecting Norwegian academic language and Norwegian topics and research perspectives. Strong growth in the proportion of foreign researchers is also linked to the issue of temporary positions, since a high proportion of them are employed on temporary contracts. Abundant access to foreign labour may also mask other underlying challenges, including poor recruitment of Norwegian students to natural sciences and mathematics.

¹² In the health sector, the specialist health service started using the publication indicator in 2021, but with a different approach to the weighting of quality.

¹³ Norwegian Directorate for Higher Education and Skills (2022a).

5.4 The Government's policy

The Government believes that ensuring that Norway has a well-functioning research system is a political responsibility, where the roles of different actors are clarified in relation to each other and balanced to enable them, as a whole, to achieve the overriding objectives of research policy. A system that has such complicated tasks and involves so many people will inevitably encounter challenges, and many of the challenges must be addressed by the research-performing institutions and policy agencies in their ongoing strategic restructuring. However, the overall challenges outlined above indicate that political action is also needed in the time ahead. In certain areas, the knowledge base is sufficient to allow relatively quick action, while a more long-term approach is needed in other areas.

A thorough assessment of the optimal relationship between the three research-performing sectors, including in light of the challenges described above, is a matter that requires more long-term study. The Government has previously established a principle whereby policy development for one of the research-performing sectors must be seen in conjunction with the policies for the other research-performing sectors.¹⁴ The preliminary assessment of the current situation with respect to responsibilities, roles and tasks is that it is too unclear and under too much pressure, and that this complicates the development of the sectors and of the research system as a whole. A further complication is that there is considerable variation within the three sectors. Returning to a 'traditional division of labour', which some people have advocated, is thus not desirable. The OECD stated in its input to the long-term plan that this division of labour 'has become largely obsolete in many areas due to the natural evolution of the missions of these institutions and to the complexity of the scientific, technological, and societal challenges with which they contend'.¹⁵ The Government shares the OECD's assessment on this point, and therefore does not consider it an option to, for example, limit the universities' activities to basic research.

We need a better basis for analysis to be able to clarify what constitutes expedient roles, responsibilities and tasks for different categories of actors going forward. The Government has therefore decided to initiate work on a dedicate white

paper on the research system, which will look at these issues, among others, in more detail.

A closely related topic that must also be considered in this work is the Research Council's roles and functions in the Norwegian research system. The Council is a key actor with powerful instruments at its disposal and a comprehensive system for quality assuring and awarding funding to research projects. However, its central role also entails a risk of, for example, universities basing their activities on the Research Council and not developing sufficient strategic capacity of their own at the different levels of the organisation to secure good, clear research profiles, including comprehensive recruitment and career plans and continuous assessment of the quality of project ideas.¹⁶ The vulnerability this entails was made evident when the Research Council's financial problems in spring 2022 generated a great deal of unease in research communities and a fear that it would be virtually impossible to carry out important research projects and recruit new researchers as desired. The Government believes that the Research Council's roles and functions need to be assessed to ensure that it generates added value for Norwegian and Sami research without infringing on the research-performing institutions' strategic responsibility. In that connection, more consideration needs to be given to what constitutes an expedient breakdown between the big funding channels for Norwegian research, such as the relationship between basic allocations and competition-based funding and the relationship between international funding – from the EU in particular – and national funding.

In addition to the roles and functions of the Research Council vis-à-vis the research-performing institutions, closer consideration must also be given to its relationship to the government administration and its role as research policy adviser, and, in particular, its relationship to the Ministry of Education and Research, which is responsible for coordinating research policy.

The Government has announced that it will consider changing the Research Council's budget, including a review of the chapters and items in the parts of the national budget that concern the Research Council. The Council currently operates with a complicated budget model, with funding being allocated over many items in the national budget and with the opportunity to transfer unused allocations to the following year's budget. The Government wishes to look at alternatives

¹⁴ Ministry of Education and Research (2020).

¹⁵ Larrue and Santos (2022).

¹⁶ Research Council of Norway (2014).

that can contribute to more expedient funding of Norwegian research and innovation through the Research Council and to better financial management. The current financial situation makes this issue more relevant than ever. The Government will return to this topic later in connection with the 2024 national budget. A review is also needed of the Research Council's advisory function in its ordinary day-to-day work, in challenging situations such as the current financial situation, and in relation to large-scale processes such as work on this long-term plan.

The year 2023 marks the 30th anniversary of the establishment of the Research Council, and ten years since it last underwent an evaluation. In light of the discussion above, the Government believes that the time is ripe for a review of the Research Council and its functions in the Norwegian research system. This review will be an important element in the knowledge base for the white paper the Government plans to present towards the end of the current parliamentary term. It will also provide a comprehensive assessment of the measures necessary to secure a well-functioning and forward-looking research system in Norway and increase the added value created by the Research Council.

The advantages and disadvantages of the sector principle receive a great deal of attention. In any case, the coordination of research policy must be improved and consolidated. It is therefore necessary to look at the strengths and weaknesses of the current system and how it can be improved overall.

One of the Government's objectives is for the business and industry sector to carry out more research than it does today, and the aspects of the current research system that promote such a development and those that do not should therefore be assessed. The majority of research and innovation in business and industry is carried out without public funding. This suggests that the business sector considers it profitable to invest in new knowledge. The institute sector, including the public administrative institutes possess essential expertise that can help to resolve the challenges facing society. We need the institutes to use their strengths, including as 'research departments' for small and medium-sized enterprises. At the same time, preliminary figures indicate that business and industry is now procuring less R&D services. This must be investigated further. Although one of four enterprises report R&D activities, around only 5 per cent of them take advantage of the total policy instrument system

for research, development and innovation. We need more knowledge about how the authorities can help to strengthen business and industry's own research and research-driven innovation efforts.

International collaboration is a precondition for achieving national research and higher education objectives. The Government will continue to help Norwegian actors to make good use of the opportunities in the European research and innovation collaboration. This requires a good national support system that mobilises and supports participation in Horizon Europe and national competition arenas that are geared towards working well with the European arenas and mobilising participation in the framework programme. Norway will also help to develop European policy with a view to ensuring a well-functioning European research area that also benefits Norwegian researchers and knowledge actors.

With respect to Norwegian academic language, the Government has made it clear that the responsibility set out in Section 1-7 of the Act relating to Universities and University Colleges on maintaining and further developing Norwegian academic languages must be followed up in practice. Norwegian has lost ground to English (what is known as domain loss) in both research and higher education, a development the Government views with concern. The situation is particularly challenging for Nynorsk, the lesser used of the two official forms of written Norwegian, but Bokmål is also under considerable pressure. The rapid decline in the use of Norwegian as a language of instruction in recent years is a particular concern, a development that is linked to a shortage of Norwegian teaching aids in many subjects. The Government believes this development must be reversed, and that it must be done in time. The Government will therefore continue to fund Norwegian language scientific journals and development of textbooks in Norwegian, especially Nynorsk, and Sami, which suffer the most serious shortage of textbooks. Without a good Norwegian academic language, higher education graduates will struggle to communicate in an academic language with Norwegian society and the labour market. This will be detrimental to dissemination during a period when it should be being strengthened, as the Kierulf Committee recently advocated, cf. Chapter 7. Research and researcher training will also be negatively impacted over time by inadequate Norwegian academic language, particularly in subjects where knowledge is irrevocably linked to its linguistic presentation. Aware-

ness of the value of protecting and developing a first language as an academic language is increasing around the world.

In the allocation letters for 2022, the Government asks the institutions to fulfil their responsibility for Norwegian academic language, by, among other things, providing language tuition to employees who need it and continuing to work on Norwegian academic terminology in both forms of written Norwegian. The University of Bergen is doing important work with respect to academic terminology through *Termportalen*, a freely available Norwegian terminology resource that covers a range of academic subjects. The Government expects the institutions and academic communities to contribute to developing *Termportalen* and similar initiatives so that we will continue to be able to do academic work in Norwegian. The Ministry of Education and Research will follow developments in this areas and assess the need for more drastic measures if the situation does not improve soon.

The funding system in the university and university college sector has recently been reviewed. An expert group (‘the Hatlen Committee’) presented a comprehensive review of the funding system in March 2022 in which it proposed, among other things, simplifying the funding system considerably by reducing the number of indicators from eight to two.¹⁷ The Government will present a more detailed assessment of the Hatlen Committee’s proposals on the development of the funding system for state universities and university colleges at a later date. See Proposition No 1 to the Storting (Resolution) (2022–2023) for the Ministry of Education and Research for more details.

The Government will work to promote a diverse university and university college sector where clearer profiles and division of labour between the institutions will contribute to high quality and accessibility in research and higher education. Development agreements were introduced as a policy instrument to address differentiation in governance and to enable the institutions to carry out their mission and meet national, regional and local needs. The agreements were entered into in groups during the period 2016–2018, and will be in force until the end of 2022. Report No 19 to the Storting (2020–2021) *Styring av statlige universiteter og høyskoler* (‘Governance of state universities and university colleges’ – in Norwegian only) concluded that the development agreements will be given a more central role in

the governance of the sector. New development agreements will apply for the period 2023–2026.

The development agreements will be based on the sector objectives. In spring 2022, the Ministry of Education and Research stipulated three new overriding sector objectives for universities and university colleges applicable from 2023:

- high quality in education and research
- sustainable societal development, welfare and innovation.
- good access to education, research and skills across Norway

These objectives have been specifically formulated for the universities and university colleges, with the distinctive features of the sector in mind, but correspond well with the overriding objectives of this long-term plan, which applies to all Norwegian research and higher education. Participation in international education and research collaboration is a precondition for the universities and university colleges achieving these objectives.

The institutions shall have freedom to develop their own profiles. However, the Ministry of Education and Research has the overriding responsibility to ensure that society’s needs are met through good resource utilisation. The development agreements shall play a part in following up strategically important areas in order to achieve the sector objectives and follow up the objectives and priorities set out in the long-term plan, based on the distinctive nature of the institutions and each institution’s profile. The development agreements are part of the Government’s trust reform, cf. box 3.14. The Ministry of Education and Research is in a dialogue-based process with the institutions regarding new agreements in 2022.

Much of the discussion on diversity in Norwegian higher education has been about university colleges’ possibility to become universities through an accreditation process. The Government has appointed an expert group to assess the quality and accreditation requirements for universities. The expert group’s proposals will make up part of the decision-making basis when the Government considers these issues in connection with the proposition on a new act relating to universities and university colleges in 2023.

With respect to the university and university college sector, the Government has also expressed the clear objective of reducing the proportion of temporary positions to bring it in line with the rest of the labour market. The Government will propose amendments to the Act relating to Universities and University Colleges in its fol-

¹⁷ Hatlen et al. (2022).

low-up of this objective to rein in the possibilities for temporary appointments. However, more holistic and long-term efforts are also needed in this area in extension of, among other things, the Ministry's *Strategi for forskerrekruttering og karriereutvikling* ('Strategy for researcher recruitment and career development' – in Norwegian only) and the work in progress on new regulations relating to appointments.¹⁸ This work should be seen in light of the fact that assessment systems for researchers and research are changing, both in Norway and abroad, among other things to change the quality culture by shifting the exaggerated focus on publication figures, cf. Chapter 7.

5.5 Measures

The Government will:

- present a white paper on the research system during the current parliamentary period based on, among other things, a review of the Research Council. The paper will look at the research-performing sectors in context with each other and with the Research Council's functions.

- perform a review of the Research Council and its roles and functions in the Norwegian research system
- strengthen the knowledge base and coordination mechanisms for research policy
- ensure good Norwegian follow-up of the increased focus on a European Research Area and consider drawing up a national roadmap for Norwegian follow-up of relevant ERA measures
- follow up the universities' and university colleges' work on strengthening the position of Norwegian academic language and assess the need for further measures if the situation does not improve
- present a strategy that aims for research and development in business and industry to correspond to 2 per cent of GDP by 2030
- present a more detailed assessment of the Hatlen Committee's proposals on the development of the funding system for state universities and university colleges at a later date
- follow up the work on recruitment and career to facilitate a comprehensive career policy at the universities and university colleges, including efforts to reduce the proportion of temporary positions by means of a new act relating to universities and university colleges and the management dialogue with the sector

¹⁸ Ministry of Education and Research (2021d).

6 Missions

The Government wishes to contribute to research-based knowledge being used to solve the concrete problems that are the challenges of our age. Both basic research and applied research are important preconditions in that connection. However, traditional research policy instruments alone do not provide enough direction or momentum to enable us to actually solve the problems in time. Large amounts of knowledge are published in articles and reports, but the way from publication to concrete application is sometimes too long and too much is left up to chance. This situation forms the backdrop to the Government introducing missions as a new instrument in Norwegian research and innovation policy in the present long-term plan.¹ The first missions will be on sustainable feed and inclusion of more children and young people in education, employment and society. See the more detailed discussion of these missions in Chapter 3, under the thematic priorities *climate, the environment and energy* and *trust and community*. Norway is also an active participant in the EU missions through Horizon Europe.

6.1 What are missions?

Missions are ground-breaking initiatives where the goal is to find solutions to defined technological and/or societal problems by a set deadline. A mission may be initiated when the challenge is known, but the solution is not. This work method provides an opportunity to involve enterprises, public service providers and regulatory authorities etc. in collaboration with researchers.² Its intention is for knowledgeable people from different sectors to coordinate their efforts to succeed. The missions shall also use the knowledge already out there, and the results shall actually be implemented in society.

International developments over the past few years, in the EU in particular, have shown that missions are a promising research and innovation

policy tool. However, the idea behind missions is by no means new. It has existed in various forms since the end of World War II, but has been revived, among other things, through the European Commission's work on Horizon Europe. Other countries, including the UK and the Netherlands, have also established strategies for such missions.³ The OECD has been another important driver in the development of mission methods.⁴

To mobilise sufficient efforts from those involved, the goal of a mission must be defined in such a way that it is possible to determine whether it has been achieved by the set deadline. The goal of the mission will thus be a quantitative measure or a clearly defined qualitative goal. Defined sub-goals can serve to indicate whether the results of the different measures and projects are pointing in the right direction.

The large challenges facing society that the missions are intended to address, rarely have simple solutions. The missions the Government is now set to launch cut across several policy areas and require policy agencies to follow them up. The missions thus have clear political support, and broad participation by relevant actors will be encouraged.

Missions are divided into two broad types: accelerators and transformers. The object of pure accelerator missions is to increase the tempo of developments within a given, delimited area. Transformer missions are more complex and entail extensive social changes and amendments to regulations, legislation and policy.

These two broad types are not mutually exclusive. We can envisage major transformer missions that involve a range of accelerator missions, but also smaller transformer missions with clear goals in certain underlying areas. To what extent the missions are research-driven can vary, but research-based knowledge will generally play an important role.

¹ See also Normann et al. (2022).

² See Larrue in particular (2021).

³ Mazzucato (2019).

⁴ Larrue (2021).

6.2 EU Missions

The European Commission has launched five missions in its framework programme for research and innovation, Horizon Europe. Four of the five EU Missions ‘Restore our Ocean and Waters’, ‘Climate-Neutral and Smart Cities’, ‘Adaption to Climate Change’ and ‘A soil Deal for Europe’ are linked to the EU’s political ambition to achieve a green transition, the UN Sustainable Development Goals and the Paris Agreement. The fifth Mission, ‘Cancer’ is linked to the EU’s cancer plan. Norway’s participation in the EU missions has the political support of the Government.⁵ The European Commission also places great emphasis on the EU missions being implemented at the national, regional and local levels.

The ministries have a clear role to play in following up the EU missions because cross-cutting coordination is sorely needed, as there are close links between our national and international agendas, and because the ministries shall help to develop regulatory frameworks that support the goals. National initiatives and activities will also be linked to activities at the EU level. Closely involving the ministries will help to ensure more efficient mobilisation, coordination and implementa-

Box 6.1 Mission on cancer – national hub

The Research Council of Norway, Innovation Norway, the Directorate of Health, the regional health authorities, Oslo Cancer Cluster, SINTEF, the Cancer Register of Norway, the Norwegian Association of Local and Regional Authorities, Oslo University Hospital (Comprehensive Cancer Centre), the Norwegian Cancer Society and others make up a national hub for the follow-up of the EU ‘Mission on Cancer’. One of the goals of the national hub is to ensure good information flow and coordination between the EU and relevant Norwegian communities. Another of the hub’s functions is to ensure rapid mobilisation of the different Norwegian cancer research communities. The hub shall also boost innovation to increase the likelihood of succeeding in the competition for EU funding. Moreover, it shall facilitate cooperation with international communities to boost national initiatives.

tion of Norwegian participation and national policy. The Research Council and Innovation Norway are also responsible, at the overriding level, for coordinating and mobilising Norwegian participation in line with their role as the national support system for Horizon Europe.

6.3 Missions in Norway

Although missions have not been an integral part of overriding Norwegian research and innovation policy to date, the policy agencies apply an approach with many similarities to missions in certain areas to accelerate technology development, for example in PILOT-E and CLIMIT. The OECD and NIFU point out that these challenge-driven programmes are a great point of departure for realising accelerator missions where maturing and commercialising technology are important factors.⁶

The missions that are being launched in the present long-term plan are based on areas that the Government gives high priority to, and where research-based knowledge and skills are a prerequisite for achieving the concrete goal. Emphasis is also placed on ensuring that the other conditions required are in place. One important premise is that the missions must fit into existing decision-making structures and that they have a clear and measurable political goal to ensure that goal achievement can be described and assessed.

The following two missions are being launched in connection with this long-term plan:

Sustainable feed

The Government has set the objective of ensuring that all feed for farmed fish and livestock shall come from renewable sources, thus reducing greenhouse gas emissions from food systems. Food security could come under pressure from population growth, increased pressure on areas and resources, and less secure supply lines. The sustainable feed mission will help to achieve new and innovative solutions for better resource utilisation. The mission will also make an important contribution to the goals Norway has set for the climate, environment, food production, employment and value creation. The final wording of the main objective, quantification and further developing the sub-goals will be completed during the design and implementation phase in 2022/2023.

⁵ Ministry of Education and Research (2022).

⁶ See Normann et al. (2022) and Larrue (2021).

The mission is described in more detail in section 3.3 under the thematic priority *climate, the environment and energy*.

Including more children and young people in education, employment and society

The Government will launch a mission that will include more young people in education, employment and society by employing a cross-sector and targeted approach. Exclusion of young people is a major challenge in society and entails significant costs for the individual and society. Exclusion among young adults often stems from experiences in childhood and adolescence. The final wording of the main objective, quantification and further developing the sub-goals geared towards education and qualification, health, quality of life, coping, participation and inclusion, will be done during the design and implementation phase in 2022/2023. The mission is described in more

detail in section 3.6 under the thematic priority *trust and community*.

6.4 Further work

The two missions will be further developed and implemented during the design and implementation phase planned for 2022/2023. This phase will establish how the missions are to be organised, and ensure that the policy agencies and relevant research communities and users are properly involved in their further development. User participation will be particularly vital for ensuring that the missions have the support of the actors that will ultimately use the knowledge. The design and implementation process will clarify the budgetary framework for subsequent work on the missions.

7 Academic freedom and trust in research

Modern society is dependent on research – in the technology we use, in research-based professions, as the basis for public debate and in a wide range of other areas. We have become used to this being so, and we take it for granted in our daily lives. However, looming crises remind us of how important research is. We turn to research in the face of war, terror, health threats or a global climate crisis to understand what is happening and what our options are.

We trust research because we assume researchers are free to pursue the truth without being swayed by other considerations and because we know that all research has to undergo rigorous peer review. Researchers are also in fierce competition with each other, while they are also bound by research ethics.¹ This is all conducive to trust.

A new report on this topic from Oslo Metropolitan University (OsloMet) emphasises, however, that we should not take this trust in research and researchers for granted, and that trust should, furthermore, not be blind.² Research itself teaches us that established truths must be challenged. This applies both within academia and in public debate. Unquestioning trust in research is thus not desirable. However, if this trust falls too low, to a level below healthy scepticism and objective criticism, this may be a sign that something is wrong. The reasons for this should then be investigated, to determine whether an unhealthy distrust and suspicion of research has taken hold, or whether research has actually become less trustworthy, generally speaking or in specific areas.

Trust in research in Norway today is generally high.³ However, a number of detrimental trends have also been registered here in Norway in recent years. There have been reports in various contexts of pressure on academic freedom, and particularly on academic freedom of expression.⁴

Furthermore, although the general trust in research is high, there are clear differences in trust levels between disciplines and sections of society. Certain areas of research are perceived as controversial and are at times subject to polarised debate marked by limited objectivity.⁵

These challenges are the impetus for the Government's intention to use the long-term plan to focus attention on trust. The conditions that the Government considers particularly important for maintaining a high level of trust in research going forward are set out below. The population's high level of trust in research is, in turn, a precondition for society continuing to invest in and base its development on research-based knowledge.

7.1 Academic freedom of expression

The Ministry of Education and Research appointed an expert committee in summer 2021, chaired by Associate Professor Anine Kierulf (hereinafter referred to as the Kierulf Committee), to investigate the conditions for academic freedom of expression in Norway. The Committee presented its report in March 2022, Official Norwegian Report (NOU) 2022: 2 *Academic freedom of expression – A good culture of free speech must be built from the bottom up, every single day*.

The Kierulf Committee believes that academic freedom of expression is a prerequisite for any academic activity. The Committee puts it thus: 'Free speech is the lifeblood of academia'.⁶ As in the preparatory works to the current provisions on academic freedom set out in Section 1-5 of the Act relating to Universities and University Colleges, the Kierulf Committee believes that the grounds for academic freedom of expression are not primarily consideration for the researchers, but society's need to broadly trust the pursuit of truth.⁷ It is good for society that established truths are challenged. Other important grounds,

¹ The National Research Ethics Committees (FEK) (2014) set out general research ethics guidelines.

² Thue et al. (2022).

³ Research Council of Norway (2022a).

⁴ Mangset et al. (2021).

⁵ Ibid. Also see Thue et al. (2021) and Thue et al. (2022).

⁶ Official Norwegian Report (NOU) 2022: 2, p. 8.

⁷ Ibid.

according to the Committee, are the need for informed, democratic debate, social, cultural and political diversity, and innovation and competitiveness.⁸

The Kierulf Committee regards academic freedom of expression as a ‘functional aspect of both the general freedom of expression and the individual academic freedom.’⁹ In line with its remit, the Committee primarily concentrates on individual academic freedom of expression, understood as each academic staff member’s freedom and responsibility to express themselves on academic issues at their own discretion and in line with fundamental scientific quality requirements and research ethics.¹⁰ The Kierulf Committee believes that it is the scientific quality requirement that primarily distinguishes academic freedom of expression – which applies specifically to academic staff when they make statements in their professional capacity – from the general freedom of expression that applies to all citizens, of whom no such requirements are made. The Committee points out that the limits for the academic freedom of expression of individual employees must be deemed to be very wide. The Committee also believes that the quality requirement must be understood as a responsibility that both the individual and the professional community must address by means of open and objective debate, and not through prescribed advance control, sanctions or undue pressure.

The Kierulf Committee’s report looks at freedom of expression in research, education and dissemination, but with particular emphasis on dissemination, which, in the Committee’s opinion, receives too little attention.

Academic freedom of expression and dissemination are closely interlinked – they both function as knowledge-based, truth-seeking communication. Dissemination is important within academia, among peers and between and among the administration, staff and students. Academic free speech is also crucial for the fulfilment of academia’s broad civic mission through dissemination to the broader public – as communication of knowledge from experts to the public, and vice versa.

Based on the knowledge base available, the Kierulf Committee believes that academic freedom of

expression faces numerous forms of challenges in Norway today:

Political and structural priorities, funding, rules and guidelines as a framework for academic freedom of expression, security assessments, tensions within academia, an uncollegial climate of debate, a culture of conformity, cancel culture, disagreements about quality control, and challenges in connection with external dissemination and communication, such as populism, politicisation and media challenges. A harsh debate climate can be particularly demanding, not least for those working on controversial academic topics.

The Kierulf Committee believes that individual academic freedom of expression is so fundamental that the provision that addresses this topic in the Act relating to Universities and University Colleges should be amended to ensure it is properly safeguarded. This is in line with the assessments made by the Aune Committee, which submitted proposals for a new act relating to universities and university colleges in 2020.¹¹ The Kierulf Committee makes concrete recommendations on how this can be done. Many of the challenges discussed in the excerpt above are, however, such that they primarily require a better academic culture of free speech. This kind of culture cannot simply be created through legal provisions, it must primarily come from the academic communities themselves.

As a basis for further discussion in the academic communities and at the institutions about what constitutes a good culture of free speech, the Kierulf Committee has proposed a declaration of academic freedom of expression. The declaration sets out in brief what academic freedom of expression is, on what grounds it is based and its implications. The Kierulf Committee has also prepared ground rules for free speech that are geared towards individual academics. The declaration and these ground rules are included in appendix 1 to this long-term plan.

The Kierulf Committee also addresses some important preconditions for a good culture of free speech and dissemination activities, not least well-developed Norwegian academic language. The Committee has a number of recommendations for measures geared towards the academic institutions and communities about how academic freedom of expression can be strengthened by means

⁸ Official Norwegian Report (NOU) 2022: 2, p. 25 ff.

⁹ Official Norwegian Report (NOU) 2022: 2, p. 20.

¹⁰ Official Norwegian Report (NOU) 2022: 2, p. 7.

¹¹ Official Norwegian Report (NOU) 2020: 3.

of e.g. institutional strategies, wise leadership, awareness-raising about what academic freedom of expression entails, and procedures for dealing with difficult and delicate situations in academic communities.

Recommendations aimed at the authorities are discussed in more detail below.

The Government's assessment

The Government believes that the Kierulf Committee's report provides a thorough and appropriate discussion of what academic freedom of expression is and the grounds on which it is based. The report is a necessary reminder that academic freedom of expression for the individual researcher is vital for ensuring that academic activity can continue to enjoy the high level of trust it has in Norway today. The Government also believes that the report provides a good, balanced description of the challenges facing academic freedom of expression. These challenges must be taken seriously while they are still manageable. If they are played down, we run a risk of diminishing trust in research. Experience from other countries shows that this can happen in a short space of time.

The Government notes that the Kierulf Committee points to both external and internal challenges. In both cases, the management of the academic institutions plays a key role as guardians of academic freedom of expression. With respect to pressure from outside academia, be it improper interference by unprofessional clients or harassment and threats in social media, it is essential that the researchers who find themselves in such situations feel they have the support of the employer institution in exercising their academic freedom of expression. In cases where challenges arise within the academic community, e.g. strong pressure to conform or cancellation attempts, it is also important that the management takes its responsibility seriously. The management should combat use of non-academic types of sanctions and facilitate objective discussion based on a diversity of perspectives in the academic communities. Young researchers and temporary employees may find themselves in a particularly vulnerable position (see Chapter 5 for a more detailed discussion of the challenges posed by temporary positions).

The Government has noted the Kierulf Committee's proposal to enshrine the institutions' responsibility to protect academic freedom of expression in law, and agrees that this may be a

relevant measure. The Government will consider how this can be done in the work on a new act relating to universities and university colleges, in light of the input from the consultation round. In that context, the Government will also consider the other legal amendments proposed by the Kierulf Committee.

The Government believes that the same fundamental conditions for academic freedom of expression must apply to research, higher education, dissemination and artistic development, and it expects all universities, university colleges, hospital trusts, regional health authorities and research institutes that receive basic allocations from the state to protect their employees' freedom of expression. The Government also urges other academic organisations, including business and industry research entities, to safeguard academic freedom of expression.

Moreover, the Government believes that this is well founded given that the Kierulf Committee's report places particular emphasis on dissemination, both because pressure on researchers' freedom of expression often arises in connection with dissemination activities, and because dissemination appears to have a weaker foundation in academia today than the other academic tasks. As already mentioned, the Kierulf Committee makes several interesting points and proposals on how dissemination can be strengthened. Regarding the proposal to introduce a dissemination indicator in the funding system for state universities and university colleges, the Government will return to this point in connection with its comprehensive review of the funding system. See Proposition No 1 to the Storting (Resolution) (2022–2023) for the Ministry of Education and Research for more details. The Government also endorses the proposal to simplify the reporting system for dissemination, and will ask Sikt to start working towards this goal. The Ministry of Education and Research will raise the matter of dissemination in management dialogue with the universities and university colleges.

The Government shares the expert committee's assessment that a good culture of free speech must be built from the bottom up, and that freedom of expression and quality assurance must be managed in day-to-day work by the academic communities through objective and critical debate. Basic statutory provisions are necessary, but a good culture of free speech requires students and employees to internalise knowledge about what freedom of expression entails, on what grounds it is based and its implications. The decla-

ration and ground rules on free speech proposed by the Kierulf Committee in its report, together with the debate this report has created, provide a good point of departure in that respect. As the Committee also points out in its report, a well-developed Norwegian academic language is a precondition for good dissemination work. See Chapter 5 for a more detailed discussion of Norwegian academic language.

The Government expects academic institutions, and higher education institutions in particular, to attend to, in the course of their ordinary activities, the training in academic freedom of expression needed by different levels of employees and students. This could, for example, be by means of the mandatory introductory philosophy course Examen philosophicum, researcher training or management training. The Government also expects institutions that offer researcher training to consider how this training can develop the skills needed for the important academic task of dissemination. The Government will consider whether responsibility for providing training in academic freedom of expression and dissemination should be enshrined in law in connection with the proposal for a new university and university colleges act.

In recent years, academic freedom has also garnered a great deal of attention outside Norway, including in the European Research Area. The Government will promote academic freedom in all arenas where Norway participates in international work.

7.2 More about academic quality

Academic freedom is inextricably linked to a commitment to comply with scientific quality norms. This association is underlined in the title of the relevant provision in Section 1-5 of the current Act relating to Universities and University Colleges, ‘academic freedom *and responsibility*’ and in that institutions are obliged to maintain a ‘high professional level’. Section 1-1, Purpose of the Act, sets out that the institutions shall provide higher education, conduct research and academic and artistic development at a ‘high international level’.

The Kierulf Committee also highlights academics’ responsibility for academic quality, both as individuals and as members of research communities:

First, academics have a responsibility to adhere to the norms for scientific quality that

apply in their field of research and the norms regarding objectivity and impartiality that enable debate. Second, they have a responsibility to help ensure that other academics also adhere to these norms; for example, through peer reviews and the advancement of alternative hypotheses, or by challenging ideas using counter-arguments in debates.¹²

The Kierulf Committee makes an important clarification on how this responsibility should be exercised, however:

...quality control of academic expressions shall be carried out by peers within the academic community, using scientific methods and relevant arguments, not by the state through the use of legal sanctions, political decisions or guidelines, nor by the academic institutions.¹³

This raises an important question for academic institutions, not least for universities and university colleges, with their statutory responsibility for academic quality:

How can the management of a university fulfil its responsibility for ensuring that teaching, research and academic and artistic development work maintain a high professional level and are conducted in accordance with recognised scientific, artistic, educational and ethical principles, while at the same time safeguarding and promoting the individual’s academic freedom (of expression)?¹⁴

The Kierulf Committee’s assessment is that the academic institutions, i.e. the board and management at different levels of the organisations, cannot and should not perform quality control themselves. The institutions nevertheless have a responsibility for ensuring that they are carried out ‘by peers within the academic community, using scientific methods and relevant arguments’. It is the academic management at faculty and institute level (or equivalent) that has to ensure that ongoing quality assurance is well attended to in the organisation’s day-to-day work, at the same time that the academic freedom (of expression) of each employee is safeguarded. This is a demanding balancing act, which is also why the Kierulf

¹² Official Norwegian Report (NOU) 2022: 2, p. 7.

¹³ Ibid.

¹⁴ Official Norwegian Report (NOU) 2022: 2, p. 60.

Committee places so much emphasis on wise management and good training.

The Government endorses the Kierulf Committee's understanding of the institutions' combined responsibility for academic freedom of expression and academic quality. It is therefore vital for society's trust in research and research-based knowledge that academic quality is upheld at the institutions. It is equally important that attempts are not made to control academic quality by means of sanctions or governance instruments implemented by the institutions as employer, or by political or legal action.

With respect to the established peer review systems, which are academia's own means of assuring academic quality through e.g. publications, projects and appointments, it must be stressed that these are under development both in Norway and abroad. The San Francisco Declaration on Research Assessment (DORA) was launched in 2012. The declaration, which has since been signed by the Research Council of Norway and several other higher education and research institutions, contains a set of recommendations on good practice for quality assessment. One of the most important objectives of the declaration is to combat the tendency seen in recent years to base quality assessment on research journals' impact factor and other quantitative indicators alone. The declaration encourages more assessment of research work based on its actual quality.

In addition to the academic communities' peer reviews in connection with publications and appointments etc., the Research Council is responsible for conducting large national quality evaluations of Norwegian academic communities' research activities. The evaluation work itself is carried out by international referee panels based on relevant quality criteria. NOKUT has a similar responsibility for evaluating the academic communities' education activities. These evaluations of quality are important for strengthening the communities' work on quality, and thus ensure that people in general can continue to have a high level of trust in research-based knowledge and skills. In order to better coordinate the quality evaluation of research and higher education, the Ministry of Education and Research established a separate framework for this purpose in 2021.¹⁵

¹⁵ Cf. The Ministry's letters of allocation to the Research Council of Norway and NOKUT for 2022.

7.3 Responsibility, involvement and use of research

Research does not take place in a vacuum. A lot of research is developed in dialogue with users and partners in different sectors of society. How research is used by, for example, political authorities, the media and business and industry, also impacts trust significantly.¹⁶ Irresponsible use and dissemination can put research in a bad light. It is therefore important to avoid tendentious renditions of research. One should also avoid selecting certain findings at the expense of others that are equally relevant based on a wish to substantiate a predetermined conclusion, whether this is done knowingly or unknowingly. This is something the media must also bear in mind. A new survey from the Institute for Social Research (ISF) shows that the most important reason for some researchers being hesitant about communicating their research is the fear of journalists presenting it in a misleading manner to make it fit with a specific journalistic angle.¹⁷

The need for responsibility in the use of research is particularly evident in connection with commissioned research. The client must exercise care to ensure academic freedom is safeguarded, while they must also naturally be free to define their knowledge needs. The client, for its part, is bound by the quality requirements that apply to research. One good means of regulating the relationship between the client and the contractor is to use the Norwegian Government's standard agreement for research and investigation projects. The agreement is available to everyone who aims to ensure that their commissioned research is independent and has a high degree of legitimacy.

The need for responsibility is also becoming increasingly important in academic collaboration with other countries. Geopolitical developments entail a greater focus on security policy challenges, particularly linked to collaborations on technology. These developments also raise an important question of principle relating to how fundamental values and norms are upheld in collaborations with countries where the freedom to discuss or research politically sensitive issues is gradually being curtailed or is even non-existent. These issues will be elucidated in the guidelines on responsible international collaboration being prepared by the Norwegian Directorate for Higher Education and Skills and the Research

¹⁶ Thue et al. (2021).

¹⁷ Mangset et al. (2021).

Council on assignment for the Ministry of Education and Research.

Companies, public agencies and other users of research may find it difficult at times to determine *which* research to use, since the research literature in many areas is very extensive and often points in slightly different directions. As well as the difficulty of obtaining an overview, determining which research represents established knowledge with a high degree of consensus among academics and which is more uncertain or controversial can be challenging. A good tool for obtaining an overview over a research field is an evidence synthesis. See box 7.1 for more details. These evidence syntheses have been in use for some time in some sectors, particularly in the area of health.¹⁸ A systematic and balanced overview of a research field ensures legitimacy across sectors. We also reduce the risk of decisions being made on an inadequate basis, and, not least, of initiating new research in areas that have already been investigated. The Government will therefore endeavour to increase the use of evidence syntheses in public sector activities, also based on resource considerations.

Citizen science and citizen participation have been introduced in recent years, among other

things, to boost the legitimacy of research by establishing closer links between research and society. For example, the EU has emphasised citizen research in the Horizon Europe framework programme, and is now testing different methods of involving citizens in research, particularly in the missions. In some areas, the trend is moving towards placing emphasis on the local context of knowledge production, particularly when knowledge is being developed with a view to local application. An example here could be using traditional knowledge to investigate issues concerning the interests of indigenous peoples. These are interesting initiatives, and the potential of such methods for strengthening trust in research should be investigated more closely in the years to come.

7.4 Other factors relating to academic freedom

In the debate on academic freedom and the consultation round for the Kierulf report, it has been pointed out several times that this topic is extensive and touches on many aspects of academic activities, including organisation, funding, management, different forms of political governance and so on. The Government agrees that safeguarding academic freedom is important in all matters that relate to academic activities. This is not limited to each academic staff member's academic freedom of expression, which was the main topic set out in the Kierulf Committee's remit. As the Kierulf Committee mentions, academic freedom is also linked to a range of structural factors. The policy in these areas, whether relating to funding, legislation or other matters, must be formulated with a view to safeguarding academic freedom.

It is, however, necessary to distinguish between the core academic activities, covered by Section 1-5 of the Act relating to Universities and University Colleges on academic freedom and responsibility, and other aspects of running research and higher education institutions that are not directly related to the core tasks. In Report No 19 to the Storting (2020–2021) *Styring av statlige universiteter og høyskoler* ('Governance of state universities and university colleges' – in Norwegian only), a distinction is made between academic freedom and *institutional self-governance*, and the report writes about the latter:

When universities and university colleges are also given institutional self-governance in non-

Box 7.1 Evidence syntheses

Evidence syntheses are literature studies that are carried out according to a predefined, systematic and explicit method. The category evidence syntheses includes systematic reviews and scoping reviews. They share the objective of identifying all relevant research of high quality that answers a clearly defined question.

The Norwegian Network for Evidence Syntheses (*Norsk Nettverk for Systematiske Kunnskapsoppsummeringer*, abbreviated NORNESK) was established in 2019 to increase demand for and application of systematic evidence syntheses in all fields. Its object is to ensure that services, education and research are well informed and based on reliable research-based knowledge. One of its other important objects is to reduce the scope of unnecessary research.

¹⁸ See for example the Norwegian Institute of Public Health (2022).

academic matters, or matters with any significant relevance to academic freedom, this is based on self-governance resulting in higher goal attainment than more centralised governance. This means that institutional self-governance that cannot be justified on grounds of academic freedom must be understood as a form of delegated authority that requires satisfactory goal attainment over time.

Academic freedom thus does not mean that universities, university colleges and other academic institutions that are owned by the state and receive public funding are exempt from ordinary state governance. Nor is it an obstacle to political authorities developing and funding measures to achieve research policy or education policy objectives. Academic freedom primarily means that academic freedom of expression is not to be restricted by any factors other than academic quality requirements and Norwegian law, and that the political governance of public academic institutions must be such that researchers are given the scope to pursue the truth in line with their own professional judgement and with the academic norms of the academic community.

7.5 Measures

The Government will:

- ask all universities, university colleges, hospital trusts, regional health authorities and research institutes that receive basic funding from the state to safeguard their employees' academic freedom of expression, provide the necessary training in what this freedom entails, and ensure that academic quality norms are upheld through peer reviews and lively debate in the academic communities
- ensure that academic freedom is safeguarded in the policy for research and higher education
- consider the Kierulf Committee's proposals in connection with the Government's draft bill for a new act relating to universities and university colleges
- help to promote academic freedom through international collaboration
- raise the matter of dissemination in management dialogue with the universities and university colleges
- ask Sikt to simplify dissemination registration
- ask the Research Council and NOKUT to coordinate their evaluation activities in line with the framework for quality evaluation
- help to increase the use of evidence syntheses in public enterprises

8 Open research and the value of data

Academic freedom depends on the public's trust in research and higher education, and research and education actors can only earn that trust by demonstrating quality, ethical behaviour and openness, cf. Chapter 7.

Many people involved in research, business and industry, and other sectors of society still do not have open access to publicly funded scientific articles. It is not easy to access research datasets, and it is a prevailing international problem that some research findings are not quality assured as well as they could have been, had researchers shared and reused more data. Greater openness in research is important to bring about the desired changes in the evaluation of research and researchers. Easier access to data can trigger the innovation and value creation potential inherent in further use of the research data. The huge increase in datasets makes great demands of research networks, of computing power and of data infrastructure in all sectors. Data infrastructure is costly, and national and international solutions should therefore be used as much as possible.

8.1 Open access to scientific articles

Research results should be immediately available to everyone who needs them or is interested in following developments in the field, whether this enables them to do a good job or they need the knowledge as patients, next of kin or parents of school children. The Government's goal is for all Norwegian scientific articles financed by public funding to be openly available by 2024.

The status report for higher education shows a strong increase in the number of open articles in the past decade, with around 75 per cent of articles being openly accessible in 2021. Norway participates in international collaboration through Horizon Europa, cOAlition S, Science Europe, the OECD, the Global Research Council and UNESCO to ensure that researchers are not forced to relinquish copyrights to the big publishing houses in order to get their articles published. A central

principle in negotiations on publish and read agreements with the big publishing houses is that the terms and conditions of new agreements are open. Publish and read agreements entail a combined fee for a period for publishing articles openly and for reader access to journals that remain closed. The total costs will not increase, and the negotiations must be used to accelerate the transition to open access.

A shift to immediate open publication in open access journals or on open platforms is the Government's primary goal, and a transition period entailing a double fee for publication and reading should be as short as possible. Efforts are required on several fronts going forward if this ambition is to be achieved. Sikt must continue working on a knowledge base for developing open access publishing and on preparing analyses of the finances involved. Publish and read agreements will continue to be an important tool in this transition, and the opportunities for making research available via science archives must be strengthened, but the main focus must be on achieving open publication channels that researchers perceive as good and conferring merit.

8.2 Research data are public information

Research data from publicly funded data must on the whole be considered public information on a par with data from other publicly-funded activities. In its consideration of Report No 22 to the Storting (2020–2021) *Data som ressurs: Datadrevet økonomi og innovasjon* ('Data as a resource: data-driven economy and innovation' – in Norwegian only), a unanimous Storting endorsed four national principles for sharing and using data: 1) Data must be open when possible, and protected when necessary 2) Data should be available, findable, usable and be possible to collate with other data, 3) Data should be shared and used in a way that generates value for business and industry, the public sector and society as a whole, and 4) Data

Box 8.1 Norway should make better use of data and analyses during crises

To enable Norway to better manage crises, we need quicker access to up-to-date data, people with the right expertise and changes in the regulatory framework. Knowledge acquisition and data management should also be an integral part of contingency plans in all sectors. This is the opinion of two expert groups, led by Simen Markussen of the Frisch centre and Mari Rege of the University of Stavanger, who submitted their reports in June 2022.¹ Both expert groups point out that a well-functioning knowledge system must be built when Norway is not in a crisis. They propose a number of measures, including:

- clarify the current regulatory framework and consider introducing a new act on sharing and using data when Norway is not in a crisis to ensure we are better prepared
- take steps to enable the public authorities to test measures on a small group before, if relevant, upscaling. This way of working will require clearer guidelines.
- ensure that knowledge acquisition and sharing and using data (and, if relevant, data processing) are included in contingency plans in all sectors
- strengthen the possibilities for establishing and using emergency preparedness registers in crises. These registers provide an opportu-

nity to quickly collect and collate large quantities of data.

- provide quicker access to real-time data and raw data, both in a normal situation and during crises, and invest in infrastructure for the receipt and processing of large quantities of data
- develop common solutions to make it easier for municipalities and central authorities to share data, and make it easier to access data from public registers

The core group for a better knowledge system for crisis management shall continue working on the proposals. The core group is a collaboration between the Ministry of Labour and Social Inclusion, the Ministry of Children and Families, the Ministry of Finance, the Ministry of Health and Care Services, the Ministry of Justice and Public Security, the Ministry of Local Government and Regional Development, the Ministry of Education and Research, the Ministry of Trade, Industry and Fisheries, the Ministry of Foreign Affairs, the Norwegian Institute of Public Health, Statistics Norway, the Research Council of Norway and the Norwegian Directorate of eHealth.

¹ Markussen et al. (2022) and Rege et al. (2022).

shall be shared and used in such a manner that fundamental rights and freedoms are respected, and Norwegian civic values are upheld.

Research data are included in the EU Open Data Directive, which is set to be implemented in Norway. The directive sets out that publicly funded research data shall be free of charge if published by researchers, research-performing organisations or if research-funding organisations have already made them publicly available through an institutional or subject-based repository.¹

Europe is in the process of establishing the European Open Science Cloud (EOSC). The EOSC is a system of research infrastructures and digital platforms. The goal is for these infrastructures and platforms to communicate well and to

work in such a manner that researchers experience them as open and seamless services for storing, managing, analysing and reusing research data. This means that Norwegian solutions and research data must comply with the internationally established FAIR principles, which dictate that data must be findable, accessible, interoperable and reusable. Norwegian infrastructure must be compatible with international infrastructure and must take account of future data growth and needs for data sources to be collated both nationally and internationally.

8.3 The digital research foundation – research network and supercomputers

The research network is the internet connection for students, researchers and employees in the

¹ Ministry of Local Government and Regional Development (2022).

knowledge sector, where researchers work together and share data and results. The Norwegian research network is managed by Sikt. The network is currently used by 150 organisations in the university and university college sector, institutes, vocational colleges, science centres and business and industry organisations, and has some 300,000 users. There are 125 research networks across the world, including the Norwegian one. International collaboration means that there are particularly good, close connections between these networks, which enable them to offer all the network qualities that research and higher education need. The national research network provides access to all these networks, and to all the user services that have been developed and are available both nationally and internationally. The current network capacity agreements were entered into in 2003 and new agreements must be signed in 2023/2024.

High Performance Computing (HPC), including high-capacity data analyses, machine learning and artificial intelligence, involves thousands of computer processors working in parallel to compute and analyse huge quantities of data in real time. This kind of extensive computing cannot be performed on ordinary computers. Supercomputers are needed for this purpose.

Supercomputers have traditionally been used in research in science and mathematics, but have gradually been adopted in most disciplines, including social sciences and the humanities. The development of artificial intelligence depends on this type of hardware. Supercomputers are also being used more and more in public administration. For example, the Norwegian Institute of Public Health used this type of technology in its computing of various coronavirus-related issues during the pandemic.

Every research institution used to have its own supercomputer for High Performance Computing. There was no common strategy, and they mostly competed for the same funding. In 2004, the Universities in Oslo, Bergen and Tromsø, along with the Norwegian University of Science and Technology (NTNU) in Trondheim and the then Ministry of Education and Research, agreed to establish a company to coordinate HPC and storage. Funding comes from the four universities and the Research Council. The company has now changed its name to Sigma2 AS. It is owned by Sikt and has been assigned strategic and operational responsibility for national supercomputers. The infrastructure is available to all institutions that need this type of HPC, data storage and pertaining services.

Through Sigma2, Norway has helped to develop one of the biggest supercomputers in the world, LUMI, in Kajaani, Finland. This collaboration involves ten countries, and the project has received NOK 1 billion in funding from the EU EuroHPC programme.² Sigma2 is also involved in the network of European HPC national competence centres. This network and the HPC centres shall help industry and the public sector to start using high performance computing services in their business models and to engage in innovation and knowledge building by providing support and competence-sharing.

Supercomputers are now an absolute necessity for engaging in high-quality research and also more lately for efficient and expedient public administration. Increasing amounts of valuable data are generated, which requires this type of up-to-date infrastructure.

8.4 The digital foundation for the Norwegian Universities and Colleges Admission Service

The Norwegian Universities and Colleges Admission Service coordinates admission to 27 universities and university colleges, and 27 vocational colleges. It was among the first organisations to digitalise its solutions, and it plays a vital role in the admission process to higher education. While the technology has advanced, the Norwegian Universities and Colleges Admission Service's computer systems have not followed suit. The systems that were developed in the 1990s and early 2000s are outdated and old-fashioned in 2022.

In 2023, Sikt and HK-dir will continue planning the development of a new system. The objective of the project is to develop a secure, reliable and forward-looking system for admission to higher education and tertiary vocational education in the years to come.

8.5 Information security

A lot of research infrastructure is digital infrastructure or depends on digital infrastructure to work. This infrastructure manages and processes large assets. Examples of such assets could be large amounts of sensitive personal data, research

² It opened on 13 June 2022, and LUMI was ranked third on the international TOP500 list of the world's most powerful supercomputers.

data in the form of raw data, processed data and research results, ICT systems and e-infrastructure. These digital assets make research and education possible. The digital assets have different security needs according to whether they concern confidential information, data and systems that must work and be available in critical processes or information that must be intact and trustworthy. Some digital assets are invaluable and cannot be recreated, for example long research data time series. Information security shall help to maintain trust in the knowledge that is generated and managed by the institutions and thus also trust in the institutions themselves. Each research-performing institution is responsible for ensuring that information security and protection of privacy safeguard these assets. The responsibility for information security and protection of privacy in research and education assigned to the Ministry of Education and Research is followed up in its governance model for this. The model organises the Ministry of Education and Research's and HK-dir's responsibility and governance processes in relation to the underlying higher education and research organisations in the area of information security and protection of privacy. An annual risk and status report for the university and university college sector ensures a common understanding of the situation and provides a basis for the Ministry of Education and Research to adopt risk-reducing measures for the sector and provide individual feedback to the individual organisation.

8.6 Data infrastructure

Up-to-date data infrastructure is needed to encourage sustainable and ethically responsible data-driven research, public administration and value creation in Norway. By data infrastructure is meant the tools, services and systems necessary for obtaining, analysing, storing, organising, documenting and providing access to data.

The need for up-to-date infrastructure has been pointed out in a number of reports in recent years,³ and what is referred to as the Data Infrastructure Committee presented its report concerning *Investering i infrastrukturer for FAIR forskningsdata og særlig relevante forvaltningsdata for forskning* ('Investment in infrastructure for FAIR research data and public administration data of particular relevance to research' – in Norwegian only) in May 2022.⁴ The committee comprised representatives from research institutions and public bodies with responsibility for research data of particular relevance to research and business and industry. The committee has made use of the aforementioned reports and reports on, and initiatives for, sharing of health data, socio-economic data, marine data, and climate and environ-

³ Arbeidsgruppe om e-infrastructure (2019), Research Council of Norway (2021b), Research Council of Norway's input to LTP (2021d), Research Council of Norway (2021c), Sikt (2022) and the reports of the expert groups appointed by the Government to improve the use of data and analyses during crises (2022, see box 8.1).

⁴ Research Council of Norway (2022c).

Box 8.2 Increased reuse of Statistics Norway's data for research purposes

Statistics Norway collects and organises extensive data from administrative registers, complete censuses and sampling for preparing and disseminating official statistics. Statistics Norway's basic data are very valuable to researchers, and the Statistics Act sets out that one of its tasks is to provide information for statistical use for research purposes, within the limits of e.g. protection of privacy and statistical confidentiality.

Statistics Norway shall make microdata available to researchers and the public authorities in an efficient and reliable manner, among other things by:

- performing the Microdata 2.0 project in collaboration with Sikt

- developing better self-service solutions for researchers
- ensuring efficient and reliable access services
- collaborating with existing infrastructure solutions for secure analyses and sharing of data

An overview of the Statistics Norway data much used in connection with research is available on its website. The basic data covers a range of subjects, including demographics, elections, income, living conditions, education, labour market, business statistics, the environment, prices etc.

mental data as the background for its recommendation on the level of ambition for data infrastructure in Norway:

- researchers at Norwegian universities and institutes shall have access to data infrastructures that enable world-class research and education
- by 2030, expertise, guidance and curation of research data shall be made available to all disciplines in Norway, either in the form of national solutions or through full or partial participation in European or international infrastructure collaboration
- in selected areas, Norway shall have world-class data infrastructures that are preferred by international users
- Norway must have an escalation plan for organising and funding data infrastructures that makes it possible to reap the benefits of the huge amounts of data that will be generated with public funding in the years to come

The Government's assessment is that the Data Infrastructure Committee's proposed level of ambitions is realistic, while it also gives us something to strive for. Great investments have already been made in data infrastructure in Norway, and we can continue to build on them, with better national and international coordination. Norway is already doing very well in some areas, and can be ambitious about taking the final step towards offering world-class data infrastructure which is preferred by international users.

8.7 The Government's policy

We need greater openness and more data sharing in research to realise the goals of the long-term

plan. The digital research foundation, which comprises the research network and supercomputers, must be further developed in step with the needs of research and the public administration. The infrastructure for the Norwegian Universities and Colleges Admission Service must be updated. Information security and protection of privacy must be safeguarded to ensure fundamental rights and freedoms are respected and national security is addressed. Updated data infrastructure is needed, and work on a broad front is required to raise competence with respect to data management.

8.8 Measures

The Government will:

- ensure that publicly funded research is available and that all higher education institutions have open access publication schemes
- ask HR-dir, Sikt and the Research Council to help the research institutions devise a strategy for Norwegian scientific publication after 2024 and a plan for achieving the goals of this strategy
- ensure that Norway has an up-to-date research network
- ensure sufficient national computing capacity (supercomputers) to meet the present and future needs of research and the public administration
- continue the work of developing a new technical system for the Norwegian Universities and Colleges Admission Service
- base future work on data infrastructure on the Data Infrastructure Committee's recommendations

9 University and university college buildings

High-quality research and education is contingent on buildings that are suited to developing and disseminating knowledge, identity and values. The university and university college sector has 3.6 million m² at its disposal, and thus has the biggest portfolio in the central government civilian sector. Around 2.7 million m² are owned by the state, while some premises are rented in the private market.

In the first long-term plan – Report No 7 to the Storting (2014–2015) *Long-term Plan for Research and Higher Education 2015–2024* – the Government prioritised two building projects that are particularly important in order to achieve the goals set out in the plan: The Life Science Building in Oslo and the Ocean Space Centre in Trondheim. The Life Science Building is under construction and is scheduled for completion in 2026. The building will promote broad research collaboration between the education sector and health, business and industry actors in applied life science. The Ocean Space Centre was awarded initial construction appropriation in 2022 and is scheduled for completion in 2028. The centre will cement Norway's position as a leading ocean nation and contribute to the green transition.

In the long-term plan presented in 2018 – Report No 4 to the Storting (2018–2019) *Long-term Plan for Research and Higher Education 2019–2028* – a special policy for developing, man-

aging and prioritising university and university college buildings was established for the first time. Its main conclusion was that we must use the areas available in the best possible manner. This means that we must organise efficient premises that support the organisations' purposes.

Developments in research and education mean that the need to adapt rooms and buildings, and the pertaining organisation of activities and services, must constantly be considered. Digitalisation is bringing about changes in study habits and learning preferences, which the universities and university colleges must meet to stay relevant. One thing we learned from the coronavirus pandemic was that education in future should combine physical attendance and digital options to promote learning, the learning environment, flexibility and sustainability. The physical and technological infrastructure must be organised to support physical, fully digital and hybrid teaching. Campus developments and teaching areas must therefore be adapted to different study situations. These areas and digital solutions must also be designed to support both individual work and group works in open and more 'informal' areas. Campus development plans are an important tool for enabling the institutions to adapt their premises to changing needs in a systematic manner. The scheme will be evaluated in 2022.

10 Financial and administrative consequences

Norwegian research policy sets out a target for resource use on research and development (R&D) defined in per cent. The target is that 3 per cent of gross domestic product (GDP) should go to R&D by 2030. One per cent should come from publicly funded R&D, and double that from business and industry. This target must be assessed over time and based on a normal situation, not on exceptional situations that generate strong positive or negative effects. The Government will present a strategy to achieve research and development in business and industry equal to 2 per cent of GDP by 2030.

The Ministry of Education and Research estimates that R&D allocations in the Government's national budget proposal for 2023 will total NOK 43.6 billion. This is 0.77 per cent of the GDP estimate for 2023.

Financial follow-up of the long-term plan will be addressed in the annual national budgets.

Looking ahead, the Government expects resource use to be geared towards the objectives and priorities in the long-term plan. The ministries will follow up implementation of the long-term plan in their management dialogue with the Research Council of Norway, the Directorate for Higher Education and Skills, Sikt – Norwegian Agency for Shared Services in Education and Research, universities, university colleges and other relevant underlying organisations.

The Ministry of Education and Research

r e c o m m e n d s t h a t :

The recommendation of the Ministry of Education and Research of 23 September 2022 on the Long-term Plan for Research and Higher Education 2023–2032 be submitted to the Storting.

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Appendix 1

The Kierulf Committee on academic freedom of expression (excerpt)

Box 1.1 The Kierulf Committee's proposed declaration on academic freedom of expression

Academic freedom of expression is rooted in our need to seek truth and knowledge. As a society, we depend on continuously seeking new understanding, which also entails challenging established truths. Free research and open discussion and criticism are prerequisites for scientific advances – and for them to be exploited for the common good. This freedom goes hand in hand with a responsibility to be objective and adhere to the ethical norms and professional standards of the various academic disciplines. Nevertheless, there is always a freedom to challenge these same standards.

As full members of an academic community, students also have academic freedom of expression. However, full membership does not mean they are fully fledged academics: Students shall therefore have the opportunity and a responsibility to receive instruction in scientific argumentation and thinking.

As independent stewards of academic freedom and academic freedom of expression, academic institutions are crucial for diversity and division of power in society. Academic freedom obliges academia to create the broadest possible arena for use of academic freedom of expression. Managers and other leaders in academia must assume responsibility for supporting, promoting and protecting academic staff and students in the active use of their academic freedom of expression.

Free speech is the lifeblood of academia. The institutions must therefore not place restrictions on academic staff and students' freedom to speak, write, listen, challenge and learn. An employee or student who wants to present problems, theories and views must have the opportunity to be heard – and to be confronted with questions, counter-arguments and criticism.

Academic institutions shall promote a culture of free speech characterised by mutual

acceptance and respect for disagreement, thereby contributing to a civilised discussion. They have a duty to safeguard employees and students who are subjected to unlawful expressions. However, it is not up to the institutions to protect staff and students from lawful expressions that many people disagree with or find offensive. Freedom of expression also protects embarrassing, unacceptable, immoral, unpleasant, shocking and offensive expressions. The institutions can regulate the time, place and format of activities in a way that promotes orderly discussion, but this must not restrict free and open debate. It is up to the academic staff and students, not the institutions, to applaud and commend expressions or dispute them using counter-arguments. Academic discussion requires that people's expressions are not met with silence. It requires recognition that views with which one deeply disagrees also have a place in the public sphere.

It is a central task for academic institutions to nurture academics' ability and readiness to engage in good debate and to protect their freedom to engage in discourse if someone tries to restrict it. Academic freedom and academic freedom of expression require an open culture of debate, and the institutions should therefore defend and promote debate on controversial topics. Both staff and students must engage in free discussion of controversial academic issues and be given training in critical assessment of different views, including their own.

Disciplines, faculties or institutes characterised by conformity or limited diversity of opinion are particularly encouraged to open up to and explore contrary views and approaches from outside their field.¹

¹ Official Norwegian Report (NOU) 2022: 2.

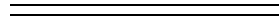
Box 1.2 The Kierulf Committee's ground rules for free speech

These ground rules for free speech can constitute a useful framework for academic freedom of expression. They are intended to serve as a checklist for everyone who wants to promote a good culture of free speech.

- Use your freedom of expression and freedom of information, also outside academic circles.
- Be brave, objective, honest and accurate with facts.
- Seek the truth, support disseminators, and welcome opposing views.
- Be an open-minded reader and listener, and a reasonable and generous colleague.

- Interpret opponents' arguments in the best possible way – for them.
- Attack the ball, not the player. Use arguments, not personal attacks.
- Be friendly, even if you disagree.
- Mistakes can be important. Acknowledge them, your own and others'.
- Know when to turn back. There is no shame in changing your mind – indeed, it is an academic virtue.
- Conduct yourself with consideration – you are an ambassador for academia.¹

¹ Official Norwegian Report (NOU) 2022: 2.



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