

Climate science for the financial sector: Managing climate risk in Norway and Sweden



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Abstract: The financial sector must prepare for a higher risk level associated with climate change impacts affecting real estate and infrastructure, as well as climate policies that will impact risk and returns from investments in various sectors.

Representatives from twenty financial institutions in Norway and Sweden have been interviewed on perceptions and management of climate change risks. The purpose was to map knowledge and perceptions, examine current management of climate-related risks and explore how risk management can be improved within these institutions.

Frequently only qualitative assessments of climate risk are made in the financial sector, because data are missing, or there is high uncertainty attached to the figures. Carbon footprint and energy use or intensity are the most common climate risk indicators, but these are insufficient measures to fully assess climate risk. Few institutions have made substantial changes in the organization of their business. Climate risk is often seen in a broader sustainability context, confer the focus on Environmental, Social, and Governance (ESG) performance. The strategy and direction of a company towards more climate-friendliness and robustness is essential to evaluate its credibility and preparedness regarding climate risk. Climate risk also implies new business opportunities.

Currently most of the focus in the financial sector is on companies' disclosure of climate relevant information, since several uncertainties exist and there is no single answer to how climate risk should best be handled. More attention is given to developing a common language on what 'green' and 'climate-friendly' imply, but even more is needed.

The financial sector needs transparent and useable knowledge on climate change and related risks, both on the broad climate picture as well as the specific issues dependent on their business area. 'Stress-testing' an institution regarding risk from the transition to a low-emission society and the physical effects of climate change is a useful framing, where a set of possible futures can be used to assess an institution's robustness. More learning and capacity building on climate risk are necessary, both in terms of organization and personnel of an institution.

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Contents

Executive summary	4
Foreword	5
1 Introduction	6
2 Climate risks for the financial sector	8
2.1 Climate risks and implications for the financial sector	8
2.2 Physical risks	9
2.3 Transition risks in the Nordics	11
3 Climate scenarios	15
3.1 Scenarios explore uncertainties	15
3.2 When is scenario stress-testing useful?	16
3.3 Energy, climate and energy models	17
3.4 What do scenarios imply?	17
3.5 Challenges for the financial sector when using scenarios	18
3.6 What kind of climate change and physical effects should Norway expect?	19
4 Regulating climate risk disclosure	21
4.1 Introduction	21
4.2 The Taskforce on Climate-related Financial Disclosures (TCFD)	21
4.3 EU's Action Plan on Sustainable Finance	22
4.4 Norwegian policy context	24
4.5 Moving forward on regulation	24
5 An interview-based survey among financial institutions in Norway and Sweden	26
6 Review of perceptions and management of climate risks based on interviews with financial institutions in Norway and Sweden	27
6.1 Perceptions of climate risk	27
6.2 Management of climate risk	27
6.3 Improved management of climate risk	29
7 Interpretation of interview findings	30
8 Way forward	32
ANNEX 1. Recommended climate-related disclosures from EU's Technical Expert Group on Sustainable Finance (TEG)	33
ANNEX 2. Questionnaire for financial institutions	34
The Wallenberg climate finance project: Questions on climate risk knowledge and management among investors	34
ANNEX 3. Summary of interviewees' responses to the questions on climate risk and management	36

Executive summary

Societies are facing rising challenges due to the impacts of climate change and are further challenged by the policies that are being implemented to reduce emissions of greenhouse gases. However, the precise timing and severity of these consequences are difficult to predict. The financial sector must prepare for a higher risk level associated with climate change impacts affecting real estate and infrastructure, as well as climate policies that will impact risk and returns from investments in various sectors and technologies. There will also be indirect impacts through supply chains and markets across borders from climate disruptions affecting trade partners and neighbor countries.

Norway and Sweden, situated at high latitude, face challenges with larger temperature increases than the global average, however their societies may be more capable in handling the physical impacts of climate change. This report gives an overview of the climate risk landscape with a focus on Norway and Sweden. Representatives from twenty financial institutions in Norway and Sweden have been interviewed on perceptions and management of climate change risks. The purpose was to map knowledge and perceptions, examine current management of climate-related risks and explore how risk management can be improved within these institutions. The interviews show that the understanding and capacity to handle climate risk varies across financial institutions.

Frequently only qualitative assessments of climate risk are made in the financial sector, because data are missing, or there is high uncertainty attached to the figures. Carbon footprint and energy use or intensity are the most common climate risk indicators, but these are insufficient measures to fully assess climate risk. Risk assessments included in Environment, Social, and Governance (ESG) ratings are broad in focus and may omit or brush over some important aspects of climate risk.

Formal processes to incorporate climate risk are emerging in some institutions, but few have made substantial changes in the organization of their business. Climate risk is often seen in a broader context, confer the focus on ESG performance. Not much is currently done on improving resilience to climate change impacts or adapting to those that have occurred. Management of climate risk should be made more systematic and should be assessed as one important issue in a broader sustainability context. The strategy and direction of a company towards more climate-friendliness and robustness is essential to evaluate its credibility and preparedness regarding climate risk. Climate risk also implies new business opportunities, not the least in improving resilience to physical impacts of climate change and robustness to transition risk.

Currently most of the focus in the financial sector is on companies' disclosure of climate relevant information, since several uncertainties exist and there is no single answer to how climate risk should best be handled. More attention is given to developing a common language on what 'green' and 'climate-friendly' imply, but even more is needed. Developing a common language and definitions, climate-relevant indicators, and data collection can help the financial sector, other sectors and society in general.

The financial sector needs transparent and useable knowledge on climate change and related risks, both on the broad climate picture as well as the specific issues dependent on their business area. 'Stress-testing' an institution regarding risk from the transition to a low-emission society and the physical effects of climate change is a useful framing, where a set of possible futures (scenarios) can be used to assess an institution's robustness - but more relevant and consistent scenario information must be provided to support financial decisions to manage climate risk. Focused climate risk assessments at the company level can supplement ESG data. Finally, more learning and capacity building on climate risk are necessary, both in terms of organization and personnel of an institution.

Foreword

This report is a product of the project 'Greening investments in the face of climate risk', which is carried out by CICERO and Stockholm Environment Institute (SEI) in the period 2016-2020. We thank the Marianne and Marcus Wallenberg Foundation for funding of the project. A special thanks is given to the financial institutions and interviewees in Norway and Sweden that have been willing to support this project. We thank our colleagues Christa Clapp, Miriam Stackpole Dahl, Harald Francke Lund and Aaron Maltais (SEI) for valuable help and comments preparing this study. The responsibility with any remaining errors rests with the authors.

1 Introduction

Climate change, mostly driven by human activities, will impact society and nature more and more. The main climate change trends are temperature increase, more extreme weather, changing precipitation patterns that can cause drought, heat waves, wildfires, or flooding and landslides, and gradual sea level rise. Climate science is striving to conjecture the implications of climate change, but the uncertainties due to the complex climate system and limitations of current models and methods are still significant. We know more about the global pattern of climate change than how impacts will play out at a larger geographical scale, such as in municipalities and local ecosystems.

Earlier emissions determine climate change in the short-term, whereas emissions over the next years will first impact climate after some decades due to delays in the climate system's responses to our emissions. Future greenhouse gas emissions depend on economic growth in countries across the world, population growth, food production and agriculture, energy sources and use, efficiency in production and consumption, land use, and technological advancements in energy systems, infrastructure, and transportation.

Climate policy will be an essential determinant for greenhouse gas emissions over the next decades. There is a significant difference between today's generally lax climate policies and the much stricter climate policies that would be needed to limit global emissions sufficiently to meet the climate target adopted in the Paris Agreement from 2015, which is 2 °C or less warming by the end of this century.¹ Over the next couple of decades changes in climate policies are expected in all nations of the world. Will higher taxes on carbon dioxide emissions be introduced, or a lower ceiling on emissions trading systems, inducing a higher price on emission allowances?² The costs of greenhouse gas reductions will be determined by forthcoming policy decisions at national and international levels, which are not easily predictable. The transition from the current to a low-emission world will impact markets in different ways. Risks as well as opportunities will emerge along with the transition.

The financial sector in the Norway and Sweden will face challenges related to climate change, both from physical impacts such as damage due to flooding events, and increased risk associated with investments and equities in companies and sectors that are vulnerable to 'transition' risk. Transition risk is due to changes in policies and economic conditions that enable a climate-friendly and climate change robust transition of societies (confer section 2.1). Fossil related industries will likely be most affected by transition risk, since they will face higher costs to emit carbon dioxide. Given that some countries are willing to implement stricter climate policies earlier than other countries, financial actors and businesses in these countries will witness earlier and bigger challenges related to transition. Situated at a high latitude, Norway and Sweden will experience larger temperature increase than the global average, but their societies are also more robust and capable of handling physical impacts of climate change. Better preparedness to manage increased climate risk involves actions at many levels for companies and organizations, such as business strategy, internal organization, information flows, training of employees, procedures, and data and tools.

¹ The Paris Agreement also states that the world should pursue 1.5 °C as the global warming target.

² In the EU's Emissions Trading System (EU ETS) the ceiling on emissions is being gradually lowered, and fewer emission allowances handed out to industry for free. A lower ceiling on emissions and transfer of surplus allowances to the Market Stability Reserve will move the EU ETS from surplus to a deficit of allowances over a few years.

In this report we provide an overview of climate risk for financial markets. We start out with a global perspective in section 2, assessing the main components of climate risk, and how much science can tell us. In section 2.3 we close in on transition risks in the Nordics. Section 3 discusses possible climate futures (scenarios) generally, before illustrating such risks in Norway. In section 4, on the status of regulating disclosure of climate risk and management of this risk in the financial sector, the scope is in part global and in part European. Section 5 introduces the survey among financial institutions in Norway and Sweden based on interviews with representatives from twenty larger financial institutions. In section 6, on perceptions and management of climate risk, findings from the interviews are presented, followed by an interpretation of these findings in section 7. Finally, in section 8, we discuss the need for better management of climate risk in financial institutions and suggest a promising way forward, emphasizing the need for more comprehensive, transparent and standardized information on climate risks, and more learning and capacity building to enable financial actors to handle climate risk in a more systematic manner.

2 Climate risks for the financial sector

2.1 Climate risks and implications for the financial sector

Climate change related risks are twofold. *Physical risk* is related to changes in the climate system, which lead to increased frequency and intensity of extreme weather events, sea level rise and other types of acute and long-term hazards causing e.g. changes in agricultural productivity, damages to buildings and production facilities, and many more. Abrupt and unforeseen changes in the physical climate increasingly create disruptions to businesses and assets. *Transition risk* relates to changes in climate policies, technology shifts and liability concerns, as we move towards a low-carbon future.³ Transition changes are due to implementation of measures and policies aiming at reducing climate change, foremost emissions of Greenhouse Gases (GHG). At global level physical and transitional climate risks are related since a physical impacts scenario depends on strategies, policies, and measures that have been undertaken in past decades, and that directly or indirectly have affected greenhouse gas emissions. Due to the inertia of the climate system the effects of greenhouse gas emissions will first play out decades later. This means that we in the longer term have a choice between various combinations of physical and transition risks.

Climate scenarios are coherent narratives which describe different futures. Scenarios are not designed to predict the future but to explore its uncertainties in a multitude of possible outcomes. They are useful for assessing climate risks for the financial market, allowing analysts to evaluate how assets will be affected under a wide range of potential future developments. A wide range of scenarios have been developed by researchers, organizations like the International Energy Agency – IEA (i.a. the World Energy Outlook - WEO), and the Intergovernmental Panel on Climate Change (IPCC). Business organizations have also developed their own scenarios, such as the World Business Council for Sustainable Development, and petroleum companies like BP and Equinor. Most scenarios show pathways and drivers of climate change, which can be aligned with certain temperature targets. Physical and transition (policy) risks are currently evaluated under a wide range of scenarios, each involving different levels of uncertainty.

Correct pricing of risk in financial markets is essential for efficient and informed economic decision making. Inadequate pricing of risk can lead to imbalances and shocks in the financial system. The value at risk from climate change under the business-as-usual emission pathway has been estimated at an average of 1.8 % (or USD 2.5 trillion) of the global financial assets (Dietz et al., 2016). A risk at this level is expected to induce weaker growth and lower asset returns across the board. A wide range of assets will be affected by physical and transitional impacts. Some sectors will mostly be affected by physical risks, such as agriculture, transportation, real estate, insurance and tourism. Other sectors will mostly be affected by transition risks, such as fossil-based industries, energy-intensive manufacturing, and transportation (the Task Force on Climate-related Financial

³ Liability refers to possible litigation from groups or countries suffering negative impacts from climate change, foremost against fossil fuel extracting companies. Examples are wildfires and sea-level rise inundating islands in the Pacific. The oil industry is already facing some legal cases related to climate change.

Disclosures - TCFD, 2018). All sectors, however, will be impacted by indirect effects, such as disruptions to supply chains and markets through cross-border effects from climate disruptions affecting neighbors and trade partners (NOU, 2018). Disclosure of operating and financial results is paramount for an accurate and timely calculation of the price of risk. Companies face increasing demand for transparency on their governance structures, strategies and risk management practices. “Increasing transparency makes markets more efficient and economies more stable and resilient” (TCFD, 2018). The common Environmental, Social, and Governance (ESG) risk ratings are deemed insufficient for climate risk assessments.⁴ Assessments included in ESG risk ratings have a broad focus and omit climate risks as such (Alnes et al., 2019).

The Paris Agreement requires nations to undertake ambitious efforts to combat GHG emissions and adapt to the impacts of climate change. As governments show increased commitment to reduce carbon emissions, a political momentum for the transition to a low-carbon future will materialize, implying that sectors which rely on emission-intensive activities will face higher transition risks. The transition to a low-carbon future presents challenges, but also opportunities for investments. The energy sector will alone require around USD 3.5 trillion on average in investments annually for the foreseeable future (TCFD, 2018).

New business opportunities linked to climate change vary by region, market and sector. Improved resource efficiency leads to reduced operating costs across production and distribution. A large percentage of global energy generation will need to move to low-emission solutions, with a dominating share of renewable energy. When consumer preferences shift towards low-emission products and services this will give innovative companies a competitive advantage. Diversification of activities in new and low-carbon activities will provide a stronger market position for the most forward-looking and resilient companies and organizations (TCFD, 2017a).

2.2 Physical risks

IPCC defines physical climate risk as dependent on the likelihood of a specific climate change (‘hazard’), the degree to which a company or sector is affected (‘exposure’), and the company’s or sector’s capability to handle the climate change (‘vulnerability’). The climate change hazard depends on probability, frequency and intensity of the climate change impacts. Physical climate risk manifests through extreme weather events (e.g. flooding, hurricanes, heat waves), and long-term changes in the Earth system (e.g. sea-level rise, increasing average temperature, and changing precipitation patterns) (Oppenheimer et al., 2014).

There is increased confidence in projections of *long-term hazards*, but some changes occur faster than previously thought. Sea-level rise, for example, was previously considered a long-term issue but is now accelerating and can lead to significant damage, especially in combination with extreme events. Other long-term hazards like droughts and freshwater shortages could affect agriculture, influence local economies and increase global food prices. Tourism might be affected by lack of snow in ski resorts in the winter season and extreme heat in the summer season. Submergence and erosion of seaside areas due to sea-level rise put infrastructure and property in cities as well as tourism in coastal areas at risk. If some Earth system tipping points are triggered, where climate impacts are accelerated because the climate system abruptly jumps from one state to another, this can result in large economic impacts and damages, or be reflected in a steep increase in the cost of adaptation. Most economic impact assessments do not account for tipping points.

⁴ Investopedia (2019) describes ESG as: “Environmental, social and governance (ESG) criteria are a set of standards for a company’s operations that socially conscious investors use to screen potential investments. Environmental criteria consider how a company performs as a steward of nature. Social criteria examine how it manages relationships with employees, suppliers, customers, and the communities where it operates. Governance deals with a company’s leadership, executive pay, audits, internal controls, and shareholder rights.”

Predictions of *extreme events* are highly uncertain but according to IPCC, it is “very likely” that extreme events will be more intense and occur more frequently in the future. Floods, storms or heat waves can affect unprepared local communities and have devastating social and economic consequences. At global level insured weather-related losses amounted to an average of USD 1.4 billion annually between 1980 and 2008. Direct and insured losses have increased substantially in recent decades (Arent et al., 2014). Adaptation measures can reduce vulnerability against extreme events and improve infrastructure and financial resilience.

Climate-related hazards and their impacts are region specific. Damage to property and infrastructure are the economic impacts most directly related to meteorological disasters linked to climate change. CICERO’s Shades of Climate Risk report (Clapp et al., 2017) identifies key uncertainties for different categories of physical climate risk and assigns different ratings of climate risk preparedness (‘shades’) based on timeframe and probability, and by region. Extreme events are likely to increase in frequency and intensity in Northern Europe, especially in winter, confer Table 1 (Clapp et al., 2017).⁵ Coastal and riverine floods, storms, cloudbursts, wildfires and landslides are the most prominent hazards in Nordic countries. But stable welfare systems, societal stability and good territorial governance make them some of the most resilient societies in the world (Well et al., 2018). In addition sea-level rise and ocean acidification will present challenges for the Norwegian economy. Agriculture, forestry and fishing are the most affected sectors. Nordic countries rely on trading with countries across the world, so physical climate impacts in other regions may significantly affect the economy and financial markets of Nordic nations (Aamaas et al., 2018).

European physical impacts

Climate risk	Key message	Key impacted sectors	Shade of Risk
Extreme precipitation	High variability expected in precipitation, greater intensity in North. Precipitation could become more extreme in Mediterranean when it does occur after long dry spells (see also drought)	Infrastructure in high density urban areas	Northern & Central Europe ●
			Southern Europe ●
Flooding	Flooding from precipitation patterns and snow melt is observed and expected to increase	Infrastructure in high density urban areas	All ●
Drought	Reduced water availability in the South	Infrastructure (high density areas and along rivers), Energy (reduced hydropower generation in the South, increased in North), Agriculture (combined with ground water sinking from irrigation)	Northern Europe ●
			Southern Europe ●
Sea level rise	Sea level rise a concern low-lying coastal areas, especially in combination with extreme events such as hurricanes and spring floods	Infrastructure in coastal regions, nuclear energy	Coastal areas ●
Heat stress	Heat stress observed especially in South and expected to increase with high likelihood	Impacts on health, labour productivity, Agriculture (crop production, wildlife in South)	Northern Europe ●
			Southern Europe ●
Wind	No clear trend	Energy (changes in wind energy production uncertain, reductions most likely in South)	All ●

Table 1. Physical impacts from climate change in Europe (Clapp et al., 2017; www.cicero.uio.no/en/climateriskreport).

Financial markets are global in nature. Therefore, it is relevant to take global physical risks into consideration when evaluating impacts for the economies of the Nordic countries. Physical climate impacts create risks for Nordic economies through investments abroad and through the influence of global supply chains on economic activity. Prytz et al. (2018) identified the global physical risks

⁵ CICERO works in close collaboration with the financial sector and supports the work conducted by the climate risk expert commission through the ClimINVEST project (Bruin et al., 2019). ClimINVEST brings scientists and investors together to co-design tailored information on climate change to support financial decision making in the face on physical climate risks and opportunities.

with largest impact on the Norwegian economy. Direct investments in real estate may be particularly vulnerable to physical climate risk. Through more impacts from climate change domestically and Norwegian investments abroad, and possible underpricing of risks by insurance companies, the Norwegian insurance industry will increasingly depend on the global re-insurance market. Investments in Norway may earn lower returns because of large economic consequences of climate change (Aamaas et al., 2018).

Nordic countries will face relatively higher temperature increase than the global average. Intermediate projections suggest a temperature increase of some 4 - 5 °C in Norway by 2100 compared to the reference period (1971-2000), with higher warming in the winter. The highest temperature increases are expected in the Arctic region and at Svalbard. Precipitation is also expected to increase, especially in the Arctic and northern areas, with an increase in rain in the southern areas and on Svalbard. Extreme precipitation events are also expected to become more frequent in the future. 200-years events are expected to increase by some 35 %. Societal costs of climate change impacts in Nordic countries are expected to increase relative to global GHG emissions. Data from the Norwegian Natural Perils Pool (Norsk Naturskadepool) shows that most of their payments since 1980 were directed to cover damages created by storms and hurricanes (Aamaas et al., 2018). The Norwegian government appointed a Climate Risk Commission to assess climate-related risks, and potential impacts for the Norwegian economy, which emphasized that Norway's climate is becoming warmer, wetter and wilder (NOU, 2018).

2.3 Transition risks in the Nordics

2.3.1 Transition risk and physical risks are linked

Physical risks and transition risks are linked. If climate policies over the next decades are lax, we will experience more climate change impacts and higher physical risk with a few decades delay due to the inertia of the climate system. However, transition risk will in that case be low. If, on the other hand, climate policies are strict, physical impacts and risk will be reduced, whereas transition risk will be higher. Higher transition risk could significantly affect companies and financial institutions.

Lax climate policies could be understood as countries only implementing their current pledges to the Paris Agreement to reduce their emissions, which would lead to a warming by end of this century at around 3 °C or somewhat higher. This level of warming would cause severe physical consequences, such as droughts and extreme rainfall, and would have a significant effect on the operating environment of many sectors and companies. The political and regulatory pressure on industries to develop low-emission operations would, however, be relatively low.

Strict climate policies could be defined as a situation where parties to the Paris Agreement strengthen their efforts to reduce greenhouse gas emissions, since Parties to the agreement have agreed to strengthen their efforts over time, and sufficiently to meet the 2 °C target. Such a climate policy would require a much higher price on emissions of GHG, through taxing or emissions trading, and regulation through minimum standards for energy efficiency and emissions efficiency. Government support would also be needed for research and development programs for climate-friendly and -robust technologies. A transition at this scale is likely to impact a wide range of sectors in all regions of the world.

2.3.2 Sectors contributing to the transition

Power generation

According to data compiled by the IEA, Norway and Sweden are among the countries with the highest electricity demand per capita in the world (Haines, 2016). This reflects a high level of development and the use of electricity in areas where other countries have traditionally used fossil

energy, such as residential heating. Due to the large share of hydropower and nuclear power (Sweden), greenhouse gas emissions from electricity generation are low. However, under a scenario where efforts are being undertaken to limit global warming to 2 °C or below, electricity demand and supply, the generation mix and structure, transmission and distribution grids, as well as market structures would face substantial changes. The reasons for these changes are increased electrification of sectors such as industry and transport, and an increase in the share of renewable energy generation in order to serve the increased demand in a sustainable way.

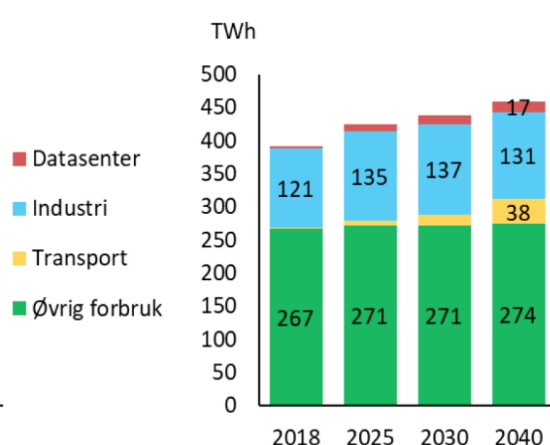


Figure 1. Developments in Nordic electricity demand (Statnett, 2018).

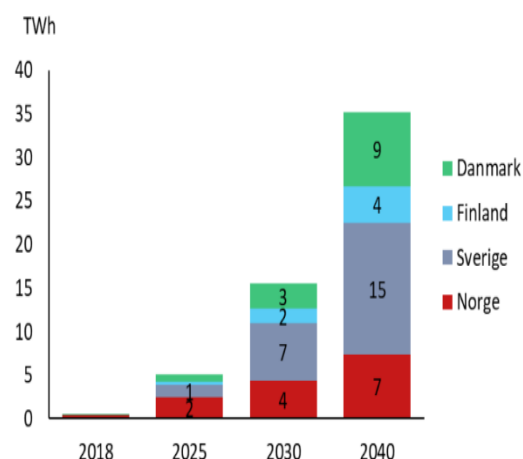


Figure 2. Power demand from electric vehicles in the Nordics (Statnett, 2018).

According to an analysis by the Norwegian Transmission System Operator (TSO), the Norwegian industry sector is projected to be responsible for almost all the increase in electricity demand between 2018 and 2025, which is forecasted to be at 13 TWh, see Figure 1 (Statnett, 2018). Thereafter, demand from industry will fall slightly until 2040. According to this analysis, the industries behind this increase are the metallurgical industry and offshore oil and gas installations, where the latter increase in demand is due to investments in land-based power instead of gas turbines on oil and gas producing platforms in the North Sea.

Transportation

For Norway and Sweden, one of the main drivers of the expected increase in demand for electricity is the electrification of transport. This sector stands for about 50 % of the expected increase of 70 TWh between 2018 and 2040 across the four Nordic countries, see Figure 2 (Statnett, 2018). At least the market for light duty personal vehicles has made impressive advances in countries that provide clear incentives or introduce strict regulations. In Norway, which has the highest share of chargeable cars in the world, more than half of newly registered light duty vehicles in the first quarter of 2019 were electric (Dagens Næringsliv, 2019). This is driven by strong favoring of electric to fossil fueled cars, foremost exemption of import and value added taxes, low annual tax, exemption or reduced road toll rates, allowing electric cars in public transportation lanes, and reduced rates for ferry transport. The target is to cut emissions from transport by ca. 40 % in 2030. Transport is not covered under the EU's Emissions Trading System (EU ETS), but agreement between the EU and Norway for targets in non-ETS sectors is being finalized. Sweden ranks first in the EU and third in the world regarding the share of chargeable cars, behind Norway and Iceland (Seehusen, 2018). However, at the end of 2018 there were 65.000 chargeable cars on the road in

Sweden, while the number for Norway was 265.000. Electrification has also begun to advance into short haul transportation of goods.

Shipping

In addition to road vehicles the electrification of the maritime sector has started and gained momentum. In Norway, the battery-driven ferry Ampere has been transporting vehicles across Sognefjorden since 2015. This ferry was built due to a public tender process requiring ferry companies to choose low-emission technologies. The construction of charging facilities for electric ferries is supported by Enova.⁶ According to the Norwegian Public Roads Administration, there will be 70 electric ferries operating in Norway in 2022 (Flaaten, 2018). Driven by demand specifications in tenders by municipalities or petroleum companies like Equinor, electric ferries and hybrid supply ships have grown in numbers. One of the indicators for this trend is Siemens, which is planning a battery factory in Trondheim after publishing an analysis that shows a large potential for switching to electric boats in the aquaculture industry.

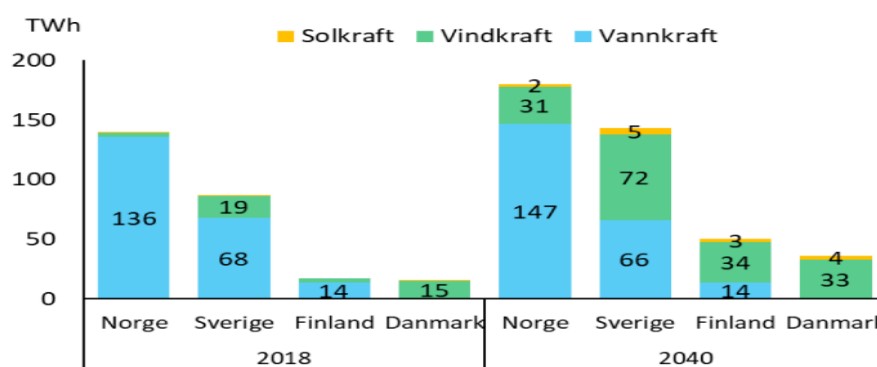


Figure 3. Development of Nordic renewable generation (Statnett, 2018).

In order to serve the increased demand from transport, industry and other sectors in a sustainable way, all Nordic countries are expected to increase renewable electricity generation, particularly wind power, see Figure 3. The Norwegian-Swedish green certificate system, which subsidizes renewable energy up to a defined capacity limit will reach that ceiling about 10 years ahead of schedule (Statnett, 2018).⁷

Carbon capture and storage

According to many climate and energy system models and scenarios that are in line with keeping the temperature increase below 2 °C at the end of the century, technologies such as Carbon Capture and Storage (CCS) are deemed necessary. These technologies can be applied to coal-based or gas-based power stations and industries that emit CO₂, thereby reducing the amount of CO₂ that is released to the atmosphere. CCS is required for two of the technologies that can extract CO₂ from the atmosphere (bioenergy combined with CCS, and direct air capture), thereby reducing the amount of carbon in the atmosphere, since this is deemed necessary in most scenarios that meet the

⁶ Enova SF is owned by the Ministry of Climate and Environment and contributes to reduced greenhouse gas emissions, development of energy and climate technology and a strengthened security of supply.

⁷ Norway will leave the green certificate system by end of 2021.

target in the Paris Agreement. CCS is currently used at around 20 plants globally. The major challenge is high cost and a low value of avoided CO₂ emissions. A much stricter climate policy, necessary to meet the 2 °C target, would significantly increase the price of CO₂ emissions, likely making CCS cost-effective and providing incentives for countries and industry to invest in the technology. Globally, the rollout of this technology lags far behind the need, even for the scenarios with a conservative demand for CCS capacity. Two CCS projects to separate CO₂ from natural gas exports have existed for many years in Norway (Sleipner and Snøhvit). Currently the CCS technology is tested at two pilot projects, which is a cement producing plant (Norcem, Brevik) and a waste incinerator (Fortum, Oslo), aiming at developing at least one full-scale CCS demonstration plant in Norway. The Norwegian government is allocating funds to the development of these pilot projects but underlines the necessity for other European countries to invest in CCS (Statsbudsjettet, 2019). Equinor, Shell and Total cooperate to develop a CCS value chain around the North Sea, confer the 'Northern Lights' project, where the CO₂ storage component is part of the Norwegian government's full-scale CCS demonstration plan.

2.3.3 Identifying companies' position in the transition

For a successful transition we need all sectors to move towards low-carbon and climate resilient solutions. However, it is not easy for the financial sector to analyze the degree of sustainability and climate risk exposure of single companies – and to fully exploit the value creation potential associated with companies providing sustainable solutions. We have identified a need for evaluating which companies are best situated to contribute to the low-carbon, climate resilient future, and to facilitate this, a need for a practical tool to better understand climate risk (Alnes et al., 2019).

By assessing companies' revenues and investments with CICERO's 'shades of green' rating method we can track how aligned companies are with what climate science tells us is necessary in order to transform the economy in a low-carbon and climate resilient way (Clapp et al., 2017). CICERO has undertaken such an assessment in a feasibility study that involved several Norwegian companies, both listed and unlisted ones, from different sectors. In the small sample we found companies with revenues almost exclusively from 'brown' activities, while there were also companies in transition and those whose revenues stem from green activities only. An example of a company with 'brown' activities is Aker ASA, a holding company invested mainly in the oil and gas sector. Our analysis found Yara to be an example of a company in transition. This fertilizer producing company has made ambitious steps toward substantially reducing emissions from fertilizer and nitrate production. However, the majority of fertilizer production is still viewed as a 'brown' activity due to high emissions associated with production as well as application of the end-product. The methodology is being further developed in CICERO's 'Sustainable Edge' research project from autumn 2019.

3 Climate scenarios

3.1 Scenarios explore uncertainties

The global average temperature is likely to be some 1.5 °C higher than pre-industrial levels over the next 10-20 years, regardless of the emissions scenario, since there is a substantial time lag before the full effect of emissions is absorbed by the climate system. Towards the end of the century, global average temperature increase could span from approximately 2 °C to 4 °C, across a range of emission scenarios. Given today's global emission trend, a 3 °C warming by 2100 is more likely than 2 °C. Due to the high latitude, a 2 °C global average warming could mean a 3 °C warming in the Nordic countries, and even more in the winter season and in Northern Norway. Since we cannot predict national climate policies around the world, and due to uncertainties regarding the response of the climate system, there is no straightforward way of forecasting which physical risks and transition risks we will be facing, and the magnitude of each risk. For that reason, different scenarios are employed in science, politics, and economics. Constructing scenarios is not like forecasting but rather exploring the effect of various uncertain factors and their combinations under different possible future development pathways.

Shared Socio-Economic Pathways (SSPs) is the latest generation of scenarios that provide input to climate models assessed by IPCC. These scenarios are designed to better inform decision makers on different approaches to meet climate change targets and support a risk management approach that combines emission reductions with adaptation to climate change. Confer the large number of scenarios in Figure 4, from high emissions (SSP5-8.5), through the intermediate emissions (SSP4-6 and SSP2-4.5), to low emissions (SSP1-2.6 and SSP1-1.9), where the latter describes a future in line with the Paris Agreement's ambition to keep global warming below 2 °C by 2100.

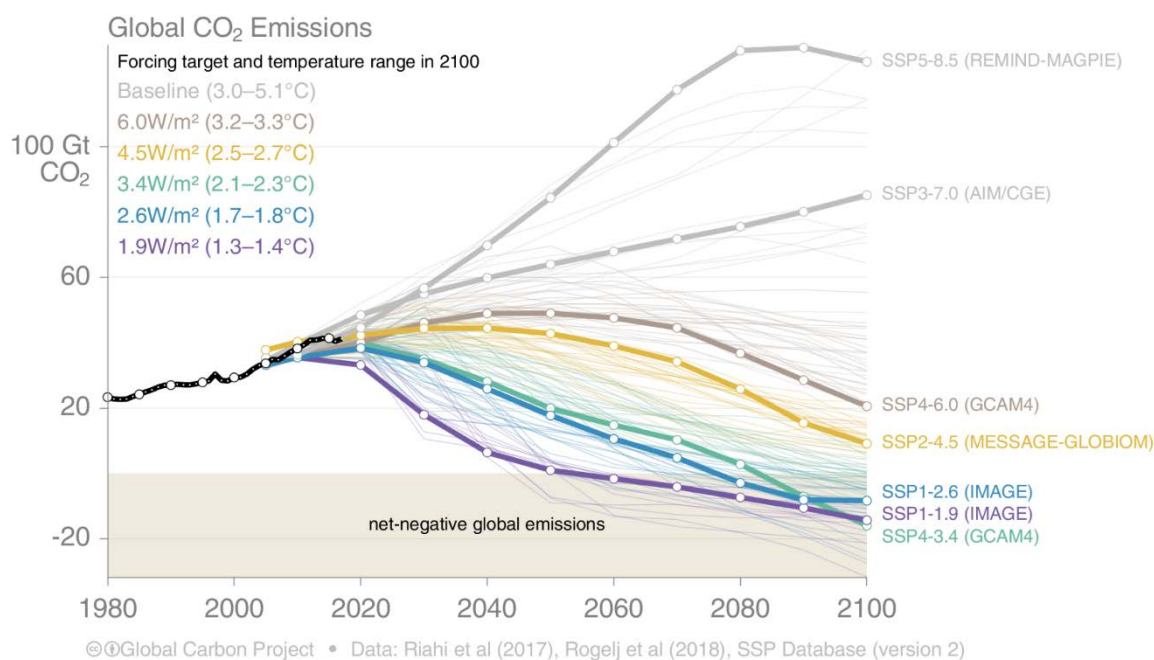


Figure 4. Historic and projected emissions for different Shared Socio-Economic Pathways - SSPs (Global Carbon Project, 2019).

3.2 When is scenario stress-testing useful?

Corporations and financial institutions are exposed to some climate risk regardless of what the temperature increase will end up being, e.g. through loans, investments, insurance or risk underwriting. Achieving the goal of the Paris Agreement would entail comprehensive changes to the way we produce and consume goods and services but saves us from the most dramatic physical effects. If the Paris goal is missed by a wide margin and temperature increases by 3 - 4 °C, the effects of a warmer climate will affect all sectors in all regions, while the transition pressure will be lower (confer section 2.3.1).

In the short to medium term, industries that supply or use fossil fuels are most likely to be disrupted. While transition risks tend to have a built-in lead time for companies to plan and adjust, abrupt shocks that may result from physical climate change deserve immediate attention. Already today, physical climate impacts increasingly confront corporations and financial stakeholders with unplanned and abrupt changes, related to electricity supply, production, transportation, as well as supply chains.

Scenario stress-testing is useful for some risks and periods. Stress-testing against a range of scenarios can help prepare for better management of transition risk. Corporations and the financial sector can improve resilience towards physical impacts, e.g. regarding damages from extreme weather events (Berg et al., 2018). However, in the next 10-20 years, we will witness impacts from past emissions that have already committed us to close to 1.5 °C warming by end of this century. We expect a 2 – 4 °C warming by end of this century, dependent on countries' ability to reduce emissions and meet the Paris Agreement goal of less than 2 °C warming.

3.3 Energy, climate and energy models

Transitional impacts on the energy system can be examined using scenarios in energy system models, e.g. the World Energy Outlook, published by the International Energy Agency - IEA (WEO, 2017). They can be used to e.g. estimate emissions and carbon prices. Physical impacts and transition impacts on a global scale can be examined using scenarios from climate system models. They translate emissions into climate variables, e.g. temperature. Specific regional impacts, e.g. precipitation and wind, can be examined in greater detail using regional models and assessments, downscaled from global climate models. In so-called integrated assessment models, energy system and climate system modules enable linking of models of the energy system to temperature increases in coherent scenarios, as well as calculating economic implications, see the schematic model depicted in Figure 5.

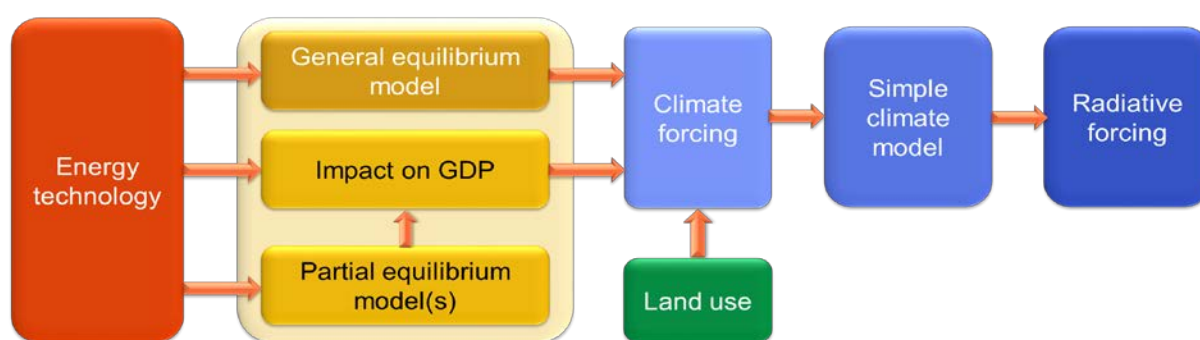


Figure 5. Energy, climate and economic components of a typical integrated assessment model (Aaheim and Torvanger, 2019).

3.4 What do scenarios imply?

The World Energy Outlook (WEO) scenarios are the most widely used scenarios to assess transition risk across various industries. Many other organizations and corporations develop their own scenarios based on the WEO. The WEO is updated annually but only covers the next 20 years.

The WEO from 2017 includes three scenarios: *Current Policies scenario*; *New Policies scenario*; and *Sustainable Development Scenario*. In Figure 6, we have broken the scenarios down into some of their key assumptions, where we consider these as building blocks. They are CO₂ price, energy efficiency, renewable power generation, Electric Vehicles (EV), and CCS. One can think of each scenario as constructed of these building blocks. We don't show the assumptions on demand for oil, gas and other energy sources, which are specific to each scenario. The assumptions in these scenarios show the global levels, e.g. of the renewable energy share in the power mix, which are necessary in order to reach the temperature target in each scenario. While the scenarios work as targets that need to be met in order to achieve a goal (the temperature outcome), they can be translated into a risk perspective. If policy makers are dedicated and committed to a certain temperature outcome, meeting the targets involve transition risk and disruption in various sectors (see section 2.3 for more information on transition risk).

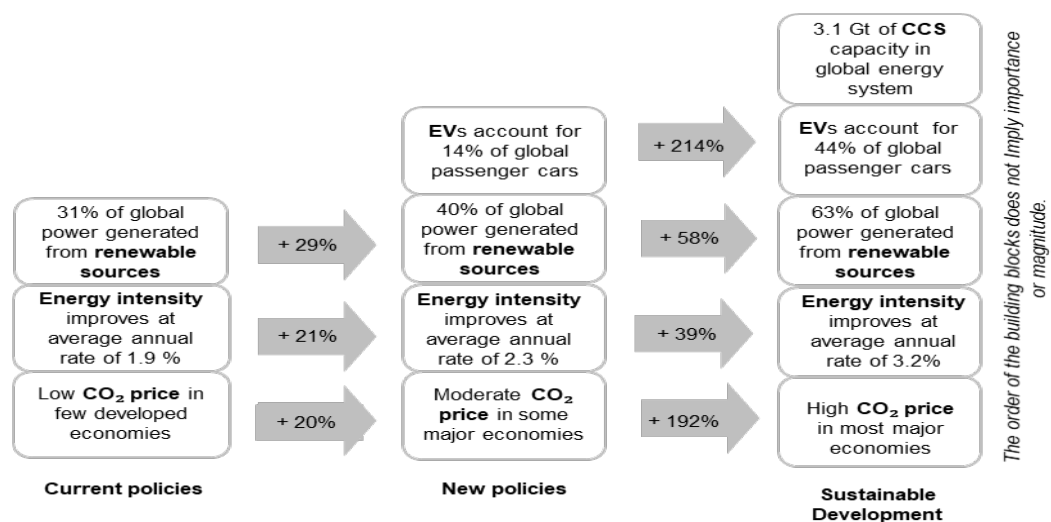


Figure 6. Scenarios from World Energy Outlook (WEO, 2017).

3.5 Challenges for the financial sector when using scenarios

The financial sector is used to operate under conditions of economic, political, monetary and financial uncertainty, and is using scenarios to stress-test their assets and operations against detrimental impacts on asset quality, capital adequacy, and liquidity. However, in terms of the climate change challenge there is a plethora of climate scenarios and modelling approaches available, leaving a confusing landscape for financial actors. Few of the data sources are comparable, and essentially nothing is directed towards supporting risk-based financial decisions in shorter time frames. CICERO has identified several areas where the scenarios on offer today do not match the needs of users in the financial sector, which is a challenge for climate risk reporting and disclosure. The Taskforce on Climate Related Disclosures (TCFD) and upcoming EU regulation recommend more disclosure and better reporting. CICERO has already identified perspectives from users in the financial industry from several workshops, and meetings with financial institutions, and these corroborate with the findings of others (Weber et al., 2018).⁸ Key scenario challenges for financial users include:

- **Risk versus targets:** Emission scenarios are usually developed for temperature or emission policy *targets* to identify what is required in a transition, while the financial sector, and users more broadly work much more closely with probabilities and risk management (Morgan and Keith, 2008).
- **Time scales:** Emission scenarios are generally developed in five- or ten-year time steps, but most financial actors work in time scales of less than five years.

⁸ Examples: Launch of CICERO's "Climate Scenarios Demystified" report (Blackrock, London, February 2018); Finance Dialogue & CICERO scenario workshops with investors (London, June and December 2018); Ny Ålesund Symposium on Navigating Climate Risk (Svalbard, September 2018); the SEI and CICERO event on greening investments and management of climate risk for financial institutions in Sweden, which was part of this research project, funded by the Marianne and Marcus Wallenberg Foundation (Stockholm, May 2019), among others.

- **Metrics:** The financial sector already has a variety of in-house tools that require certain inputs (e.g., gross domestic product, inflation, interest rates), though many of which may not be outputs from scenarios.
- **Granularity:** Emission scenarios often consider country groupings (coarse regions) and a limited number of sectors, while financial actors often need specific sectoral or country detail.
- **Diverse financial mandates:** Some financial actors have an objective to assess climate risk, whereas others want to take one more step and reduce climate risk given existing technologies, policies, and conditions of society. The most dedicated want to capitalize on new opportunities and propel the world towards 2 °C.
- **Diverse scenario users:** There is a broad range of financial actors (e.g. banks, asset managers, asset owners, etc.), each with different needs according to their mandate (risk management, time scales, metrics, granularity, and objectives)
- **Diverse scenarios:** Different modelling and scenario exercises have unique capabilities, some of which may suit some users better than others.

The complexity and partial mismatch must be addressed by scenario producers, scenario users and intermediaries who are able to connect the different approaches to scenarios.

3.6 What kind of climate change and physical effects should Norway expect?

In Norway and the rest of the world we already see climate change impacts, for example flooding due to extreme rainfall. Still, we must prepare ourselves for the unexpected. The experience of the weather conditions we know from recent decades is not enough to prepare for the weather of the future. The total amount of precipitation will increase, except in the summer in southern regions, and the rain will fall more intensely and more frequently (Aamaas et al., 2018; NOU, 2018; Norway's Climate Risk Commission, 2019).

Northern regions are expected to warm more than the average. If the world fails to reduce emissions sufficiently, Norway will in the worst-case face warming of some 5 °C. Norwegian counties will experience similar but also differing effects. The four climate change impacts that are most likely to increase in probability are heavy precipitation, rain floods, storm surges, and different kinds of avalanches (snow, ice, dirt, and stone), see Figure 7 for some examples. Landslides due to increased erosion in streams and rivers can generate liquified clay avalanches.

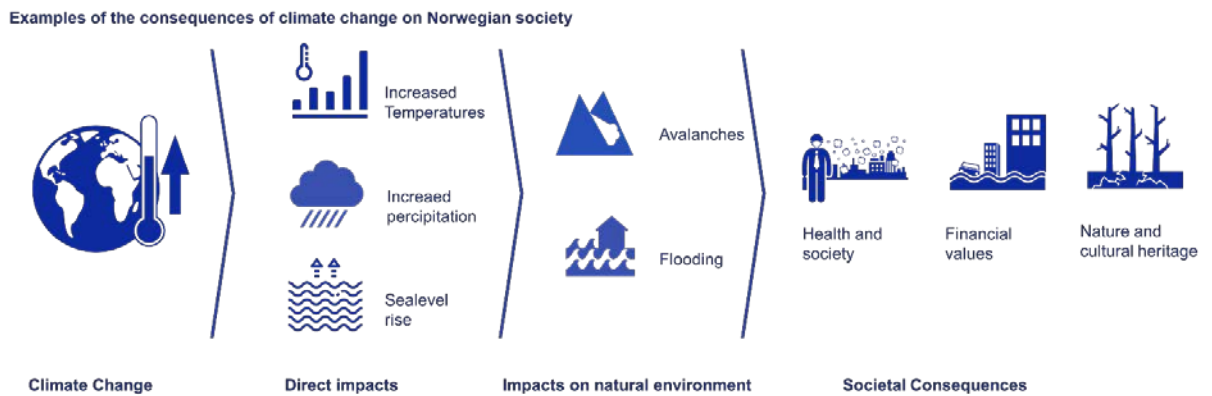


Figure 7. Examples of climate change and consequences in Norway (Aamaas et al., 2018).

To what extent a county is exposed to these climate changes and effects varies greatly. Counties and organizations must therefore assess the likelihood that certain effects of climate change will occur, and to what extent the municipality is exposed and vulnerable. Given well developed economies and institutions, advanced economies, and highly skilled citizens, the Nordic countries have high capacity to build resilience in advance and adapt to impacts from climate change. But the Nordics are also exposed to indirect effects from trading partners and neighboring regions, for example climate impacts that cause economic, social and political instability.

4 Regulating climate risk disclosure

4.1 Introduction

The importance of the financial sector for the transition to a low-carbon society was highlighted in the Paris Agreement (UNFCCC, 2019). In 2015, the Financial Stability Board (FSB) established a Taskforce on Climate-related Financial Disclosures (TCFD) as a result of a request from the G20 group of countries for the FSB to consider the financial stability risks associated with climate change. In 2017 the TCFD developed a set of recommendations to stream-line climate-related financial risk disclosure, see Figure 8 (TCFD, 2017b). Raising awareness in the financial community that climate risk can translate to significant financial risk, the TCFD recommends disclosure on climate risk for all financial actors and companies.

Beyond the voluntary recommendations of the TCFD, some EU countries already have in place mandatory reporting requirements. The most notable example is France's Article 173, which requires carbon disclosure for listed companies and recommends the use of a range of scenarios to physical and transition risks (PRI, 2016). The EU's 2018 Action Plan on Sustainable Finance outlines a path to align the current EU Non-Financial Reporting Directive with the TCFD regulation, creating synergies for reporters and investors. The EU Commission has set up a Technical Expert Group on Sustainable Finance (TEG) to assist the development.



Figure 8. Timeline of key policy initiatives.

4.2 The Taskforce on Climate-related Financial Disclosures (TCFD)

The recommendations of the TCFD are designed to be high-level and applicable to all organizations, with the stated goal of encouraging reporting that is consistent, useful for decisions, and forward-looking. The focus of the recommendations is on the material financial impacts of

climate-related risks and opportunities for companies (TCFD, 2017b). This focus on financial materiality sets the TCFD apart from the majority of so-called non-financial disclosure reporting guidelines in that the TCFD explicitly creates a framework for climate risk to be disclosed as a part of financial reporting (PWC, 2017). The recommendations are structured into four areas of disclosure as described in Figure 9.



Figure 9. Key recommendation of the TCFD (TCFD, 2017a).

A central recommendation from the TCFD is the use of climate scenarios to bound the risks that lie in different futures and climate pathways for corporations as well as financial actors. The TCFD recommends stress-testing across a range of scenarios, including a 2 °C scenario (TCFD, 2019b). The inclusion of scenario stress-testing is one way that TCFD practically encourages companies to implement and report on forward-looking climate risk assessments.

Support for TCFD is strong among financial sector actors. There are over 580 current supporters of the TCFD including major banks, asset managers, pension funds and insurers (TCFD, 2019a). However, the uptake of TCFD reporting was slow to start. A 2018 report from the consultancy EY, which surveyed 500 companies across highly impacted sectors in 18 key markets regarding their implementation of the TCFD recommendations, finds that “most companies are lacking high quality disclosure aligned to the TCFD recommendations” (EY, 2019). Part of the reason for the slow uptake is a lack of guidance and tools, and a lack of understanding of how to engage in the recommended scenario stress-testing. A more recent survey by the credit agency S&P Global, found that of the largest 2500 companies in the world, 70 % have at least limited TCFD filings (Trucost, 2019). The TCFD published a review of climate-related financial disclosures over three years for over 1000 companies. The review found that while disclosure has increased, the level of disclosure is still insufficient for investors, and the taskforce expressed concern about the lack of decision-useful information on climate. A key area where better information is needed is on the link between climate impacts and financial impact on business (TCFD, 2019c).

4.3 EU's Action Plan on Sustainable Finance

The EU has adopted ambitious climate targets and has major investment needs in sustainable infrastructure. To support the engagement of private finance, the EU has begun implementation of a

comprehensive action plan on Sustainable Finance. The aim of the action plan is systematic changes to the EU financial system, the goals being to re-orient capital flows towards sustainable investment, manage financial risks stemming from climate change, resource depletion, environmental degradation and social issues, and foster transparency and long-termism in financial and economic activity (TCFD, 2018). EU's TEG expert group is assisting the development of, among others, guidance on improved corporate disclosure of climate-related information. One of the cornerstone policies to be developed by the TEG is the EU taxonomy for Sustainable Activities (EU, 2019c). The second draft of the taxonomy released in June 2019 lists criteria and thresholds for 67 activities across 8 sectors. This taxonomy presents a binary approach to identifying green activities - an approach that has been met with mixed reactions from the market. Mark Carney, Governor of the Bank of England, stated in a speech at the UN Secretary General's Climate Action Summit 2019 that "Mainstreaming sustainable investing will require a richer taxonomy – 50 shades of green" (Carney, 2019). CICERO has pioneered a climate risk approach to green bond assessments with our shades of green methodology, and with the view that climate risk should be assessed on a spectrum, similarly to other financial risks. The EU commission had originally planned to introduce the taxonomy in 2020, but recently pushed back implementation until 2022 (Reuters, 2019). All planned actions on sustainable finance are shown in Figure 10.

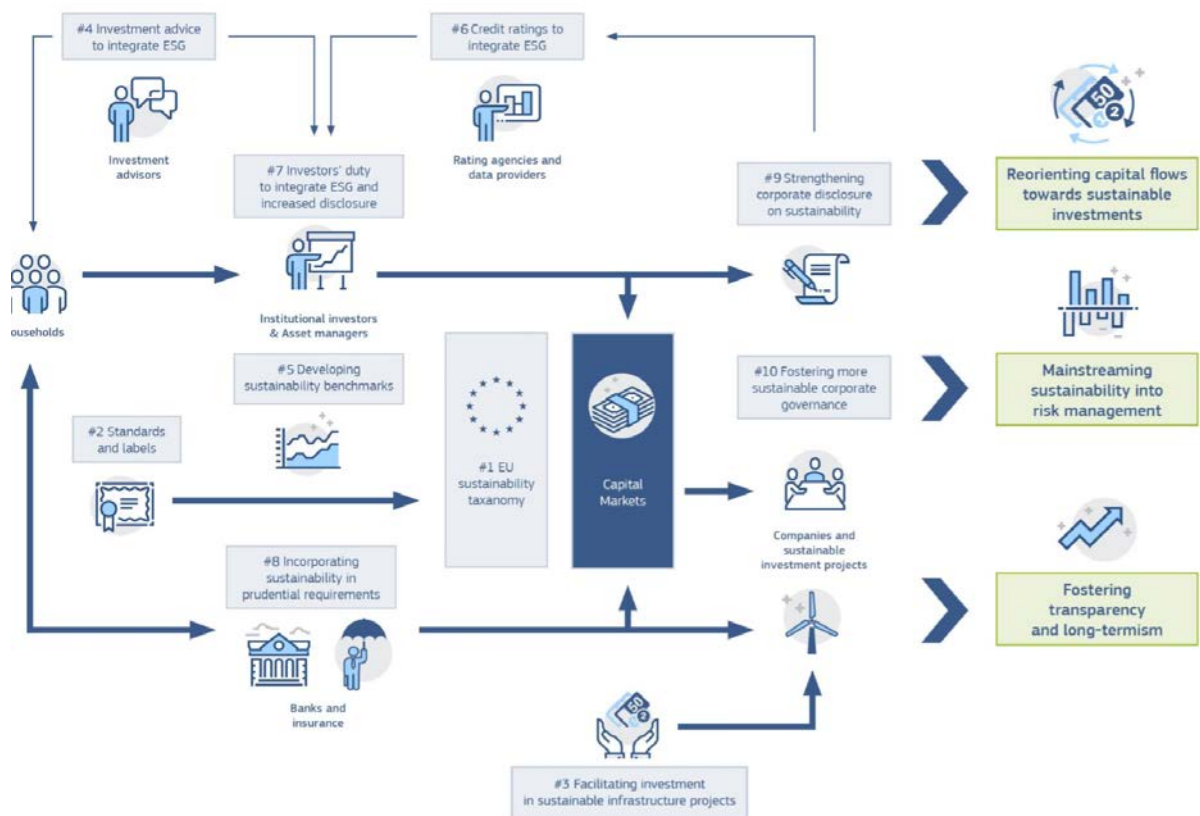


Figure 10. Planned EU actions. (EU, 2018).

A key aspect of the EU action plan is changes to the EU's Non-Financial Reporting Directive (NFRD). NFRD requires large companies to disclose material Environmental, Social, and Governance (ESG) risks, and how these risks are managed (EU, 2019a). The Directive currently allows companies to disclose information in a flexible manner. The EU action plan states that

going forward, an appropriate balance needs to be struck between flexibility and standardization of disclosure to better facilitate data analysis for investment decisions (EU, 2018). The Commission also notes that there are concerns that the current accounting rules are not conducive to sustainable investment decision-making.⁹

Strengthening sustainability disclosure and accounting rulemaking (action 9 in the EU action plan) includes a revision of the Non-Financial and Diversity Information (NFI) directive. The TEG released their Report on Climate-related Disclosures in January 2019 (TEG, 2019a). The report proposes updated guidance to companies on reporting in line with the TCFD recommendations. The TEG provides guidance on climate related disclosures on the company's business model, policies and due diligence processes, outcomes, principal risks and risk management, and key performance indicators. For an overview of the disclosures that the TEG expects all companies to disclose (scope 1 disclosures), see Table A1-1 in Annex 1. Scenario analysis is highlighted as an important tool for companies, though not explicitly mentioned in the scope 1 disclosures. A summary of responses to the call for feedbacks to the report is found in TEG (2019b).

4.4 Norwegian policy context

In their final report, the *Climate Risk Commission*, appointed by the Norwegian government, suggested that the government should endorse the principles on disclosure and reporting recommended by TCFD, and focus on the usefulness of scenario analysis (NOU, 2018; TCFD, 2018).¹⁰

The Ministry of Finance provides annual reports on the financial stability and financial market in Norway, for the Norwegian Central Bank. The 2018 report included a brief section on climate risk, noting that the government will consider changes to disclosure requirements on the basis of how TCFD recommendations are taken up by market actors, recommendations of the climate risk commission, and international policy developments (Ministry of Finance, 2018; EU, 2018).

Finance Norway has developed a financial industry roadmap for green competitiveness. The vision presented in the roadmap is that the finance industry creates value and contributes to green competitiveness by financing and securing climate knowledge and good management. The Norwegian roadmap has similarities with the European Commission's action plan for financing sustainable growth. Among the recommendations outlined is to align climate reporting with the recommendations of the TCFD (Finance Norway, 2018).

4.5 Moving forward on regulation

The recommendations of the Financial Stability Board's TCFD are important first steps to establish tools and a common language to describe climate risk for corporations and the financial sector (TCFD, 2017a). The EU Action Plan takes important steps towards designing EU financial policy to foster sustainable finance, and at the national level in Norway there are government and industry initiatives to assist disclosure of climate risk.

⁹ The action plan specifically mentions concerns of the impact the new accounting standard on financial instruments (IFRS 9) might have on long-term investments.

¹⁰ The commission was led by Martin Skancke, who is chair of the UN Principles of Responsible Investment.

For reporting companies and their investors, the current situation is that there are many overlapping guidelines and initiatives at the international, regional and national levels. In addition to those discussed above, there is a multitude of voluntary guidelines and initiatives for reporting sustainability data, for example the Global Reporting Initiative (GRI) and Climate Disclosure Project (CDP).

Financial sector actors have a dual role as both users and providers of information and disclosure. Efforts to align guidelines and communicate alignment to reporting organizations may be key to success. The EU Action Plan guidelines and the local Norwegian guidelines either build on the TCFD recommendations or have the explicit goal to integrate TCFD recommendations. TCFD on its end has already mapped the alignment of their recommendations to several voluntary guidelines including the G20/OECD Principles of Corporate Governance, CDP, GRI, Climate Disclosure Standards Board (CDSB) reporting frameworks and the International Integrated Reporting Framework (TCFD, 2017b). A potential hurdle for complete alignment is that the guidelines have different audiences and different scopes. For example, whereas TCFD is focused on risks to the company as a result of climate change and climate policy, the EU NFRD covers both these and how company operations impact climate change and policy. The TCFD is also more narrowly focused on disclosures to investors, whereas many voluntary guidelines target disclosure to all stakeholders.

5 An interview-based survey among financial institutions in Norway and Sweden

An interview-based survey among financial institutions in Norway and Sweden was carried out in autumn 2017 and spring 2018. The purpose was to map knowledge and perceptions of climate risks, current management of these risks within the institutions, and explore how risk management could be improved. Large institutions within different categories of financial institutions were selected (a few institutions declined to participate). We ended up with interviewing representatives from 15 Norwegian and 5 Swedish institutions. These are commercial banks, pension funds, insurance companies, asset management, private equity, and sovereign equity funds. The interviews lasted about one hour and were conducted at meetings at the financial institutions. In a couple of cases the interviews had to be done over phone or as a written response to the questionnaire. The questionnaire shown in Annex 2 was sent out to all interviewees in good time before the interviews were done.

The findings from the survey are presented in terms of perceptions and management of climate risk, and measures for improved management of this risk in section 6, before an interpretation of these findings in section 7. A complete summary of the interviews is shown in Annex 3, divided into three tables on knowledge and perceptions, needs related to risk management, and suggestions for improving climate risk management.

6 Review of perceptions and management of climate risks based on interviews with financial institutions in Norway and Sweden

6.1 Perceptions of climate risk

Based on the interviews we find that the financial sector in Norway and Sweden accepts that global warming is ongoing and that it is mostly induced by human actions (confer Table A3-1 in Annex 3). So far only small physical impacts of climate change have been observed, and these are mostly of concern for insurance companies. The Paris Agreement is considered as a milestone that provides a clear signal of the direction forward. The world's ability to meet the 2 °C target is, however, considered as uncertain. Norwegian financial institutions have a special focus on transition risks associated with fossil fuel related investments. Oil and gas extraction and the associated supply chain represents a large share of the Norwegian economy.

There are big differences when it comes to the level of knowledge among employees in financial institutions, with variations across positions in an institution and across institutions. The knowledge level is highest among employees responsible for sustainability, commonly referred to in the industry as Environmental, Social, and Governance (ESG).

6.2 Management of climate risk

6.2.1 Strategies

Climate risk is given attention in leadership groups. However, the understanding of climate risk varies and is limited in many cases (confer Table A3-2 in Annex 3). Some managers believe that climate risk does not affect financial returns. The knowledge gaps regarding uncertainty, scenarios, and sustainability among employees often mean that climate risk is not managed systematically and in a satisfactory manner. Formal processes for incorporating climate risk are emerging in some institutions - often within asset management, but is absent in others. Some interviewees think that climate risk indicators and qualitative assessments are not important. A short investment time horizon in the financial sector is an obstacle to prioritize climate risks, since climate risks are perceived to be long-term. Others see the value in ESG indicators in general, but do not find the indicators delivered by third party actors very useful.

Sustainability concerns are part of for Corporate Social Responsibility (CSR) and Public Relations (PR) but does not yet play an important role for risk assessments and management of assets and portfolios. Some interviewees expect that better management of sustainability will support long-

term return on investments. Reducing the energy use and the carbon footprint of property and assets is seen as straightforward targets.

The financial institutions have so far not made substantial changes to their organization, but some procedural changes have been carried out to better integrate ESG concerns in their operations. Some institutions have re-allocated personnel or hired new employees to better handle climate risk and sustainability, for instance to increase capacity to handle green bonds.

In terms of portfolio management, most of the interviewees are actively incorporating some aspects of ESG risk management. The main alternatives used are setting standards, such as using sustainability criteria to define minimum performance for inclusion in a portfolio, ESG risk analysis, and active ownership (i.e. asking questions to company management and trying to influence operations), or exclusion. It makes sense for long-term investors to include sustainability in their due diligence processes. The most important measures are reducing overall risk through diversification of assets in a broad portfolio, reduced exposure through divesting from fossil industries, and more focus on climate-friendly investments. Not much is done on improving resilience to climate change impacts or adapting to impacts that have occurred, so this area is a promising investment opportunity. Some institutions have adopted extended mandates to lend to companies in the renewable energy sector.

6.2.2 Tools

Management of climate risks require methods, tools and data. A straightforward method is to select a set of indicators relevant for physical and/or transition risks, allowing comparison of performance across portfolios and assets, as well as disclosing some aspects of an institution's own performance. The most common climate-related indicators among the institutions are energy use and carbon dioxide emissions. Water use and wastewater management are reported by some institutions. Some calculate carbon intensity, defined as carbon dioxide emissions relative to energy use or economic value of activity. Reporting of energy use and carbon dioxide emissions is most developed. Scenario analysis is used by about a quarter of the financial institutions. Some interviewees state that scenarios are not relevant to their business due to their short investment time horizon. Many institutions rely on qualitative assessments of climate risk. The IPCC reports and documents on the Paris Agreement documents are less useful, since they are too broad and not adapted to the needs of the financial sector. When assessing performance of companies invested in, annual reports are of mixed value.

When analyzing an institution's own performance in terms of operation of buildings and emissions due to travels, easily accessible and relevant indicators are energy use in buildings, carbon footprint from buildings and travels, and water and waste management. The same indicators are relevant when assessing operations of companies invested in, but in this case the focus is on physical and transition risk of a company, and how well this risk is managed. Asset and portfolio managers in almost half of the financial institutions attach weight to ESG measures in companies, whereas other financial institutions consider ESG as less relevant for investors.

During the interviews conducted in this project, respondents mentioned the risk of 'reporting fatigue' among companies and in their own organizations. Collecting information from each company is possible when the portfolio consists of a limited number of assets, but not for a big portfolio.¹¹ Purchase of ESG and climate-related data from specialized external providers makes a broader and more comprehensive assessment of a portfolio feasible. ESG data can be used to

¹¹ As an illustration a big portfolio could be defined as containing more than a hundred assets. For lenders, such as commercial banks, collection of information is easier since they require enough documentation from companies to provide loans.

determine the level of engagement with a company, such as issues to bring up at meetings, voting at general assemblies, and as a last resort, exclusion of a company based on certain criteria.

6.3 Improved management of climate risk

In the interviews, representatives from the financial institutions were asked about their needs to improve management of climate risk.

In terms of knowledge on climate change, an overview of the big climate picture is important, as well as more comprehensive climate risk information, dependent on the financial institution's business and sector engagement, relevant technologies, locations, and time perspectives (confer Table A3-3 in Annex 3). Knowledge about specific climate risks is needed, foremost climate impact indicators that depend on space, time and risk level. Better knowledge is important, as well as improved competence, and capacity to assess climate risk, and the most material climate risks should be identified. The importance of physical risks compared to transition risks depends on the financial institution's business area. Exposure to fossil fuels is an important indicator of transition risk, whereas physical climate change impacts sectors to different degrees, real estate being an example of a highly exposed sector.

7 Interpretation of interview findings

How do these responses compare to our assessment of how well the financial sector is managing climate risk today?

Where should the financial institutions be moving in terms of management of climate risk in the next decade?

Management of climate risk should be made more systematic. This means understanding how climate risk can affect certain sectors, time horizons and asset classes under different scenarios, and how this knowledge informs decision making and improved capacity in terms of personnel, organization and procedures required. High-risk investments could be avoided, and risk reduced through diversification across different sectors, technologies and locations. As an example, risk associated with agriculture related investments can be reduced through investing in a portfolio of assets across locations, crops and practices. In some cases, purchase of insurance can be a good supplement. Asset positions with high or increasing risk should be evaluated for the possibility of divestment. Since some climate change is unavoidable, business opportunities related to improved resilience to climate change are of high interest. Climate change and stricter climate policies not only generate possible costs, but also new business opportunities in climate friendly and robust sectors and technologies.¹²

Climate change being only one among many environmental and social considerations, this implies that a better understanding of the broader sustainability issues, and on possible trade-offs between these, should be sought. Sustainability perspectives are relevant both for operation of own institutions as well as for investments in bonds and equities. In addition, the broader sustainability scope can be handled through ESG and Socially Responsible Investment (SRI). In this process collaboration with external knowledge providers is useful. More and more attention will be given to assurance and companies' performance with respect to climate friendliness and robustness for own operations and for assets invested in. Information on climate-related risks should be integrated into the operations and management of all financial institutions.

The most promising investments combine good climate risk management with competitive combinations of return and risk. At the asset level it makes sense to steer away from fossil industries in the long run. New investments should be assessed for vulnerability regarding policy changes, higher carbon pricing, changes in consumers behavior, and possibility to pass on higher costs to customers.

When investing in companies, the credibility of the company's strategy should be considered, together with the viability of business model, responsiveness to future challenges, and the capacity and flexibility to adapt to changing conditions. Robustness of companies regarding climate risk is essential. To compare the climate risk preparedness of companies an interesting approach is 'stress-testing', where one assesses whether a company is moving in a more climate-friendly and climate robust direction, whether the company is flexible and able to adapt to expected climate changes, has

¹² Some interesting green opportunities are interconnectors that improve grid efficiency and capacity, electric transportation, high-capacity batteries, fuel cells powered by hydrogen, rail-based transport, efficient and smart buildings, 'sharing economy' enabled by new information technologies, and digital platforms.

a viable business model, and in-house capacity to handle climate risk. Stress-testing may also include an assessment of market prospects for the company's products. The overall carbon dioxide intensity of a company invested in can be compared to an average or a minimum performance level for that industry.

Both physical impact risks and transition risk of companies should be considered. The standard indicators employed in the financial sector are energy use and efficiency, and carbon footprint and intensity. Waste and water management is added by some institutions. Assessing climate risk would be made easier if a standard was established, defining a list of indicators, including definitions and measurement of these indicators. Lifecycle and supply chain data should be included in the methodology. A standard methodology would make assessments and comparison of companies by third parties more straightforward, for instance in the form of a screening tool for companies. To collect data, a standard list of questions for company leaders would be useful. The financial sector should support research that can improve methodologies, tools and data collection to improve the sector's preparedness for climate change and climate policies. Currently there is limited information available from companies on climate-related risks, so better disclosure of climate-relevant activities would be beneficial. In any case improved transparency and disclosure of climate-related information is essential, in accordance with due diligence and best practice. More data and more detailed data are needed to reduce uncertainty. This information must be transparent and practically useful for the financial sector.

8 Way forward

To improve the ability of financial institutions to manage climate risk they will need easily accessible and practically useable information relevant for climate risk assessments. Financial institutions need a broad overview of climate change issues, but also specific information related to space, time and level of risk associated with each institution's business area. Given the overload of climate risk relevant information, selecting and synthesizing information is essential. A lot of climate risk information is available from various suppliers, but the information is not comprehensive enough, lacks standardization, or is not sufficiently transparent. Climate risk should be assessed as one important issue in a broader sustainability context. Qualitative information can be more useful than numbers due to high uncertainty associated with numerical analyses.

A more common language on green and climate friendly is beneficial, as well as more emphasis on and standardization of climate risk disclosure. More consistency of climate risk relevant indicators, definitions and data collection is helpful for the financial sector and its relations to investors and society in general. More and better data is needed for scenario analyses, both for the near-term and long-term. The data and tools to analyze and interpret results must be sufficiently flexible as to allow the information to be fitting and handy for a financial institution, given its business and needs.

The handling of climate risk would be simplified if managed in a more systematic manner. This also connects to the credibility of an institution's strategy and preparedness regarding climate risk. Both risks related to physical climate change and risks related to the effects of stricter climate policies (transition risk) are relevant for financial institutions, but the relative importance depends on the business area of a financial institution. Stricter climate policies will imply price changes to input factors for companies and to demand for their products and services. Real estate is a sector particularly exposed to physical risk. High exposure to fossil fuels or a high carbon footprint increases the transition risk. At the portfolio level climate risk can be reduced through diversification across different assets. Climate change, however, also implies new business opportunities, not the least in terms of smart investments to improve resilience to the impacts of climate change and higher robustness regarding transition risk.

More learning and capacity building on climate risk are important, both in terms of organization, procedures and personnel of an institution. This can help support mainstreaming of climate risk within an organization.

ANNEX 1. Recommended climate-related disclosures from EU's Technical Expert Group on Sustainable Finance (TEG)

EU NFRD Overview of Recommended General Disclosures	
<i>Irrespective of own assessment companies should disclose:</i>	
<ul style="list-style-type: none"> • their governance processes addressing climate-related risk and opportunities, • how climate change is incorporated into their strategy and risk management processes, and • their direct GHG emissions (Scope 1) and GHG emissions from consumption of purchased electricity, heat or steam (Scope 2) 	
<i>Based on own assessment companies should disclose</i>	
Business Model	<ul style="list-style-type: none"> • Significance of climate-related issues for the business model and impact on strategy.
Policies and Due Diligence Processes	<ul style="list-style-type: none"> • Board's oversight of climate-related risks, opportunities and impacts (TCFD Governance). • Management role in assessing and managing climate-related risks, opportunities and impacts (TCFD Governance). • Systems and processes in place for identifying, assessing climate-related risks and impacts and how they are integrated into their overall risk management (TCFD Risk Management).
Outcomes	<ul style="list-style-type: none"> • GHG emissions and related targets. • Impact of the company's activities on climate change and natural capital dependencies also including those related to water consumption, deforestation, biodiversity loss, pollution, land use, etc., where relevant. • Insights on impact of climate-related risks and opportunities on the strategy, financial planning as well as mitigation and adaptation actions.
Principal Risks and Their Management	<ul style="list-style-type: none"> • Climate-related risks and opportunities identified over the short, medium, and long term (TCFD Strategy). • Processes for managing climate-related risks (TCFD Risk Management). • Impacts of the company on climate change mitigation and/or adaptation.
Key Performance Indicators	<ul style="list-style-type: none"> • Scope 1 and Scope 2 emissions and emissions from the value chain (Scope 3). • GHG emissions targets. • Sectoral and company-specific key performance indicators (KPI).

Table A1-1. Overview of recommended general disclosures from EU's Technical Expert Group on Sustainable Finance (TEG) (EU, 2019b).

ANNEX 2. Questionnaire for financial institutions

The Wallenberg climate finance project: Questions on climate risk knowledge and management among investors

Short narrative on background and purpose of the project.

This interview is part of the project 'Greening investments in the face of climate risk', funded by the Wallenberg Foundation. The project is carried out by CICERO and Stockholm Environment Institute (SEI). SEI explores motivations for issuers and investors to engage in the green bonds market. CICERO explores knowledge level and handling of climate change related risks among investors in green financial products, foremost green bonds. Based on CICERO's findings, we will propose improvements to the climate change information for financial markets, in terms of both accessibility and usefulness of the information.

This interview belongs to CICERO's part of the research project. The interview will last about one hour.

Thank you for your willingness to participate in this study!

Introduction

- A. What do you associate with climate risk?
- B. Are you familiar with the Paris Agreement?
- C. Do you think the climate target in the Paris Agreement of less than 2 °C warming by 2100 can be met?

Handling of climate risk

Climate risk depends on the climate scenario (climate change), the exposure of your company/organization to climate change, and your vulnerability. Climate risk can be due to physical impacts or to new or stricter climate policies, e.g. causing a higher price on carbon dioxide emissions. Figure 1 portrays the main physical and transition (policy) risks, and how they translate to potential financial impacts.

Your organization

- 1. What is your role in the organization (bank/company/fund/stock exchange/consultancy/public authority)?
- 2. Have you invested in green bonds or other green financial products?

Impacts, exposure and vulnerability

- 3. Is your company **today affected** by climate change impacts; in case which?

4. What do you anticipate to be the most important and **challenging climate risk** related issues for your company by 2030?
5. Is your business today **vulnerable to physical impacts** of climate changes (flooding, droughts, sea level rise, and disturbances of delivery chains)? Will your company be more affected by **physical impacts** of climate change (exposure) by 2030?
6. Is your business today **vulnerable to policy changes** to support green transformation, such as a higher carbon price, or to major technological changes? Will your company be more affected by **climate policy** changes (exposure) by 2030?

Disclosure and risk management

7. Do you measure and/or **report on climate-related indicators** (such as emissions of carbon dioxide) for your investment portfolio? In case, where?
8. Are risks and opportunities from climate change **integrated** into your company's risk analysis - or portfolio management and risk analysis - e.g. as a sustainable/green investing strategy, or another green offering? In case, what tools and ratings do you use?

Climate scenarios and hazard

9. If integrated into your company's risk analysis, what climate change **scenarios** do you build on?
10. How do you consider and **handle uncertainties** related to climate change and future policies?

Risk management

11. Has your company over the last five years invested money to **improve resilience** to climate change (reducing vulnerability)?
12. Do anticipated climate change impacts lead you to **divest** from certain assets in order to reduce the vulnerability of your portfolio?
13. How is climate risk **managed** in your organization? Have you **recruited** or allocated work force to climate risk related work?
14. Have you made changes to the **organization, system, or procedures** to better manage climate risk related challenges?

Accessible and useful information

15. What type of **scientific-based information on climate risk** are you currently using, such as Bloomberg, specialized ESG analysis or databases, news reports, company reports, etc.?
16. What would be most useful **scientific-based information on climate risk** to your organization? (Examples are temperature change, precipitation change, extreme weather risk, supply chain disturbances, impacts on food prices, availability of water for industry and households, indirect price effects through energy and other markets, carbon price to meet Paris agreement target, reduced fossil subsidies, and market prospects for fossil energy).
17. How should scientific-based information **best be communicated and transferred** to you and your organization – What form and through which channels? (Examples are compact reports, seminars, media articles, graphics, tables, computer tools, and interactive computer tools).

ANNEX 3. Summary of interviewees' responses to the questions on climate risk and management

CLIMATE RISK KNOWLEDGE, STRATEGIES AND PRACTICES USED BY FINANCIAL INSTITUTIONS.			
Level	Knowledge	Strategies	Tools
All levels	<p>Large differences in knowledge level across employees, dependent on role in institution.</p> <p>Agreement on that human-made global warming is happening, the Paris Agreement is a milestone with a clear signal, but that the World's ability to meet the climate target is uncertain.</p> <p>So far small physical climate impacts, with exception of insurance companies.</p> <p>Transition risk through fossil-related investments.</p>	<p>Climate change and risk are given attention in leadership groups.</p> <p>Build knowledge, competence, and capacity.</p> <p>Collaboration with external knowledge providers is useful.</p> <p>More attention to the broader sustainability agenda.</p> <p>Reduce carbon footprint.</p> <p>Reduce energy use.</p>	<p>Carbon footprint calculations.</p> <p>Energy use.</p> <p>Qualitative assessments.</p> <p>GHG emissions reporting most developed.</p> <p>Annual company reports are of mixed value.</p> <p>IPCC and Paris Agreement documents are less useful.</p>
Corporate level	<p>Not sure that green bonds make a difference.</p> <p>Climate risk not managed systematically due to lack of understanding.</p>	<p>Some institutions use scenarios.</p> <p>Can use a set of scenarios to handle uncertainty.</p> <p>No substantial changes to organization.</p> <p>Some procedural changes due to better ESG integration.</p> <p>Some expect that sustainability supports long-term return.</p> <p>Identify most material climate risks (TCFD).</p> <p>Some have hired new employees to better handle climate risk and sustainability.</p>	<p>Energy use in own buildings.</p> <p>Carbon footprint from buildings and travel.</p> <p>Water and waste management.</p> <p>ESG score relevant for some, not for others.</p> <p>Some re-allocation of personnel.</p> <p>Increase capacity to handle green bonds.</p> <p>Financial products better aligned with sustainability.</p>
Portfolio level	<p>Some managers think climate risk does not affect financial returns.</p> <p>Unsatisfactory understanding of climate scenarios, and uncertainty.</p>	<p>Main alternatives: setting standards, active ownership, exclusion, and ESG risk analysis.</p> <p>More climate-friendly investments, such as green bonds.</p> <p>Reduced exposure through divesting from fossil industries.</p> <p>Diversification through broad portfolio.</p> <p>Green opportunities in interconnectors and grid efficiency and capacity, electric transport, batteries, railroad, efficient buildings, 'sharing economy', digital platforms, hydrogen and fuels cells.</p> <p>Some use climate scenarios.</p> <p>Others assess robustness of companies.</p> <p>If a company is doing little, ask questions and try to influence.</p>	<p>Carbon footprint, carbon intensity, and energy use of companies.</p> <p>Water and waste management.</p> <p>Collect information from each company, if not too many in portfolio.</p> <p>Stress-test companies: assessing whether a company is moving in right direction, is flexible and able to adapt, has a viable business model, and capacity to handle climate risk.</p> <p>Assess future markets for company's products.</p> <p>Extended mandates to lend to renewable energy.</p> <p>The time horizon of portfolio managers can be short.</p>

Individual level (equity, debt)	Limited understanding of sustainability and climate risk.	Steering away from fossil industries. New investments assessed for vulnerability w.r.t. policy changes, higher carbon pricing, changes in consumers behavior, and possibility to pass on higher costs to customers. Investments in resilience as an opportunity.	Overall CO ₂ intensity compared to external index. Use ESG data to determine how to engage with a company, e.g. general assembly voting, exclusion or not. Some think that climate risk indicators and qualitative assessments are not important.
Asset level	Limited understanding of sustainability and climate risk.	Long-term investors include sustainability in due diligence processes. Sustainability is not a CSR/PR consideration. No formal process to incorporate climate risk. Short investment time horizon.	Some financial institutions find that scenarios are less relevant, e.g. due to a short investment time horizon.

Table A3-1. Climate risk knowledge, strategies and practices used by financial institutions.

NEEDS RELATED TO CLIMATE RISK MANAGEMENT				
Level	Knowledge	Strategies	Tools	Activities
All levels	Big climate picture.	More systematic management of climate risk.		
Corporate level	More comprehensive climate risk information.	Better capacity in terms of personnel, structure and procedures.	Carbon footprint. Carbon intensity. Energy efficiency. Water and waste management.	Focus on new business opportunities. Support research. Report to Climate Disclosure Project, etc.
Portfolio level	Physical impacts. Transition/policy development risks. New business opportunities.	Diversification across different sectors, technologies and locations. Promising climate-related investments: new technologies, green financial products. Climate friendly and climate robust.	Carbon footprint. Carbon intensity. Energy efficiency. Water and waste management. Oil and gas exposure. Standard for operation of companies. Third party assessments. Disclosure. Due diligence.	Support development of standards. Seek more detailed data and reduce uncertainty. Improve transparency and disclosure. Assess physical impact risks of companies. Assess transition risks of companies. Assess performance.
Individual level (equity, debt)	More knowledge about climate risk. Climate impact indicators – space, time, risk level. Exposure to fossil fuels. Better understanding of sustainability: definition and interpretation, trade-offs across different goals.	Resilience as business opportunity. Handling of ESG and SRI. Integrate information. Avoid high-risk investments.	Standard list of questions for company leaders. Screening tool. ESG screening tool for loans.	Practically useful information. Diversify investments to reduce risk. Divest from positions with high or increasing risk. Build higher resilience to physical and transition climate risks. Lending function receive extended mandate.
Asset level	Impacts on real estate. Disclosure of climate-relevant activities. Knowledge about specific climate risks.	What time horizon are decisions based on? Assess company strategy realism. Viability of business model. Assess flexibility. Responsiveness to future challenges. Capacity to evolve. Improved resilience as business opportunity.	Life-cycle analysis. Climate risk stress test. Insurance.	Practically useful information. Diversify investments to reduce risk, e.g. in agriculture across locations, crops and practices; in insurance across different objects at different locations. Divest from positions with high or increasing risk.

Table A3-2. Needs related to climate risk management.

SUGGESTIONS FOR IMPROVING CLIMATE RISK MANAGEMENT				
Level	Knowledge	Strategies	Tools	Activities
All levels	Increase knowledge on how climate change may impact different sectors and activities, and how this may lead to financial losses or gains.	Increase climate risk capacity.		Easily accessible and usable knowledge.
Corporate level	Improve understanding of climate risk.	Identify robust strategies.	Standardize climate risk information. More comprehensive life cycle analysis. Qualitative tool to measure climate risk. Brief reports.	Seminars. Media, op-eds, etc. Climate courses. Dialogues and meetings.
Portfolio level	Identify new business opportunities. Improve risk profiles of different industries and technologies. Improve scenario analyses. Improve transition risk assessment.	Opportunities in new industries and technologies, e.g. renewable energy, grid infrastructure, and green financial products.	Databases. Qualitative tool to measure climate risk. Internet based tools. Brief reports.	Seminars. Climate courses. Dialogues and meetings.
Individual level (equity, debt)	Develop specific climate impact indicators: space, time, risk level.	Enable longer time horizon for company decisions.	Internet based tools. Qualitative tool to measure climate change risk. Quantitative tool to measure climate change risk. Internet based tools. Brief reports.	Seminars. Climate courses. Sustainability courses. Dialogue and meetings. Due diligence review. Short, quick reactions to market developments.
Asset level	Specific climate impact indicators: space, time, risk level.		Internet based tools.	Brief reports. Seminars. Dialogue and meetings.

Table A3-3. Suggestions for improving climate risk management.

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CICERO is Norway's foremost institute for interdisciplinary climate research. We help to solve the climate problem and strengthen international climate cooperation by predicting and responding to society's climate challenges through research and dissemination of a high international standard.

CICERO has garnered attention for its research on the effects of manmade emissions on the climate, society's response to climate change, and the formulation of international agreements. We have played an active role in the IPCC since 1995 and eleven of our scientists contributed the IPCC's Fifth Assessment Report.

- We deliver important contributions to the design of international agreements, most notably under the UNFCCC, on topics such as burden sharing, and on how different climate gases affect the climate and emissions trading.
- We help design effective climate policies and study how different measures should be designed to reach climate goals.
- We house some of the world's foremost researchers in atmospheric chemistry and we are at the forefront in understanding how greenhouse gas emissions alter Earth's temperature.
- We help local communities and municipalities in Norway and abroad adapt to climate change and in making the green transition to a low carbon society.
- We help key stakeholders understand how they can reduce the climate footprint of food production and food waste, and the socioeconomic benefits of reducing deforestation and forest degradation.
- We have long experience in studying effective measures and strategies for sustainable energy production, feasible renewable policies and the power sector in Europe, and how a changing climate affects global energy production.
- We are the world's largest provider of second opinions on green bonds, and help international development banks, municipalities, export organisations and private companies throughout the world make green investments.
- We are an internationally recognised driving force for innovative climate communication, and are in constant dialogue about the responses to climate change with governments, civil society and private companies.

CICERO was founded by Prime Minister Syse in 1990 after initiative from his predecessor, Gro Harlem Brundtland. CICERO's Director is Kristin Halvorsen, former Finance Minister (2005-2009) and Education Minister (2009-2013). Jens Ulltveit-Moe, CEO of the industrial investment company UMOE is the chair of CICERO's Board of Directors. We are located in the Oslo Science Park, adjacent to the campus of the University of Oslo.