Addressing future societal challenges in Norway

Detailed methodology report

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Foresight study for the Research Council of Norway to help inform the future of research and innovation in Norway

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Preface

As part of its current strategy (2020–2024), the Research Council of Norway (RCN) has three primary objectives: ground-breaking research and radical innovation, sustainable development, and restructuring of the business and public sectors. Against this backdrop, the RCN commissioned RAND Europe and DAMVAD Analytics to carry out a foresight study to help inform the future of research and innovation (R&I) in Norway. The work will contribute to the development of a robust evidence base for the RCN's input to the revision of the Norwegian government's Long-Term Plan for Research and Higher Education 2019–2028 (hereafter, LTP). The study will also help inform the RCN's internal decision making, strategies and organisational activities.

The study focuses on the five strategic areas identified in the RCN's current strategy: (i) oceans; (ii) green transition; (iii) health and welfare; (iv) cohesion and globalisation; and (v) technology and digitalisation. The specific aims of the study were to:

- Identify a set of potential priority missions or targeted, challenge-based policy actions within and across (or outside) the five strategic areas that the RCN, together with other stakeholders, could consider implementing in the future to help address societal challenges; and

- Identify system-level structural measures to potentially facilitate the development of a resilient R&I environment in Norway.

We adopted a mixed-methods, participatory approach to the research, involving a variety of methodologies, such as trend analyses, literature reviews, stakeholder interviews, focus groups, an online survey of the public, crowdsourcing ideas and information from experts, future scenario analyses and workshops. All of these methods are covered in this report.

We envisage that the research will be of interest to funders and academia, national and local government policymakers, innovators and practitioners, and industry, and, more broadly, to anyone – including the public – interested in R&I and wider societal challenges.

This report explains our methodology to carry out the research and is one in a series of nine reports describing different elements of the study. The other reports are as follows:

- Health and welfare: An analysis of trends, future directions and potential missions to address societal challenges in Norway

- Oceans: An analysis of trends, future directions and potential missions to address societal challenges in Norway

- Green transition: An analysis of trends, future directions and potential missions to address societal challenges in Norway

- Technology and digitalisation: An analysis of trends, future directions and potential missions to address societal challenges in Norway

- Cohesion and globalisation: An analysis of trends, future directions and potential missions to address societal challenges in Norway

- Structural measures to develop a resilient research and innovation environment in Norway

- A summary of potential cross-cutting missions to address future societal challenges in Norway

- Addressing societal challenges in Norway: Key trends, future scenarios, missions and structural measures

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Abbreviations

3H	Three Horizons [model or framework]
ABP	Assumption-based planning
AI	Artificial Intelligence
GNI	Gross national income
ICT	Information and communication technology
LTP	The Long-Term Plan for Research and Higher Education 2019–2028 – Meld. St. 4 (2018–2019) Report to the Storting (white paper)
ML	Machine learning
ODA	Official Development Assistance
PESTLE	Political, economic, societal, legal, technological and environmental
R&D	Research and development
R&I	Research and innovation
RRI	Responsible research and innovation
RCN	Research Council of Norway

1. Introduction

The research and innovation (R&I) landscape in Norway is underpinned by Norway's overarching ambition for research and higher education, namely to help facilitate growth in overall value creation, to create new and profitable jobs, to restructure the Norwegian economy and to help implement a transition towards a greener society (Ministry of Education and Research 2019). The development of a strong knowledge base through research is necessary to fulfil these ambitions but also to train the Norwegian workforce (Ministry of Education and Research 2019). The Long-Term Plan for Research and Higher Education[1] (hereafter LTP) details the Norwegian government's ambitions and policy for research and higher education in Norway. The LTP establishes ten-year objectives and priorities and concrete goals for efforts in the upcoming four-year period. It sets the course for policy development and investments in research and higher education in Norway.

The Research Council of Norway (RCN) plays a critical role in the Norwegian and international research and innovation landscape, as the national funding agency for R&I. In its current strategy (2020–2024), the RCN details priorities and goals help realise the objectives of the LTP (Research Council of Norway 2020a). As part of its current strategy, the RCN has articulated the following three primary objectives, with the overarching view of achieving a 'well-functioning research and innovation system' (Research Council of Norway 2020a):

- Sustainable development;
- Ground-breaking research and radical innovation; and
- Restructuring of the business and public sectors.

Within this framework, the RCN has also identified five core 'strategic areas' (as shown in Figure 1) within which to focus its priorities and portfolio plans and within which deliver high-impact research and innovation (Research Council of Norway 2020a).

Figure 1. The RCN's five strategic areas identified in its current strategy (2020–2024)

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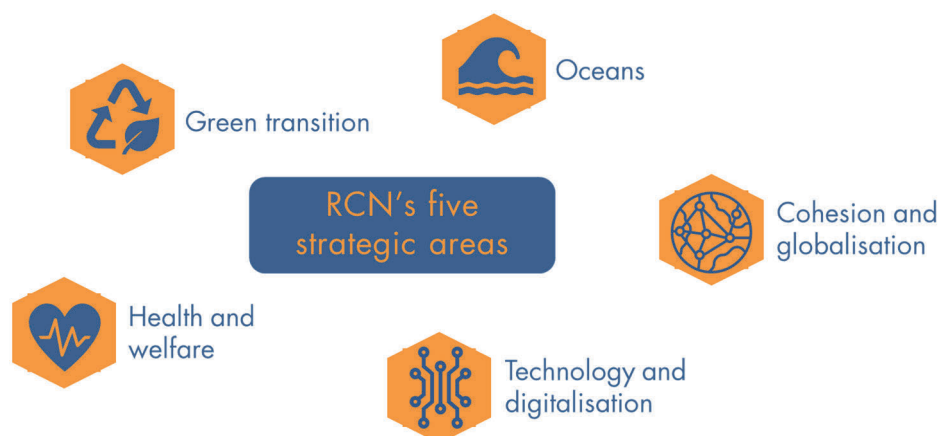
[1] The Long-Term Plan for Research and Higher education 2019-2028 – Meld. St. 4 (2018-2019) Report to the Storting (white paper).

1.1.   Objectives of the study

Against this backdrop, the RCN commissioned RAND Europe and DAMVAD Analytics to carry out a foresight study to contribute to the development of a robust evidence base for the RCN's input to the 2022 revision of the Long-Term Plan for Research and Higher Education 2019–2028 (Ministry of Education and Research 2019). The study will also help inform the RCN's internal decision making, strategies and organisational activities. The study focuses on the five main strategic areas identified in the RCN's current strategy for the next ten years (Research Council of Norway 2020) and is intended to help frame thinking about the future of R&I in relation to these strategic areas in Norway. As noted above, the five strategic areas covered by this study are: (i) oceans; (ii) green transition; (iii) health and welfare; (iv) technology and digitalisation; and (v) globalisation and cohesion. In particular, the study aims to:

- Identify a set of potential priority missions or targeted, challenge-based policy actions within, across or outside the five strategic areas for the next ten years that the RCN, together with other stakeholders, could consider implementing in the future to help address societal challenges; and

- Identify a series of system-level structural measures to facilitate the development of a resilient R&I environment in Norway.

For this study, we regard missions as targeted, timebound, measurable priority actions to help solve one or more societal challenges that the RCN and other stakeholders could consider developing and implementing in the future. In the long term, the missions will help the RCN achieve its overarching objectives (over a roughly ten-year time frame) and eventually contribute to enriching lives locally, nationally and internationally.[2] Structural measures can be considered to be foundational, system-level instruments, policies, or tools in the R&I landscape that contribute to the translation of R&I into wider societal benefits. In the context of this study, they are intended to be a range of measures (with varying levels of specificity and generally cutting across multiple strategic areas) that help develop a resilient R&I environment in Norway and also address the wider performance of the R&I system in terms of the RCN's three overarching objectives. Missions and structural measures will both require diverse stakeholders to be involved in their development and implementation. The interaction between missions and structural measures is discussed in more detail in our conceptual framework in the next section.

This report, one in a series of nine reports, outlines the methodology that we adopted to implement the research.[3]

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[2] More broadly, missions are systemic policies that operate both as a means of steering economic growth in a particular direction (by, for example, steering investments towards particular societal challenges) and as a tool that can be used to get there (by, for example, setting clear, problem-focused objectives) (Mazzucato 2018).

[3] This report on our methodology is one in a series of nine reports presenting the findings of the study. The other reports are as follows: Health and welfare: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Gloinson et al. 2021a); Oceans: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Skjoldager et al. 2021b); Green transition: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Skjoldager et al. 2021a); Cohesion and globalisation: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Gloinson et al. 2021b); Technology and digitalisation: An analysis of trends, future directions and potential missions to address societal challenges in Norway (d'Angelo et al. 2021); A summary of potential cross-cutting missions to address future societal challenges in Norway (Gunashekar et al. 2021a); Structural measures to develop a

1.2. Conceptual framework for the study

Our overall conceptual framework (Figure 2) was targeted at providing a key analytical tool to enable us to carry out a rigorous, detailed and comprehensive futures analysis for the RCN. It is based on a participatory approach involving a range of diverse stakeholders, detailed trend analyses, and rigorous scenario planning that contributed to the conceptualisation and achievement of the overarching aims of the study, i.e. to identify a set of potential priority missions related to the RCN's five strategic areas and underlying structural measures to enable the development of a robust, resilient and socially responsible research and innovation environment in Norway.

Figure 2. Conceptual framework for the study
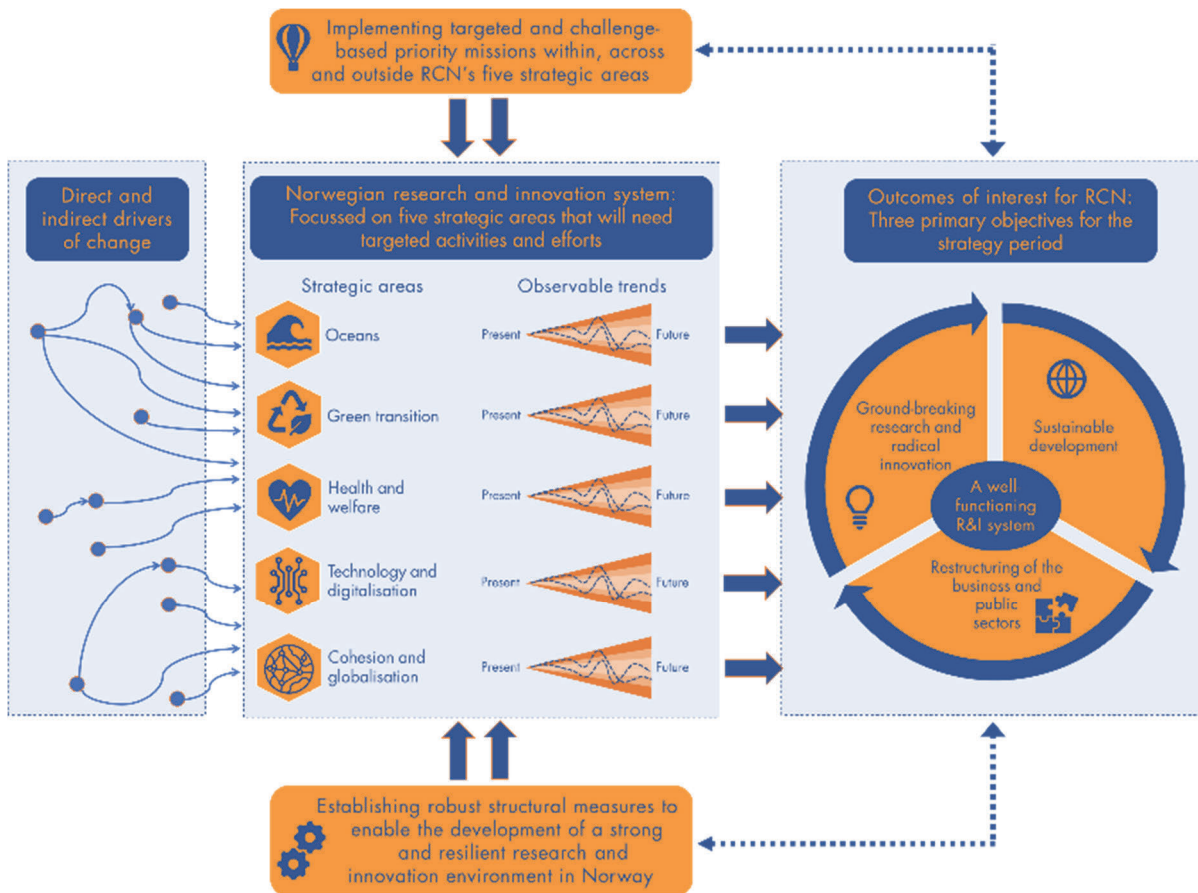
Source: Study team analysis

The conceptual framework for the study shown in Figure 2 provides a systems-level view of the various high-level interconnected components of the R&I ecosystem. A series of potentially interconnected drivers (as shown on the left of the figure) can either directly or indirectly influence or cause change in the wider Norwegian R&I system. The system itself is characterised by a series of observable trends or discernible patterns of change relating to the five strategic areas, as illustrated in the middle of the figure. An evidence-

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based foresight approach to explore a range of plausible futures can help the RCN arrive at decisions 'today' that will potentially mitigate future risks and enable future opportunities to be better anticipated. The conceptual framework therefore illustrates the importance not only of realising benefits for the Norwegian R&I system, but also of managing and mitigating against risks. As shown on the right of the figure, the system is also composed of the main outcomes of interest to the RCN, which are their primary objectives over the current strategy period (2020–2024) (i.e. sustainable development, ground-breaking research and radical innovation, and restructuring of the business and public sectors). If these outcomes are achieved, this could help realise the RCN's overarching desired outcome of a 'well-functioning research and innovation system'. To accomplish these high-level goals, it is necessary to have a set of policy levers or actions that can help steer the system towards the outcomes of interest. Therefore, identifying and implementing a set of targeted, timebound and challenge-based actions – or priority missions – within and across (or even outside) the RCN's strategic areas could form the basis for recognising concrete focus areas for the future. Furthermore, implementing the missions successfully will require the establishment or improvement – in parallel – of key underpinning structural measures at a systemic level. Thus, a mix of appropriate structural measures, together with a set of carefully developed priority missions – and both involving diverse stakeholders and building on – could help the RCN meet its current objectives and ultimately contribute to enriching lives locally, nationally, and internationally.

1.3.   Summary of the methodology

We adopted a mixed-methods, participatory approach to the research in order to achieve the study objectives, as illustrated in Figure 3. The methods included literature reviews, stakeholder interviews, focus groups, a survey of the public, crowdsourcing ideas and information from experts, future scenario analyses and workshops. Over the course of the study, we engaged with a broad range of stakeholders across academia, government, industry, the not-for-profit sector, RCN and the public. We also actively involved members of our advisory panel of experts at different points in the research.

Figure 3. High-level overview of our approach to implementing the research
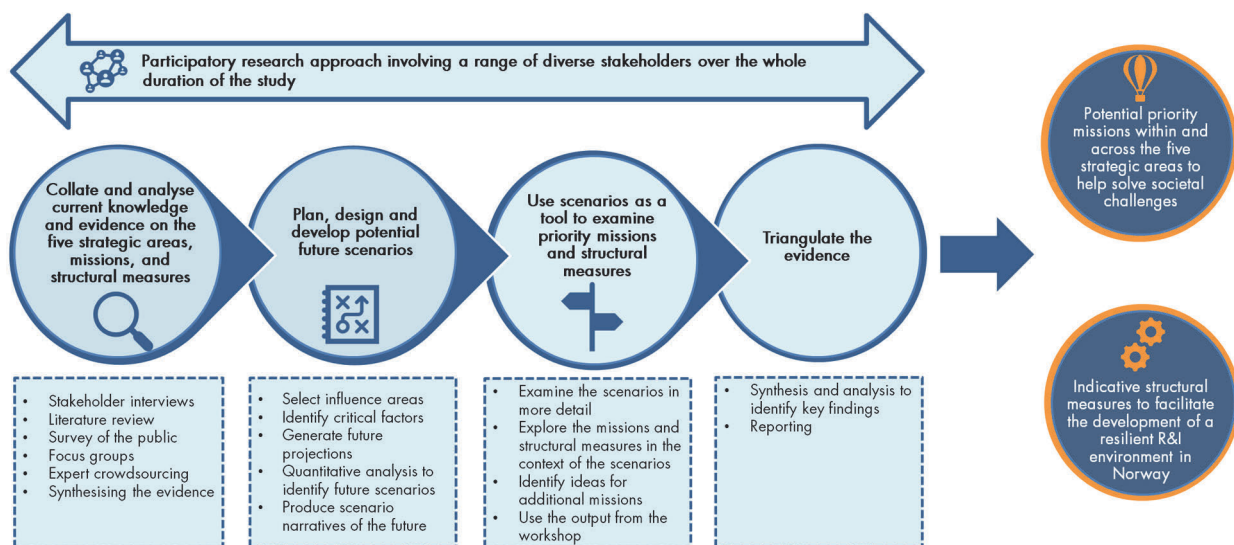
Source: Study team analysis

Our overall approach to the study aligned with the steps illustrated in the figure above and summarised below. Each of these high-level steps is elaborated upon in the remaining chapters of this report.

- **Collate and analyse current knowledge and evidence on the five strategic areas and structural measures:** The first step of the study involved collecting and analysing evidence to help develop a robust knowledge and information base. This enabled us to define and characterise the complex 'ecosystem' and associated components that shape or influence research and innovation in Norway – specifically through the lens of the five strategic areas and potential underlying structural measures. This 'trend analysis' enabled us to develop a robust and rigorous baseline understanding of the structural measures and of the strategic areas, and their general direction of travel, as well as of the key uncertainties and critical factors driving change.

- **Plan, develop and design future scenarios:** In the second step of the study, we designed and developed a series of plausible future scenarios, using a systematic scenario development approach. The scenarios enabled us to anticipate what might happen in the future in the research and innovation environment in Norway and in the wider research and innovation environment.

- **Use scenarios as a tool to examine missions and structural measures:** In the third phase of the study, we used the scenarios as a tool to support the identification of a set of priority missions and structural measures. The scenarios that we developed for the different strategic areas were assessed against the RCN's objectives when discussing the priority missions (within and across the strategic areas) and the underlying R&I structural measures that could be strengthened or established in Norway.

- **Triangulate the evidence:** In the final phase of the research, we synthesised and analysed the evidence collected during the preceding phases of the study to identify key findings (i.e. a set of indicative priority missions and potential structural measures).

Across the four different phases, several evidence and data collection activities were undertaken. These are outlined in Figure 4.

Figure 4. Main evidence and data collection activities undertaken in the research

46 stakeholder interviews

Literature review: ~450 articles

Survey of the public: 828 responses

6 focus groups involving 10 ministries

Expert crowdsourcing: 84 responses

Futures workshops: 45 participants
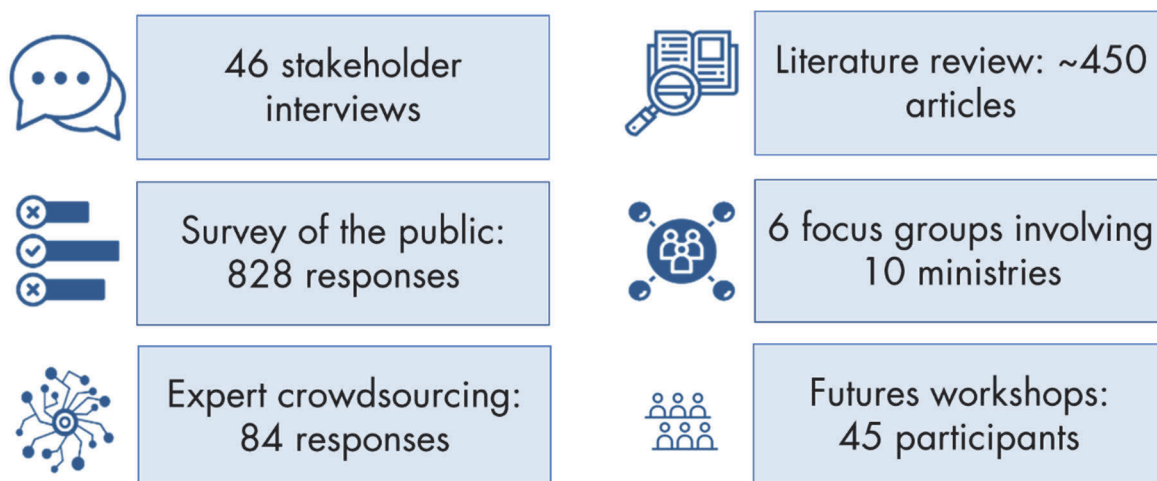
Source: Study team analysis

1.4. Outline of the report

The remainder of the report is structured as follows:

- In Chapter 2, we describe our approach to phase one of the study: 'Collate and analyse current knowledge and evidence on the five strategic areas and structural measures';

- In Chapter 3, we describe the methodology used in the second phase of the study: 'Plan, design and develop potential future scenarios';

- In Chapter 4, we describe our approach to the third phase of the study: 'Use scenarios as a tool to examine priority missions and structural measures';

- In Chapter 5, we describe our approach to triangulating the evidence from the different sources;

- In Chapter 6, we provide a summary of the limitations of the analysis; and

- In the annexes, we present comprehensive versions of the data collection protocols, as well as the scenario narratives for both scenario sets. In Annex A, we provide the data collection protocols and material used for the methodological approach in the first phase of the study. In Annex B, we provide the data collection protocols and material used in the second phase of the study. In Annex C, we present the scenario narratives.

2. Collate and analyse current knowledge and evidence on the five strategic areas, missions and structural measures

In the first phase of the study, we carried out a detailed trend analysis for each strategic area, by collecting and analysing wide-ranging evidence to help develop a robust knowledge and information base. The information collected in the trend analyses enabled us to develop a deep and rounded understanding of the status quo and direction of travel within (and outside) the R&I landscape for each strategic area (oceans; green transition; health and welfare; technology and digitalisation; and globalisation and cohesion). Specifically, we identified the main trends, enablers, barriers and uncertainties that will potentially shape the strategic area over the next ten years or so. The trend analyses were also used to collect information on and directly inform the indicative priority missions and structural measures.

In the following sections, we describe the main data collection activities employed in the research in this phase.

Literature and document review

We carried out a detailed literature and document review of academic and grey literature (over the past ten years) to understand the status quo and the direction of travel with respect to developments within (and outside) the research and innovation landscape in Norway and internationally. The literature review was carried out at three stages in the study (i.e. in relation to the strategic areas, the priority missions and the structural measures). In the literature review that formed the basis for the trend analyses of the five strategic areas, the key aims were to: (i) generate a long-list of potential trends within each strategic area, critical factors, uncertainties, and direction of travel and potential outcomes over a ten-year time period; (ii) prepare concise and message-led narrative explanations for each of the trends, their drivers and outcomes, and their interrelations; and (iii) report on the evidence base for these trends in the literature. For each strategic area trend analysis, we carried out searches in Google and Google Scholar, using targeted search strings. The search string used to search the literature is provided in Box 1 in Annex A. In addition, we built on our database of articles to review as part of the project, with examples of literature suggested by interviewees and through snowballing,[4] as well as additional targeted searches on topics of particular interest where more information was needed. The same literature review was also used to obtain ideas and inspiration for potential missions and structural measures that could be applied in the Norwegian context over the next ten years. We carried out additional desk research to identify ideas for potential missions that fall within or cut across the strategic areas. Sources for the desk research and document review were identified by snowballing from the sources we identified in the trend analyses and the crowdsourcing exercise. The desk research involved reviewing the websites of Norwegian organisations and government, as well as learning from mission-related work being undertaken in other country contexts. For the structural measures, we carried out desk research to learn from the implementation of structural measures in other country contexts. This desk research involved reviewing websites of relevant organisations at a national and an international level, as well as a selection of government departments and stakeholders, services and initiatives.

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[4] Snowballing is the process of identifying additional articles from reference lists of originally identified articles.

Interviews with key stakeholders

We carried out a series of interviews with diverse stakeholders from academia, industry, the public sector/government, the RCN and the third sector during the study.[5] As with the literature review, interviews were conducted in relation to the five strategic areas, the priority missions and the structural measures.[6] First, we carried out interviews with experts in each strategic area to gain a deeper understanding of the trends, factors, uncertainties, barriers and enablers; we also sought ideas for potential structural measures and missions related to the future of each strategic area. Second, we carried out interviews with R&I experts, experts from outside the strategic areas and experts cutting across multiple strategic areas, to identify and validate missions that cut across (or fall outside) the five strategic areas. Finally, we carried out interviews with a set of stakeholders to enhance our understanding of specific exemplar structural measures that could potentially be introduced in the Norwegian R&I ecosystem. All the interviews were semi-structured to ensure that a similar set of questions was asked of all interviewees while allowing for emergent issues to be explored. The interview protocols are included in Box 2 and Box 3, in Annex A. Interviews were conducted using Microsoft Teams or telephone and lasted up to one hour. Data were collected by taking detailed notes and by making an audio recording of each interview. In total, we carried out 46 interviews over the course of the study.

Survey of the public

An online survey was used to engage the public and obtain an illustrative snapshot view of the perceptions, opinions and perspectives of the public towards the five strategic areas. Broadly, participants were asked to describe what they thought were the biggest challenges and opportunities in relation to the five strategic areas.

Members of the public were contacted through citizen associations in Norway that distributed the survey to relevant citizens. In Table 1 below, we list the organisations that were contacted and encouraged to distribute the survey. Respondents were also recruited using the social media accounts of DAMVAD, RAND Europe and the RCN.

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[5] The breakdown of the interviewees was as follows: (i) academia: 26 interviewees; (ii) industry: 9 interviewees; (iii) public sector: 8 interviewees; and (iv) third sector: 3 interviewees. In addition, we carried out 6 focus groups with government ministries, which covered 16 representatives from across 10 ministries.

[6] Interviewee inputs are cited throughout the reports using anonymised interviewee identifiers, as follows: interviewees for oceans: INT-O-XX; interviewees for green transition: INT-GT-XX; interviewees for health and welfare: INT-HW-XX; interviewees for technology and digitalisation: INT-TD-XX; interviewees for cohesion and globalisation: INT-CG-XX; interviews cutting across multiple strategic areas: INT-CC-XX; interviewees for potential structural measures: INT-SM-XX (where 'XX' represents the unique interviewee number).

Table 1. Organisations that were approached to distribute the survey

Organisation
Agenda
Amnesty international Norge
Civita
DNT (Den Norske Turistforening)
DNT (Den Norske Turistforening)
Foreningen Norden
Lions Club International
Manifest Tankesmie
Nasjonalforeningen for folkehelsen
Natur og Ungdom
Norges huseierforbund (Bolig Mentoren)
Norges naturvernforbund
Norsk friluftsliv
Norske Folkehjelp
NSO (Norsk Studentorganisasjon)
Seniornett
Skaperkraft Tankesmien
Ungdom og Fritid
Velferdsalliancen

The survey included a small number of open-ended questions (Table 5, in Annex A, lists the questions). Responses were collected using an online survey tool.[7] Following the data collection phase, the survey responses were analysed with a natural language processing algorithm developed by DAMVAD Analytics. The algorithm extracts themes and sentiments based on open-ended survey questions. Using cluster analysis, the algorithm identifies words and sentences of words that are closely connected. This is then used to identify the underlying themes and categories of all responses. In total, we received 828 responses to the survey. Further details on the descriptive results of the survey are presented in the figure below.

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[7] The online survey platform Enalyzer (https://www.enalyzer.com/#) was used to host the survey.

Figure 5. Exemplar descriptive survey results

Descriptive result

Total number of respondents: 828

Average age of respondents: 56 years old

Gender distribution: 50/50

Share of respondents living

in Norway: 95%

Share of respondents who expressed an interest in RCN's five strategic areas

Area	
Ocean	44%
Green Transition	53%
Health and welfare	51%
Technology and digitalisation	54%
Cohesion and globalisation	38%
Other	10%

Source: Study team analysis

Expert crowdsourcing exercise

We used crowdsourcing with experts to gather additional ideas on trends, barriers, enablers and uncertainties and on potential policy measures, missions and structural measures that could help frame thinking about the future of research and innovation in Norway. For the crowdsourcing exercise, we created a data collection template that covered the key elements we wanted to capture in the trend analysis. The template was developed on a Google Sheet that was openly available to anyone who had the weblink. During the trend analysis, we compiled a long-list of stakeholders from academia, public and private sector organisations, and the third sector with a broad range of expertise in the five strategic areas, and we emailed them all an invitation to participate in the crowdsourcing. We also encouraged individuals to share the link with colleagues. We sent two reminders to all experts (unless they had already input into the spreadsheet and informed us that they had done this). The crowdsourcing exercise ran for one month. The template for the crowdsourcing exercise is provided in Table 6, in Annex A. Some experts also emailed us inputs, which we added to the final crowdsourcing sheet. In total, we received 83 detailed responses to the crowdsourcing exercise.

Focus groups and interviews with Norwegian government ministries

We conducted online focus groups and interviews with 16 representatives from Norwegian government ministries to gain qualitative insights into the policy priorities of the Norwegian government. We conducted six focus groups covering ten government ministries.[8] Group sizes ranged from between 2 to 6 people from different ministries per focus group.[9] The government ministries were grouped according to their areas of expertise and relevance to each of the five strategic areas. The focus groups and interviews were conducted using Microsoft Teams and lasted one hour. During both the focus groups and the interviews, the following topics were discussed: (i) the ministry's research and innovation priorities; (ii) key trends related to relevant strategic area(s); (iii) barriers, enablers and uncertainties related to relevant strategic area(s); and (iv)

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[8] The ten government ministries were the Ministry of Defence, the Ministry of Health and Care Services, the Ministry of Children and Families, the Ministry of Foreign Affairs, the Ministry of Research and Education, the Ministry of Climate and Environment, the Ministry of Agriculture and Food, the Ministry of Trade, Industry and Fisheries, the Ministry of Petroleum and Energy, and the Ministry of Transport.

[9] We also conducted one-to-one interviews with representatives from some of the ministries.

potential policy measures, missions and structural measures related to the future of research in innovation in Norway. The focus groups and interviews with Norwegian ministries followed a similar protocol as was used in interviews with key stakeholders in the first phase of the study.[10] Data were collected by taking detailed notes and by making an audio recording of each meeting. Interviews and focus groups with the ministries are cited using the same interview identifiers as were used for the expert/stakeholder interviews.[11]

Synthesising the evidence

The evidence from the literature reviews, stakeholder interviews, ministry focus groups, crowdsourcing exercise with experts and survey of the public was synthesised to gain an understanding of the main trends, barriers, enablers, uncertainties and policy challenges for each of the five strategic areas. This evidence base formed the basis from which to identify structural measures and indicative priority missions. It also formed the basis for the development of futures scenarios in the next phase of the study.

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[10] Box 2, in Annex A, presents the interview protocol that was used in interviews in the first phase of the study, as well as the focus groups and interviews with ministries.

[11] The ministry focus groups/interviews were given the same identifiers as other stakeholders, to ensure that their inputs to the study remain anonymous.

3. Plan, design and develop potential future scenarios

The aim of the second phase of the research was to: facilitate the anticipation of what might happen in the next ten years, help reflect changes in the wider R&I system and the 'macro' environment, and support the identification and validation of a set of priority missions for the RCN.

We constructed two scenario sets by combining various elements associated with the five strategic areas (oceans; green transition; technology and digitalisation; health and welfare; and cohesion and globalisation) to build scenarios of sufficient depth and distinctiveness. Each scenario set consisted of four future scenarios which were developed basing them on 15–20 prioritised political, economic, social, technological, legal and environmental (PESTLE) factors from the trend analyses that could influence the strategic areas. In this chapter, we outline the process for developing the four scenarios in each scenario set.[12]

The scenarios were developed using the framework presented in Gausemeier et al. (1998). The framework identifies key areas and critical factors and uses cross-impact analysis, consistency analysis and cluster analysis to identify scenarios. This approach happens in five steps, as illustrated in Figure 6, below. We describe each step in more detail in this chapter. The ScMI software suite was used to support the development of the scenarios (Scenario Management International AG 2021).

Figure 6. Approach to planning, designing and developing potential future scenarios
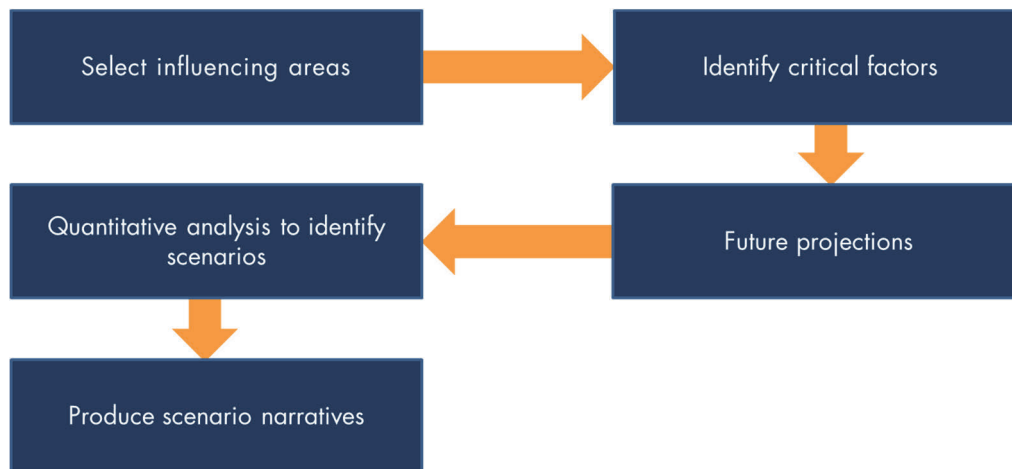
Source: Study team analysis

Select influencing areas

Several areas were identified as important based on the trend analysis for each of the five strategic areas. Key areas include those areas that both influence developments in research and innovation in Norway and are themselves influenced by such developments. These areas were broadly categorised as health and welfare, cohesion, green transition, oceans, globalisation, environment, cross-cutting, technology and digitalisation,

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[12] Further information on why we chose two scenario sets and what they encompass is provided in Section 3.4.

and research and innovation.[13] Each area can be characterised by a set of factors, for example, under the cross-cutting area, we included such factors as net immigration, exchange rate for Norwegian krone, natural resource wealth and employment, and housing locations. We created a long-list of draft PESTLE factors for each of the five strategic areas. The PESTLE factors served as key inputs to the scenario development phase of the study. The long-list of factors – which are interlinked and uncertain – was identified through the trend analysis for each strategic area. The trend analysis summarised key evidence from the desk research and interviews. It focused on the overarching trends that will influence the strategic areas, the barriers and enablers for these trends, and uncertainties that will shape the strategic areas. An initial long-list of 145 factors was compiled and shared with the RCN for their inputs. The long-list of factors for each strategic area is presented in a series of tables (Table 7 to Table 12 in Annex B).

Identify critical factors

The long-list of factors was shortlisted for the 'cross-impact analysis' (described below) by comparing the factors in an internal workshop with core members of the project team. The long-list of factors was edited and filtered based on two key decisions:

- A common definition was created, and factors were combined if similar factors were repeated across the strategic areas.

- Factors were combined if they described similar aspects of the potential future of the research and innovation ecosystem in Norway and at an international level.

We identified a set of 'critical factors' that can be regarded as factors that are uncertain, important and interlinked – these formed the basis for constructing the scenarios. To identify the critical factors for the scenarios, we carried out a cross-impact analysis of the long-list of factors. We undertook a cross-impact analysis of the long-list of factors to understand potential links between factors (how interlinked they are), and to identify the factors that are the most important. We focused on 'active' factors, which have the most influence on other factors in the system, and 'passive' factors, which are the most influenced by others. The cross-impact analysis was undertaken by the leads for each strategic area with scenario and subject matter expertise. In the cross-impact analysis, the strategic area leads were asked to qualitatively score the relationship between pairs of factors. The scoring scale is presented in Table 2.

Table 2. Scoring scale for the cross-impact analysis

Score	Definition
0	No impact
1	Weak and delayed impact
2	Medium impact
3	Strong and direct impact

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[13] These areas followed the categorisation of the RCN's five strategic areas but also added some additional areas that emerged as important during the literature review and interviews in the first phase of the study.

We focused on the direct relationship between factors. Each combination of factors was given a score based on the degree to which one factor influences another, i.e. the degree to which factor x (row) influences factor y (column). A matrix approach was used to facilitate this – with all the factors appearing in both the row and the column headings. Hence each factor pair (X, Y) was scored twice. The cross-impact analysis was used to identify the key factors from the long-list. Using the qualitative scoring system, the most active, passive and interrelated factors in the system were identified. Illustrative examples of the cross-impact analysis matrices for scenario set 1 are provided in Figure 7, below.

Figure 7. Exemplar cross-impact analysis matrix - Scenario Set 1 *(Norway in a national context)*
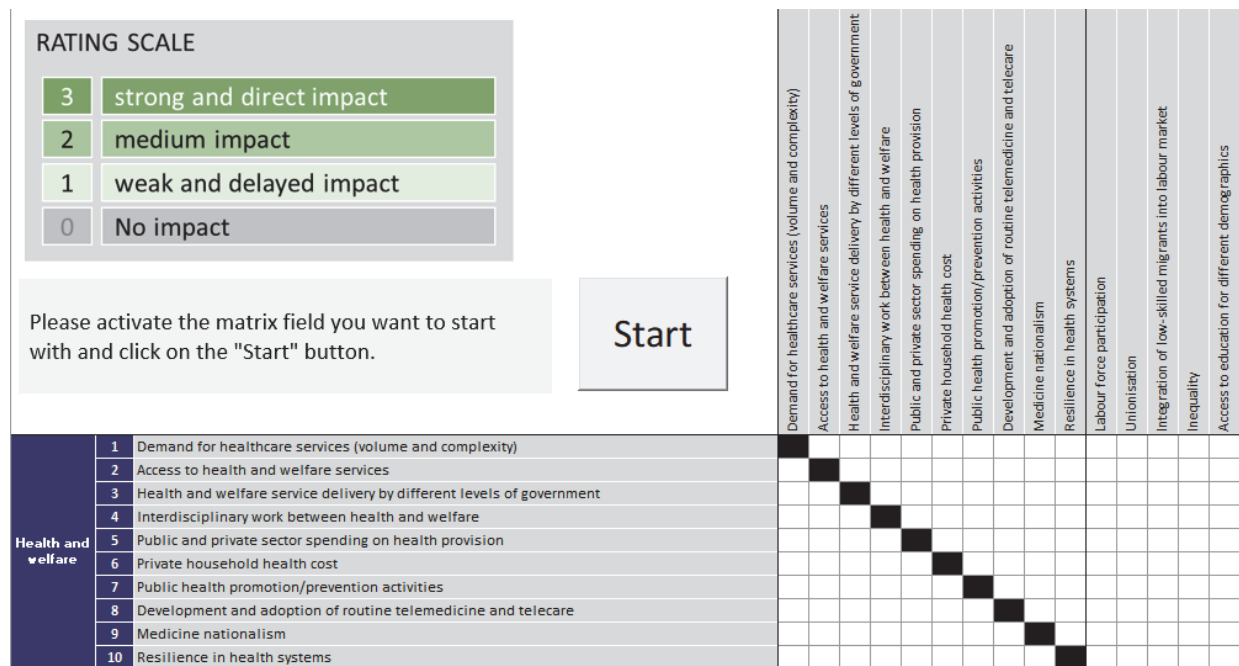
The cross-impact analysis was undertaken by core members of the study team. The figures below show the scoring of the different factors after the cross-impact analysis to identify the most active and passive factors. The process was iterative and resulted in some factors being combined into a single factor.[14] Figure 8 and Figure 9 illustrates the combined scoring for some of the factors in the first and second scenario sets. In addition to activity and passivity, uncertainty of the factors was also an important criterion for the scenarios. The x-axis in the figures below illustrates how passive the factors were (i.e. how influenced they were by the other factors in the system), while the y-axis illustrates how active the actors were (i.e. how much influence they had on the other factors in the system). We focused on the most active and passive factors (in the top-right quadrant of the figure) to consider which ones we should take forward in our analysis.

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[14] Some factors were combined during the cross-impact analysis. A total of 31 factors were used in the final scenario development. The final list of factors for the two scenario sets is included in Annex B.

Figure 8. Scoring of factors for Scenario Set 1 (*Norway in a national context*), with key below.

		Health and welfare			Cross-cutting	
	1	Demand for healthcare services (volume and complexity)		24	Net immigration	
	2	Access to health and welfare services		25	Norwegian GDP	
	3	Health and welfare service delivery by different levels of government		26	Exchange rate for Norwegian krone	
	4	Interdisciplinary work between health and welfare		27	Natural resource wealth	
	5	Public and private sector spending on health provision		28	Employment and housing locations	
	6	Private household health cost		29	Skilled labour availability	
	7	Public health promotion/prevention activities		30	Transport accessibility	
	8	Development and adoption of routine telemedicine and telecare		31	Digital infrastructure	
	9	Medicine nationalism		32	Digital inclusion and competence	
	10	Resilience in health systems		33	Digital security and privacy protection	
	11	Labour force participation		34	Attitudes to data sharing	
	12	Unionisation		35	Application of Artificial Intelligence (AI) and Machine Learning (ML)	
	13	Integration of low-skilled migrants into labour market		36	Application of biotechnology	
	14	Inequality		37	Application of nanotechnology	
	15	Access to education for different demographics		38	Application of autonomous systems and advanced manufacturing technologies	
	16	Discrimination and hate speech		39	Availability and access to high-quality public data	
	17	Levels of crime		40	Computing and energy cost of data and technology	
	18	Trust in national government		41	Technology convergence	
	19	Social and cultural diversity		42	Globalisation of R&I	
	20	The changing media picture and mobilisation of opinion		43	Continuity and flexibility of R&I funding	
	21	Pandemics and other unexpected events		44	Awareness and uptake of responsible research and innovation	
	22	Speed of environmental impact (of climate change)		45	Impact frameworks and indicators	
	23	Local air quality		46	Advance in scientific knowledge	
				47	Appetite for innovation	
				48	Structure of R&I sector	

Figure 9. Scoring of factors for Scenario Set 2 (*Norway in a global context*), with key below
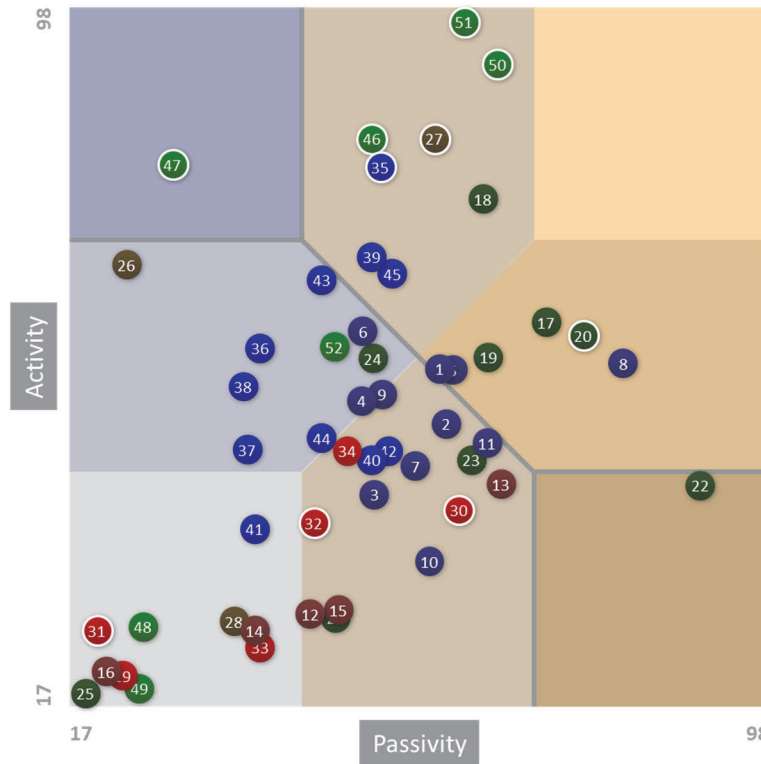
Green transition	1	Demand and support for circular products and the green transition	**Cross-cutting**	29	Net immigration
	2	Primary energy consumption		30	Norwegian GDP
	3	Domestic material consumption behaviour		31	Exchange rate for Norwegian krone
	4	Green public procurement		32	Natural resource wealth
	5	(circular) Infrastructure for energy, water, waste supply		33	Employment and housing locations
	6	Public attitudes to sustainability		34	Skilled labour availability
	7	Energy usage and waste	**Technology**	35	Digital infrastructure
	8	National adaptation to environmental and climate change		36	Digital inclusion and competence
	9	Local, small-scale initiatives		37	Digital security and privacy protection
	10	Sustainable food production		38	Attitudes to data sharing
	11	Take-up of low emissions transport		39	Application of AI and ML
Oceans	12	Diffusion of knowledge and capabilities from offshore industries		40	Application of biotechnology
	13	Investments/innovations to reduce emissions from oil extraction and products		41	Application of nanotechnology
	14	Demand for sustainable aquaculture		42	Application of autonomous systems and advanced manufacturing technologies
	15	Sustainable aquaculture		43	Availability and access to high-quality public data
	16	Emerging diseases in aquaculture		44	Computing and energy cost of data and technology
Globalisation	17	Norway's trade linkages with other countries		45	Technology convergence
	18	Norwegian cooperation with EU/EEA	**R&I**	46	Globalisation of R&I
	19	Norway's role in multilateral institutions		47	Continuity and flexibility of R&I funding
	20	Management of and access to resources in the Arctic and High North		48	Awareness and uptake of responsible research and innovation
	21	Norway's international development (ODA) contributions		49	Impact frameworks and indicators
	22	International progress towards climate targets		50	Advance in new scientific knowledge
	23	International regulations for maritime industries		51	Appetite for innovation
	24	Make up of geopolitical landscape		52	Structure of R&I sector
	25	Terrorism			
Environment	26	Pandemics and other unexpected events			
	27	Speed of environmental impact (of climate change)			
	28	Local air quality			

We also asked members of our advisory panel of experts to rank the factors in terms of importance and uncertainty. A survey was administered electronically to the pool of experts. The goal of this survey was to assess the first cut of factors by their importance (defined as the importance of the factor for the future of research and innovation in Norway) and uncertainty (degree to which there is uncertainty in the future direction of travel of the factor). The scoring scale for factors is shown in Table 3.

Table 3. Scoring scale for the expert scoring exercise

Score	Definition
Importance	
0	Not important to the future of research and innovation in Norway
1	Somewhat important to the future of research and innovation in Norway
2	Important to the future of research and innovation in Norway
3	Highly important to the future of research and innovation in Norway
Uncertainty	
0	There is no uncertainty in the future direction of travel
1	There is a small degree of uncertainty in the future direction of travel/development of this factor
2	There is some uncertainty in the future direction of travel/development of this factor
3	There is a high degree of uncertainty in the future direction of travel/development of this factor

Generate future projections

The projections – or potential directions of travel – for a factor are key components of the scenario development process. They illustrate the divergent future outcomes that could occur in different scenarios for a factor because of uncertainty in its future development. Starting from the evidence from the trend analysis, we identified the future direction of travel away from the current path. The future direction of travel was identified and described qualitatively. We sent out the projections/potential directions of travel to the senior advisory panel of experts in a survey. In the survey, we asked the experts to comment on the projections/potential directions of travel (to indicate whether they span the range of plausible future trajectories) and to indicate some of the potential key drivers that could influence the future direction of travel for each factor. An example of the projections exercise that was sent out to each expert is provided for the technology factors, in Table 14, in Annex B. The final set of critical factors and projections is presented in Table 15 for scenario set 1 and Table 16 for scenario set 2, both in Annex B.

Quantitative analysis to identify future scenarios

In the next stage, we undertook quantitative analysis to identify the scenarios for each scenario set. The quantitative analysis consisted of two parts. We first carried out a 'consistency analysis' across projections to ensure consistency of projections among the different factors. This formed the basis for identifying collections of factor projections that are consistent, and these formed the basis for the development of future projections. We also refined the projections and combined factors that were found to be highly correlated. A 'cluster analysis' was then used to identify bundles of consistent projections with different and distinct characteristics.

In the consistency analysis, we examined a matrix of projections for all factors, using a similar scoring matrix as in the cross-impact analysis. The consistency analysis was undertaken by core researchers within the study team. In the consistency analysis, the relationships between pairs of projections are scored quantitively. Every combination of a projection is given a score based on the degree to which one projection is consistent with another projection.[15] We assigned a 5 if the projections were totally consistent and a 1 if they were totally consistent. The scoring scale for the consistency analysis is provided in Table 4, below.

Table 4. Scoring scale for the consistency analysis

Score	Definition
5	Highly consistent
4	Consistent
3	Independent
2	Partially inconsistent
1	Highly inconsistent

Using the consistency scores as inputs, the cluster analysis was then be used to identify clusters of projections that consistently appear together. These helped form the basis of our scenario.

Produce scenario narratives of the future

Based on the consistency and cluster analysis, we built concise narratives around the projections for each scenario. The narrative was told from the perspective of the future (2040) and built on the factor projections and the trend analysis. The narratives aimed to provide a description of each scenario within the scenario set, situated in the context of broader societal developments and accounting for factors that are critical for the future evolution of the strategic areas. The narrative provides an indicative pathway as to how a future has been reached and is designed to provide sufficient information to 'test' the potential impact of indicative missions without being prescriptive.

To build scenarios of sufficient depth, we developed two future scenario sets, each with 4 scenarios that were based on a set of 15–20 prioritised critical factors. By having two sets of scenarios, each with a relatively large number of PESTLE factors, we maintained the detail required in the scenarios to support the examination – in a stakeholder workshop (see next chapter) – of meaningful missions/structural measures/policy actions for each of the strategic areas, while at the same time allowing the missions/structural measures/policy actions to be set against a broader landscape. With the two sets of scenarios, we were also able to more effectively deal with the relatively wide-ranging strategic areas of technology and digitalisation and cohesion and globalisation (and, to some extent, the green transition as well). These are very interconnected with different sectors, cut across the other strategic areas (and indeed other areas of R&I), and are interrelated with each other as well. The two scenario sets we developed encompassed:

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[15] The direction of influence of the projections is not important in this exercise. Some combinations of projections may not directly have an effect on one another, but can consistently appear in the same future.

- **Scenario set 1 (*Norway in a national context*):** The first scenario set broadly focuses on Norway in a national context, largely relating to the Norwegian domestic agenda. This scenario set encompasses health, welfare, education, work and skills, cohesion, and relevant aspects of technology and digitalisation, and it also covers some aspects related to the green transition (for example, in relation to the circular economy).

- **Scenario set 2 (*Norway in a global context*):** The second scenario set focuses on Norway in an international or global context, primarily relating to Norway's outward-facing role. It broadly covers themes related to climate, oceans, energy, transport, food, biodiversity, globalisation and relevant aspects of technology and digitalisation.

The scenario narratives for the two scenario sets are presented in Annex C.

4. Use scenarios as a tool to examine priority missions and structural measures

We used the scenarios, in an expert workshop setting, to examine and validate the indicative set of priority missions and to discuss potential structural measures. In this chapter, we discuss our approach to examining priority missions and structural measures in two online expert workshops in more detail.

Two online workshops were organised with 45 participants. The first workshop focused on scenario set 1 (Norway in a national context), and the second workshop focused on scenario set 2 (Norway in a global context). The workshops used a combination of breakout groups[16] and plenary sessions and were designed around the following main elements, each of which is discussed in turn below:

- Examine the scenarios in more detail;

- Explore the missions and structural measures in the context of the scenarios;

- Identify ideas for additional missions; and

- Use the output from the workshop.

Examine the scenarios in more detail

A Three Horizons (3H) model or framework was used to examine the scenarios in more detail. The 3H framework connects the present with desired or identified outcomes and is used as a tool to identify the different futures that can emerge as a result of the changes between the present and the future (Curry and Hodgson 2008). The horizons are as follows:

(i)   Horizon 1 indicates the current, prevailing system as it continues into the future, which changes over time as the external environment changes (Curry and Hodgson 2008). In Horizon 1, the current state of play is discussed and the current working assumptions and decisions that make out the present state are discussed (International Training Centre 2021).

(ii)   Horizon 2 indicates the intermediate state between the present and the future. It is a transition space, which is often unstable (Curry and Hodgson 2008). In Horizon 2, the focus is on identifying emerging changes that represent transformational shifts from the present to investigate the innovations that are visible in the present that create changes from the present to a future world (International Training Centre 2021).

(iii)   Horizon 3 represents the future of the system or environment that is being discussed (Curry and Hodgson 2008). This horizon focuses on identifying emerging changes that can represent transformational shifts from the present (International Training Centre 2021).

The 3H framework is illustrated in Figure 10, below.

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[16] Breakout groups were conducted in the online workspace Mural, which is a digital workspace for visual collaboration (https://www.mural.co/). Examples of the breakout rooms that were used in the breakouts are included in Annex D.

Figure 10. Illustration of the Three Horizons model
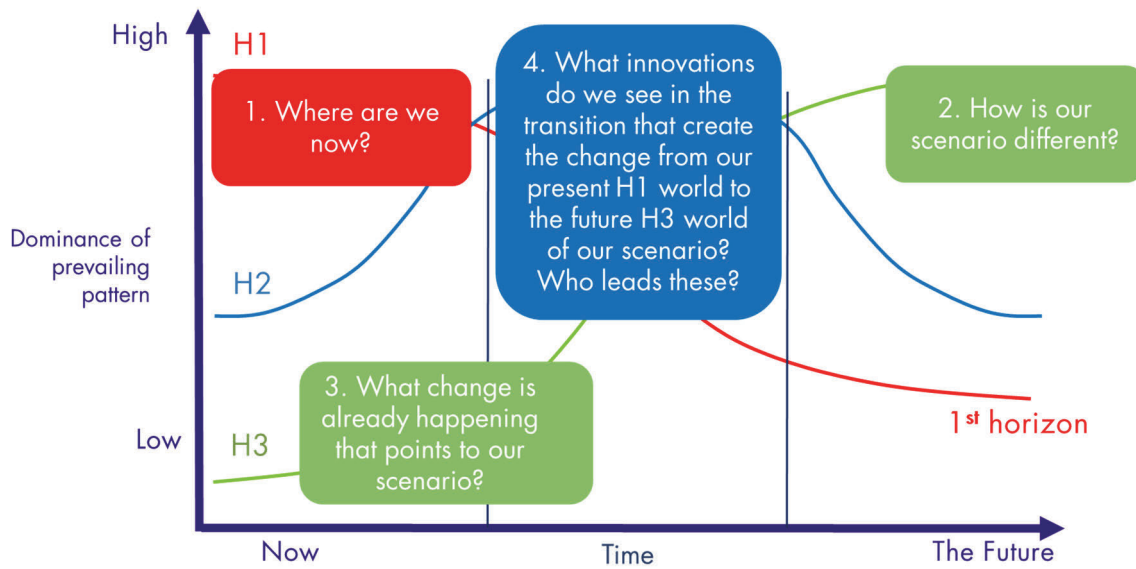
Source: Andrew Curry (2021)

Each breakout group was given a different scenario to consider. For each of the scenarios, participants were encouraged to think about: (i) how the future described in the scenario is different from where we are now; (ii) what changes occurring in the present indicate that we could be heading towards that future; and (iii) what new ideas and behaviours and social, economic and technological models we see in the transition between the present and the future. The purpose of this exercise was twofold. First, it familiarised participants with the different futures and the extent to which each is aligned or misaligned with the objectives across the strategic areas. Second, the discussions of innovations and other developments that occurred in the transition and created the change that led to each scenario provided insights into the potential roles that missions could play in supporting or mitigating the impact of these in order to achieve the strategic objectives. Key points of the discussions were reported back to the plenary session.

Explore the missions and structural measures in the context of the scenarios

In the second breakout exercise, each group was asked to consider a different set of 2–3 potential priority missions that had been developed by the study team. The participants from the groups in the first breakout exercise were split across different groups to create the groups in the second exercise. This enabled us to ensure that at least one participant from each of the groups in the first, scenarios-related breakout exercise to be present in a group in the second breakout exercise. This ensured that participants could bring insights and familiarity from the discussions of the different scenarios (from the previous exercise) to the discussions in the second breakout exercise. The exercise used an assumption-based planning (ABP) approach, which is described below.

ABP begins with examining strategic approaches or policy options in detail to identify their underlying assumptions, which may be explicit (directly stated) or implicit (unstated). Scenarios can then be used to help identify the key, 'load-bearing' assumptions, whose failure would cause the strategy to fail, and, as a further step, to identify how a strategy might be changed to reduce its likelihood of failing (hedging) or improve its likelihood of success (shaping). In the exercise, participants were asked to consider the

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assumptions underpinning the indicative missions and, additionally, the key stakeholders that would potentially be involved for a mission to be successfully implemented. To help identify the key assumptions, the participants were then asked to think about the risks and opportunities for the missions across the scenarios, drawing on the insights from the 3H discussions. This also provided insights for the study team on potential modifications to the missions that could be considered in order to improve their success.

To support the objective of the study of developing practical indicative missions that are relevant to the RCN's strategic area objectives, participants were asked about ideas for projects that could be implemented within the envelope of the mission and also to rank the missions in terms of their potential impact on the strategic area objectives and their feasibility to implement.

Identify ideas for additional missions

Having discussed how well the proposed missions might support the strategic area objectives in the context of the scenarios, for the third element of the workshop, participants were invited to present additional ideas for missions that could support the strategic areas objectives or indeed that cut across (or fall outside) these five areas. Structural measures that underpin the successful implementation of the missions were also discussed.

Use the output from the workshops

The workshop outputs were used to refine and further develop indicative missions that could be robust across different futures, as well as relevant to the strategic area objectives and feasible to implement. Although the two workshops focused on different scenario sets and explored different missions, they were run in an identical manner, so that the information relevant to the five strategic themes, as well as across all five, could be easily collated and combined.

5. Triangulate the evidence

In this chapter, we summarise our approach to the final phase of the research, in which we triangulated the evidence across the different phases of the study. Over the course of the study, the information collected in the three preceding phases – which were interlinked – was being regularly analysed as the research was being conducted. In the final phase of the research, we synthesised the evidence base across the different sources to identify key findings and themes. We further refined the main findings for each phase of the research (e.g. trends, enablers, barriers, uncertainties for the strategic areas) and articulated a series of overarching findings (e.g. the indicative priority missions and suggested structural measures), along with associated narratives. We also discussed the findings with the RCN (including the executive board) to seek their feedback. This input and feedback was incorporated into the final reports describing the findings of the research. In addition to this report on our methodological approach, we analysed and synthesised evidence for eight other reports[17]:

- Reports on the five strategic areas:

    o Health and welfare: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Gloinson et al. 2021a);

    o Green transition: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Skjoldager et al. 2021a);

    o Oceans: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Skjoldager et al. 2021b);

    o Cohesion and globalisation: An analysis of trends, future directions and potential missions to address societal challenges in Norway (Gloinson et al. 2021b); and

    o Technology and digitalisation: An analysis of trends, future directions and potential missions to address societal challenges in Norway (d'Angelo et al. 2021).

- A summary of potential cross-cutting missions to address future societal challenges in Norway (Gunashekar et al. 2021a)

- Structural measures to develop a resilient research and innovation environment in Norway (Skjoldager et al. 2021c)

- Addressing societal challenges in Norway: Key trends, future scenarios, missions and structural measures (Gunashekar et al. 2021b)

We summarise the final analysis and synthesis process for the different reports below.

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[17] All the reports were also reviewed by two independent reviewers as part of the internal quality assurance process.

Analysis of trends, future directions and potential missions to address societal challenges in Norway – the five strategic area reports

We synthesised and validated the evidence collected in the desk research carried out for each of the five strategic areas, the stakeholder interviews, the crowdsourcing exercise, the survey and the expert workshops. The results of each of the tasks were triangulated and validated against each other to form the basis for the development of inputs (and factors) for the scenario development in the second phase of the project. The results of these tasks also provided the basis for our development of the set of indicative priority missions and potential structural measures. To enable a rounded understanding and rigorous assessment of the evidence collected, we held internal study team discussions and discussed the findings with the RCN (and also presented and discussed the findings with the RCN executive board, in February and April 2021). We produced five final reports – one for each strategic area – which contained the final set of indicative priority missions for the respective strategic area, alongside detailed descriptions of the trends and scenario analyses.

A summary of potential cross-cutting missions to address future societal challenges in Norway

To identify additional priority missions that cut across (and/or fall outside) the five strategic areas, we drew on the trend analysis and scenario development phases of the study. Evidence from the tasks associated with these phases of the study were used to identify potential gaps. This evidence was supplemented and triangulated with the evidence from additional desk research and stakeholder interviews. We created a long-list of missions that cut across (and/or fall outside) the missions identified for the strategic areas; these were examined and validated in the expert workshops. These findings were further discussed in meetings with the RCN and the RCN executive board to ensure their usefulness to the Norwegian R&I context.

Structural measures to develop a resilient research and innovation environment in Norway

We employed the findings from the trend analyses (which included stakeholder interviews, desk research, expert crowdsourcing and the public survey) and the expert workshops to form a basis from which to identify structural measures and their relevance to Norway. The analysis in the first phases of the project was supplemented with evidence from additional interviews with international R&I experts and desk research. The structural measures were discussed in internal team meetings and with the RCN and the RCN executive board and were written up in a final report.

Addressing societal challenges in Norway: Key trends, future scenarios, missions and structural measures – the overarching summary report

We produced a final report containing the key takeaways of the analyses across the other reports. This report presented the main findings in relation to the five strategic areas (in terms of the key trends and indicative priority missions), the cross-cutting indicative missions, the proposed set of structural measures and the relevant aspects of the future scenarios that were used as the basis to examine the missions and structural measures.

6.   Caveats of the analysis

When reading and interpreting the analyses presented in the study, the reader needs to consider some caveats. The desk research we carried out for each of the phases of the study was not meant to be exhaustive; it did not cover all possible literature and did not necessarily capture all the details and the nuances of research and innovation in Norway. Our aim has been to provide an overview of the important background and context and to focus the analytical component of the research on R&I developments that will have the greatest impact on Norway in the future, particularly in the context of the five strategic areas outlined in the RCN's strategy document (Research Council of Norway 2020). At the beginning of the study, we ensured that we developed a robust and comprehensive understanding of the key areas of focus with regard to the five strategic areas. To facilitate this, we organised a workshop with the RCN (including key individuals associated with each strategic area) to help us develop a better understanding of the RCN's overall vision for the project in the context of the five strategic areas and potential priority missions and structural measures. In addition, we analysed the information contained in the relevant the RCN portfolio boards to better understand key focus areas (Research Council of Norway 2021).

The strategic area reports analyse the trends, future directions and potential missions regarding the five strategic areas (oceans, green transition, health and welfare, technology and digitalisation, and cohesion and globalisation). These are complex, wide-ranging areas that are rapidly evolving both in Norway and globally. We have had to keep the research focused on key important topics rather than aim for systematic coverage of all topics, in order to accomplish the objectives of the study. The areas of focus in each strategic area are not exhaustive. But because we adopted a participatory approach to the study, with the involvement of different stakeholders and methods to triangulate the evidence, we were able to cover a wide spectrum of important issues related to the strategic areas in Norway and globally. Furthermore, depending on the discussion in the literature and supported by interviewee inputs, where relevant in the analysis, we also considered the cross-cutting implications of the strategic areas on each other.

With regard to the interviews and focus groups, we employed a semi-structured protocol, and not all questions in the interview and focus group protocols were addressed to each interviewee or focus group. The interviews and focus groups were also split across different members of the study team, and therefore different styles may have been used. However, all members of the study team had a deep understanding of the primary objectives of the study and especially understood what information /insights needed to be obtained from the different interviews/focus groups. We also ensured that we covered a range of different perspective by interviewing individuals across academia, industry, the RCN, the third sector and government. We also mainly used the opinions and insights from the interviews to complement and further strengthen findings from the desk research.

Recruitment to the crowdsourcing exercise with experts relied on the RCN's networks and a selection of organisations that we identified through desk research and our own networks. The information provided in the crowdsourcing exercise was shaped by the expertise and opinions of the individuals who participated (anonymously). Therefore there may be other trends, barriers, enablers, uncertainties and policy challenges that could be learned from other stakeholders. However, the crowdsourcing exercise was not designed to be a core data collection exercise; rather, it served to complement the evidence that we had gathered through

the literature reviews and interviews. Furthermore, our mixed-methods approach to the overall study triangulated the evidence from a wide range of diverse methods to draw on the strengths of individual methods.

Although the survey of the public received more than 800 responses and had a fairly balanced representation across gender, age and the five strategic areas, it is important to highlight that the survey is not (and was not intended to be) representative of all views of the public in Norway and that some views may be over- or underrepresented. For example, the average age of respondents to the survey was 56. We published the survey on social media and contacted diverse organisations in Norway. Despite our attempt at obtaining representative results, those who have a better understanding of research and innovation in Norway may have been more likely to participate in the survey. Furthermore, the survey captures the perceptions of the public that are likely to be based on their personal experiences and opinions (rather than being an objective measure). The survey, nevertheless, provides an illustrative snapshot view of what a small segment of the Norwegian population perceived in relation to the five strategic areas and serves to validate some of the key findings of the research.

The scenario approach used in this study was designed to develop scenarios that are representative of the spectrum of possible futures, sensitise stakeholders to the range of futures that could occur and provide a useful tool for policy testing. It was not intended to provide forecasts of the future. To develop the scenarios, a set of key factors was identified, and scenarios were differentiated by the way these factors evolved in the future (their projections). Although the factor identification and the development of projections are as evidence based as possible, informed by desk research, interviews and surveys, expert judgement is a key part of the process in a future-focused study. To mitigate against potential biases this could introduce, the scenario approach followed a number of structured steps that used a scoring approach, so that they are transparent and reproducible (i.e. the cross-impact analysis, consistency analysis and cluster analysis described in Chapter 3). These were undertaken by the study team, supplemented by external advisers and experts to ensure that a range of relevant views were included. The scenario development process is essentially qualitative (cluster analysis aside), and the role of the factor projections was to provide a consistent 'skeleton' around which the scenario narratives were built, drawing on information and insights gathered from the evidence review and interviews.

Furthermore, the scenario implementation for this study was particularly complex given the need to consider five broad strategic areas. In order to provide sufficient depth in terms of factors considered, we developed two sets of scenarios (each containing four scenarios) that are consistent with each other (rather than, for example, developing five sets of scenarios, each containing one or two scenarios). Although the two sets were developed independently, some adjustments were made to factor projections after the cluster analysis to ensure that the two sets of scenarios were consistent. Having two (larger) sets of scenarios, rather than five (smaller) sets meant that we retained the depth and richness that we needed in terms of factors and were able to focus on two different aspects of the Norwegian economy and society (i.e. Norway in national and global contexts). With this approach, we were also able to effectively factor in the three overarching the RCN objectives, particularly public sector and business restructuring, in a more cohesive way and we are able to deal with the wide-ranging technology and digitalisation and cohesion and globalisation strategic areas (that themselves cut across the other strategic areas) in a more robust way.

Finally, the ideas for priority missions and structural measures that we have articulated are not intended to be definitive or exhaustive. Each mission and structural measure is proposed as an indicative idea based on the evidence that was collected during the research. The missions and structural measures were examined and validated at stakeholder workshops and further updated based on feedback received at the workshops and from the RCN and interviewees. The collection of missions and structural measures represent a broad spectrum of ideas for further consideration and exploration by the RCN – and other stakeholders that might be involved in the process – to implement any potential mission or structural measures in the future.

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Annex A. Materials and tools used in the first phase of the study

Box 1. Indicative search string used for document review

([strategic area]) AND (research OR innovation OR development) AND (barrier OR challenge OR weakness OR drawback OR criticism OR strength OR benefit OR enabler OR opportunit* OR driver OR factor) AND (future OR long-term OR prospect* OR anticipate*)

Box 2. Protocol used in the trend analyses interviews and focus groups and interviews with the Norwegian Ministries

Trends, direction of travel, enablers and barriers associated with the strategic area:

1. With regard to the current state of play of developments in [insert strategic area], what do you think are some of the main trends that we observe in Norway and Norwegian research and innovation system?
2. What are some of the main driving forces (enablers) for the [insert strategic area] and how are they driving progression? Why are these drivers important?
3. What are some of the potential barriers to development and growth within [insert strategic area], and how are they hindering progression?
4. What are some of the wider global developments in [insert strategic area]?

Trends and uncertainties that might influence the [insert strategic area] in ten years:

5. Looking forward a few years [5–10 years], what are some of the potential future trends in [insert strategic area]?
6. What are some of the implications of these developments in the future for Norwegian research and innovation, and for Norway more widely?
7. What are some of the desirable outcomes and developments that could happen in [insert strategic area]?
8. What would you worry about in terms of potential future outcomes and developments that could happen in [insert strategic area]?
9. What do you see as the biggest areas of uncertainty for the future in this strategic area?
10. Can you think of any events or types of events that would be unlikely to happen but would have a significant impact on [insert strategic area]?

Key policy challenges and solutions (missions and structural measures) associated with transforming the strategic area

11. What do you believe are some of the key policy challenges for the RCN associated with transforming [insert strategic area]?
12. What are some of the potential solutions associated with transforming the strategic area?
    a. What are some of the important policy actions to take in order to help bring about a desirable future in this strategic area and to reduce the chance of negative outcomes?
    b. Do you have any ideas regarding concrete, targeted and challenge-based 'missions' or priority actions that the RCN, together with other stakeholders, could consider – within or outside [insert strategic area], or across all five strategic areas?
    c. More generally, do you have any ideas for robust structural measures to help enable the development of a strong, resilient and inclusive R&I environment in Norway

Box 3. Interview protocol used to identify and validate structural measures

1. What structural measures are needed to facilitate the development of education and training to support the future skills needed for the Norwegian R&I system?
2. How should Norway work in terms of structuring their funding within the R&I system?
3. What are structural measures concerning facilitation of cooperation and networks that can strengthen the Norwegian R&I system?
4. How should Norway work in order to retrieve and use research-based knowledge to enhance the R&I system?
5. What structural measures can central governing institutions (or local government) implement in order to facilitate the future needs related to the five strategic areas?
6. How can technologies and digitalisation be leveraged to develop and/or strengthen structural measures for research and innovation?
o. What structural measures–related data utilisation and digitalisation can enable the development of a strong R&I environment in Norway?
7. Are there other structural measures relevant for Norway that might fall outside of the five strategic areas, but that still have relevance for strengthening a robust R&I system?

Table 5. Question used in the public survey

No.	Question
1	Enter your age in full years
2	Age
3	Which of the following areas interest you?
3.1	Oceans
3.2	Green Transition
3.3	Health and Welfare
3.4	Technology and Digitalisation
3.5	Cohesion and Globalisation
3.6	Other – please describe
4	Describe in a few sentences what comes to mind when you think about the future of Oceans (e.g. challenges, opportunities etc.).
5	Describe in a few sentences what comes to mind when you think about the future of Green Transition (e.g. challenges, opportunities, etc.).
6	Describe in a few sentences what comes to mind when you think about the future of Health and Welfare (e.g. challenges, opportunities, etc.).
7	Describe in a few sentences what comes to mind when you think about the future of Technology and Digitalisation (e.g. challenges, opportunities, etc.).
8	Describe in a few sentences what comes to mind when you think about the future of Cohesion and Globalisation (e.g. challenges, opportunities, etc.).
9	Where are you currently living?
10	Are you:
10.1	Female
10.2	Male
10.3	Other
10.4	Prefer not to say

Table 6. Template for the crowdsourcing exercise

Strategic area	Country of relevance	Trends	Enablers (please list 1-3 enablers)	Barriers (please list 1-3 barriers)	Uncertainties (please list 1-3 uncertainties)	Key R&I policy challenges that the RCN could act on, and potential solutions	Ideas for missions	Ideas for structural measures	Suggestions for materials to consult	Other comments
The strategic areas of relevance in the RCN strategy are: (i) oceans, (ii) green transition, (iii) health and welfare, (iv) technology and digitalisation, and (v) globalisation and cohesion. Please put 'other' for any other research or innovation area of interest that could be important to Norway.	Please put down the country (or countries) of relevance.	By trend, we mean discernible patterns of change over time (it would be helpful if you could list what you feel are the top 1–3 current and future trends, including the potential changes that might take place relative to the current situation).	By enablers, we mean the key factors that facilitate developments in the strategic area of interest.	By barriers, we mean the key factors that hinder developments in the strategic area of interest.	Please detail the key uncertainties related to the strategic area of interest/expertise.	Please detail the potential R&I policy challenges and solutions that might be important to the strategic area.	By missions, we mean systemic public policies that draw on frontier knowledge to attain specific goals. They provide a solution, an opportunity and an approach to address the numerous challenges that people face in their daily lives.	By structural measures, we mean those measures that address the performance of the Norwegian research and innovation system in terms of the objectives of the RCN for the next strategic period (2020–2024), namely (i) sustainable development, (ii) ground-breaking research and radical innovation, and (iii) restructuring of the business and public sectors.	Please detail any materials that would be relevant to consult.	Please use this column to comment on other rows and/or to provide any additional comments on your own example.

Annex B. Materials and tools used in the second phase of the study

Table 7. Long-list of PESTLE factors for the ocean strategic area

PESTLE	Ocean factors
Political	Political support for ocean R&D activities
Political	Demand for security measures in maritime sectors
Political	Level of global environmental cooperation
Political	International trade barriers
Economic	Access to private capital in aquaculture
Economic	Access to qualified labour
Economic	Global economic development
Social	Demand for zero-emissions solutions
Social	Diffusion of knowledge and capabilities from offshore industries
Social	Collaboration between public and private actors in Norway for ocean innovation
Social	Global public opinion on the use of fossil fuels
Social	Governmental attitudes towards issues in maritime ecosystems
Social	Demand for healthy nutrition
Social	Social acceptance of aquaculture
Technological	Streamlining of data sources across regions and sectors
Technological	Yield of maritime food production
Technological	Investments in technology to develop extraction of oil
Legal	Regulatory frameworks to support the competitiveness of Norwegian maritime industries
Legal	International regulations for maritime industries
Environmental	Access to sustainable feed for aquaculture
Environmental	Emerging diseases
Environmental	CO_2 emissions from oil-based products
Environmental	Impact of climate change on ocean temperature

Note: We developed concise descriptions of all the factors.

Table 8. Long-list of PESTLE factors for the green transition strategic area

PESTLE	Green transition factors
Economic	European demand for circular products
Economic	Price of green energy
Economic	Demand for natural resources
Economic	Domestic material consumption behaviour
Economic	Primary energy consumption
Economic	Incentive scheme for scientists
Environmental	Climate and environmental risks
Environmental	Speed of environmental consequences
Legal	International binding climate targets
Political	Green public procurement
Political	Political prioritisation of the green transition
Political	Political instability in partner countries
Political/Legal	Policy and regulatory frameworks that support circular systems
Social	Consumers' knowledge of impact from climate change
Social	Social willingness to change behaviour
Social	Company culture to support the green transition
Social	National public opinion on the use of fossil fuels
Technological	Infrastructure for energy, water, waste supply
Technological	Speed of technological development
Technological	Digital knowledge and infrastructure
Technological	Data quality for monitoring the green transition

Note: We developed concise descriptions of all the factors.

Table 9. Long-list of PESTLE factors for the health and welfare strategic area

PESTLE	Health and welfare factors
Political	Regional innovation strategies and the impact on local innovation initiatives in health and welfare
Political	Centralisation of health and welfare service delivery
Political	Medicine nationalism
Social	Collaboration and interdisciplinarity in research
Social	Public health promotion activities
Political	Norwegian participation in international cooperation in health policy
Political	Segmentation of the health and welfare sector
Economic	Payroll contributions to health and welfare services
Economic	Spending on prevention
Economic	Private household out-of-pocket health expenditure
Economic	Private sector health expenditure
Economic	Public sector health expenditure
Economic	Funding for the health and life science industry
Social	Demand for healthcare services
Social	Training of health professionals
Social	Access to health and welfare services
Social	Mental health disorders in adults, children and young people
Social	Public trust in health and welfare R&I and institutions
Social	Activation of social and community support to facilitate self-management
Technological	Rapid innovation and uptake of information and communication technology (ICT)
Technological	Rapid innovation and uptake of biotechnology
Technological	Automation of health and welfare services
Technological	Rapid innovation in nanotechnology
Technological	Digitalisation and use of health data
Technological	Development and adoption of routine telemedicine and telecare
Legal	Safety, privacy and data security regulations
Environmental	Antimicrobial resistance
Environmental	Air pollution
Environmental	Rising temperatures and adverse impacts on health
Environmental	Energy usage and waste in hospitals and healthcare services

Note: We developed concise descriptions of all the factors.

Table 10. Long-list of PESTLE factors for the technology and digitalisation strategic area

PESTLE	Technology and digitalisation factors
Political	The free flow of data and digital services
Economic	Funding and continuity of funding
Economic	Impact frameworks and indicators
Social	Ageing population
Social	Public trust in science and technology
Social	Digital skills and inclusion
Social	Awareness and uptake of responsible research and innovation (RRI) among the scientific community
Social	Availability and access to high-quality public data
Technological	The computing and energy cost of using big datasets
Technological	Processing capacity of computers
Technological	Digital infrastructure
Technological	Developments in bioinformatics
Technological	Developments in synthetic biology
Technological	New knowledge within the other science and technology areas
Technological	Technology convergence
Technological	Access to high-performance computing
Technological	Digital security and privacy protection
Social	Public attitudes to digital security and privacy
Economic	Industrial upscaling and standardisation of production
Technological	Use cases for adoption of artificial intelligence and machine learning
Legal	Regulation
Legal	Intellectual property system
Environmental	Climate change and environmental impacts
Environmental	Norway's extended coastline
Environmental	Risk of harm to the environment

Note: We developed concise descriptions of all the factors.

Table 11. Long-list of PESTLE factors for the globalisation and cohesion strategic area – globalisation factors

PESTLE	Globalisation factors
Political	Globalisation
Political	Cooperation with the European Union and the European Economic Area
Political	External interference in Norwegian domestic policy
Political	Great power rivalry
Political	Close security relationships with major powers
Political	Norway's role in multilateral institutions
Political	International development contributions
Political	Bipartisan political support for international development commitments
Economic	Internationally trading Norwegian companies
Economic	Global trade intensity
Economic	Trade openness
Economic	Exchange rates for the Norwegian krone (NOK)
Social	Immigration
Social	Emigration
Social	International terrorism
Social	A changing media picture
Social	Ability to respond to pandemics and other unexpected events
Social	Global respect for international human rights
Technological	Digital threats in Norway

Note: We developed concise descriptions of all the factors.

Table 12. Long-list of PESTLE factors for the globalisation and cohesion strategic area – cohesion factors

PESTLE	Cohesion factors
Political	Unionisation
Political	Innovation and renewal in the public sector
Political	Coordination between local and national government
Economic	Labour force participation
Economic	Returns from natural resource wealth
Economic	Business regulation that facilitates transparent and accountable company operations
Economic	Income inequality
Economic	Tax levels
Economic	Public sector funding for research in the social sciences and humanities
Economic	GDP
Economic	Levels of inflation
Social	Perception of immigration
Social	Integration of low-skilled migrants into labour market
Social	Discrimination
Social	Far-right extremism
Social	Poverty-related problems
Social	Trust in public institutions
Social	Private–public partnerships
Social	Education level in workforce
Social	Education spending
Social	Ageing population
Social	Participation of socially and culturally diverse groups
Social	Levels of crime
Social	Polarisation of the public debate
Technological	Internet and smartphone usage
Technological	Technology adoption
Technological	Automation

Note: We developed concise descriptions of all the factors.

Table 13. Draft PESTLE factors identified for the two broad scenario sets

Scenario set 1		Scenario set 2		
Health and welfare	**Cohesion**	**Green transition**	**Oceans**	**Globalisation**
Demand for healthcare services Access to health and welfare services Health and welfare service delivery by different levels of government Interdisciplinary work between health and welfare Public and private sector spending on health provision Private household health cost Public health promotion/prevention activities Development and adoption of routine telemedicine and telecare Medicine nationalism Resilience in health systems	Labour force participation Unionisation Integration of low-skilled migrants into labour market Inequality Access to education for different demographics Discrimination and hate speech Levels of crime Trust in national government Social and cultural diversity The changing media picture and mobilisation of opinion	Demand and support for circular products and the green transition Primary energy consumption Domestic material consumption behaviour Green public procurement (circular) Infrastructure for energy, water, waste supply Public attitudes to sustainability Energy usage and waste National adaptation to environmental and climate change Local, small-scale initiatives Sustainable food production Take-up of low-emissions transport	Diffusion of knowledge and capabilities from offshore industries Investments/innovations to reduce emissions from oil extraction and products Demand for sustainable aquaculture Sustainable aquaculture Emerging diseases in aquaculture	Norway's trade linkages with other countries Norwegian cooperation with EU/EEA Norway's role in multilateral institutions Management of and access to resources in the Arctic and High North Norway's international development (ODA) contributions International progress towards climate targets International regulations for maritime industries Make-up of geopolitical landscape Terrorism
Factors across both scenario sets				
Environment	**Broad cross-cutting factors**	**Technology and digitalisation**		**Research and innovation**
Pandemics and other unexpected events Speed of environmental impact (of climate change) Local air quality	Net immigration Norwegian GDP Exchange rate for Norwegian krone Natural resource wealth Employment and housing locations Skilled labour availability Transport accessibility	Digital infrastructure Digital inclusion and competence Digital security and privacy protection Attitudes to data sharing Application of AI and ML Application of biotechnology Application of nanotechnology Application of autonomous systems and advanced manufacturing technologies Availability and access to high-quality public data Computing and energy cost of data and technology Technology convergence		Globalisation of R&I Continuity and flexibility of R&I funding Awareness and uptake of responsible research and innovation Impact frameworks and indicators Advance in scientific knowledge Appetite for innovation Structure of R&I sector

Table 14. Example of survey exercise for the projections/potential directions of travel for the prioritised critical factors

Theme	No.	Factor	Definition	What could the ten-year projection look like for the factor?	1. Projections exercise	
					Please provide comments on the suggested projections	Key drivers
Technology	10	Digital infrastructure	Refers to the degree of digital knowledge in Norwegian industries regarding the use of digital tools, the research in new digital solutions and the necessary digital infrastructure (such as cloud, software, hardware and the processing capacity of computers, etc.) (Ministry of Climate and the Environment 2020a).	Digital infrastructure conducive to developments in research and innovation Digital infrastructure is not conducive to developments in research and innovation		
	11	Digital inclusion and competence	Refers to the digital skills required by the population to participate in the digital economy (OECD 2017).	Digital inclusion and competence increase across the Norwegian population There is no change in digital inclusion and competence in Norway Digital inclusion and competence decrease across the Norwegian population		
	12	Digital security and privacy protection	This refers to cyber-security and data protection challenges raised by an increasingly digital and data-dependent economy and society. Digital security incidents appear to be increasing in terms of sophistication, frequency and influence (OECD 2020b)	Digital security threats increase in Norway, demanding increasing privacy protection Digital security threats remain the same in Norway, demanding the same level of privacy protection Digital security threats decrease in Norway		
	13	Attitudes to data sharing	This refers to the public's level attitudes to data sharing, including their perceptions to the ethics of data sharing, digital security and privacy.	High concern around data sharing Moderate concern around data sharing Low concern around data sharing		
	14	Application of artificial intelligence (AI), machine learning (ML), and big-data analytics	Refers to the use of these technologies to process and analyse large datasets. AI and ML are modes of data analysis that allow computers to identify patterns and relationships through mathematical algorithms (European Commission 2021).	Increased application of AI, ML and big-data analytics No change in the application of AI, ML and big-data analytics Decrease in the application of AI, ML, and big-data analytics		

Theme	No.	Factor	Definition	What could the ten-year projection look like for the factor?	1. Projections exercise	
					Please provide comments on the suggested projections	Key drivers
	15	Application of biotechnology	Refers to the application of biotechnology in Norway, defined as the application of science and technology 'to living organisms as well as to parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services' (Ministry of Education and Research 2011).	Increased application of biotechnology No change in the application of biotechnology Decrease in the application of biotechnology		
	16	Application of nanotechnology	Refers to the application of nanotechnology in Norway, defined as chemical bonding; molecular and atomic phenomena in chemistry and physics; and the building blocks and key components of biological macromolecules and structures that support gene technology, cellular biology and neuro-informatics (Research Council of Norway 2006).	Increased application of nanotechnology No change in the application of nanotechnology Decrease in the application of nanotechnology		
	17	Application of autonomous systems and advanced manufacturing technologies	Refers to the application of autonomous systems, including robotics, and advanced manufacturing technologies in Norway. Autonomous devices and systems comprise systems and devices that can properly understand and perceive their environment, translate this into action that is meaningful, and then perform these actions without human interference. Advanced manufacturing technologies comprises computer-controlled or micro-electronics-based equipment used to design, manufacture or process a product (European Commission 2021).	Increase in the application of autonomous systems Increase in the application of advanced manufacturing technologies No change in the application of autonomous systems No change in the application of advanced manufacturing technologies Decrease in the application of autonomous systems Decrease in the application of advanced manufacturing technologies		
	18	Availability of and access to high-quality public data	This refers to the volume of availability and access to public data that is generated by multiple sources (e.g. consumers, research) that is available in the world. This is in part facilitated by cross-border data sharing (Ministry of Education and Research 2018).	Fast growth in the volume and availability of high-quality public data Moderate growth in the volume and availability of high-quality public data Slow growth in the volume and availability of high-quality public data		

Theme	No.	Factor	Definition	What could the ten-year projection look like for the factor?	1. Projections exercise	
					Please provide comments on the suggested projections	Key drivers
				No growth in the volume and availability of high-quality public data		
	19	Computing and energy cost of data and technology	Refers to the computing and energy costs of using datasets and technology. The demand for data-driven Internet technologies and the increasing use of large amounts of data could lead to an increase in energy use and require storage in data centres that use electricity (Jones 2018).	Increased computing and energy costs No change in computing and energy costs Decreased computing and energy costs		
	20	Technology convergence	This refers to the increasingly complex convergence of enabling technologies, such as nanotechnology, biotechnology and digital technologies. Convergence involves the combination of different technologies, in particular biotechnology, with the increasing 'digitalisation' of technologies, e.g. the combination of biology with computer sciences (Åström et al. 2017).	Increased technology convergence No change in technology convergence Decreased technology convergence		

Table 15. Final list critical factors scenario set 1 (Norway in a national context)

Factor	Definition	Projections
Demand for healthcare services (volume and complexity)	Pertains to the population's demand for healthcare in Norway and for different health and care services. This can be influenced by changing healthcare needs, with the ageing population leading to demands for longer-term care and to changes in demand that result from climate change (which affects local air quality) and pandemics (European Commission 2019).	Demand for healthcare increases and healthcare becomes more complex Demand for healthcare remains as now Decreased demand for healthcare
Access to health and welfare services	Refers to the Norwegian welfare state's overarching goal to ensure universal coverage of welfare services, such as health and welfare services. All Norwegian citizens are supposed to have basic access to welfare services independently of their born characteristics, social status, gender, age, sexual orientation, ethnicity, place of residence, role in the labour market or social status (Ministry of Health and Care Services 2018). This access is partially determined by the private health expenditures of households and the health and welfare infrastructure that is in place across municipalities.	Increased access to health and welfare services No change in access to health and welfare services Decreased access to health and welfare services
Interdisciplinary work between health and welfare	Pertains to the health and welfare research funded and performed in and across universities, industry and hospitals. It includes the incorporation of social sciences and technological and engineering sciences in health and welfare research (OECD 2020a).	Successful interdisciplinarity and collaboration – both nationally and internationally – lead to fruitful alliances Interdisciplinarity and collaboration are inconsequential, with little progress made Lack of interdisciplinarity and collaboration, deliberately or otherwise
Development and adoption of routine telemedicine and telecare	*Telemedicine* refers to the remote provision of clinical health services, such as doctor–patient consultation, whereas *telecare* describes remote monitoring of patients to enable them to manage their condition(s) in the community (Kaufman 2017). *Telehealth* is a broader term that encapsulates both telemedicine and telecare, as well as the use of technology to support associated non-clinical services, such as continuing medical education (Kaufman 2017).	Telehealth becomes the default option for health and welfare Telehealth becomes the norm for certain services in certain areas and with certain patient groups Norway's health and welfare sector reverts to their pre-COVID application of telehealth
Discrimination and hate speech	Refers to the unequal treatment or hate speech towards certain population groups based on their gender, pregnancy, leave in connection with childbirth or adoption, care responsibilities, religion, belief, ethnicity, disability, sexual orientation, gender identity, gender expression, age or other significant characteristics of a person. Equality pertains to equal status, opportunities and rights, and it presupposes accessibility and accommodation (NIM 2019; Ministry of Culture 2020).	Increase in hate speech and discrimination Incidence of hate speech and discrimination remains the same Decline in hate speech and discrimination
Trust in public institutions	Pertains to the level of trust in government institutions – particularly political institutions – in Norway as measured by high levels of integrity, fairness and openness of institutions, and the	Trust in public institutions increases There is no change in trust in public institutions

Factor	Definition	Projections
	responsiveness and reliability of governments to deliver public services and anticipate new needs ((Hein et al. 2020; Eurostat 2018; OECD 2020c)	Trust in public institutions decreases
The changing media picture and mobilisation of opinion	Pertains to the degree to which social media platforms and the algorithms they use shape the news that people read and their behaviour online and can contribute to the spread of disinformation (Devaux et al. 2019).	Social media platforms and algorithms are increasingly used as sources of information and contribute to the spread of disinformation Social media platforms and algorithms are increasingly used as sources of information, but have little impact on the spread of disinformation Social media platforms and algorithms are used at the same level, with no change in impact on the spread on disinformation
Net immigration	Pertains to the levels of immigration into Norway ((Slettebak 2020; Statistics Norway 2020)	Increase in immigration into Norway Level of immigration into Norway remains the same. Decrease in immigration into Norway
Natural resource wealth	Pertains to the share of Norway's gross national income (GNI) that comes from natural resources, including minerals, oil and gas, compared with wealth accumulated from sustainable sources, such as water and wind power (Norwegian Petroleum 2020).	Norway's wealth from natural resources increases as a share of Norway's GNI Norway's wealth from sustainable sources increases as a share of Norway's GNI There is no change in natural resource wealth as a share of Norway's GNI
Location of jobs and housing	Pertains to where people live and work, as this will be relevant for how and how much they travel, density of living, ease of implementing circular systems, access to healthcare, etc.	Continued trend for jobs to be concentrated in large cities, particularly Oslo and Bergen New housing developments located in transport-friendly locations More dispersion across smaller cities and towns (with mixed transport links) Jobs and housing demand more dispersed
Skilled labour availability	Pertains to the availability of skilled labour in the labour market in Norway and the degree to which it meets employment demand (OECD 2019).	The availability of skilled labour increases in Norway There is no change in the availability of skilled labour in Norway The availability of skilled labour decreases in Norway
Digital skills	Refers to the digital skills required by the population to participate in the digital economy and the reduction in the digital divide(OECD 2017). The digital divide pertains to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies, and their use of the Internet for a wide variety of activities.	Digital skills increase across the Norwegian population and the digital divide decreases There is no change in digital skills and the digital divide in Norway The digital divide increases across the Norwegian population
Digital security and privacy protection	This refers to cyber-security and data protection challenges raised by an increasingly digital and data-dependent economy and society. Digital security incidents appear to be increasing in terms of sophistication, frequency and influence(OECD 2020c).	Digital and cyber-security threats increase in Norway, demanding increasing privacy protection. Norway is unable to respond

Factor	Definition	Projections
		Digital and cyber-security threats decrease in Norway as Norway is better able to respond
Data sharing	This refers to the data sharing at national, regional and international levels.	Reduced data sharing Moderate data sharing Increased data sharing
Technology convergence	This refers to the increasingly complex convergence of enabling technologies, such as nanotechnology, biotechnology and digital technologies. Convergence involves the combination of different technologies, in particular biotechnology, with the increasing 'digitalisation' of technologies, e.g. the combination of biology with computer sciences (Åström et al. 2017).	Increased technology convergence and application of enabling technologies No change in technology convergence and the application of enabling technologies Reduced technology convergence and application of enabling technologies
Globalisation of R&I (international collaboration and data sharing)	Pertains to international collaboration and data sharing for the globalisation of research and innovation, including the streamlining of data sources across regions and sectors, international researcher mobility, and sharing of private data (Directorate-General for Research and Innovation 2015).	Increase in international collaboration and data sharing for R&I (open and distributed) No change in international collaboration and data sharing for R&I (increased, but fragmented) Decrease in international collaboration and data sharing for R&I
Structure of R&I sector (share of public/private)	Pertains to the funding of the R&I sector, including the division of funding between the public and private sector.	Funding for R&I in Norway is sufficient and continuous for different actors (private/public) in the R&I sector Funding R&I becomes more fragmented Funding in the R&I sector decreases

Table 16. Final list critical factors scenario set 2 (Norway in a global context)

Factor	Definition	Projections
Demand and support for circular products and the green transition	Refers to the demand for products that are produced in line with a circular system or to promote a circular economy or the green transition at a company, regional, national, European and global level that can facilitate Norwegian solutions (Ministry of Climate and the Environment 2020b; European Commission 2019; Ministry of Climate and the Environment 2020a). At a company level, this is related to areas of supply chains and procurement, as well as daily offers to employees, such as bottled water or vegetarian lunches (Kirchherr et al. 2017; INT-GT-4).	The market demands an increased share of circular products and the green transition No change in the product demand for the circular economy and the green transition Reduced demand for circular products and the green transition
(circular) Infrastructure for energy, water, waste supply	Pertains to governmental and other (local community and private sector) initiatives to develop and implement circular economy based tools, resources and services for environmental and climate adaptation (Nordgren, Stults, and Meerow 2016).	Circular initiatives (across a range of sectors) develop rapidly and are implemented at national, regional and local levels across Norway There is rapid development in circular initiatives, but implementation remains localised Circular economy efforts remain

Factor	Definition	Projections
		focused on current approaches to water/energy and waste
Investments/innovations to reduce emissions from oil extraction and products	Refers to a reduction in ongoing and new field development projects in oil and gas in Norway ((Norwegian Petroleum 2020). Also captures innovations to reduce emissions from oil extraction and products, such as innovations that lead to declining growth in the resources and size of offshore discoveries, as well as innovations in alternative energy sources, such as hydro-power (Mikkelsen et al. 2004).	Increase in investments or innovations to reduce emissions from oil extraction and products in Norway Investments or innovations to reduce emissions from oil extraction and products remain stable in Norway Decrease in investments or innovations to reduce emissions from oil extraction and products in Norway
Sustainable aquaculture	Pertains to the use of sustainable aquaculture in Norway and globally, including an increase in the yield of maritime production (Norsk Industri 2017), sustainable fish feed for Norwegian aquaculture (Ernst & Young 2019), and the sustainable use of Norway's long and complex coastline.(Ministry of Education and Research 2019; Stévant et al. 2017)	Expanded aquaculture sector with increased share of sustainable farming Expanded aquaculture sector but no increase in share of sustainable farming Little expansion in aquaculture sector
Norway's trade linkages with other countries	Pertains to Norway's trade in goods and services with other countries. Trade openness can be calculated by dividing the sum of exports and imports by GDP (Eurofund 2019).	Increase in Norwegian trade linkages with other countries No change in Norwegian trade linkages with other countries Decrease in Norwegian trade linkages with other countries
Norwegian cooperation with EU/EEA	Pertains to Norway's cooperation and integration with the European Union and the European economic area on such issues as trade, immigration, foreign policy issues, justice and home affairs, and the European single market (Research Council of Norway 2020b).	Increase in Norwegian cooperation with the EU/EEA Norwegian cooperation with the EU/EEA remains stable Decrease in Norwegian cooperation with the EU/EEA
Norwegian shipping industry	Pertains to Norway's role in the international shipping industry and the extent to which there is a greening of the international shipping industry.	Greening of international shipping industry is extensive Greening of the shipping industry increases Greening of the shipping industry continues as now
Make-up of geopolitical landscape	Refers to the make-up of the geopolitical landscape, including competition between geopolitical powers and the levels of political stability in Norway's partner countries (Research Council of Norway 2020b; Froggatt et al. 2020).	The geopolitical landscape becomes more stable, with greater cooperation with and stability in Norway's partner countries There is no change in the stability of the geopolitical landscape The geopolitical landscape becomes less stable, with less cooperation with and stability in Norway's partner countries

Factor	Definition	Projections
Speed of environmental impact (of climate change)	Refers to the speed of which the environment changes due to climate change and the varied potential impacts of environmental change. This refers to ocean temperature, extreme weather and the attitudes of the Norwegian public to climate change and climate change mitigation, etc. (Aalst 2006; Sygna et al. 2004; INT-GT-4)	Environmental changes are happening quickly, with wide-ranging impacts as Norway is unable to respond Environmental changes are happening slowly, with few impacts as Norway is able to respond
Natural resource wealth	Pertains to the share of Norway's GNI that comes from natural resources, including minerals, oil and gas, compared with wealth accumulated from sustainable sources, such as water and wind power ((Norwegian Petroleum 2020). It also captures primary energy consumption at a global level.	Greening of the international shipping industry is extensive Greening of the shipping industry increases Greening of the shipping industry continues as now
Skilled labour availability (to match employment demand)	Pertains to the availability of skilled labour in the labour market in Norway and the degree to which it meets employment demand (OECD 2019).	The availability of skilled labour increases in Norway There is no change in the availability of skilled labour in Norway The availability of skilled labour decreases in Norway
Technology convergence	This refers to the increasingly complex convergence of enabling technologies, such as nanotechnology, biotechnology and digital technologies. Convergence involves the combination of different technologies, in particular biotechnology, with the increasing 'digitalisation' of technologies, e.g. the combination of biology with computer sciences (Åström et al. 2017).	Increased technology convergence and application of enabling technologies No change in technology convergence and the application of enabling technologies Reduced technology convergence and application of enabling technologies
Globalisation of R&I (international collaboration and data sharing)	Pertains to international collaboration and data sharing for the globalisation of research and innovation, including the streamlining of data sources across regions and sectors, international researcher mobility and sharing of private data (Directorate-General for Research and Innovation 2015).	Increasing international collaboration and data sharing for R&I (open and distributed) No change in international collaboration and data sharing for R&I (increased, but fragmented) Decrease in international collaboration and data sharing for R&I
Structure of R&I sector (share of public/private)	Pertains to the funding of the R&I sector, including the share of funding between the public and private sector	Funding for R&I in Norway is sufficient and continuous for different actors (private/public) in the R&I sector Funding R&I becomes more fragmented Funding in the R&I sector decreases

Annex C. Future scenario narratives

C.1. Scenario set 1: Norway in a national context

The following set of four distinct future scenarios were discussed at a stakeholder workshop organised on Tuesday, 23 March 2021. Below we show a table containing the key characteristics and underpinning factors of the four scenarios. We then present more detailed one-page narratives of the scenarios that were developed to support the futures analysis for this study. The scenarios were used during the workshop to examine a series of priority missions and structural measures that were under consideration in this study.

This scenario set broadly focuses on Norway in a national context, largely relating to the Norwegian domestic agenda. This scenario set encompasses such themes as health, welfare, education, work and skills, cohesion, and relevant aspects of technology and digitalisation, and it also covers some aspects related to green transition (for example, in relation to the circular economy).

Figure 11. Key characteristics and underpinning factors of the scenarios

Category	Factor	Protectionist decline	Going green together	Slowly changing society	Technological trajectory
Health and welfare	Demand and access to health and welfare services	↔	↑	↔	↔
	Collaboration and interdisciplinarity	↓	↑	↔	↑
	Development and adoption of telemedicine and telecare	↔	↑	↔	↑
Economy and society	Discrimination and hate speech	↑	↓	↑	↔
	Use of social media to spread disinformation	Increasingly used, with impact on the spread of misinformation	Increasingly used, but little impact on misinformation	Increasingly used, with impact on the spread of misinformation	Increasingly used, with impact on the spread of misinformation
	Trust in public administration	↓	↑	↔	↔
	Net immigration	↔	↓	↔	↔
	Natural resource wealth	Slow growth or stagnation	Steady growth, with greater share from sustainable sources	Steady growth, but no change in share from sustainable sources	Steady growth, but no change in share from sustainable sources
Location of jobs and housing and greening initiatives	Skilled labour availability to match employment demand	↓	↑	↔	↑
	Location of jobs and housing	More dispersion with mixed transport links	Continued trend for jobs to be located in large cities and transport-friendly locations	Continued trend for jobs to be located in large cities and transport-friendly locations	More dispersion with mixed transport links
	Ability of Norway to adapt to environmental change	↔	↑	↔	↑
	Circular infrastructure for energy, water and waste supply	Focussed on current approaches	Develop rapidly and are implemented at national, regional and local levels	Rapid development, but implementation is localised	Rapid development, but implementation is localised
Technology, digital skills and digital threats	Digital skills	Digital divide increases	Digital skills increase, digital divide decreases	Digital skills and digital divide remains as now	Digital divide increases
	Digital security and cyber security protection	Norway is unable to respond, digital and cyber security threats demand increase protection	Norway is better able to respond, decreasing digital and cyber security threats	Norway is unable to respond, digital and cyber security threats demand increase protection	Norway is better able to respond, decreasing digital and cyber security threats
	Data sharing	↓	↑	↑	↑
	Technology convergence and use of enabling technologies	↓	↑	↔	↑
Research and innovation	Globalisation of research and innovation and data sharing	Decrease in international data sharing and collaboration	Increasing international data sharing and collaboration (open and distributed)	Increasing international collaboration and data sharing (closed)	Increasing international data sharing and collaboration (open and distributed)
	Funding for research and innovation	Decreases	Sufficient and continuous for different actors	Fragmentation	Sufficient and continuous for different actors

Source: Study team analysis

Scenario 1: Protectionist decline

Global developments

Shifts in geopolitical power in the 2020s led to a period of political instability over the next decade with serious implications for global trade. Struggling to maintain supply chains, countries increasingly put pressure on locally based companies to serve their needs first. Many countries have adopted a protectionist approach, increasingly looking inwards to protect their own populations. As a result, Norway has become increasingly dependent on primary exports. Even within the EU, which initially sought to maintain a united front, there are divergent views on how to tackle current problems of climate change and stagnant economic growth.

Health and welfare in Norway

The delivery of health and welfare in Norway has also been affected by protectionism. Unable to make proper use of collaboration and imports of medical equipment from other countries, the Norwegian government has struggled to use technology and innovation to meet the complex health needs of the Norwegian population. However, there has been increased national spending on the healthcare sector in terms of research and training, as well as frontline delivery, although medical and care services have not been linked up. Approaches to complex health needs related to an overall increase in life expectancy, population ageing and immigration are largely reactive, with limited capability in preventative strategies. Protectionism presents a significant impediment to pharma and life sciences, hindering the development of industries that thrive on collaboration and sharing.

Societal and economic development

With the slowdown in sovereign wealth fund growth and unpredictability in global markets, Norwegian business and consumer confidence is low. At the same time, the ageing population in Norway has increased spending on social services and pensions. Norway has continued to accept some migrants from countries affected by instability or the effects of climate change, from a pragmatic perspective – to not make the current international situation worse – and to meet some of its labour shortages. However, reduced cooperation with the EU means that skilled labour is generally in short supply. Despite increased growth in some sectors, such as domestic food production, overall productivity growth and labour force participation are low and trust in public institutions is declining. Stagnant economic growth has also reduced much-needed investment in a digital infrastructure that facilitates data sharing, adequately deals with cyber and privacy protection threats, and helps increase the digital skills of the Norwegian population. There is a lack of transnational cooperation of social media, and social media continues to be used extensively to influence public debate on immigrants, spread hate speech and polarise Norwegian society.

The location of jobs and housing and greening initiatives

With limited employment opportunities in urban areas, where the effect of increasing temperatures is also more apparent, Norwegians are dispersing across smaller cities and towns. However, this dispersal is limited by a lack of investment in public transport and digital connectivity. The decrease in urbanisation has positive impacts on health outcomes of populations, with less traffic and pollution. Recent investments have also improved access to health and welfare services across different geographical locations in Norway, although research and training still tends to be city based. There have been some successes in greening domestic energy and linking up waste and energy across the public sector, but the circular economy is not seen as the way forward by politicians or citizens.

Research and innovation

Overall, funding in the R&I sector has reduced, and it is fragmented due to general mistrust of the government and international actors. Norwegian actors are finding it difficult to compete in the world market. These issues are further amplified by the absence of coordination and collaboration across stakeholders in the R&I system in a national and international arena, as well as limited data sharing. Furthermore, the lack of relevant competencies in the labour market required for meeting current and future demands of the sector has created longer-term challenges. In Norway, the absence of infrastructure and funding to support partnerships, combined with restrictions on data access and sharing, has prevented Norway from leveraging and capitalising on the data economy and on the digitalisation trends in the health, pharma and life sciences.

Health and welfare	
Demand and access to health and welfare services	↔
Collaboration and interdisciplinarity	⬇
Development and adoption of telemedicine and telecare	↔

Economy and society	
Discrimination and hate speech	⬆
Use of social media to spread disinformation – increasingly used with impact on the spread of misinformation	
Trust in public administration	⬇
Net immigration	↔
Natural resource wealth – slow growth or stagnation in the economy	

Location of jobs and housing and greening initiatives	
Skilled labour availability to match employment demand	⬇
Location of jobs and housing – more dispersion with mixed transport links	
Ability of Norway to adapt to climate change	↔
Circular infrastructure for energy, water and waste supply – focussed on current approaches.	

Technology, digital skills and digital threats	
Digital skills – digital divide increases	⬇
Digital security and cyber protection – Norway is unable to respond, and threats increase, demanding increasing protection	
Data sharing	
Technology convergence and use of enabling technologies	⬇

Research and innovation	
Globalisation of research and innovation and data sharing – decrease in international data sharing and collaboration	
Funding for research and innovation – decreases	

Scenario 2: Going green together

Global developments

During the 2020s there was a realisation across governments, industry leaders and populations that the relationship with the planet is key and resources and time are finite. This led to efforts at the international level and activism at the local level to build a green agenda. Norway, already a leader in renewable energy and decarbonised transport, has focused on further reducing its environmental and climate impact.

Health and welfare in Norway

Norway has undergone significant demographic changes, with a shift towards a higher number of senior citizens. This has created pressure for the healthcare system due to increased demand for services. On the other hand, there is increased access to health and welfare services as a result of policies promoting decentralisation towards municipalities and increasing digitalisation of the healthcare sector. Telehealth has become the default option, allowing for a more targeted and less resource-intensive provision of services, reducing unnecessary travel. Access to healthcare has also improved through strategies focused on reducing and preventing social inequalities in health, such as prevalence of risk factors in population sectors with lower income and education. Alongside these changes, there has been an increase in digital skills across the Norwegian population due to efforts from the government to build digital competence by adapting the education curricula and providing adequate training across all age groups and sectors. These educational programmes have also sought to develop other relevant employment skills as the economy continues to move from a consumption to a green approach.

Societal and economic development

Norway has seen a decline in hate speech and discrimination, partly as a result of interventions, such as the increased capacity of authority to tackle these issues, especially in the online environment. Internet and smartphone use remain high in Norway. With the higher level of digital competence across all demographics and improved data security and ethics standards, social media is generally seen as a reliable source, used to facilitate a range of peer-to-peer activities and communications, from grassroots to government. Pockets of misinformation remain, however, and attract a vocal minority. Data security standards have also created tensions given the overregulation perceived by the Norwegian population.

The location of jobs and housing and greening initiatives

The success of Norway's approach is reflected in the level of trust in Norway's public administration, which continues to grow. This has been important in fostering green transition initiatives through the interconnection between citizens, local governments and local businesses. Cross-sectoral cooperation and cooperation across different governance levels have promoted a circular economy at national, regional and local levels. The Government Pension Fund of Norway has managed to adequately manage climate risks by investing in climate change policy and new technology. This is particularly the case within regions with higher population density, such as cities, where the adaptation of the built environment has been an important priority for the green transition, and green initiatives, such as urban farming and 'green builds' that are fully carbon neutral, have become more widespread. Additionally, citizens have a more prominent role in the green transition through higher levels of engagement in innovation and green entrepreneurship, as well as through local activism. There are, however, challenges in fostering behavioural change; older generations show more reluctance to adapting to new social norms, while younger generations feel they are being asked to pay too much of the price for climate change.

Research and innovation

Open science and increased data sharing have made research more accessible to citizens and policy makers, which has been particularly beneficial in supporting evidence-based policy for the green transition. Increased data availability has also allowed researchers to better evaluate the effectiveness and acceptability of initiatives, and to determine how Norway can best leverage and adapt to these. Aligned with the focus on cybersecurity in the EU Framework Programme, Norway has made a key priority to embed data protection and information security in its information and communications technology policy strategy, which has allowed for a better response to digital and cyber security threats, which have now decreased. Additionally, the green transition has led to a redistribution of jobs, away from jobs in a fossil-fuelled industry towards jobs in a green economy.

Health and welfare
- Demand and access to health and welfare services ⬆
- Collaboration and interdisciplinarity ⬆
- Development and adoption of telemedicine and telecare ⬆

Economy and society
- Discrimination and hate speech ⬇
- Use of social media to spread disinformation – increasingly used, but little impact on the spread of disinformation
- Trust in public administration ⬆
- Net immigration ⬇
- Natural resource wealth – steady growth in the economy, greater share of wealth from sustainable sources

Location of jobs and housing and greening initiatives
- Skilled labour availability to match employment demand ⬆
- Location of jobs and housing – located in big cities and transport-friendly locations
- Ability of Norway to adapt to climate change ⬆
- Circular infrastructure for energy, water and waste supply – develop rapidly and are implemented at national, regional and local levels

Technology, digital skills and digital threats
- Digital skills – decrease, digital divide increases
- Digital security and cyber protection – Norway is better able to respond, decreasing threats
- Data sharing ⬆
- Technology convergence and use of enabling technologies ⬆

Research and innovation
- Globalisation of research and innovation and data sharing – increasing international data sharing and collaboration (open and distributed)
- Funding for research and innovation – sufficient and continuous

Scenario 3: Slowly changing society

Global developments

The mid- to late 2020s saw a return to business as usual for most of the world and Norway. Strategic alliances have largely remained the same, and there is a slow but steady drift of economic power and influence away from Western powers. Although there have been periods of strong support for environmental activism, particularly in Europe, this has not been sustained, and internationally there has not been a real impetus for change. There has been some progress towards reducing emissions, but without a clear vision at the international level, this progress has not been sufficient, and the impacts of climate warming are starting to be felt.

Health and welfare in Norway

Trends towards technological innovation and digitalisation in the healthcare system in Norway have continued, and there are areas of Norway where there is strong technological innovation. However, these are not widely rolled out across different regions in Norway, and there are challenges with collaboration between the private and public sectors. Some private initiatives exist in the healthcare sector, but the Norwegian system continues to rely heavily on public funds, and measures to improve care coordination have been only partly successful. The healthcare workforce has been only partly able to meet the growing health and long-term care needs that have resulted from Norway's ageing population, increased immigration, and the effects of climate change. There is also a reluctance to address the underlying issues of social inequalities in life expectancy, disparities among income groups, and behavioural risk factors.

Societal and economic development

Regional conflicts and climate change have created increased pressure on immigration globally, but Norway has always had strong measures in place to ensure education and employment for migrants. Despite this, tensions still exist, particularly with regard to cultural integration. With only incremental changes in the make-up of the Norwegian welfare provision and labour markets, trust in public institutions remains relatively high, but there is concern about Norway's strategy for ensuring it has the necessary digital and employment skills to deal with changes in the national and global landscape. Although there is good digital provision in Norway, lack of appropriate regulation of the digital space means that social media continues to be a source of misinformation, feeding potential social divisions.

The location of jobs and housing and greening initiatives

There has been an increasing concentration of the Norwegian population in urban areas, as a thicker labour market in the cities has been better able to meet the demand of workers with specific qualifications. At the same time, commercial activity has opened up in the Arctic following the lack of impetus to deal with climate change internationally, which has accelerated the melting of the sea ice in the Arctic. This has accelerated economic growth in counties in northern Norway, but challenges persist with ensuring that there is access to labour with the necessary skills and expertise to make use of an improved knowledge base and value creation in the North. Regional development initiatives also remain weakly connected and do not really support the Sami community and their employment and business opportunities. Because Norwegians are concentrated in cities, it has been easy to join together energy and waste initiatives across hospitals and public sector buildings. This has also facilitated the creation of city-led initiatives, but their wider take-up has not been incentivised. Many Norwegians feel that they are already playing their part with renewable energy and electric vehicle use. Although people have greater access to services in urban areas, the concentration of people in cities also means that there are increased pressures of mass marketing, availability of unhealthy food choices and access to transport, which all have an effect on lifestyles and negative health outcomes.

Research and innovation

National and international collaboration for R&I continues to increase, but researchers continue to voice concerns about data sharing, and funding for interdisciplinary research is limited. The lack of collaboration between industry and the higher education sectors also poses key challenges for Norway. The skills that Norwegians obtain through higher education are not fully aligned with the skills needed in the labour market, particularly as new areas of innovation open up and automation, the application of artificial intelligence and broader technology convergence start to change the nature of employment. There is a fragmented funding landscape that is largely focused on excellent science, while the translation into innovation outputs is limited. In health, Norway concentrates health R&D in university research, and there is weak coordination between the different key actors in the R&D health system, which has had resulted in a lack of cost-effectiveness in the development of pharmaceuticals in Norway.

Category	Factor	Trend
Health and welfare	Demand and access to health and welfare services	↔
	Collaboration and interdisciplinarity	↔
	Development and adoption of telemedicine and telecare	↔
Economy and society	Discrimination and hate speech	↔
	Use of social media to spread disinformation – increasingly used, with impact on the spread of disinformation	
	Trust in public administration	↔
	Net immigration	↔
	Natural resource wealth – steady growth in the economy, no change in share of wealth from sustainable sources	
Location of jobs and housing and greening initiatives	Skilled labour availability to match employment demand	↔
	Location of jobs and housing – located in big cities and transport-friendly locations	
	Ability of Norway to adapt to climate change	↔
	Circular infrastructure for energy, water and waste supply – rapid development, but implementation localised	
Technology, digital skills and digital threats	Digital skills – remains as now	
	Digital security and cyber protection – Norway is unable to respond, demanding increased protection	
	Data sharing	⬆
	Technology convergence and use of enabling technologies	↔
Research and innovation	Globalisation of research and innovation and data sharing – increase in international data sharing and collaboration	
	Funding for research and innovation – fragmentation	

Scenario 4: Technological trajectory

Global developments

In line with the prevailing international view, Norway has focused on technological advances to promote economic growth and support its sustainability goals. Technology and the knowledge-based economy have been the main tenets of the Norwegian R&I agenda, from both an international and a domestic perspective, with new technologies and their convergence having brought about significant advances in health and welfare. However, changes in employment have created new social inequalities.

Health and welfare in Norway

Many digital solutions have been integrated into health and welfare services, which has helped to address the continued demand and pressure for these services. Automation and artificial intelligence are commonplace in healthcare, and telehealth has become the default option for health and welfare. Digital technology, such as robotics, is used to help support the autonomy of older people. Thanks to its comprehensive health databases and its ability to exploit large amounts of patient data, Norway was able to rapidly digitalise the health sector. In addition, health data; an improved focus on funding; and developments in and convergence of bioinformatics, genetic engineering, biotechnology and nanotechnology have enabled Norway to move towards personalised medicine, which has made great strides since the 2020s. Overall, this has led to a more patient-centred health system. However, there are concerns that the health system is becoming 'twin-track', because users have to be digitally competent and willing to share personal data to access it and because some advanced treatments are only available privately.
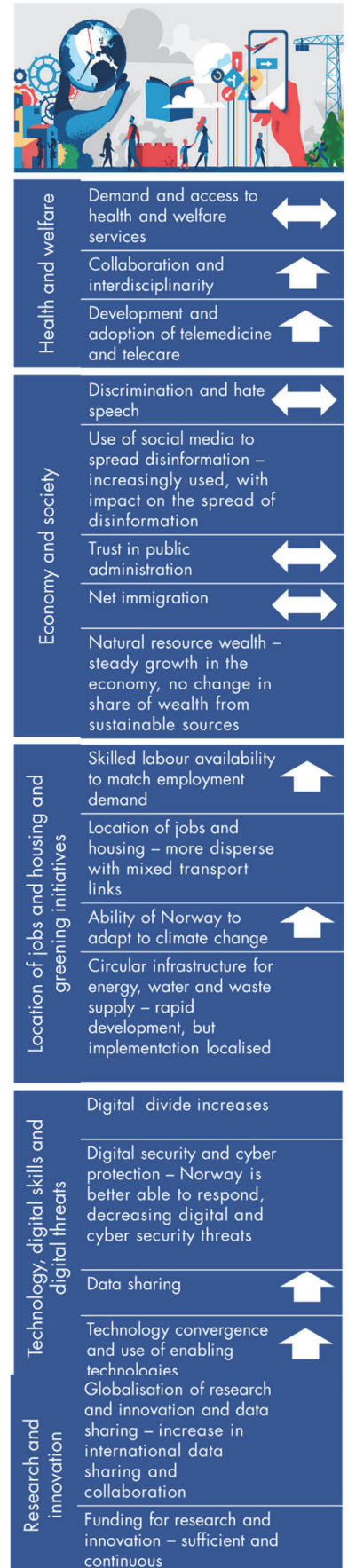
Societal and economic developments

Although a substantial part of the Norwegian population now has access to Internet and service industries, such as banking, finance and tourism, have achieved efficiency gains and improved their business processes, some people are being left behind in terms of their digital skills even though the economy is doing well. Technology convergence and development has been led by Norwegian industry, and central and local government and other public sectors have not fully integrated common systems for user-friendly digital services. There is acceptance from the public that data generally has to be shared to access services and participate in society, and the Norwegian population continues to have a relatively stable level of trust in its public institutions. However, trust in government has, at the same time, not increased, and the perceived lack of control around data privacy and security issues threatens to reduce it further. The application of advanced technologies has contributed to efficiencies in transport, health, agriculture and food, and manufacturing industries, at the same time transforming employment in these industries. Norway has actively addressed these changing employment needs through education and training policies. Although overall immigration to Norway has remained stable, there has been a shift in the type of immigrant, to higher-skilled, wealthier immigrants. However, the need for some low-skilled labour remains, and political tensions around the role of immigrants in the Norwegian economy and society persist.

The location of jobs and housing and greening initiatives

Remote working has been the norm since the 2020s. Investment in digital infrastructure has continued, and many Norwegians have moved out of urban centres to smaller cities and towns, where the impacts of climate change are currently more supportable. The Internet and social media are key elements of this lifestyle, with vast amounts of data changing hands and control of platforms still in the hands of Big Tech companies that actively resist regulation. Norway is not alone in struggling to police misinformation, and it has invested heavily with partners in cyber security prevention.

Research and innovation

The increased use of artificial intelligence, big data and genomics in Norwegian society has been associated with a steadily rising demand for data and data sharing both nationally and internationally. Norway has been able to widely deploy technologies across sectors due to increasing collaboration and funding for collaboration across sectors. However, R&I initiatives for developments in technology tend to be geared towards developments in the natural sciences. There is a lack of recognition of the human, ethical and legal challenges that emerge with increased data sharing and resulting privacy and cyber security threats, which contributes to a growing distrust of pervasive technology in Norway.

Category	Indicator	Trend
Health and welfare	Demand and access to health and welfare services	↔
	Collaboration and interdisciplinarity	↑
	Development and adoption of telemedicine and telecare	↑
Economy and society	Discrimination and hate speech	↔
	Use of social media to spread disinformation – increasingly used, with impact on the spread of disinformation	
	Trust in public administration	↔
	Net immigration	↔
	Natural resource wealth – steady growth in the economy, no change in share of wealth from sustainable sources	
Location of jobs and housing and greening initiatives	Skilled labour availability to match employment demand	↑
	Location of jobs and housing – more disperse with mixed transport links	
	Ability of Norway to adapt to climate change	↑
	Circular infrastructure for energy, water and waste supply – rapid development, but implementation localised	
Technology, digital skills and digital threats	Digital divide increases	
	Digital security and cyber protection – Norway is better able to respond, decreasing digital and cyber security threats	
	Data sharing	↑
	Technology convergence and use of enabling technologies	↑
Research and innovation	Globalisation of research and innovation and data sharing – increase in international data sharing and collaboration	
	Funding for research and innovation – sufficient and continuous	

C.2. Scenario set 2: Norway in a global context

The following set of four distinct future scenarios were discussed at a stakeholder workshop organised on 24 March 2021. Below we show a table containing the key characteristics and underpinning factors of the four scenarios. We then present more detailed one-page narratives of the scenarios that were developed to support the futures analysis for this study. The scenarios were used during the workshop to examine a series of priority missions and structural measures that were under consideration in this study.

This scenario set focuses on Norway in an international or global context, primarily relating to Norway's outward-facing role. It broadly covers themes related to climate, oceans, energy, transport, food, biodiversity and globalisation, as well as relevant aspects of technology and digitalisation.

Figure 12. Key characteristics and underpinning factors of the scenarios

Category	Factor	Protectionist decline	Global greening	Slowly shifting power	Technological trajectory
Green transition	Demand and support for circular products	↓	↑	↓	↔
	Circular infrastructure for energy, water and waste supply	Circular economy remain focussed on current approaches to water/energy/waste	Circular initiatives develop rapidly and implemented at national, regional and local levels	Circular economy remain focussed on current approaches to water/energy/waste	There is rapid development in circular initiatives, but implementation remains localised
	Investments/innovations to reduce emissions from oil	↓	↑	↔	↔
	Ability of Norway to adapt to climate change	↓	↑	↓	↓
	Food security and supply	Norway maintains security of food supply with higher share of domestic production	Norway maintains security of food supply with higher share of domestic production	Norway maintains security of food supply with same share of productions as now	Norway maintains security of food supply with same share of productions as now
	Low-carbon business models (international)	No change in emergence	Rapid emergence	No change in emergence	Emergence in some sectors
Oceans	Sustainable aquaculture	Little expansion in aquaculture sector	Expanded aquaculture sector with expanded share of sustainable farming	Expanded aquaculture sector with expanded share of sustainable farming	Expanded aquaculture sector but no increase in share of sustainable farming
	Norwegian shipping industry	Greening of international shipping industry remains as now	Greening of international shipping industry is extensive	Greening of international shipping industry remains as now	Greening of the shipping industry increases
Globalisation and society	Norway's trade linkages with other countries	↓	↑	↔	↑
	Norwegian co-operation with EU/EEA	↓	↑	↔	↑
	Natural resource wealth	Slow growth or stagnation	Steady growth, with greater share from sustainable sources	Steady growth, but no change in share from sustainable sources	Steady growth, but no change in share from sustainable sources
	Make up of geopolitical landscape	Less stable with a shift in global power	More stable with greater cooperation with and stability in Norway's partner countries	No change in stability of the geopolitical landscape	No change in the stability of the geopolitical landscape
	Natural resource wealth	Slow growth or stagnation in the economy	Steady growth in Norway's wealth with a greater share from sustainable sources	Steady growth in Norway's wealth, but no change in the share from sustainable sources	Steady growth in Norway's wealth, but no change in the share from sustainable sources
	Skilled labour availability (to match employment demand)	↓	↑	↔	↑
	Technology convergence and the use of enabling technologies	↓	↑	↔	↑
Research and innovation	Globalisation of research and innovation and data sharing	Decrease in international data sharing and collaboration	Increasing international data sharing and collaboration (open and distributed)	Increasing international collaboration and data sharing (closed)	Increasing international data sharing and collaboration (open and distributed)
	Funding for research and innovation	Decreases	Sufficient and continuous for different actors	Fragmentation	Sufficient and continuous for different actors

Source: Study team analysis

Scenario 1: Protectionist decline

Global landscape

Shifts in geopolitical power that came to the fore in the 2020s led to a period of political instability over the next decade, with serious implications for global trade. Struggling to maintain supply chains, countries increasingly put pressure on locally based companies to serve their needs first. By 2040, this has led to mistrust even among former close allies. Many countries have adopted a protectionist approach, increasingly looking inwards to protect their own populations. Even within the EU, which initially sought to maintain a united front, member states have divergent views on how to tackle current problems of climate change and stagnant economic growth. At the international level, cooperation on climate goals has plummeted and targets agreed at the last United Nations Climate Change Conference, five years ago, look increasingly unattainable. The negative impacts of climate change have been limited only by the poorly performing global economy.
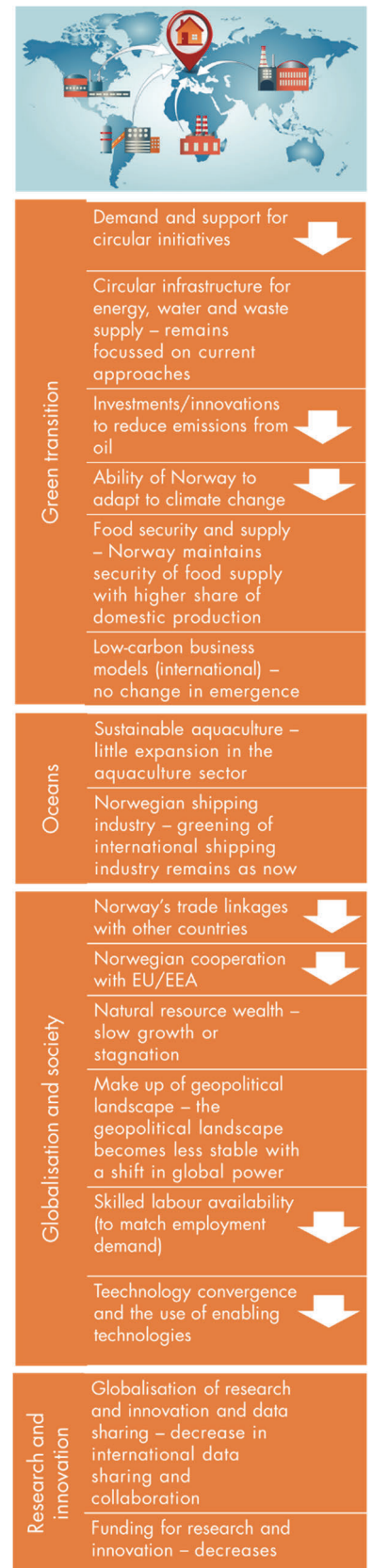
Trade and availability of skilled labour

The uncertainty in global trade has seen countries re-shore food production and manufacturing. In Norway, as elsewhere, there has been investment in automation and additive manufacturing to support this move. Although there has been an increase in immigration from countries affected by instability or climate effects, reduced cooperation with the EU means that skilled labour is in short supply. Norway remains a trusted partner for energy, but export demand for the industry has fallen, and some countries have chosen to invest in home-grown renewable energy to secure their supply. Demand for Norwegian seafood products and shipping in global markets is also down, and Norway's imports of manufactured items have also declined.

Circular initiatives

Despite Norway's success in greening its domestic energy and transport sectors, successive governments have found it increasingly difficult to encourage further behavioural change through circular economy initiatives when consumption is down and many in the population are worrying about how to pay their bills. Stagnant economic growth has meant that much-needed investment in digital infrastructure has also stalled. Compounding this, the levels of public trust in science and technology are at an all-time low, and a few high-profile cyber-attacks have dominated the headlines.

Research and innovation

Research and innovation in Norway has been affected by reduced funding and the loss of some external collaborators, as mistrust also pervades this sector; long-term investment in research loses out to short-term policy needs as both governments and industry tighten their belts. Most funding now comes from national bodies and aims at least to facilitate collaboration between public and private sectors domestically. Opportunities are seen to develop the ocean and onshore environments for food and energy production. There is also an ambition to develop new applications using skills and innovations from the petroleum sector that could boost the economy.

Green transition
- Demand and support for circular initiatives
- Circular infrastructure for energy, water and waste supply – remains focussed on current approaches
- Investments/innovations to reduce emissions from oil
- Ability of Norway to adapt to climate change
- Food security and supply – Norway maintains security of food supply with higher share of domestic production
- Low-carbon business models (international) – no change in emergence

Oceans
- Sustainable aquaculture – little expansion in the aquaculture sector
- Norwegian shipping industry – greening of international shipping industry remains as now

Globalisation and society
- Norway's trade linkages with other countries
- Norwegian cooperation with EU/EEA
- Natural resource wealth – slow growth or stagnation
- Make up of geopolitical landscape – the geopolitical landscape becomes less stable with a shift in global power
- Skilled labour availability (to match employment demand)
- Teechnology convergence and the use of enabling technologies

Research and innovation
- Globalisation of research and innovation and data sharing – decrease in international data sharing and collaboration
- Funding for research and innovation – decreases

Scenario 2: Global greening

Global developments

During the 2020s, there was a further realisation across governments, industry leaders and populations that their relationship with the planet is key and resources and time are finite. This led to efforts at the international level and activism at the local level to build a green agenda. The EU sees the benefits not only of greater internal cooperation, but also of building external relations and leading by example. Relations between major powers have improved as these countries see value in pursuing a 'green economy' approach, focusing on innovative solutions for all sectors, rather than securing ownership of rapidly depleting resources. Regions like Africa and South America are now recognised for their valuable resources, but regional disparities still remain. The impacts of climate change are happening at a slower rate, but the longer-term focus is on adaptation, as the current trajectory, tracking close to a 2°C increase, looks hard to maintain.

Circular economy

The top-down approach means that low-carbon business models have developed across many sectors where there are international trade sectors, and this is matched by a demand within Norway, in Europe, and internationally for products and services that have a low impact on the environment and climate. A circular economy approach has been central to this. Some change has been industry led, some has been driven by international agreements and legislation; Norway has worked hard within supra-national institutions to further this agenda and support regional change through overseas aid. But changing consumer attitudes has also been key, and top-down approaches are balanced against initiatives driven by communities and government at the local level, where quality of life is displacing consumption as a measure of success and there is a focus on local production and consumption. Yet tensions persist among different stakeholder groups, with some advocating a more relaxed approach to the environment given the gains made in recent years.
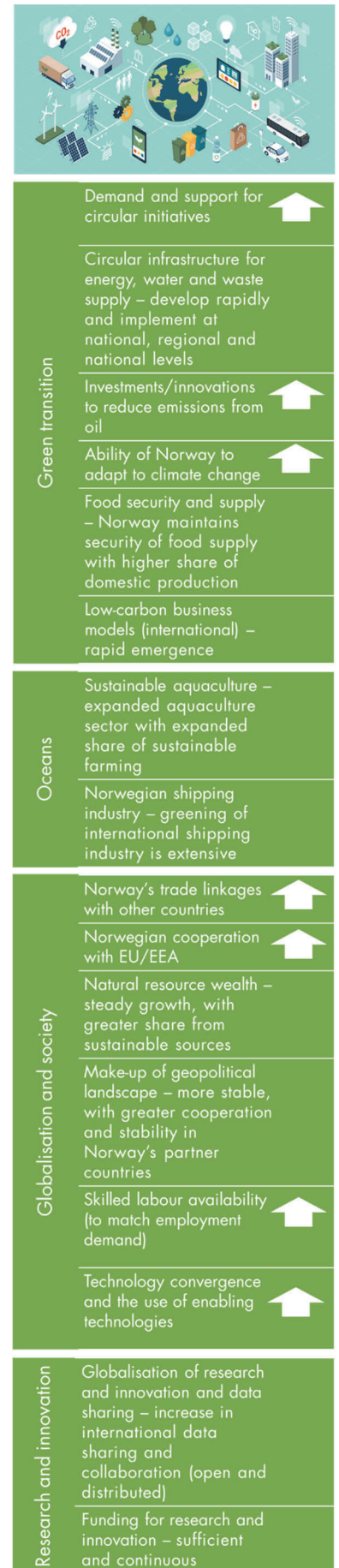
Renewable energy

There has been a rapid move away from fossil fuel dependence to electricity from renewables, linked to expanding regional grids. The Government Pension Fund of Norway has managed to adequately manage climate risks by investing in climate change policy and new technology. International travel and transport of goods have not returned to levels seen in the 2010s. Norway has invested heavily in offshore renewables and is a key proponent of greener and smarter shipping – one area where hydrogen has taken off.

Circular initiatives and technology in Norway

In Norway, circular initiatives have been introduced in relation to key sectors of energy, waste and water by the government, but there is also a supportive environment for local solutions, resulting in a boom in green entrepreneurship that enjoys easy access to European markets. Technology and data are seen as key to sustainable solutions, from food to retail, with many of these starting at a small scale, seizing supply chain opportunities offered by a move to low-carbon business models by bigger companies at the national and international level and the public sector. However, technology is seen as the means and not the end. Norway has also seen its aquaculture exports expand, although for fresh products these have focused on EU markets, and the domestic share of food production has also increased.

Research and innovation

There has been investment in research, which is seen as key to a green future, both within the EU and in Norway. This has been accompanied by greater collaboration between these partners and internationally. To facilitate openness in research and innovation, the EU has also worked together with industry and national governments to develop protocols for data sharing, improved data security and authentication. While there has been action to re-align education and training to better match skills to the changing employment opportunities in Norway, these systems are still seen as being slow to respond. Collaborative research in social sciences has also been important to maintain momentum towards climate goals and global stability, keeping citizens educated and engaged.

Green transition
- Demand and support for circular initiatives ↑
- Circular infrastructure for energy, water and waste supply – develop rapidly and implement at national, regional and national levels
- Investments/innovations to reduce emissions from oil ↑
- Ability of Norway to adapt to climate change ↑
- Food security and supply – Norway maintains security of food supply with higher share of domestic production
- Low-carbon business models (international) – rapid emergence

Oceans
- Sustainable aquaculture – expanded aquaculture sector with expanded share of sustainable farming
- Norwegian shipping industry – greening of international shipping industry is extensive

Globalisation and society
- Norway's trade linkages with other countries ↑
- Norwegian cooperation with EU/EEA ↑
- Natural resource wealth – steady growth, with greater share from sustainable sources
- Make-up of geopolitical landscape – more stable, with greater cooperation and stability in Norway's partner countries
- Skilled labour availability (to match employment demand) ↑
- Technology convergence and the use of enabling technologies ↑

Research and innovation
- Globalisation of research and innovation and data sharing – increase in international data sharing and collaboration (open and distributed)
- Funding for research and innovation – sufficient and continuous

Scenario 3: Slowly shifting power

Global developments

The mid- to late 2020s saw a return to business much as usual for most of the world. Although Britain's exit from the European Union did result in a small shift in trading patterns, strategic alliances have largely remained unchanged, and the slow but steady drift of economic power and influence away from Western powers has continued. Regional conflicts rumble on, but wider geopolitical tensions, for a while the focus of global attention, have now largely eased. The intervening years have seen the usual rounds of climate and trade summits, but existing supra-national structures are losing their relevance. Although there have been periods of strong support for environmental activism, particularly in Europe, this had not been sustained, and internationally, it has not led to impetus for real change. There has been some steady progress towards reducing carbon emissions, but, as foreseen, without a clear vision at the international level, this has not been sufficient, and the impacts of climate warming are starting to be felt.

Economic trends

Economic trends towards increasing supply chain efficiencies through automation, artificial intelligence, and distributed ledger technologies have continued, as have efforts to decarbonise the transport and energy sectors. Electric cars are now increasingly widespread, but there is a lack of consensus on greening international shipping and aviation. Progress in other sectors, which depend on commercial incentives for citizens and businesses, is more limited. The circular economy is still seen as a key solution by the EU, but it has not gained much traction across member states, especially when other problems seem more pressing.

Oceans

The ocean has become an important focus for the Norwegian economy. There is continued demand for sustainable gas from Norway's key partners as they transition towards net-zero, and Norway has expanded its ocean-bed carbon storage capability to decarbonise its gas exports. Other offshore technologies, such as solar panels and wave energy convertors, are being explored to supplement its hydropower and offshore wind farms. As a knowledge leader in the oceans sector, Norway has exported these solutions, often as part of its efforts to support developing countries. At the same time, Norway has seen increased demand for seafood, leading to an expansion in that sector. However, by 2040, the ability of the ocean to sustain all this activity is not clear. The impacts of climate change are particularly felt in the High North, and these changes have accelerated changes in Arctic ecosystems and the loss of sustainable habitats for Arctic species. Norway is increasingly looking to Europe and the Nordics for collaboration to solve some of these challenges. The rapid melting of the sea ice in the Arctic in recent years has reduced some of the natural ice borders between countries, creating a renewed focus on opportunities for commercial activity in the region but also tensions with other nations.

The circular economy in Norway

Norway has opted for a government-led approach to the circular economy, mainly focusing on its energy and waste sectors as areas where these approaches could be the most beneficial. Local initiatives aimed at reducing consumption through reuse, repairing and recycling are encouraged but currently not incentivised, and many Norwegians feel that by leading on renewable energy and electric vehicle use, they are already playing their part. Green shipping is one area where Norway is leading the way again, having introduced electric batteries and carbon capture technologies into its domestic fleet.

Research and innovation

Funding for research and development has remained fragmented both within Norway and externally. Norway has continued to co-operate closely with its EU/EEA partners. Substantial funding has been available in some areas, but the closed nature of collaboration between institutions and the lack of focus on monitoring and data sharing have meant that resources have not been targeted appropriately; there has been a lack of investment in interdisciplinary collaboration; and challenges remain with the translation of excellent science into innovations. Norwegian efforts in technology convergence have remained broad, covering energy, electronics and optics, the environment, and health. But because much research is still undertaken by the private sector and because the humanities, social science and legal perspectives on technology have not been systematically addressed, this has so far not led to the expected transformational change.

Green transition

- Demand and support for circular initiatives ▼
- Circular infrastructure for energy, water and waste supply – focussed on current approaches to water/energy/waste
- Investments/innovations to reduce emissions from oil ◄►
- Ability of Norway to adapt to climate change ▼
- Food security and supply – maintains food supply with same share of production as now
- Low-carbon business models (international) – no change in emergence

Oceans

- Sustainable aquaculture – expanded aquaculture sector, with expanded share of sustainable farming
- Norwegian shipping industry – greening of international shipping industry remains as now

Globalisation and society

- Norway's trade linkages with other countries ◄►
- Norwegian cooperation with EU/EEA ◄►
- Natural resource wealth – steady growth, but no change in share from sustainable sources
- Make-up of geopolitical landscape – no change in the stability of the geopolitical landscape
- Skilled labour availability (to match employment demand) ◄►
- Technology convergence and the use of enabling technologies ◄►

Research and innovation

- Globalisation of research and innovation and data sharing – increase in international data sharing and collaboration (closed) ▲
- Funding for research and innovation – fragmentation

Scenario 4: Technological trajectory

Global developments

After some turbulence at the start of the 2020s, the focus has been on revitalising the global economy, which is seen as a key driver for reducing global inequalities and achieving inter-regional stability. As economic and geopolitical power has continued to shift towards the BRIC (Brazil, Russia, India and China) countries, Western democracies have looked to establish new regional relationships that have opened up opportunities for Norway for trade, investment and R&I collaboration. Norway has continued to play an active role in international institutions, but the prevailing international view has been that climate change goals can be achieved through digitalisation and technological advances. Consumption is still regarded as an important driver of economic growth, and the green agenda has somewhat taken a back seat. This is reflected in the current pace of environmental change, with the result that by 2040, there is a growing clamour for more action.

The use of technology

Technology has played a key in role in recent economic growth, impacting on many areas of daily life as using the Internet for entertainment, socialising shopping, working, accessing services and education has become the norm. Automation and AI are commonplace across a range of sectors, and technology convergence has led to a re-alignment in the transport, health, agriculture, food and manufacturing industries, resulting in new players and new business models. Although the perception is that power remains in the hands of a few, rapid regional expansions have created new firms. Technology has contributed to reducing carbon emissions, from large-scale carbon capture and storage and green hydrogen generation, to small-scale urban farming. Innovative technological solutions have also been implemented to both reduce and remove marine biowaste and plastics. But technology is now seen by some as a problem too in terms of resource and energy use. The past decade has also seen considerable movement of goods and people across the planet, as well as continued urbanisation. And, while changes in employment brought about by technological advances have been accommodated in some countries through forward-looking skills and education strategies, this is by no means the norm, potentially introducing new inequalities.

The Norwegian economy

The Norwegian economy has also shown strong growth, fuelled by a continued close relationship with Europe but also by new trade links, providing technology partners and new markets for seafood products and energy solutions. Norway has invested in integrating energy and waste systems at a national level, collaborating closely with European neighbours on these and exporting this expertise. It has also continued to expand its carbon capture and storage capability, but hydrogen from sea-splitting, first trialled as part of shipping, is a potential new export. There has also been rapid growth in green initiatives in other areas that are often technology led. There is demand for sustainable solutions at the European level, but without real cross-sectoral synergies, it remains difficult for new green companies to expand outside Norway.

Research and innovation

Technology and the knowledge-based economy have been the main tenets of the Norwegian R&I agenda both from an international and from a domestic perspective, with technology seen to underpin many sustainability objectives. To promote openness and transparency in international data sharing and collaboration, public funding from national bodies and the EU has been supplemented by the development of new relationships with universities and research institutes, including in South-east Asia and South America. This has resulted in a rapid expansion in the research base, without having to be overly dependent on a small number of foreign economies and the private sector. A key part of the agenda has also been developing a base of highly skilled workers, both through an open-door policy for overseas researchers and an agile, responsive higher education sector. But less focus has been placed on training for those who have seen their jobs displaced.

Green transition
- Demand and support for circular initiatives
- Circular infrastructure for energy, water and waste supply – rapid development, but implementation remains localised
- Investments/innovations to reduce emissions from oil
- Ability of Norway to adapt to climate change
- Food security and supply – maintains food supply with same share of production as now
- Low-carbon business models (international) – emergence in some sectors

Oceans
- Sustainable aquaculture – expanded aquaculture sector, with no change in share of sustainable farming
- Norwegian shipping industry – greening of international shipping industry increases

Globalisation and society
- Norway's trade linkages with other countries
- Norwegian cooperation with EU/EEA
- Natural resource wealth – steady growth, but no change in share from sustainable sources
- Make-up of geopolitical landscape – no change in the geopolitical landscape
- Skilled labour availability (to match employment demand)
- Technology convergence and the use of enabling technologies

Research and innovation
- Globalisation of research and innovation and data sharing – increase in international data sharing and collaboration (open and distributed)
- Funding for research and innovation – sufficient and continuous