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Climate assessments of six key Norwegian sectors

°CICERO

Center for International Climate Research

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Abstract: The Sustainable Edge sector briefs summarize material climate-related risks and impacts to investors and lenders. The briefs cover key risks, emission sources, risk management and climate-related regulation relevant for each sector. They also provide key analyst questions that are important to consider in order to understand the climate risk of companies in the sector. The sector briefs are developed to support capacity building on climate risk in financial institutions.

The six sectors covered are agriculture, aluminium, aquaculture, land transport, real estate, and shipping. The next section summarizes some key messages from each brief.

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Contents

Sustainable Edge Sector Briefs

Year 2020

Summary

The CICERO sector briefs summarize material climate-related risks and impacts to investors and lenders. The briefs cover key risks, emission sources, risk management and climate-related regulation relevant for each sector. They also provide key analyst questions that are important to consider in order to understand the climate risk of companies in the sector.

The sector briefs are developed to support capacity building on climate risk in financial institutions. The audiences for the briefs are both potential investors and lenders to the sector.

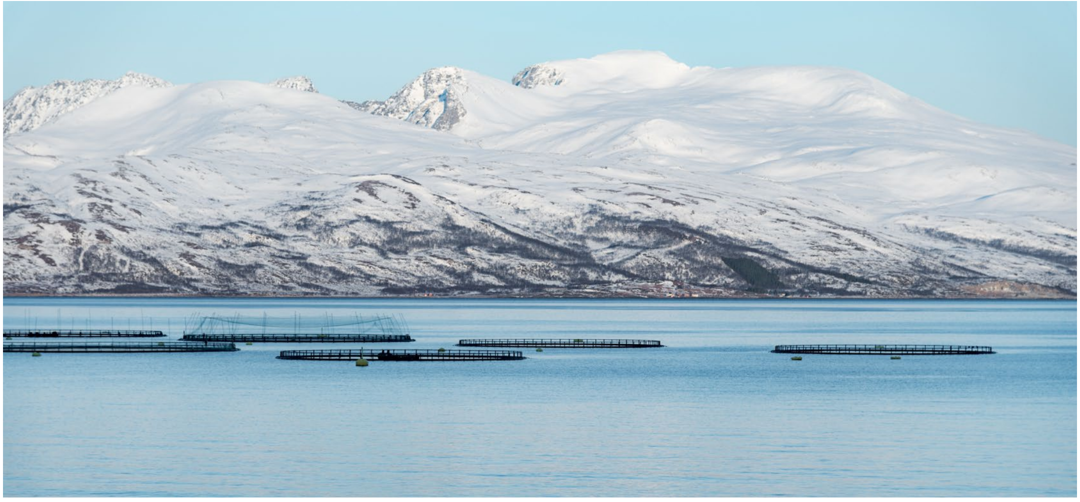
The six sectors covered are agriculture, aluminium, aquaculture, land transport, real estate, and shipping. The next section summarizes some key messages from each brief.

The briefs were developed by CICERO and CICERO Shades of Green as a part of the Sustainable Edge research project. The topics covered in the briefs were chosen after dialog with financial sector partners on their key needs and interests related to climate risk. The analysis methodology is rooted in CICERO's climate science and build on CICERO Shades of Green's methodology for green bond frameworks. The briefs should be considered science-based opinions.

The assessments focus on climate-related issues and risks. Other environmental and social aspects may be noted, but assessing material social, ethical and governance issues are outside the scope of the assessment. We discuss governance specifically in the context of climate governance, this should not be viewed as a substitute for a full evaluation of the governance of the sector and does not cover, e.g., corruption.

This introduction serves as a reader's guide to the briefs and provides an overview of some key aspects of climate risk assessment. This background knowledge includes understanding the basics of climate risk, emissions accounting, and the CICERO Shades of Green methodology.

SECTOR BRIEF: AQUACULTURE



Norway is the world's largest producer of farmed salmon. The carbon footprint of farmed salmon is substantially lower than that of beef, but higher than that of poultry. The majority of salmon's carbon footprint arises in the production of inputs (mainly soy) for salmon feed. In addition, aquaculture causes a range of local environmental problems in Norwegian fjords.

SECTOR BRIEF: ALUMINIUM

Aluminium production is a necessary sector in the low carbon future. Aluminium does not corrode and can reduce weight when replacing heavier metals, potentially improving energy efficiency and electrification in some industries. The single largest source of emissions in the production is electricity use. Today, a large proportion of the energy generation relies on fossil fuel and shifting towards renewables has vast potential for emissions reductions. Aluminium can be recycled, and aluminium produced through recycling emits only a fraction of the emissions from primary production.

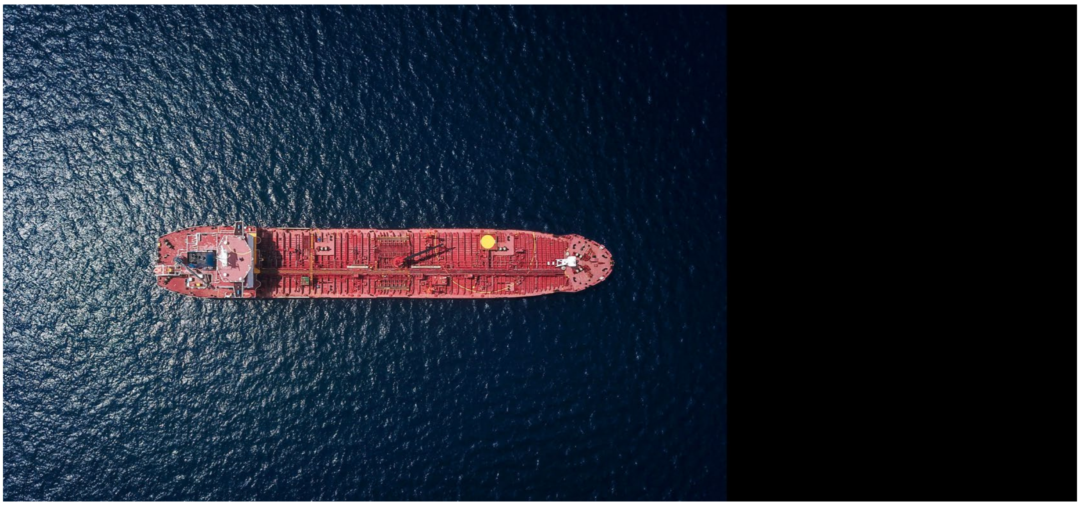
SECTOR BRIEF: REAL ESTATE

The real estate sector is already facing climate risks, and these are expected to increase in severity over time. The key emission sources from buildings are construction, energy use during operations and demolition. In Norway, direct emissions of greenhouse gases from heating and cooling during operations are lower than in other regions due to the high level of renewable energy in the grid and the prevalence of electric heating. The indirect emissions related to production and transport of materials and waste handling related to construction and refurbishment of buildings are therefore important considerations.

SECTOR BRIEF: AGRICULTURE

The agricultural sector can contribute significantly to the transition to a low carbon economy, primarily by reducing emissions of greenhouse gases other than CO_2 (such as methane), maintaining carbon sinks, and increasing sequestration. Establishing detailed emission benchmarks is difficult due to lack of data and large variations in emission intensity and mitigation potential at the farm level. Meat and dairy production are far more emission intensive than other types of production. It is likely that there will be substantial changes in the demand for food driven by both policies and norms.

SECTOR BRIEF: SHIPPING



Emissions from shipping accounts for 3 percent of global greenhouse gas emissions and have increased in recent years. Zero-emissions technologies are available only for short distances and small ships, while the majority of emissions are from long-distance freight. To reach emission reduction targets set by the International Maritime Organization (IMO), zero-emissions technologies for long distance trade must be developed, as improvements in fuel efficiency will not suffice. For ships built today, there is a significant risk of lock-in to fuels that are likely to become uncompetitive during the ship's lifetime.

SECTOR BRIEF: LAND TRANSPORT

In 2019, emissions from road transport constituted almost 17 % of total Norwegian emissions. Electric vehicle uptake is expected to grow exponentially for light distribution vehicles, while hydrogen and advanced biofuels could be good solutions for heavy-duty trucks and inter-urban passenger buses. Expected major drivers in the decarbonisation of this sector include technology focused measures such as improving energy efficiency and fuel switching, as well as structural changes that avoid or shift transport activity.

Contents

About the Sustainable Edge Project

The sector briefs were developed by CICERO and CICERO Shades of Green as a part of the Sustainable Edge research project. The research project also developed a method to better understand how well-aligned a company's business activities are with the transition to a low carbon economy. A company's revenues and investments are assessed on a scale from dark green to dark brown depending on how the activities contribute to a low carbon future.

CICERO Shades of Green AS is a subsidiary of CICERO established in November 2018. CICERO Shades of Green AS has commercialized a corporate climate risk assessment based partially on the Sustainable Edge research, in addition to own methodological development.

The Sustainable Edge project is financed by ENOVA SF and our financial sector partners: Oslo Pensjonsforsikring, CICERO Shades of Green AS, Nysnø, Sparebank 1 SMN, Sparebank 1 Nord-Norge, SR-Bank, Samspar and Sparebank 1 Østlandet. Thank you also to our partners Finans Norge and Schjødt.

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Further information about specific cases referred to in the report can be found at www.cicero.green

Understanding climate risk

Climate change impacts financial value and is a risk to investors and lenders. The ways climate change poses risks to financial value are often categorized into physical and transition risk (Clapp, Lund, Aamaas, & Lannoo, 2017).

Physical risk

Physical climate risk is caused by changes in temperature, precipitation and extreme weather. These could be acute risks, for example, storm surges destroying property and disrupting supply chains. Changes can also be chronic, for example, climate change will impact the growth conditions for agricultural products.

Physical risks impact companies by direct damage to assets and indirect impacts from supply chains. Climate change poses risks to the economy and financial system through direct and indirect transmission channels, see figure 1.

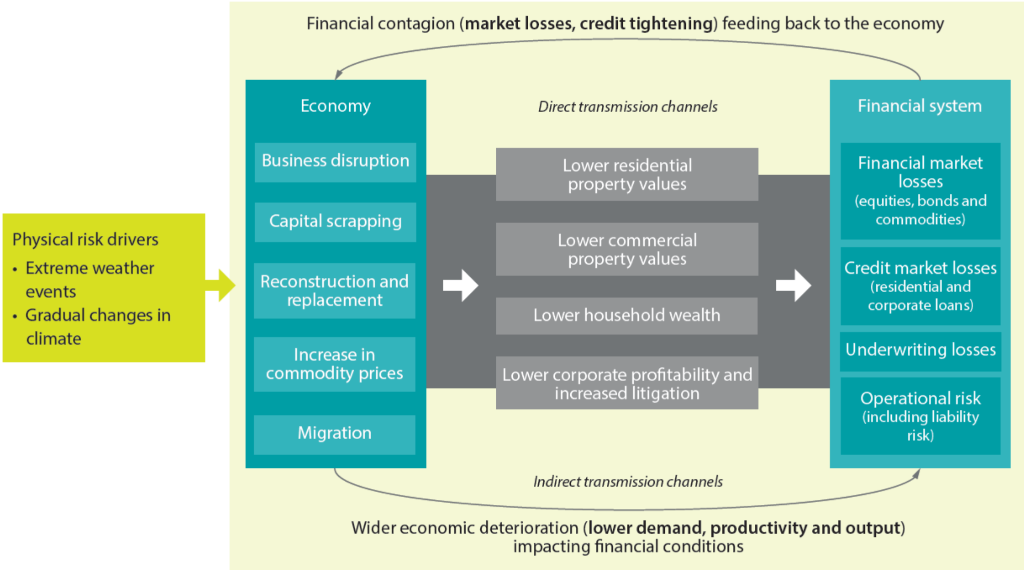

Figure 1: Physical risk transmission channels (NFGS, 2019)

Research suggests that unless we act to reduce emissions, the physical impacts of climate change on the global economy will be substantial in the second half of the century- Some studies have estimated that average global incomes may be reduced by up to a quarter (NGFS, 2019).

Transition risks

Transition risks are political, legal, and technological risks as a result of the transition to a low carbon economy. Policy changes could include carbon pricing, as well as incentives to promote low carbon growth. For example, policies incentivizing the purchase of electric vehicles change the market conditions for car manufacturers. Technology changes include potential continued rapid reductions in the costs of renewable energy and energy storage technologies. Liability risks are the potential for certain companies or countries to be held liable for their contribution to climate change in a court of law. Transition risk also includes changes in consumer preferences, for example, some

European countries are experiencing a shift towards more plant-based diets and away from red meats, which poses a risk to the meat and dairy industry.

For financial institutions, transition risks can materialize through various transmission channels that affect performance and creditworthiness of the companies and securities in their lending and investment portfolios, see figure 2.

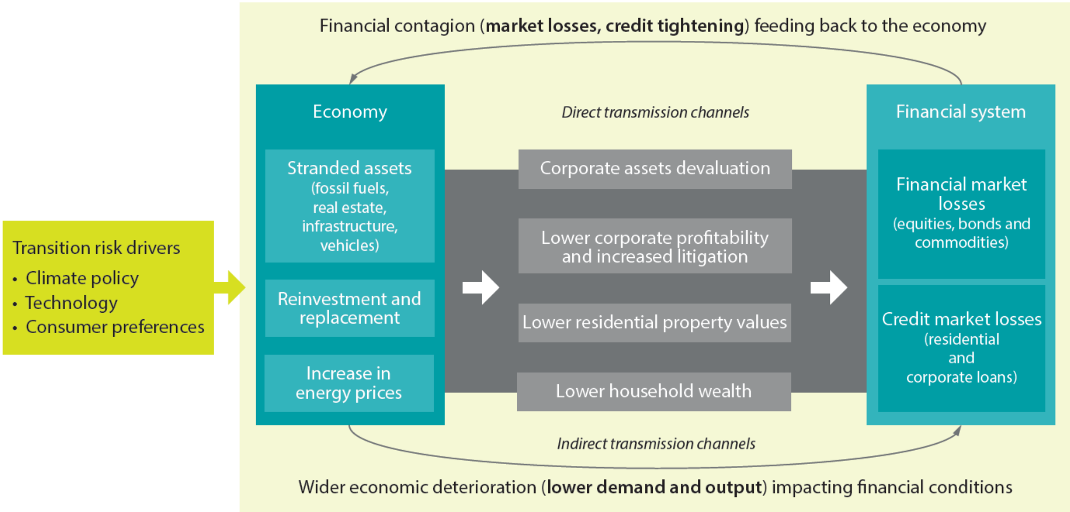

Figure 2 Transition risk transmission channels (NGFS, 2019)

The Intergovernmental Panel on Climate Change (IPCC) has estimated that USD 830 billion annually up to 2050 is required in energy-related investments to be compatible with a 1.5°C scenario (IPCC, 2018). This could be viewed both as a risk to the incumbent energy sector and as an opportunity for forward-thinking companies.

Climate change will also provide economic opportunities in many sectors. The transition to a low carbon economy will require a host of low carbon technologies providing market opportunities. The physical impacts of climate change will lead to opportunities in resilience and adaptation technologies, for example a number of Dutch companies have begun exporting their expertise in flood management across the world.

Further reading

The Shades of Risk report highlights climate risks that require immediate attention from investors. Shades of risk covers physical, policy, liability and technology risks and categorizes these risks by region, timeframe and probability.

The CICERO led project ClimINVEST has developed a suite of scientific factsheets aimed at building financial decision-makers' understanding about physical climate risk assessment, data needs, climate modeling and extreme events.

Climate scenarios

Scenarios can be useful for understanding climate related risk under different potential futures. A climate scenario is a coherent narrative describing a future. Typically, scenarios also show the pathway to that future and drivers of change along the way. It is important to understand that scenarios are not forecasts or projections, there are usually not probabilities attached to scenarios.

Many organizations develop climate scenarios. Scenarios from the International Energy Agency (IEA) and those assessed by the Intergovernmental Panel on Climate Change (IPCC) are independently produced and well-renowned. In addition, business organizations (e.g. World Business Council for Sustainable Development) and companies (e.g. Statoil, BP) produce their own scenarios.

Scenarios allow investors and other financial actors to assess how their assets and portfolios will be affected under a range of possible future developments, helping them to assess climate risk.

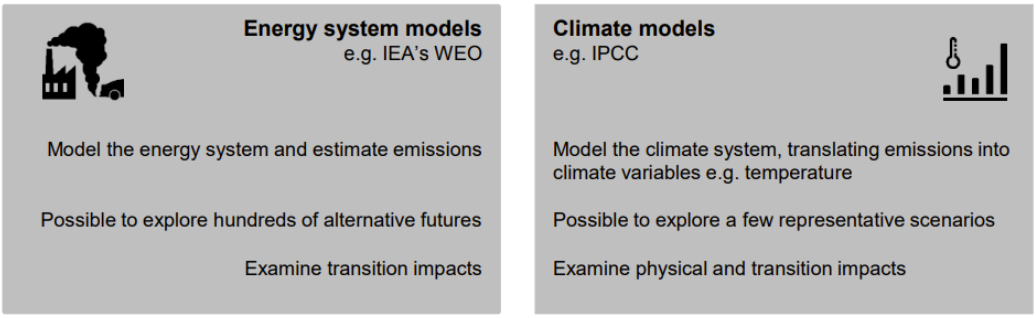

Figure 3 Energy systems models vs climate models (CICERO, 2018)

- **Energy system models**: transition impacts on the energy system can be examined using scenarios in energy system models (e.g., the World Energy Outlook by the International Energy Agency - WEO). These models estimate emissions and assess carbon prices.

- **Climate models:** physical impacts and transition impacts on a global scale can examined using scenarios from climate system models (e.g. IPCC). They translate emissions into climate variables, e.g. temperature. Specific regional impact, e.g. precipitation and wind, can be examined in greater detail using regional models and assessments.

In combination, energy system and climate system models enable us to link models of the energy system to temperature increases in coherent scenarios.

Further reading

CICERO's climate scenario guide explains how investors can use scenarios to evaluate different financial risks.

Identifying key emissions sources

An understanding of the key drivers of emissions in a sector is helpful for understanding climate risk. To identify these key emissions sources, it is necessary to consider both direct emissions from companies in the sector and indirect emissions from the supply chain, use and end-of life of the products or services.

The GHG Protocol is the established best-practice for greenhouse gas accounting. The organization has developed standardized frameworks to measure emissions from private and public sector operations, value chains and mitigation actions. Their corporate standard introduced the concept of emission scopes, which is a helpful framework for understanding emission sources from companies and for sectors. There are three emission scopes, see figure 4.

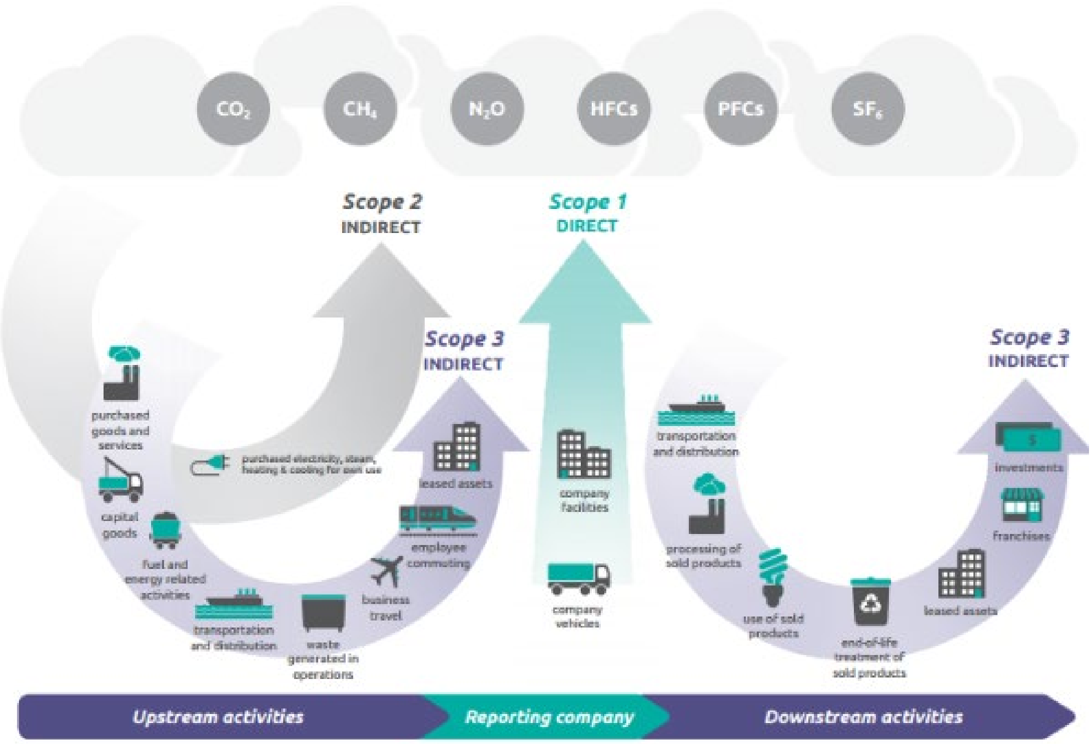

Figure 4 Emission scopes. Source: GHG Protocol (2011)

Scope 1: Are all direct GHG emissions from sources owned or controlled by the organization**.** Process emissions are usually large in certain industry sectors like oil and gas, aluminium, and cement. Manufacturing companies that generate process emissions and own or control a power production facility will likely have large direct emissions. Office-based organizations may not have any direct GHG emissions.

Scope 2: Are indirect GHG emissions from the generation of purchased electricity, heat, and steam. Almost all businesses generate indirect emissions from the use of electricity in their processes and to heat and cool buildings.

Scope 3: Are all other indirect emissions from sources not owned or controlled by the organization, e.g.. extraction and production of materials; transportation of materials; use of sold products and services; landfilling of waste. Scope 3 is often called supply chain emissions and includes upstream and downstream activities.

It is common for companies to begin reporting on scope 1 and 2 and expand to scope 3 as they gain experience. Scope 3 is generally more difficult to estimate and can also be the major source of emissions for many sectors. Data availability and quality is usually a challenge for emissions accounting, and these challenges are particularly prevalent when estimating supply chain emissions.

Further reading

The Greenhouse Gas Protocol has a number of resources and tools for estimating emissions. The Corporate Standard provides both requirements and guidance for preparers of corporate-level GHG emissions inventory.

Key policy initiatives

The Task Force on Climate-related Financial Disclosure (TCFD)

The emerging best-practice in climate risk disclosure is the TCFD guidelines. The TCFD was created by the Financial Stability Board in response to a request by the G20 finance ministers. Support for TCFD is strong among financial sector actors.

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, 2017). This focus on financial materiality sets the TCFD apart from most 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 5.

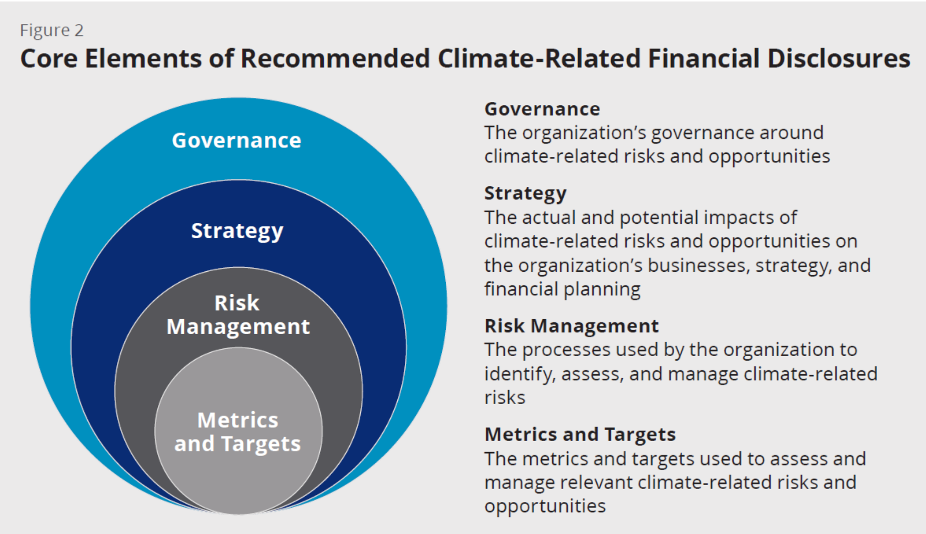

Figure 5 Recommendations for Climate-related Financial Disclosure. Source: TCFD, 2017.

A central recommendation from the TCFD is to use climate scenarios to understand 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, 2017b). The inclusion of scenario stress-testing is one way that TCFD practically encourages companies to implement and report on forward-looking climate risk assessments.

Further reading

The TCFD knowledge hub includes the recommendation, implementation guidance and case studies.

EU Taxonomy

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.

EU's Technical Expert Group (TEG) assisted the development of, among others, guidance on improved corporate disclosure of climate-related information. One of the cornerstone policies developed by the TEG is the EU Taxonomy for Sustainable Activities (EU, 2020). The latest draft of the taxonomy, released in November 2020, lists criteria and thresholds for a large number of activities across various sectors. The current EU Taxonomy draft sets additional requirements in the area of "Do no significant harm" for example these could include physical risk assessments, sustainability criteria for materials, water consumption etc. The current draft also requires minimum social safeguards.

Further reading

The history and progress of the EU Taxonomy implementation can be followed on the European Commission's website, the latest version of the delegated acts includes the detailed taxonomy criteria.

CICERO Shades of Green

The Shades of Green methodology was introduced in 2015. It is rooted in CICERO's climate science and developed to be applied to the green finance market. This method is focused on avoiding lock-in of greenhouse gas emissions over assets' lifetime and on promoting transparency on resiliency-planning and strategy. The method takes a long-term view on activities that support a low-carbon and climate resilient society.

For a successful transition we need all sectors, including those that would not qualify for a green shading today, to move towards low-carbon and climate resilient solutions. In order to cover the spectrum of activities, we expanded the shades and added a yellow and red shade, see figure 6. By assessing a company's current activities and investments via our expanded methodology, we gain a snapshot of current climate-risk exposure. By shading investments, we provide a forward-looking assessment of companies' efforts towards a green transition. Over time, the shading of activities and planned investments can be updated annually to track companies' progress towards transition.

SHADES OF GREEN	EXAMPLES
°C **Dark green** is allocated to projects and solutions that correspond to the long-term vision of a low carbon and climate resilient future.	Solar energy projects
°C **Medium green** is allocated to projects and solutions that represent steps towards the long-term vision but are not quite there yet.	Green buildings with a high level of certification and energy efficiency
°C **Light green** is allocated to transition activities. These projects and solutions could have lower emissions, but do not by themselves represent or contribute to the long-term vision.	Substantially more efficient manufacturing of fossil fuel intensive materials
°C **Yellow** is allocated to projects and activities that do not contribute to transition. These activities could have some emissions and be exposed to climate risks. This category also includes activities with too little information to assess.	Efficiency in fossil fuel infrastructure
°C **Red** is allocated to projects and activities that have no role to play in a low-carbon and climate resilient future. These are heaviest emitting assets, with the most potential for lock-in of investments and risk of stranded assets.	New infrastructure for coal

Figure 6: Expanded Shades of Green rating method

We apply our extended Shades of Green methodology to assess the greenness of the defined activities, related revenue streams and investments. Some of the factors we consider include the avoidance of locking-in fossil infrastructure, contribution to technological advancement of the sector, downstream and upstream emissions, and regional considerations.

Our view is that the green transformation must be financially sustainable to be lasting at the corporate level. We have therefore shaded the company's current revenue generating activities. Shaded investments add a forward-looking element and provide insight into future revenue streams and corporate strategy in relation to the green transformation. If assessments are updated on an annual basis, investors will be able to track companies' progress in the transition to operations that are in line with a net-zero carbon and climate resilient future.

Further reading

The CICERO Green Best Practices 2020 report showcases examples of green bond second opinions and company assessments. These examples highlight best practice approaches to some of the environmental considerations in various sectors. Download the report here:

Data and indicators for climate risk disclosure

Meaningful indicators are helpful for comparing companies' climate risk exposure and impact.

Existing indicators in this space tend to focus on climate impacts, such as emissions to water and air, and especially CO_2 emissions. Emissions from scope 1, 2 and 3 are useful for understanding the largest climate impact of companies and sectors. However, emissions do not tell the entire story as efficiency improvements can improve the emissions intensity, but the risk of locking in emission-intensive technologies is not regarded.

CICERO sector briefs suggest some indicators that cover elements of transition and physical risk and environmental impacts by sector. These are preliminary indicators and metrics that will be further developed. Within each sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment. While the indicators can provide good information, no indicator alone provides a full picture of climate risk. In addition, the data quality and availability of corporate ESG data present challenges. As methodologies and data availability evolves, we expect improvement to the current indicators and the emergence of new climate relevant indicators.

The core recommendation from the Sustainable Edge project is for companies to link environmental reporting with financial reporting. We would encourage financial institutions to encourage corporate reporting that illustrates the climate risk of corporate activities and allow for comparability across companies and over time. One approach is presented in the CICERO Green company assessments, which assign a Shade of Green to revenue streams and investments.

The currently available quantitative indicators on climate risk do not give a complete basis for a climate risk assessment. We recommend that investors and financiers also conduct a qualitative analysis of companies. To assist this analysis, our sector briefs include key analyst questions that can be used to understand the climate risk and climate management of companies within the sector.

Further reading

The Sustainable Edge project conducted a review of climate risk data providers. Our findings are summarized in the report Missing the forest for the trees.

CICERO Shades of Green has commercialized a corporate climate risk assessment based on the Sustainable Edge research. The company assessments assign a shade of green to a company's revenues and investments as well as assessing the governance structure to indicate the greenness of a company.

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Sustainable Edge
Sector Brief: Aquaculture

Year 2020

Sector definition

NACE code A3.2.1: Marine aquaculture. Geographical scope: Norway.
Value chain activities included: Feed production; Fish farming; Processing; Transport.
Most important connecting activities: Production of agricultural and marine ingredients for feed.

Summary

Norway is the world's largest producer of farmed salmon, 95% of which is exported, 70% to the EU. Seafood is the most valuable Norwegian export after petroleum, and salmon accounts for 66% of this export. The carbon footprint of farmed salmon is substantially lower than that of beef, but higher than that of poultry. The majority of salmon's carbon footprint arises in the production of agricultural and marine inputs for salmon feed. Brazilian soy is a particularly problematic input, as its cultivation is linked to deforestation. In addition, aquaculture causes a range of local environmental problems in Norwegian fjords, including prevalence of sea lice, increased levels of disease, nutrient leaching, and decline in wild salmon stocks. Norwegian Seafood Federation is looking for more volume growth in the future to continue developing the industry.

Main climate and environmental risks[1]

Happening now	Limitations in licenses for production due to local environmental problems (particularly sea lice)
Likely in short term	More frequent periods of abnormally high sea temperature
Likely in medium term	Climate policies in Norway and internationally will likely increase the cost and availability of feed and transport

[1] The selection of key risks and categorization of those is based on expert judgement. Short-term refers to impacts that are likely in the next decade.

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Physical risk exposure

- Water temperatures >14°C reduces growth health, and welfare. Above 20 °C, growth stops and mortality increases. Projections under RCP 4.5 (mild scenario) shows negative effect on production in southern Norway due to temperature rise already in the 2020s (Falconer et al, 2020).
- Increased freshwater runoff and sea water temperature may facilitate increased spread of sea lice (Berg et al, 2012).
- Increased storm activity can cause damages and fish escapes (Barange & Perry, 2009).
- More frequent algal blooms (Barange & Perry, 2009), as experienced in Northern Norway in 2019.
- Catches and prices of fish for feed depend heavily on weather events that relate to climate change (FAIRR, 2019a).
- Ocean acidification has been hypothesized to affect young salmon growth (Ou et al., 2015) but the effect on salmon is understudied; no conclusion can be reached.

Transition risk exposure

- The government has for the first time instructed a reduction in production in some areas due to sea lice pressure.
- Increased concern with the negative environmental effects of aquaculture may result in further restrictions, limiting growth or increasing costs.
- Stricter climate policies (like higher carbon price) would make product transport more expensive.
- Stricter climate and environmental policies in the agricultural sector may make inputs to feed production more expensive.
- Evolution of plant-based and cell-based meat production may affect demand for seafood (FAIRR, 2019a).

Key statistics & background figures

- Aquaculture has surpassed wild fishing as the main provider of seafood globally. Aquaculture represents 47% of global fish production, 53% if excluding non-food uses (FAO 2018).
- Fish accounts for about 17% of animal protein consumed by the global population. Fish consumption has increased by 3.2% in volume annually over the period 1961-2016, outpacing the growth for meat.
- Salmonoids account for 18% of world trade in fish and fish products by value, more than any other species group (FAO 2018).
- Norway is the world's largest producer of farmed salmon, the second largest when including all farmed finfish, and the seventh largest when including all farmed seafood (FAO 2018). Aquaculture accounts for 72% of Norway's seafood exports (seafood.no).
- The sector accounts for 1.3% of GDP in mainland Norway, counts around 1000 farms[2] , and employs 8000 people. Annual growth in value terms 1995-2017 has been almost 10% (NOU 2019: 18).
- Direct emissions from farms and associated vessels in Norway: 454 000 tonnes CO2 annually (1% of Norway's territorial emissions) (ABB/Bellona, 2018). These emissions are covered by the Norwegian CO2 tax (544 NOK/ton CO2e). Indirect emissions are many times larger. Feed production accounts for ~80% of the carbon footprint.
- No reliable statistics are available for the sector's GHG emissions globally.

[2] of which 600-700 are typically producing at any point in time while the rest are in fallow periods.

Contents

About this brief

This sector brief was developed by CICERO as a part of the Sustainable Edge research project. The purpose of the brief is to outline the key material climate-related issues for the sector. The audience for the brief is the financial sector, either as potential investors or lenders to the sector. The reader is expected to have background knowledge of the sector and of climate risk assessment. The analysis methodology is rooted in CICERO's climate science and build on CICERO Shades of Green's methodology for green bond frameworks. This brief is to be considered a science-based opinion. CICERO Shades of Green AS is a subsidiary of CICERO established in November 2018.

CICERO Shades of Green AS has commercialized a corporate climate risk assessment based partially on the Sustainable Edge research, in addition to their own methodological development.

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Please note this assessment focuses on climate-related issues and risks. Other environmental and social aspects may be noted, but assessing material social, ethical and governance issues are outside the scope of the assessment. We discuss governance specifically in the context of climate governance, this should not be viewed as a substitute for a full evaluation of the governance of the sector and does not cover, e.g., corruption.

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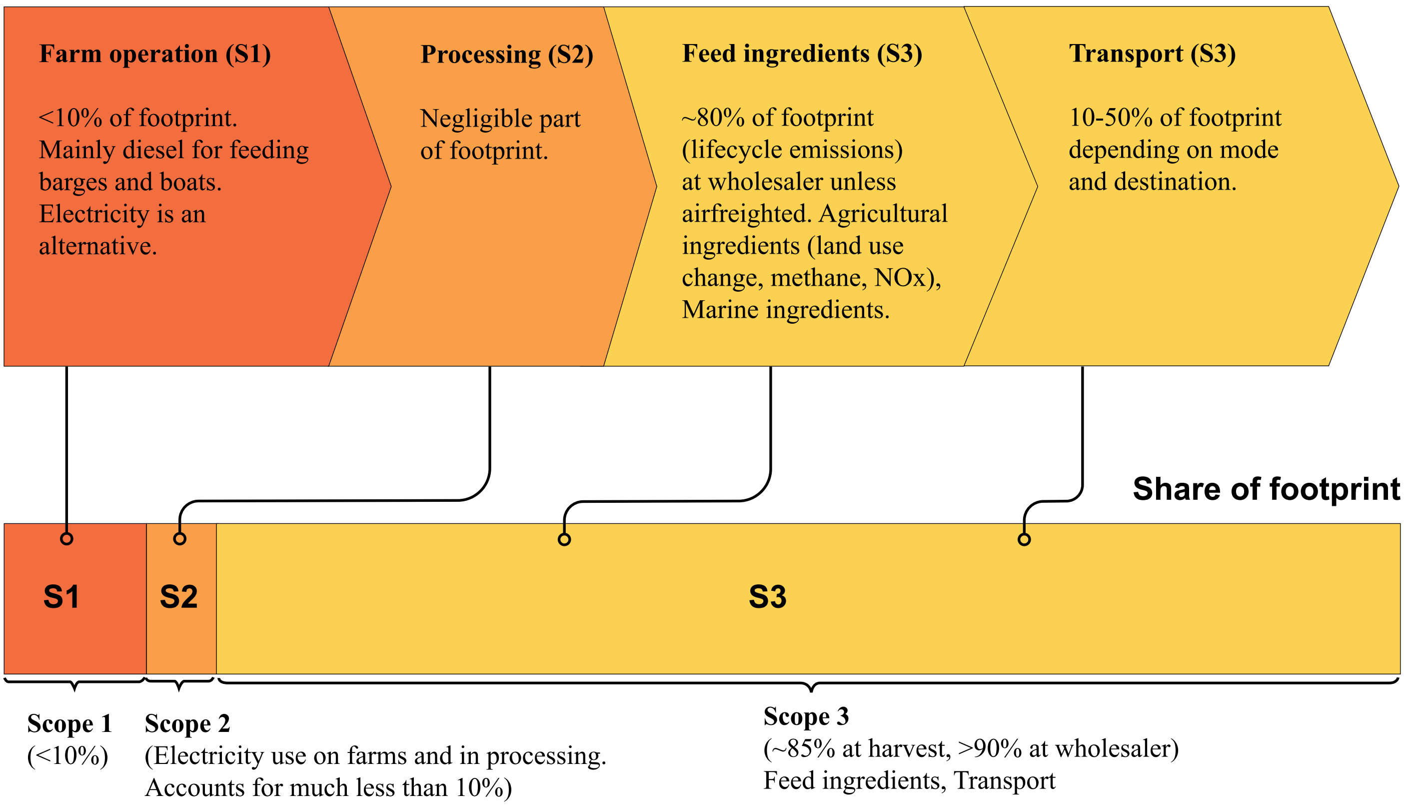
Emissions

Main sources[3]



Scope 1 (S1)

Definition: Direct emissions from owned or controlled sources, e.g. fuel use by boats and other farm infrastructure, direct emissions from feed factories, and transport fuel.

Status:

- Feeding barges are powered by electricity or diesel generators and are the most energy intensive piece of equipment at farms.
- Vessels used in farm operations currently use diesel, with some hybrid vessels recently added. Fully electric alternatives are under development.

Potential and challenges: to reduce scope 1 emissions

- Around 60% of farms are connected to the electricity grid.
- Connecting more farms and electrifying vessels could reduce Norwegian fish farms' direct emissions by 75% using existing technologies (ABB/Bellona; 2018).
- For remote localities, hybrid diesel generators can improve efficiency. These can later be replaced by on-site electricity generation (ABB/Bellona, 2018).
- See Klimakur 2030 (S09) for more detailed assessments.

No targets set by government or industry organizations. Some companies have set targets (see Table 2).

[3] Key source: Winther et al. (2020)

Scope 2 (S2)

Emissions are considered negligible due to Norway's supply of carbon-neutral hydropower.

Scope 3 (S3)

Definition: All indirect emissions that occur in the value chain of the reporting company including up- and downstream emissions, most notably emissions relating to production of inputs to feed.

Status:

- Generally, the amount and type of feed used determines the carbon footprint of farmed salmon, except if the fish is airfreighted (Winther et al., 2020).
- Land-use change alone accounts for around 28% of footprint at slaughter, but estimation is uncertain. These emissions are embodied in soy protein concentrate from Brazil, which may contribute to deforestation (see Pitfalls).
- Like soy, micro ingredients (e.g., amino acids and phosphate) provide a disproportionate contribution to the footprint.
- For marine ingredients, the main emissions source is fuel use in fishing vessels.
- Transport emissions vary greatly by mode and destination. Generally contribute <25% to the final footprint, but air transport to Asia more than doubles the footprint (Winther et al., 2020).
- Ship and rail transport give the lowest emissions (Winther et al., 2020)

Potential and challenges: to reduce scope 3 emissions

- Feed efficiency is an important determinant of scope 3 emissions. Sea lice and diseases cause mortality and reduced growth thus causing reduced efficiency over the last decade (Winther et al., 2020).
- Feed composition is also important. Reducing the share of marine ingredients reduces overexploitation of wild fish stocks but increases emissions from agricultural inputs.
- To reduce risk of deforestation from increased soy demand, conduct dialogue with Brazilian soy suppliers, or source from other countries. E.g. Salmon Group (network for smaller fish farmers) replaced Brazilian soy with European soy in 2019.
- There is potential for reduction in soybean protein concentrate. Currently ranges from 10%-26% across Norwegian feed producers (Regnskogsfondet & FIVH, 2017)
- More sustainable protein sources are under development, based on, e.g., seaweed and insects. Research is needed to assess the carbon footprint of these alternatives.
- There has been a large increase in airfreight of Norwegian seafood in recent years. Farming closer to markets can reduce the need for airfreight (Winter et al., 2020).

No targets set by government or industry organizations. Some companies (Mowi, Grieg) have set voluntary targets that cover scope 3.

Climate risk management

Current risk management

- The major Norwegian feed producers are engaged in a dialogue with their soy suppliers to encourage reduced deforestation. Soy currently imported to Norway is certified not to come from land recently deforested.
- The Coller FAIRR Protein Producer Index analyze the 60 largest global meat, dairy and aquaculture producers across a range of environmental, social and governance risk factors.
- Climate disclosure by the major firms is generally good. This includes reporting according to TCFD recommendations.

Key opportunities

- Demand is expected to increase as global population is projected to grow beyond 9 billion by 2050 (FAO 2018)[4].
- Capture from fisheries has been stagnant for 30 years and is not projected to increase. One third of fish stocks are fished beyond biological sustainability (FAO 2018).
- Aquaculture has the potential to address the gap between aquatic food demand and supply and to help countries achieve their economic, social, and environmental goals (FAO 20118).
- The potential for emissions reductions from the replacement of red meat with farmed seafood and plant-based diets is estimated at 2.9 million tonnes of CO2 equivalent between 2021-2030. This is almost double any other mitigation measure within the food sector. (Klimakur, 2020).
- Shifting diets from red meat to farmed seafood could spare millions of tonnes of feed crop annually (Froelich et al, 2018).
- The climate footprint of farmed salmon is substantially lower than that of beef, and in between those of pork and poultry. (Winther et al, 2012). Climate polices may therefore make farmed fish more competitive.
- Aquaculture facilities located closer to the shore (60%) are already connected to the grid. The remaining 40% that are located further offshore will be more expensive to electrify but will likely receive subsidies through, e.g., Enova (Klimakur 2030).
- Sea temperature rise in Northern Norway likely beneficial for growth but also likely to increase disease and parasites (Falconer et al, 2020.).
- Climate impacts on agriculture may increase global demand for farmed fish (Mikkelsen & Buanes, n.d.).
- Innovations may significantly reduce the climate and environmental impacts of aquaculture. E.g., closed containment systems (CCS), new alternatives to soy, new delousing technologies. Note that may also pose a risk to the Norwegian industry as it will allow a range of northern countries without fjords to enter the market on the supply side.
- Delaying the transfer of fish from land to sea (post-smolt production) reduces escapes, mortality, sea-lice problems, and the amount of time the fish interacts with the marine environment (NOFIMA, 2019). However, land-based systems require more energy (Klimakur 2030).
- Growth in aquaponics (combining aquaculture with cultivating plants in water) makes the industry more climate resilient, less resource-intensive, and reduces waste. However, it will require considerations like electricity cost, combined risk of aquaculture and hydroponics (NIBIO, 2015)

[4]Note that population scenarios are under revision.

Key pitfalls

- Greater demand for fish will lead to greater risk for environmental impacts from aquaculture, including fish escapes, disease, lice, and mineral leaching (Klimakur 2030).
- Farmed salmon is the Norwegian seafood product with the highest emissions (Winther et al., 2020).
- Demand for soy contributes to demand for tropical deforestation (Regnskogsfondet & FIVH 2017), and thus to GHG emissions and other negative environmental impacts. Soy protein concentrate makes up 10-26% of the feed produced in Norway. Most soy currently imported to Norway is certified not to come from land recently deforested. However, a problem with the certification schemes is that major soy producers currently only certify a small share of their production, while the rest may contribute to deforestation. It is not possible to reliably quantify the emissions difference between certified and non-certified soy (Winther et al, 2020). Demand for marine ingredients in feed puts pressure on wild fish stocks.
- Airfreight over long distances can more than double the product's footprint and there has been a large increase in airfreight of Norwegian salmon in recent years. (Winther et al, 2020).
- Fish escapes pose a serious threat to wild salmon stocks, as the farmed fish modify the gene pool and outcompete local species.
- The high concentration of salmon in farms allow sea lice to thrive, which also pose a threat to wild salmon stocks. Closed containment systems offer a solution to this issue.
- Chemicals used for delousing may negatively affect wild species such as cod and shrimp, and thus coastal fisheries.
- Increasing problems with disease and sea lice have increased the carbon footprint of farmed salmon, through reduced feed efficiency and increased use of service vessels for treatment (Winther et al, 2020).
- Organic matter from open-net pens negatively affect life on the adjacent seabed.
- Medicines have been found to kill shrimp and other crustaceans in laboratory experiments.
- Copper used in antifouling paint for fish farm installations is a toxin polluting the local marine environment.
- Concern about fish welfare is increasing among consumers. Fish disease and mortality also lead to increased emissions through lowering the feed efficiency.

Disclosure and integration of climate risk

Climate disclosure by the major firms is relatively good (see Table 1). Some have also set targets for reducing emissions (see Table 2). However, only one company has set a target for reducing scope 3 emissions, which account for ~80% of total emissions.

Disclosure of climate risk and environmental impact

Norwegian aquaculture companies score well in terms of GHG disclosure compared to other protein producers (Fairr 2019b).

Company	CDP Climate Change 2019	CDP Forests 2019	Completeness of emissions disclosure (scope 1&2) (FAIRR, 2019b)
Mowi	A-	No response	Complete
Salmar	B	Declined to participate	Complete
Lerøy Seafood Group	C	No response	Complete
Bakkafrost	Declined	Declined to participate	Complete
Austevoll Seafood	No response	No response	Company not assessed
Grieg Seafood[5]	A	Declined to participate	Complete
Norway Royal Salmon	B	Submitted but was not scored	Company not assessed

Table 1. Companies disclosure of climate risk. Companies are listed in order of valuation at Oslo Stock Exchange (NOU, 2019).

[5] Mowi, followed by Grieg Seafood, recently issued the first green bonds in the aquaculture sector (both rated medium green).

Integration of climate risk in operations / decisions

The Coller FAIRR Protein Producer Index analyses the 60 largest global meat, dairy and aquaculture producers across a range of environmental, social and governance risk factors. Of the seven companies ranked as lowest risk, five are Norwegian aquaculture companies (see Table 2 below). Although scope 3 emissions account for >90% of GHG emissions at wholesaler, most companies lack targets covering scope 3 emissions-reduction.

Company	Fairr (2019b) risk index rank	GHG mitigation target strength (FAIRR, 2019b)	Change in reported emissions 2017-2018 (FAIRR, 2019b)
Mowi	1 (low risk)	Target covers >95% emissions in scope	Large decrease
Salmar	7 (medium risk)	Partial target	Increase
Lerøy Seafood Group	2 (low risk)	Target covers >95% emissions in scope	Increase
Bakkafrost	3 (low risk)	Energy-related target	Increase
Grieg Seafood	5 (medium risk)	Target covers >95% emissions in scope	Increase

Table 2: Companies' engagement with climate risks.

Regulations and scenario information

Policies in Norway

- Production requires a permit, which are issued based on environmental requirements in the Aquaculture act and the Biodiversity act.
- The government introduced the “traffic light system” for sustainable growth in 2017, to determine where production can be expanded (green) and where it must be reduced (red). Two out of 13 zones got a red light in 2020. However, the only environmental indicator relates to sea lice effects on wild salmon (Fauchald, 2017), thus ignoring other environmental issues. Chemical delousing improves the sea lice situation but may cause harm to other species, while treatment with hot water increases salmon stress and mortality.
- Climate considerations are not included in the regulatory system and neither government regulation nor voluntary certification schemes currently address GHG emissions. However, GHG emissions may become a criterion for permit issuances in the future (Klimakur 2030, p. 176).
- Voluntary certification schemes (e.g. ASC, BAP, Global GAP, and particularly organic schemes) set stricter criteria than Norwegian regulation to address non-climate environmental challenges.

EU Taxonomy

Sector is not included in the EU Taxonomy as of November 2020.

Global scenarios

- The FAO (2018) predicts 36.7% growth in global aquaculture production from 2016-2030 (in tonnes). For Norway, the predicted growth is 30% (FAO 2018).
- One report estimated a potential for a fivefold increase in Norwegian aquaculture production 2010 to 2050 (by value) given that challenges around local environmental impact and feed ingredients sourcing were resolved (DKNVS & NTVA, 2012).

CICERO Shades of Green & analyst perspective

CICERO Dark Green for the sector[6]

Considerations for main activities

- Both the site and associated vessels should be electrified, along with a focus on improving energy efficiency.
- Closed containment systems (CCS) onshore greatly reduce local environmental effects and may increase feed efficiency, although energy use increases greatly. CCS opens opportunity to place "catch-crops" e.g., shellfish nearby to filter organic effluents and to use as feed (Rosten et al., 2013). Moving all current aquaculture onshore would increase Norway's electricity consumption by 7-11 TWh (5-8%) and require upgrading of the grid (Klimakur 2030). CCS farms at sea have succeeded in eliminating escapes and lice, but do not contain the waste. Not yet in commercial production (SFI, 2018).
- Offshore farming reduces contact with wild salmon stocks and facilitates greater dilution of waste (SFI, 2018). However, increased distance to shore makes electrification more difficult, increases transportation, and increases exposure to wind and waves.
- Ensure local coastal communities and stakeholders are involved in decision-making process (FAO, 2017a).
- Incorporate integrated monitoring and information systems to aid in responding to environmental impacts.
- Optimize feeding with alternative (non-soy/fishmeal/fish oil) feeds, to improve fish health and reduce emissions intensity (FAO, 2017b).
- Focus on biodiversity, which improves fish health and resilience to disease. (FAO, 2017a).

Considerations for upstream and downstream factors

- Product transport should not be by air, and preferably by ship or rail.
- Soy from suppliers that do not contribute to deforestation in their operation, for example from countries where agriculture is not expanding.
- Alternatively: soy-free feed. Alternative vegetable protein sources are already used. Potential future alternatives include insects, seaweed, and wood.
- Feed production mill emissions can be reduced by using alternative lower emission fuels.
- Utilize by-products from processing and reduce waste along the value chain. (FAO, 2017a)
- Marine ingredients in feed should comply with the Aquaculture Stewardship Council's criteria.

The Shades of Green methodology assesses alignment with a low-carbon resilient future. CICERO Dark Green is allocated to projects and solutions that correspond to the long-term vision of a low carbon and climate resilient future. For more information see: https://www.cicero.green/our-approach

Current best practice - activities

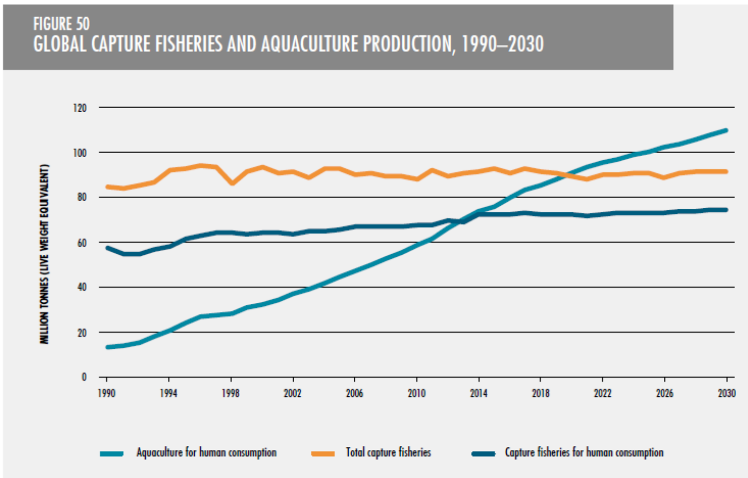
- ★ Since the majority of emissions arise from feed production, there should be a focus on feed sourcing, efficiency, and composition.
- ★ Several voluntary certifications schemes exist but, like Norwegian regulation, the certification schemes do not consider GHG emissions. The Aquaculture Stewardship Council (ASC) is regarded as having the strictest environmental criteria (FIDRA, 2018). In many respects, they are much stricter than the standards set by Norwegian government (Vormedal & Gulbrandsen, 2018). The ASC requires soy to be sustainably sourced (relying on soy certification schemes), from 2022, but its operationalization is relatively weak.
- ★ Most soy imported to Norway for aquaculture feed is certified according to ProTerra, which provides a better safeguard against deforestation than required by the ASC.
- ★ Organic salmon farming uses less soy and has stricter criteria on deforestation and pesticide use (Regnskogsfondet & Framtiden i Våre Hender, 2017).
- ★ 60% of aquaculture facilities in Norway are connected to the electricity grid (Klimakur 2030).
- ★ Closed containment systems reduce fish escapes and prevent sea lice and disease spreading in wild salmon. Post-smolt production involves keeping the young fish in such systems for longer before transfer to open net pen systems. Environmental benefits are less time interacting with the marine environment, lower mortality, and reduction in sea lice problems. However, energy consumption goes up.
- ★ New technologies for monitoring and de-licing can be used to achieve increased growth, improved fish welfare, reduced local environmental impact, and reduced carbon emissions through increased feed efficiency.

Current best practice - Governance

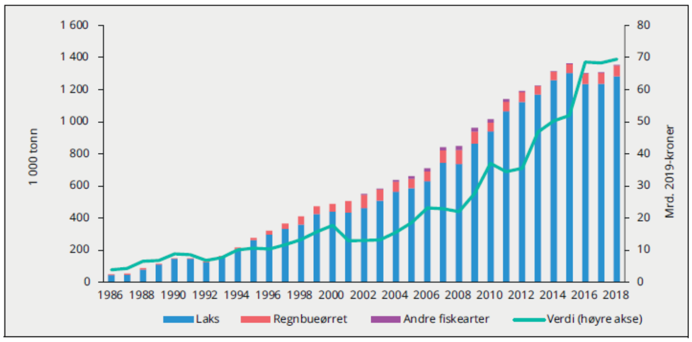
- ★ Norwegian aquaculture companies and feed producers are engaged in a the ‘Aquaculture Dialogue on Sustainable Soy Sourcing from Brazil’ with ProTerra and major soy suppliers, working towards reducing deforestation also in non-certified production.
- ★ Several aquaculture companies and feed producers signed the New York Declaration on Forests at the UN Climate Summit in 2014, setting a goal to eliminate deforestation from the production of agricultural commodities such as soy.
- ★ Several Norwegian companies in the aquaculture supply chain are signatories to the Cerrado Manifesto Signatories of Support, an initiative aiming to halt deforestation in the Cerrado in Brazil, which is currently the world’s largest area of deforestation. Grieg Seafood is in the sterring group. Grieg Seafood has also, together with Tesco and Nutreco, launched the Cerrado Funding Coalition, which aims to provide financial incentives for soy farmers in the Cerrado to halt deforestation.

Data and indicators for climate risk disclosure

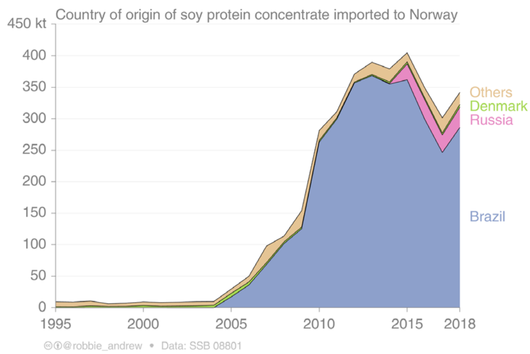
Historic data



1 Global Capture Fisheries and Aquaculture Production. Source: FAO 2018



2 Sale of farmed fish for food consumption in Norway 1986-2018. Note: blue = salmon, red 0 trout, purple= other, green =value Source: NOU 2019: 18.



3 Import of soybean protein concentrate for use in Norwegian aquaculture feed by country of origin. Imports from Brazil raise concerns about deforestation. Source: SSB (2019).

Climate-relevant data sources

- FAIRR (2019b) finds that the five Norwegian aquaculture companies included in their analysis all provide complete GHG inventories. Data is available to investors at fairr.org.
- Responses to the CDP are available at cdp.net.
- Data on mortality, sea lice, mineral effluent available at Miljøstatus for Fiskeoppdrett.

Potential difficulties in attaining / using existing data

- As >90% of total emissions at wholesaler are scope 3, estimation is complex and uncertain.
- Footprint estimation would be simplified if companies collected the most critical data in a standardized way and ideally made them public (Winther et al, 2020).
- Fish farmers generally do not include energy use of sub-contractors in their GHG accounting (Winther et al., 2020).
- Some exported fish is processed and re-exported, which is not captured in current estimations

Indicators which would improve climate risk disclosure[7]
Transition risk

Preliminary indicator or metric	Benchmark/ typical value/range/ASC limit
GHG emissions per kg salmon at slaughter (incl. from feed inputs)	*Avg: 5.75kg (Range: 3.4-6.8kg) (Winther et al, 2020)*
Total GHG emissions (scope 1,2 & 3)	
% soy used in feed	*Range: 10-26% (Regnskogsfondet & FIVH 2017).*
% soy originating from Europe	*Typically 0, but Salmon Group has achieved 100% (salmongroup.no /internasjonal-interesse-for-vart-nye-for/)*
% soy certified by ProTerra or equivalent	*Typically 100%*
Feed conversion ratio	*1.32 for Norwegian aquaculture industry as a whole in 2017*
Fish mortality	*16.2% in 2019 (Norwegian Veterinary Institute, 2020)*
Fishmeal Forage Fish Dependency Ratio	*ASC: <1.2*
Fish Oil Forage Fish Dependency Ratio	*ASCD: <2.52*
% marine ingredients certified	*ASC: 100%*
Fish escapes	*ASC: ≤300 fish per production cycle*
Sea lice concentrations	*ASC: ≤0.1 mature female lice per farmed fish*
Chemical and therapeutant use	*ASC: Cumulative parasiticide treatment index ≤13*
Copper levels in sediments	*ASC: <34 mg Cu/kg dry sediment weight,*
% of sites certified by, e.g., ASC	*MOWI: 42% ASC*
Proportion of produce transported by air.	*20% in 2018 (Bellona)*

[7]Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment.

Preliminary indicators for physical risk

Water temperature (°C)	Implications for salmon
>20	*Growth stops, mortality increases*
16-20	*Reduced welfare and feed intake, growth slows, stress and mortality increases.*
14-16	*Sub-optimal growth, higher risk of reduced health and welfare.*
11-14	*Optimal growth and feed intake.*

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Key analyst questions for all companies in this sector

1. Does the company have a strategy to reduce GHG emissions? Does the company have or plan to set a science-based target to reduce GHG emissions?
2. Does the company report annually on scope 1, 2 and 3 emissions? Does this include emissions from the sourcing of fish feed?
3. Is the company investing in feed innovations that reduce reliance soy?
4. What measures are taken to encourage reduced deforestation in soy production?
5. What measures are taken to improve feed efficiency?
6. What proportion of sites are certified according to the ASC or other schemes? Does the company have a target to certify additional sites?
7. What measures have been taken to reduce local environmental issues (see Pitfalls)?
8. What proportion of produce is transported by airfreight? Does the company take measures to limit airfreight?

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Sustainable Edge
Sector Brief: Real Estate

Year 2020

Sector definition

This document defines the activities of the real estate sector as developing and managing buildings and areas. The sector encompasses real estate developers, landlords, companies managing buildings and advisors. This sector brief covers companies that primarily operate real estate assets in Norway. Real estate activities depend on inputs from other sectors including materials, construction companies, utilities (heat, electricity and water), financial services and insurance.
Real estate activities are defined here as NACE codes F41.1 (Development of building projects), L68.1 (Buying and selling of own real estate), L68.2 (Renting and operating of own or leased real estate. Construction companies are not covered in this brief.

Summary

The real estate sector is already facing climate risks, and these are expected to increase in severity over time. The key emission sources from buildings are construction, energy use during operations and demolition. In Norway, direct emissions of greenhouse gases from heating and cooling during operations are low due to the high level of renewable energy in the grid and the prevalence of electric heating. The indirect emissions related to production and transport of materials and waste handling related to construction and refurbishment of buildings is much higher. Key options for reducing indirect emissions include: choice of low emission building materials, prioritizing refurbishments over newbuilds, implementing low emission construction sites and access to public transportation to reduce tenants' transport emissions.

Main climate and environmental risks[1]

Happening now

1. Heavy rainfall can lead to floods, urban stormwater and mudslides
2. Sea level rise can worsen impacts of flooding and extreme weather, and impact some high value coastal properties
3. Stricter regulations for energy use and/or efficiency may require refurbishments and affect the value of buildings
4. Buildings in urban areas without or with limited access to public transportation may face reduced attractiveness given efforts to reduce emissions from transportation

[1] The selection of key risks and categorization of those is based on expert judgement. Short-term refers to impacts that are likely in the next decade.

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Physical risk exposure

- Extreme precipitation (1) and its impacts are already observed with a significant probability to increase (CICERO, 2017). Among the impacts towards 2050 (2) of extreme precipitation are pluvial floods (urban flooding) and fluvial floods (rivers, lakes)
- Flooding from changing precipitation patterns and snow melt is already observed with a significant probability to increase
- Landslides are expected to increase in intensity and frequency in the next few years, especially for winter. Mountainous regions are especially sensitive.
- Sea level rise is expected to impact low-lying coastal areas. Impacts become more severe if in combination with extreme rainfall and/or winds (CICERO 2017)
- Periods with heat stress could manifest towards mid-century (CICERO 2017). There are observations that this is already affecting the building sector in terms of the attractiveness and value of individual buildings.

Transition risk exposure

- Mandatory efficiency upgrades may be required
- Buildings in locations where increased physical risk impacts are expected may face rising insurance premiums
- Buildings without or with limited access to public transportation may face reduced attractiveness given efforts to reduce emissions from transportation
- Changing consumer preferences might increase demand for buildings with high energy-efficiency
- Public-sector tenders may increasingly require low emission construction sites
- Heating systems based on fuel oil have been banned in Norway from 2020
- Bans on natural gas-based heating systems have not been officially proposed, but government has assessed the technical and economic possibilities for converting to alternatives. (Mdir NVE 2020). Political discussions on this should be followed closely

1) Definition of extreme precipitation used here is frequency of ‘very wet days’, defined here as the 90th percentile of daily precipitation on wet days

(2) Projected impacts towards 2050. Based primarily on RCP2.6 and RCP8.5 results for 2046-2065. CICERO 2017. (See flom-sonkart)

Key statistics & background figures

- In Norway, direct emissions of greenhouse gases from heating and cooling are about 1.2% of total territorial emissions (expected to fall after ban on fuel-oil heating). The emission intensity has been approximately halved since 2010. (Mdir 2016)
- Indirect emissions related to production and transport of materials and waste handling related to construction and refurbishment of buildings accounts for around 10% of total territorial emissions in Norway. (Bygg21 2018: Bygg- og eiendomssektorens betydning for klimagassutslipp)
- Emissions connected to building materials, construction and demolition of buildings are a considerable share of total life-cycle emissions and range between 33% and 57%, depending on building type and age (Dibk 2018)
- According to a report from Asplan Viak, a little over half of all life cycle greenhouse gas emissions from a new building (TEK17) comes from heat and energy use, while approximately 40% comes from use of materials. Emissions associated with construction and demolition account for 2-5% (Dibk 2018)
- The energy intensity of buildings varies by building type. The most recent official data on energy use in buildings is from 2012 or 2011. In 2011, average energy intensity for commercial buildings was 230 kWh/m2 (in use) and 179 kWh/m2 for all real estate activities (SSB, 2011). According to the EIA global energy efficiency is expected to be improved annually by 1,6 percent.
- 63% of Norwegian private homes have no known Energy Performance Certificate (EPC) label, 7.7% are rated G and only 0.35% are rated A. (Enova energy statistics)
- BREEAM-NOR is the most used environmental certification scheme for all building types in Norway. 305 buildings are currently registered under this scheme. 66% are office and educational buildings. 71% are in Oslo and Østlandet (Grønn Byggallianse 2019)
- The availability of updated and encompassing energy data is very limited. See chapter on data and indicators.

Contents

About this brief

This sector brief was developed by CICERO as a part of the Sustainable Edge research project. The purpose of the brief is to outline the key material climate-related issues for the sector. The audience for the brief is the financial sector, either as potential investors or lenders to the sector. The reader is expected to have background knowledge of the sector and of climate risk assessment. The analysis methodology is rooted in CICERO's climate science and build on CICERO Shades of Green's methodology for green bond frameworks. This brief is to be considered a science-based opinion.

CICERO Shades of Green AS is a subsidiary of CICERO established in November 2018. CICERO Shades of Green AS has commercialized a corporate climate risk assessment based partially on the Sustainable Edge research, in addition to their own methodological development.

The Sustainable Edge project is financed by ENOVA SF and our financial sector partners: Oslo Pensjonsforsikring, CICERO Shades of Green AS, Nysnø, Sparebank 1 SMN, Sparebank 1 Nord-Norge, SR-Bank, Samspar and Sparebank 1 Østlandet. Thank you also to our partners Finans Norge and Schjødt.

Please note this assessment focuses on climate-related issues and risks. Other environmental and social aspects may be noted, but assessing material social, ethical and governance issues are outside the scope of the assessment. We discuss governance specifically in the context of climate governance, this should not be viewed as a substitute for a full evaluation of the governance of the sector and does not cover, e.g., corruption.

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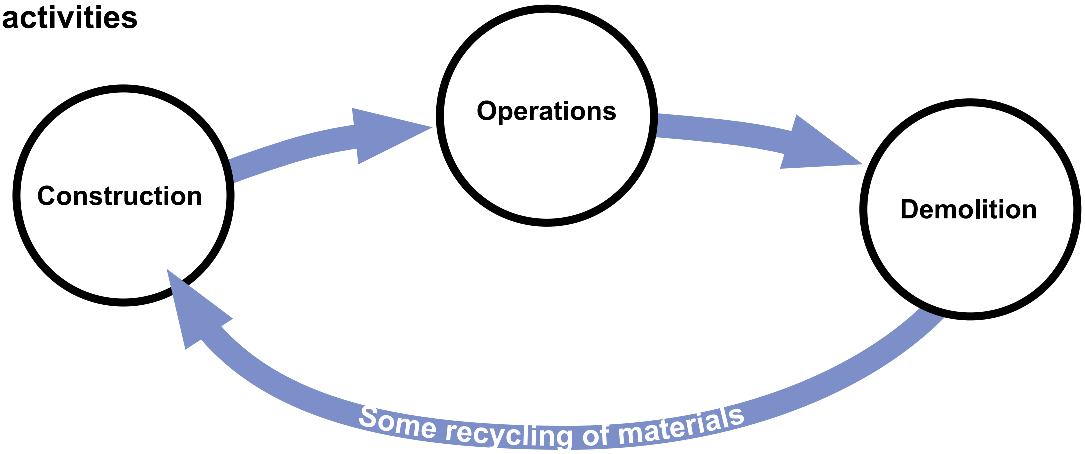
Emissions

Main activities



Scope 1

Definition: Direct emissions from owned or controlled sources, e.g. on-site fossil heating

Status:

- Scope 1 emissions from the real estate sector and their assets are small, of the order of 1,2% of total territorial Norwegian emissions (Mdir 2016)
- These emissions are expected to fall since fuel-oil based heating systems was banned from 2020.
- While fuel oil has a direct emissions factor of 315 tCO2/t, the alternatives power and district heating emit indirectly resp. 100 and 114 gCO2/kWh (Dibk 2018)
- Passive houses represent best practice.
- Older buildings are generally much less energy efficient.

Potential and challenges:

- Natural gas is still used as a heating fuel. Bans have not been officially proposed, but political discussions on this should be followed closely.
- According to the IEA, buildings in 2040 could be nearly 40% more energy efficient than today, on a global average level.

Targets

Along EU's climate goals, Norway is to reduce emissions from sectors including heating of buildings by 40% on average until 2030 with 1990 as base year. Specific targets for buildings have not been defined.

Scope 2

Definition:

Indirect emissions from generation of purchased energy, e.g. electricity, district heating.

Status:

Emissions from electricity and heat generation are low but depend on chosen emissions factor.

Scope 2 emissions’ share of life-cycle emissions	
Office building	52%**
Apartment building	52%**
Commercial building	67**

*med standard byggematerialer   **electricity and district heating, TEK 17
Kilde: Direktoratet for byggkvalitet, 2018

Potential and challenges:

- The emissions grid factor in Norway is low in European comparison.
- In some areas, district heating is available and sometimes mandatory to use. A share of district heating stems from waste incineration, including fractions of solid plastics.

Targets

The Parliament has decided on a goal of 10 TWh reduced energy use annually in existing buildings by 2030 – specific actions to achieve this have not yet been defined (TU 2019).

Scope 3

Definition:

All indirect emissions that occur in the value chain of the reporting company including up- and downstream emissions, e.g. production- and transport of building materials, construction and machinery, demolition and material removal.

Status:

- Scope 3 emissions are substantial, approx. 10% of national emissions.
- 93% of residential buildings have access to public transport within 500m walking distance (incl. bus) and by 15% (excl. bus) (2019, Eiendomsverdi).

Scope 3 emissions' share of life-cycle emissions	
Office building	47% (materials 40%, construction 5%, demolition 2%)
Apartment building	48% (materials 39%, construction 6%, demolition 3%)
Commercial building	33% (materials 27%, construction 4%, demolition 2%)

Potential and challenges:

- Depending on building type, the choice of building materials has a strong impact on life-cycle emissions of a building. A large number of LCA studies show that wood-frame building results in lower primary energy and GHG emission compared to non-wood alternatives including concrete and steel. (R&D Fund for public real estate, 2016)
- Given the footprint from materials, refurbishments have a lower climate effect than newbuilds
- Low emission construction sites can reduce life-cycle emissions by 4-6%
- Access to low-emission public transportation reduces tenants' transport emissions. Further electrification of the vehicle fleet will also reduce Scope 3 emissions.

Targets

Norway has no specific emission targets on building materials or low-carbon public transport access but aims to achieve 40% emissions reductions by 2030 and 80-95% by 2050 at a national level.

Disclosure of climate risk

Disclosure of climate risk and environmental impact

The real estate sector in Norway scores low compared to other sectors in a survey of sustainability reporting by the 100 largest listed Norwegian companies. The score assesses reporting under GRI, CDP, TCFD, SDGs. Only one company from this sector, Entra, was among the top 14 performers. (Governance Group 2019)
A survey of publicly listed real estate and building companies across 18 major markets, including Norway, showed that this sector lacks behind other non-financial sectors regarding disclosure of climate risks according to the TCFD recommendations. (EY 2018)
Eiendomsverdi and Kartverket and other actors are collecting data but reporting of key metrics is insufficient.

Regulations and scenario information

Policies in Norway

- Norway has no specific emission targets for buildings but aims to achieve 40% emissions reductions by 2030 and 80-95% by 2050.
- The Parliament has decided on a goal of 10 TWh reduced energy use in existing buildings by 2030. New buildings have to follow the existing building regulations at any one time. Currently, the regulation named TEK17 (to be updated in 2020) provide an energy standards varying by type of building.
- Currently, flood zones and immediate risks are included in the standard building planning procedure. The Norwegian Water Resources and Energy Directorate (NVE) provides detailed maps of flood zones and hazard maps for flooding.[2] The data used for these maps varies in age and is based on statistical analysis of historical data, data on typography and hydraulic modelling. There are limitations with using historical data to predict future flood events as flooding patterns are changing due to climate change.
- In Norway, natural hazard insurance coverage is high due to the government-mandated bundling of flood and fire insurance through the Natural Perils Insurance Act. For uninsurable assets, the government has a separate natural hazard compensation scheme. Due to the mandatory insurance coverage, direct damages to property are less of an immediate concern. However, indirect costs, e.g. from transport disruptions, may not always be covered.
- The EU, and Norway, aims to achieve a 70% recycling rate for waste from construction. Companies' efforts to increase the share of sorted and recycled waste from construction are insufficient to reach this target (34% in 2017, EY 2019).
- The building sector has developed a roadmap for sustainable growth towards 2050, which includes several recommendations for the sector. Some of the key recommendations include certifying the organization, removing all fossil fuel heating, requesting fossil free construction sites and commissioning an energy budget for the estimated actual energy consumption (Grønn Byggallianse, 2016)

2 The maps can be accessed here: https://www.nve.no/flaum-og-skred/kartlegging/flaum/

EU Taxonomy

The March 2020 EU taxonomy includes the following real estate related activities : Construction of new buildings (F41.1 F41.2) and Building renovation (F41.1 F41.2), Individual renovation measures, installation of renewables on-site and professional, scientific and technical activities (F41.2), and Acquisition and ownership of buildings (L68).

The following criteria applies to construction of new buildings

- The net primary energy demand of the new construction must be at least 20% lower than the primary energy demand resulting from the relevant regulations[3].

Note that the construction of new buildings designed for the purpose of extraction, storage, transportation, or manufacture of fossil fuels is not eligible.

Renovation is eligible when it meets either of the following thresholds[4]:

- Major renovation: compliant with the requirements set in the applicable building regulations for 'major renovation' transposing the Energy Performance of Buildings Directive (EPBD)
- Relative improvement: the renovation achieves savings in net Primary Energy Demand of at least 30% in comparison to the baseline performance of the building before the renovation.

Under the category F41.2, a range of Individual renovation measures, installation of renewables on-site and professional, scientific and technical activities are eligible. These include for example, Replacement of existing windows with new energy efficient windows, Installation of solar hot water panels and Accredited energy audits[5].

Acquisition and ownership of buildings could be eligible in these two cases[6]:

- Case A – Acquisition of buildings built before 31 December 2020: calculated performance of the building must be within the top 15% of the local existing stock.
- Case B – Acquisition of buildings built after 31 December 2020: The building must meet the criteria established for the 'Construction of new buildings'.

Note that large non-residential buildings must meet an additional requirement: efficient building operations must be ensured through dedicated energy management.

The current EU taxonomy draft sets additional requirements in the area of "Do no significant harm" in terms of physical risk assessment, building materials, water consumption etc.

The current draft also requires minimum social safeguards, currently defined as meeting the International Labour Organisation (ILO) Core Labour Practices.

Global scenarios

- The buildings and buildings construction sectors combined are responsible for 36% of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions (IEA 2019). Energy demand from buildings and buildings construction continues to rise, driven by improved access to energy in developing countries, greater ownership and use of energy-consuming devices, and rapid growth in global buildings floor area, at nearly 3% per year.
- The IEA Efficient World Scenario highlights the potential for global building energy demand to decline between now and 2040, despite total building floor area growing by a further 60%. On average, buildings in 2040 could be nearly 40% more energy efficient than today.
- Space heating offers over a quarter of the potential energy savings. Water heating efficiency could also improve by 43% and improvements in space cooling, which is the fastest growing source of building energy demand, could see air conditioner efficiency double.

[3] See the EU Taxonomy for detailed criteria https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en
[4] As above
[5] As above
[6] As above

CICERO Shades of Green & analyst perspective[7]

CICERO Dark Green for the sector

Considerations for main activities

- CICERO Dark Green shading is difficult to achieve in the building sector because buildings have a long lifetime.
- CICERO Dark Green shading in the building sector should therefore conform to strict measures and is reserved for the highest building standards such as LEED Platinum, BREEAM Outstanding, Zero-Energy buildings and passive houses.
- Energy efficiency should be significantly below current regulations/standards (for example, a 30 % improvement).
- Resiliency is a core consideration for a Dark Green shading. The main risk to consider in most Norwegian regions is flood risk and other risks of more intense precipitation, for example, risk of urban overflow and increased snow loads. For some regions, mudslides, avalanches and more intense storms should also be considered. Heat stress may be a concern for certain buildings in urban settings.

Considerations for upstream and downstream factors

- Dark Green projects have strict climate related requirements for material, handling of waste during construction.
- Minimal emissions from construction are permissible for Dark Green projects, however, efforts should be taken to establish zero-emission construction sites.
- The building should encourage a low-emission transportation system. Consider access to public transportation, availability of charging points for EVs, pedestrian and bicycle accessibility

Current best practice – activities

★ Ambitious greenhouse gas emission targets with a clear timeline, taking into account life-cycle considerations and emissions from sub-contractors upstream (construction) and downstream (demolition) activities.

★ Environmental impact assessment of refurbishment versus new construction before investment decisions.

★ Due consideration of transport solutions and associated lifetime emissions for new projects.

Current best practices – governance

★ Climate sensitive key performance indicators regularly measured and reported systematically to the leadership of the company.

★ Climate risk assessment including scenario analysis relevant both to physical and transition risks.

★ Transparent and regular reporting against established targets verified by independent third parties.

7 The Shades of Green methodology assesses alignment with a low-carbon resilient future. CICERO Dark Green is allocated to projects and solutions that correspond to the long-term vision of a low carbon and climate resilient future. For more information see: https://www.cicero.green/our-approach

Key opportunities

- Buildings that are already green now can face lower risk of future upgrade costs and physical climate impacts, lower operating risks and lower risk of becoming stranded assets (World Green Building Council).
- Deep retrofits are often cost efficient and achieve a better climate impact than newbuilds.
- Access to low-carbon public transport can provide long-term benefits for tenants/owners.

Key pitfalls

- Incentive problems for builders/owners/ tenants:
  - Builders do not necessarily focus on long-term efficiency.
  - Owners do not necessarily upgrade the building as the running costs are carried by the tenants.
  - Tenants often have less flexibility to upgrade efficiency as this requires investments from owners.
  - Public transport access of buildings not necessarily in the focus of builders/owners/tenants.
- In the long run, insurance coverage might be insufficient to cover climate risk impacts on supply chain and communication infrastructure.
- Building materials, construction emissions, transport solutions and waste handling (scope 3) should be in the focus in a Norwegian context as the potential for reducing life-cycle emissions is higher than in procured power and heat (scope 2).
- Energy efficiency improvements may lead to rebound effects. When the cost of an activity is reduced there will be incentives to do more of the same activity. This could be less of a concern in Norway given the high share of renewables in the grid.

Data and indicators for climate risk disclosure

Historic data

Figure 1 illustrates that specific energy use decreased only slightly while average energy use remained unchanged. Figure 2 illustrates that there is a long-term consistent trend that more new buildings are constructed than older buildings being refurbished. This is probably not a trend that is most aligned with a low carbon and zero emission vision of the future.

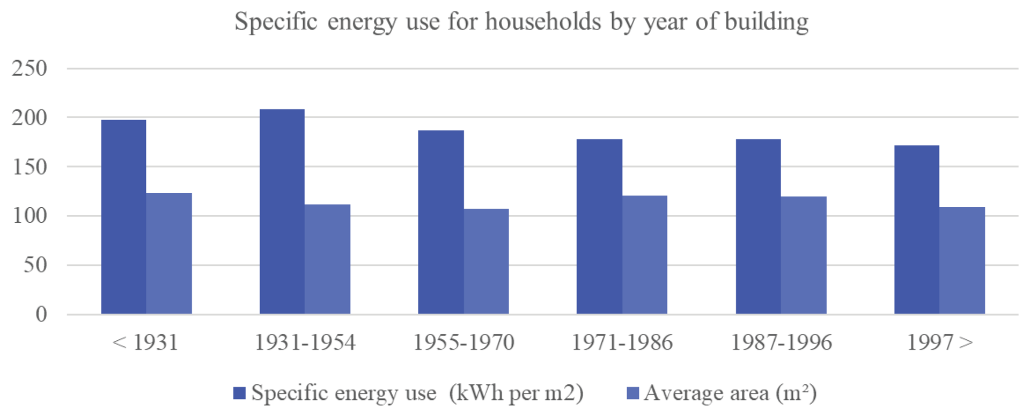


Figure 1 energy use for households.

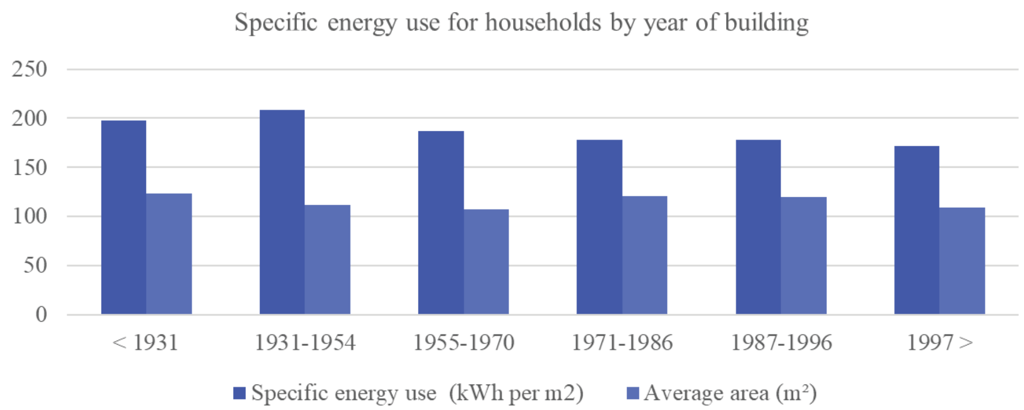


Figure 2 production index

The most recent available official data from Statistics Norway is from 2012 and 2011. The average energy use for residential buildings in 2012 was 181 kWh/m2 (in use). The average energy use in commercial buildings in 2011 was 230 kWh/m2 (in use). Average energy use by all real estate activities (2011) in Norway: 179 kWh/m2 (in use) (Statistics Norway).

Climate-relevant data sources

- Data in the building sector remains scarce.
- Full coverage of energy efficiency data in Norway is not yet available.
- Additional efforts are needed to capture building materials and construction emissions accounting.

Potential difficulties in attaining / using existing data

- There is currently no systematic way of capturing national buildings' Scope 1, 2 and 3 emissions.
- The Norwegian EPC label covers only approximately 20% of the total building stock. Since the EPC label covers energy efficiency and heating character on a specific scale, actual emissions accounting is difficult to obtain.
- Currently, the EPC label is in the phase of being updated.
- Some data sources do not clearly separate between commercial and residential buildings.

Indicators which would improve climate risk disclosure[8]

Preliminary indicators and metrics
Electricity intensity (kWh/m2), heating energy intensity (kWh/m2) and carbon intensity (CO2eq/m2) (Estimated or measured. Area as BOA or BRA, please indicate.)
Installed heating type(s)
Supply chain emissions of construction and building materials
Percentage of sorting of waste from construction activities
Percentage of materials recycling from construction related waste (2017: 34%, EU target: 70% in 2020. EY 2019)
Demand for low fossil/fossil free construction-sites in standard tendering documents
For what share of the real estate assets has a physical climate risk assessment been conducted?
What share of the real estate assets are in areas prone to flooding and urban overflow?

Indicators providing information on the scale of climate hazard (e.g. heavy precipitation) could be relevant for the individual buildings. Some indicators of physical climate risk are being developed by the CICERO lead CimINVEST project and will be presented in an open access data portal. The project has also developed factsheets on climate risks that provide guidance on physical risk assessment[9].

8 Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment.
9 These can be downloaded here: https://cicero.oslo.no/en/climinvest

?

Key analyst questions for all companies in this sector

1. What are the company's goals for energy intensity? How do these compare to regulations?
2. How does the company consider environmental and climate impacts linked to transport solutions/public transport access?
3. How does the company consider the full life-cycle emissions of the building incl. construction emissions and from building materials and recycling?
4. How are decisions about new build vs renovating older buildings taken? Is there a consideration of the potential to use existing infrastructure or materials from any demolition?
5. How does the company assess, integrate and disclose climate risk exposure?
6. How resilient are the buildings to physical impacts, including increased precipitation (flooding and urban overflow), heat stress, snow loads and wind?
7. How are environmental characteristics and energy use discussed with potential tenants?
8. Does company obtain third-party building certifications for the buildings?
9. What is the current share of recycling of waste from construction, are there defined targets? (EU target: 70%)

Additional data and information

Building age

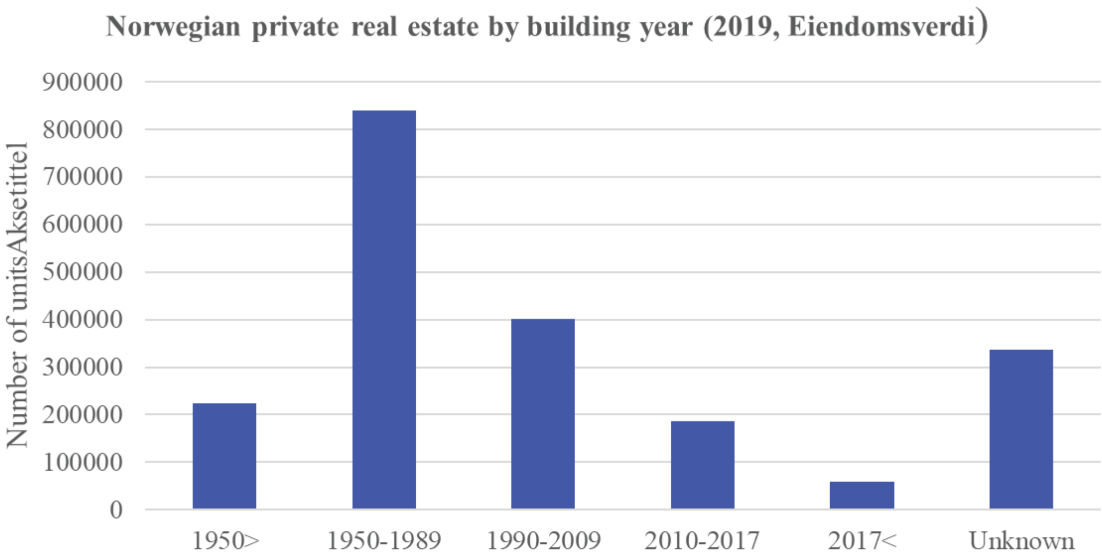


Figure 3 private real estate by building year

Most buildings are between 20 and 50 years old. Rehabilitation is therefore a primary concern.

Energy intensity in different building types

Highly specialized buildings, e.g. hospitals, are most energy intensive, while business and industry buildings have the greatest gap between the best and the average buildings in this sample

Building category	Average energy intensity (kWh/m2)	Average energy intensity (kWh/m2) of top 5%
Office building	174	84
Schools	138	69
Kindergartens	164	66
Apartment buildings	139	54
Shops	145	58
Business buildings	168	48
Hospitals	200	98
Industry and storage buildings	188	49
Health buildings	178	89
Sports buildings	145	47

Sample of 3300 Norwegian commercial buildings' energy intensity (2019, Entro)

BREEAM certifications

BREEAM Outstanding can reduce CO2 emissions by half compared to standard buildings. This certification is most expensive for office and shopping buildings, with an added cost of approximately 10%. Source: Caroline Gjøsund Larsen, 2018.

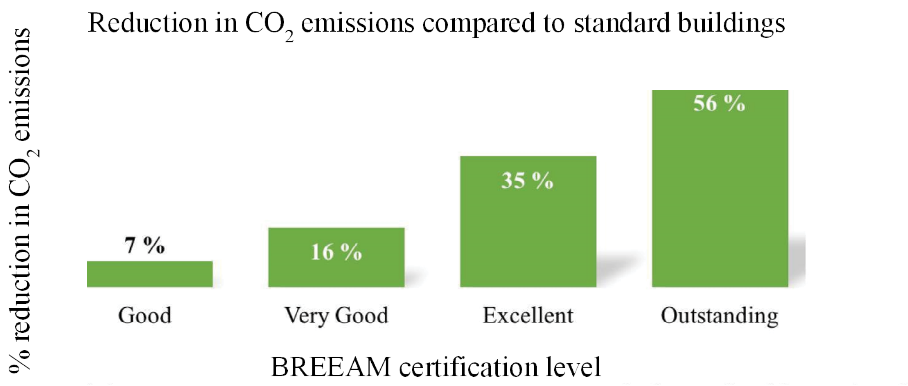


Figure 4 BREEAM and reduction in CO2 emissions

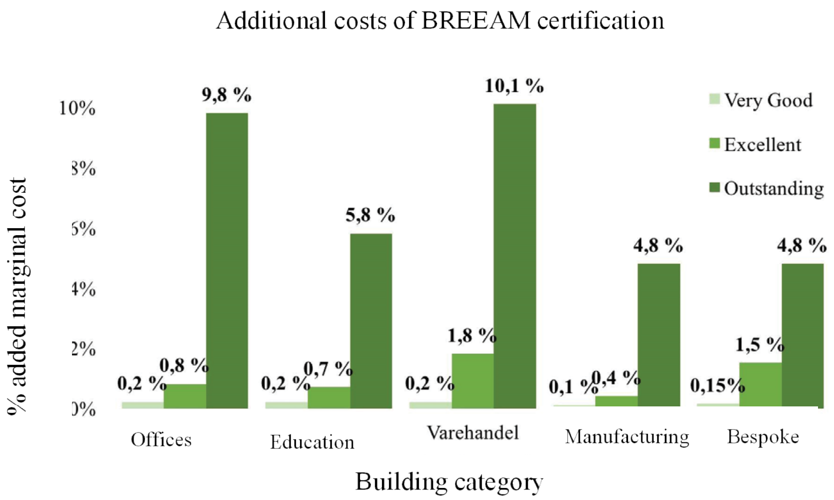


Figure 5 Additional costs of BREEAM

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Sustainable Edge Sector Brief: Aluminum

Year 2020

Sector definition

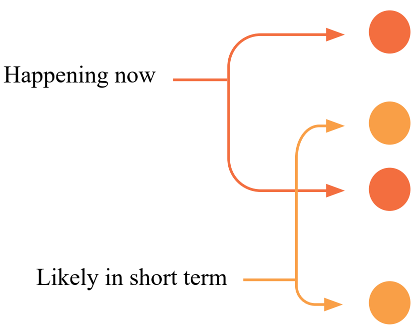
NACE Code C24.4.2 Aluminum Production.

This document outlines the aluminum production activities related to alumina smelting and fabrication of aluminum into the end products. The aluminum industry is highly consolidated. There are less than 300 aluminum production sites globally, supplied by around 40 bauxite mines (Carbon Trust, 2011). This sector brief therefore has a global scope and is best applied to vertically integrated producers.

Summary

Aluminium production is a necessary sector in the low carbon future. The end products are used in a wide range of industries. Aluminium does not corrode and can reduce weight when replacing heavier metals, potentially improving energy efficiency and electrification in some industries (ex. vehicles). The largest share of the sector Greenhouse Gases (GHG) emissions come from the smelting of alumina (aluminium oxide) into primary aluminium due to the high electricity demand and process emissions. The single largest source of emissions is electricity use. A large proportion of the energy generation in aluminium production relies on fossil fuel and shifting towards renewables has vast potential for emissions reductions. Aluminium can be recycled, and aluminium produced through recycling emits only a fraction of the emissions from primary production. R&D is ongoing on continuous and disruptive technology developments (see Fact box), with the potential to reduce GHG emissions considerably.

Main climate and environmental risks[1]



1. Increased precipitation leading to environmental contamination from bauxite mining operations.
2. Extreme weather events disrupting supply chain (mining operations).
3. New and tightened carbon pricing policies and border tax adjustment policies could increase costs[2].
4. Lock-in of uncompetitive technologies.

[1] The selection of key risks and categorization of those is based on expert judgement. Short-term refers to impacts that are likely in the next decade.
[2] This might also be an opportunity for low-carbon producers.

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Physical risk exposure

- Greatest physical risk would occur under high-emission scenarios, causing extreme weather events and their impacts to increase.
- Mining operations are increasingly exposed to extreme weather events (e.g. cyclones, flooding and droughts) (ICMM, 2013).
- Extreme precipitation (CICERO, 2017) can impact surface structures designed to contain (liquid) waste. The run-off can cause harmful environmental impacts and may require additional investments in water management facilities and reinforcement of deposit structures for waste and materials (e.g. bauxite/red mud tailings)
- Heat stress and draughts are observed in all regions (CICERO, 2017) and can affect power supply, water supply, human health and the functioning of machinery (ICMM, 2013).
- Low-lying coastal and off-shore mining may be impaired by rising sea levels and storms, causing storm surges (ICMM 2013) (e.g. bauxite mine in Kaloum, Conakry, Guinea).

Transition risk exposure

- The sector will increasingly be exposed to policies that seek to impose a cost of carbon on GHG-emissions, through the development of new and tightening of existing carbon pricing mechanisms (ICCM, 2013; EU, 2020). This is likely to increase aluminum prices, benefitting the low-cost, low-carbon producers but putting greater pressure on coal-based refineries (TCFD, 2019).
- Metal Exchanges (e.g. London Metal Exchange) may impose disclosure regulations regarding the carbon footprint of aluminum producers.
- Aluminium producers should be prepared to report alignment with relevant thresholds in the EU taxonomy from 2022. The threshold criteria will be subject to periodical updates.
- Risk of lock-in to technologies that become uncompetitive during the smelters' lifetime. Current investments in R&D for lower-carbon technologies will lead to increased market accessibility of new tech and may lead to the phase-out of outdated technologies (TCFD, 2019)

Key statistics & background figures

- The aluminium sector accounts for about 2% of global GHG-emissions or approximately 1 Gt CO2 (Saevarsdottir, 2019).
- Aluminium production requires large amounts of electricity. Emissions from the generation of electricity represents the major source of emissions for the industry as a whole. The use of carbon anodes during production represent the second largest source of emissions.
- Emissions intensity (CO2eq/ton aluminium) vary widely, depending on the mode of electricity production, whether the aluminium is virgin or recycled, and the technologies used in the different stages of production. The global average for total CO2-emissions from aluminium production is 14,4 t CO2eq/t Al produced. However, a total emission of about 3,5 t CO2eq/t Al is possible using modern technology and renewable power production (Saevarsdottir, 2019).
- Demand for primary aluminium is projected to grow by 50 % by 2050, reaching approximately 100 million tons. Demand is driven by key sectors including automotive, buildings and packaging. (European Aluminium, 2019).
- China is the largest market for aluminium, representing over half of all global primary demand. High demand growth is expected in India, other Asian countries and Africa, whereas European demand is expected to remain stable. (European Aluminium, 2019).
- The largest companies in this sector are listed in OECD countries and several are diversified with major operations in e.g. mining of other commodities. By contrast, more than half of global primary aluminium production is located in China. (TPI, 2019b).
- The Transition Pathway Initiative (TPI) assessed 12 of the world's largest, publicly listed companies involved in aluminium production. Three of them align with the Paris Agreement benchmarks in terms of emission intensity: Alcoa, Norsk Hydro and Rio Tinto (TPI, 2019b).

Contents

About this brief

This sector brief was developed by CICERO as a part of the Sustainable Edge research project. The purpose of the brief is to outline the key material climate-related issues for the sector. The audience for the brief is the financial sector, either as potential investors or lenders to the sector. The reader is expected to have background knowledge of the sector and of climate risk assessment. The analysis methodology is rooted in CICERO's climate science and build on CICERO Shades of Green's methodology for green bond frameworks. This brief is to be considered a science-based opinion.

CICERO Shades of Green AS is a subsidiary of CICERO established in November 2018. CICERO Shades of Green AS has commercialized a corporate climate risk assessment based partially on the Sustainable Edge research, in addition to their own methodological development.

The Sustainable Edge project is financed by ENOVA SF and our financial sector partners: Oslo Pensjonsforsikring, CICERO Shades of Green AS, Nysnø, Sparebank 1 SMN, Sparebank 1 Nord-Norge, SR-Bank, Samspar and Sparebank 1 Østlandet. Thank you also to our partners Finans Norge and Schjødt.

Please note this assessment focuses on climate-related issues and risks. Other environmental and social aspects may be noted, but assessing material social, ethical and governance issues are outside the scope of the assessment. We discuss governance specifically in the context of climate governance, this should not be viewed as a substitute for a full evaluation of the governance of the sector and does not cover, e.g., corruption.

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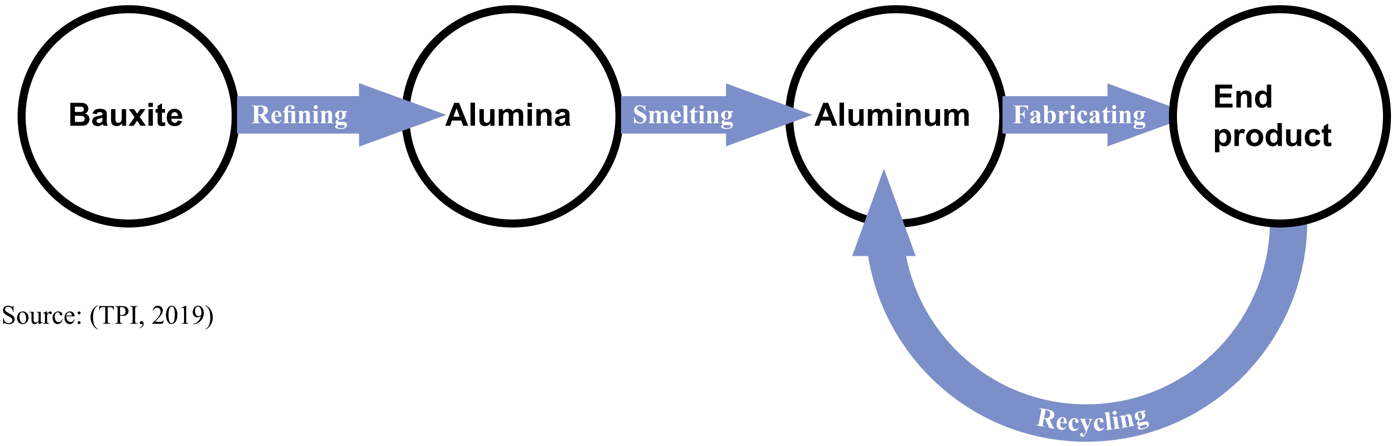
Emissions

Main sources[3]



Source: (TPI, 2019)

Scope 1 emissions (S1)

Status:

- Direct emission arises mostly from anode degradation (ca. 80%) in the electrolytic cell, and to a lesser degree from Perfluorocarbons (PFC) gasses (ca. 19%) (Carbon Trust, 2011).
- Direct CO2 emissions represent ca. 27 % of emissions from mining to semi-finished end product (Carbon Trust 2011 based on data from 2007/2008. Other studies put the figure at 17%, e.g. GNCS fact sheet 2010).
- From 1990 – 2019, the direct GHG emissions per ton of European aluminum production was reduced by 55 percent. The driver of the emissions reduction was a 97 % reduction of PFC emissions. (European Aluminum, 2019).
- Note that we cover electricity in the section on Scope 2. Some aluminum producers own their energy sources, in these instances electricity use would be included in scope 1.

Potential and challenges: To reduce scope 1 emissions

- Worldwide deployment of best available technology could achieve significant emissions reductions. The current technology is reaching its theoretical limits for emissions improvement. Further improvements among the best-in-class plants will only be reached with breakthrough innovations. (European Aluminum, 2019).
- R&D on new technologies will, if implemented, reduce among others scope 1 emissions (see Fact box).

Targets

- Aluminum is included in the EU ETS and the ambitions are scheduled to increase in Phase 4.
- Aluminium is included in the EU Taxonomy (EU-TEG, 2020).
- Importers of aluminum to the EU may in the future be required to bear the cost of embedded emissions. According to the European Commission (2020) a carbon border adjustment mechanism is considered as an action to address carbon leakage.

[3] Scope 1: Direct emissions from owned or controlled sources; Scope 2: Indirect emissions from generation of purchased energy; Scope 3: All indirect emissions that occur in the value chain of the reporting company including up- and downstream emissions. See the GHG Protocol for more information on scopes https://ghgprotocol.org/

Scope 2 emissions (S2)

Status:

- Scope 2 emissions mainly originate from purchased electricity. Some aluminum producers also own their energy sources, complicating the separation of scope 1 and 2. In this section we consider electricity use.
- Currently, a large proportion of the energy use in aluminum production relies on fossil fuel (due to the energy mix of the regional grids at production sites).
- Emissions related to electricity demand represent around 65% of total (Scope 1 & 2) emissions from aluminum production (TPI, 2019).
- While aluminum energy intensity (kWh/t) is gradually decreasing (IEA, 2019), overall energy consumption for aluminum production has almost quadrupled since 1980.

Potential and challenges:

- Replacing fossil fuel electricity production with renewable energy sources can significantly reduce Scope 2 emissions.
- Use of off-grid renewable electricity sources to power individual smelters is challenging due to the need for uninterrupted electricity supply.
- More than half of the global aluminum production is located in China. Over 80% of the electricity generation mix in China consists of coal and oil.
- Targets
- The IEA Sustainable Development Scenario pathway (SDS) requires global energy intensity (MWh/t) of overall aluminum production to fall by at least 1.2% annually up to 2030 (IEA, 2019). The European average emission intensity in 2017 was 15.29 MWh/t (EU TEG, 2020)

Scope 3 emissions (S3)

Status:

- Upstream scope 3 emissions from mining and refining of bauxite ore are estimated at ~6% between mining and semi-finished end products (Carbon Trust 2011).
- Aluminum is used in a wide range of end products, from vehicle manufacturing to beverage cans.
- Aluminum recycling emits 5% CO2 relative to emissions resulting from production of primary aluminum. Only 32% of aluminum was produced from scraps in 2017 (IEA, 2019).
- Europe is the leading in recycling, both in terms of recycling rates and production. Over half of the aluminum produced in Europe in 2019 was from recycled aluminum. The share of recycled aluminum in European end-use applications was 26 % in 2000 (European Aluminum, 2019).
- Scope 3 emissions are difficult to measure.

Potential and challenges:

- Increasing the recycling systems to re-use aluminum from buildings and cars in all countries.
- Aluminum would make cars lighter, saving fuel, but this could lead to an increase in the production of high emitting vehicles, typically heavy cars, like SUVs and limousines.

Targets

- The automotive industry is increasing the share of aluminum in European cars, to meet the European Commission's requirements to limit average CO2 emissions below 130g/km. From 2021, phased in from 2020, the EU fleet-wide average emission target for new cars will be 95 g CO2/km (EU, 2020).

Climate risk management

Current risk management

In order to meet expected future demand, while meeting climate change targets, the industry must deliver significant decarbonisation. Short term options to increase recycle rates exist, and should be given increased focus. Medium term options include new technology to reduce the carbon intensity of primary aluminium production (see Fact box).

The Aluminium Stewardship Initiative (ASI) has developed a certification program for sustainable aluminium .[4] These include smelter-specific emissions thresholds. Smelters starting production after 2020 must keep Scope 1 and 2 GHG emissions below 8 tCO2e /t aluminium produced. Existing aluminium smelters that were in production before 2020 must meet this by 2030 (ASI, 2020). Per July 2020, 59 certifications had been issued to plants in 28 counties[5]. While this represents a step in the right direction, this certification does not by itself mitigate climate risk. For comparison, TPI has estimated that the average carbon intensity of an aluminium producer aligned with a 2-degree scenario is less than 5.5 t CO2eq /t aluminium produced in 2020 (TPI, 2019).

According to projections by PWC on behalf of European Aluminium, a decarbonization of the European power sector, could reduce the carbon intensity of European primary smelters to 1,73t CO2eq /t aluminium in 2050. This study shows the importance of energy sources to the overall emissions of aluminium. (European Aluminium, 2019).

Key opportunities

- Aluminium is a key input to many technologies needed in the low carbon transition and can assist efficiency improvements in other sectors e.g. by reducing vehicle weight.
- Increasing share of recycling, and especially recycling combined with renewable energy use, can bring down emissions.
- Increasing the share of renewable energy sources in aluminium production would also decrease emissions in the production of virgin aluminium.
- Climate aware customers will demand aluminium produced with reduced CO2-emissions.
- New production technologies could drastically reduce GHG-emissions, see Fact box.
- Carbon Capture and Storage (CCS) could be used to capture emissions from the production process. However, CCS is not currently commercially viable.

Key pitfalls

- Increasing demand for aluminium can increase emission intensity of the aluminium sector if fossil fuel electricity is used in the production of the additional capacity. Note that the new aluminium production is expected to be in Asia (China and India) and based on coal (European Aluminium, 2019).
- While many of the end-products aluminium is used for could be classified as low carbon, aluminium production itself is an emission intensive activity and could be subject to stringent emissions policies.

4 For more information see: https://aluminium-stewardship.org/why-aluminium/responsible-aluminium-asi-role/
5 For a map over certified facilities see https://aluminium-stewardship.org/asi-certification/map-of-asi-certifications/

Disclosure and integration of climate risk

Disclosure of climate risk and environmental impact

- Emissions disclosure and publicly available emission data is limited. For Norwegian aluminium production, GHG- and production data at the plant level is given on www.norskeutslipp.no
- Companies that do disclose emissions, do so in different ways: some focus on recent and current emission intensities (CO_2eq/t aluminium) and set future targets in terms of intensity; some report on their emissions in absolute terms (un-normalised); and other companies set targets in terms of emissions intensity (i.e. total emissions related to overall activities). The latter involves some assumptions on the company's future activity levels.
- The aluminium producers should be prepared to report on alignment with relevant thresholds in the EU taxonomy.

Integration of climate risk in operations / decisions

- Transition Pathway Initiative (TPI) assesses the world's largest publicly listed companies involved in aluminium production. Out of the 12 companies evaluated by TPI, seven companies integrate climate risk in their operations and decision making through an established process to manage climate-related risks.
- Three companies assessed by TPI incorporate climate change risks and opportunities into their strategy and undertake climate scenario planning.
- Several of the big aluminium producers (e.g. Hydro, Alcoa and Rio Tinto) have started to report on climate risk in accordance with the TCFD-recommendations.

Regulations and scenario information

Policies in Norway

Aluminium is included in the European Emissions Trading System (EU ETS)[6]. The Norwegian aluminium sector is also regulated by the Industry Emissions Directive (IED), enforced through permits from The Norwegian Environment Agency. Requirements include cleaning the PCF-gases and to improve energy efficiency. Importers of aluminium to the EU may in the future be required to bear the cost of embedded emissions through a border adjustment tax. (EU, 2020).

Enova SF, a government enterprise, has provided technical and financial support to several R&D projects in the aluminium sector.

EU Taxonomy

Aluminium manufacturing is covered by the EU Taxonomy (March 2020), and is eligble if it is relying on low carbon energy (e.g. hydropower) and reduced direct emissions. Criteria 1 in combination with either Criteria 2 or 3 must be met (EU-TEG, 2020):

- Criteria 1: Direct emissions for primary production must not exceed the EU-ETS benchmark (1.514tCO_2eq/t as of June 2019);
- Criteria 2: Electricity consumption for electrolysis is under the European average emission factor (15.29 MWh/t as of June 2019 (IAI, 2017) but shall be updated annually)
- Criteria 3: Average carbon intensity of electricity used for primary aluminium production must not exceed 100 gCO_2eq/kWh (Taxonomy threshold, subject to periodic change).
- Threshold criteria will be subject to periodical updates, e.g. due to tightening of EU-ETS benchmarks for the phase 4.

All aluminium recycling is eligible due to significantly lower emissions. No additional mitigation criteria need to be met.

6 The market price at the close of September 25,15 EUR per ton CO2, https://markets.businessinsider.com/commodities/co2-european-emission-allowances

In addition, the criteria above, the "do no significant harm" objective must be met. The main potential significant harm to other environmental objectives from the manufacture of aluminium is associated with e.g. emissions to air and the toxic, corrosive and reactive nature of waste. See the EU taxonomy excel tools for more details on aspects of this objective for the sector.

Global scenarios

- Chemicals, iron and steel, and aluminium production together account for around 15% of electricity use worldwide. Aluminium production grew at 6% per year since 2000, leading to a 5% electricity growth in that sector – the fastest rate among end-uses in industry (IEA WEO 2018.)
- The IEA Sustainable Development scenario (SDS) assumes increased policies to support recycling of aluminium, steel, paper and plastic across all regions.

CICERO Shades of Green & analyst perspective[7]

CICERO Dark Green for the sector

Considerations for main activities

- Manufacturing of secondary aluminum (i.e. production of aluminum from recycled aluminum) combined with renewable electricity generation is the lowest emissions option for the sector.
- Relying on renewable energy generation is the only low-carbon alternative for aluminum production.
- Recycling of own scrap is highly encouraged

Considerations for upstream and downstream factors

- Upstream solutions include identification of water scarcity risks and appropriate management of water quality and consumption around bauxite mining, including waste disposal and bauxite tailings.
- Downstream solutions involve circular economy thinking and pollution prevention. Appropriate waste management and use of aluminum scrap (incl. old scrap and from own production process).
- Aluminum used in transportation and aviation can decrease emissions by decreasing the weight of a vehicle which leads to lower fuel consumption. Potential rebound effects if e.g. larger vehicles (SUVs) become more popular due to lower costs related to energy efficiency.
- Aluminum is a necessary material for many products that support a low carbon future. Producers should take climate change impact considerations into account when they decide whom to sell extruded products.

7 The Shades of Green methodology assesses alignment with a low-carbon resilient future. CICERO Dark Green is allocated to projects and solutions that correspond to the long-term vision of a low carbon and climate resilient future. For more information see: https://www.cicero.green/our-approach

Current best practice – activities

- ★ Best practice is a high focus on R&D on new technologies (see Fact box) with concrete plans for zero emissions in 2050, renewable energy sources for electricity generation and implementing the latest energy efficiency technologies.
- ★ Aluminium companies should be involved in R&D developments on new technologies (see Fact box) and energy efficiency..
- ★ Aluminium producers can benefit from sourcing renewable Power Purchase Agreements (PPAs) to lock in renewable energy capacity for their production.
- ★ Norsk Hydro's technology pilot project in Karmøy is testing the most climate and energy-efficient aluminium production technology in the world and is using renewable energy sources.
- ★ Alcoa, Norsk Hydro and Rio Tinto are the three aluminium producers that are currently aligned with the Paris Agreement benchmark (TPI, 2019b)

Current best practices - governance

- ★ Best practice includes setting long term targets for reducing GHG emissions, undertaking scenario stress-testing, and incorporating climate risks and opportunities in company strategy, e.g. by adopting reporting according to the TCFD-recommendations.
- ★ Alcoa, Rio Tinto and South32 integrate climate risk into their strategic assessment (TPI, 2019b)

Data and indicators for climate risk disclosure

Historic data

Figure 1 illustrates that there is a long-term consistent trend of increasing energy consumption associated with aluminium production. This is probably not a trend that is most aligned with a low carbon and zero emission vision of the future.

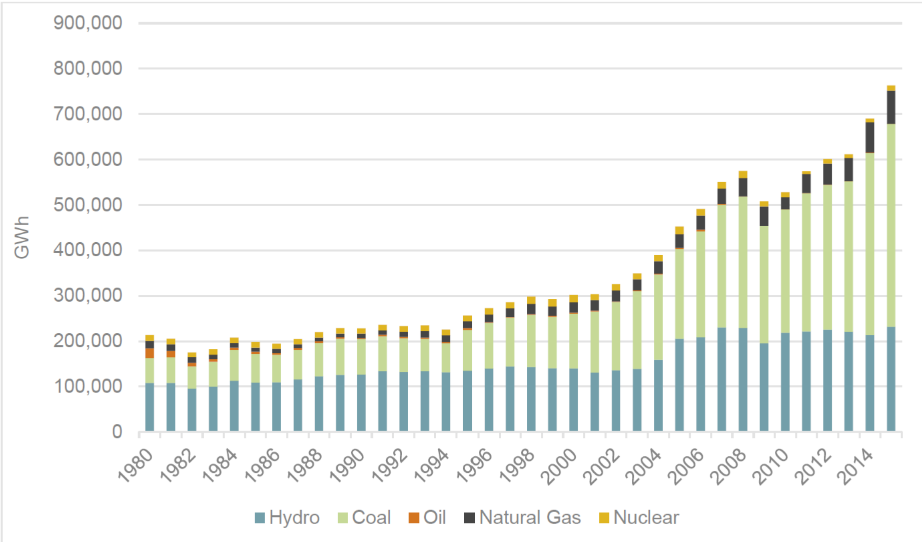


Figure 1 Global aluminum industry power mix for years 1980 – 2015 (IAI, 2017)

Figure 2 shows the historical sectorial end-use of aluminium, and projected demand to 2027. The figures show high historical and expected growth in demand from key sectors. Transport and construction are the most important sectors, each representing about a quarter of demand. Other key sectors include packaging, electrical, machinery and consumer durables.

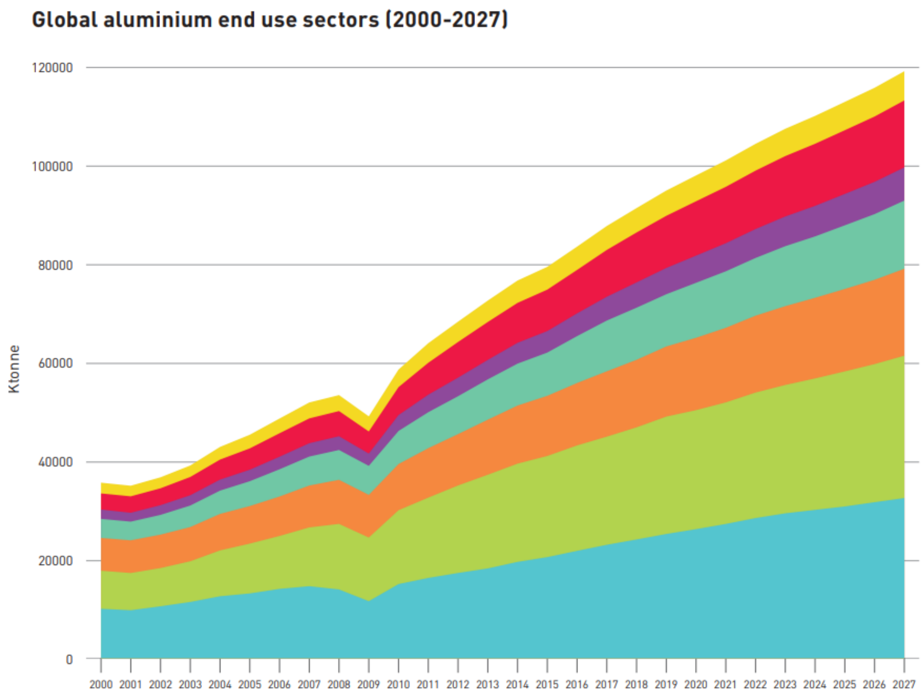


Figure 2 Global aluminium end use sectors (2000 – 2027). Source: European Aluminium (2019), CRU (2018)

Figure 3 shows the emission intensity of aluminium production per ton, and the electricity mix by regions in 2008. Note that since this there have been both efficiencies in the aluminium production process and some changes to the regional grids. However, the link between fossil fuel heavy grids and a high emissions intensity hold. China is the largest producer of aluminium and produces at the highest emission intensity. At present Europe is the largest market for aluminium. In the context of an anticipated three or four fold increase in global aluminium production and consumption over the next 40 years, there is a strong possibility that EU aluminium production will not grow above current levels, while aluminium consumption continues to rise.

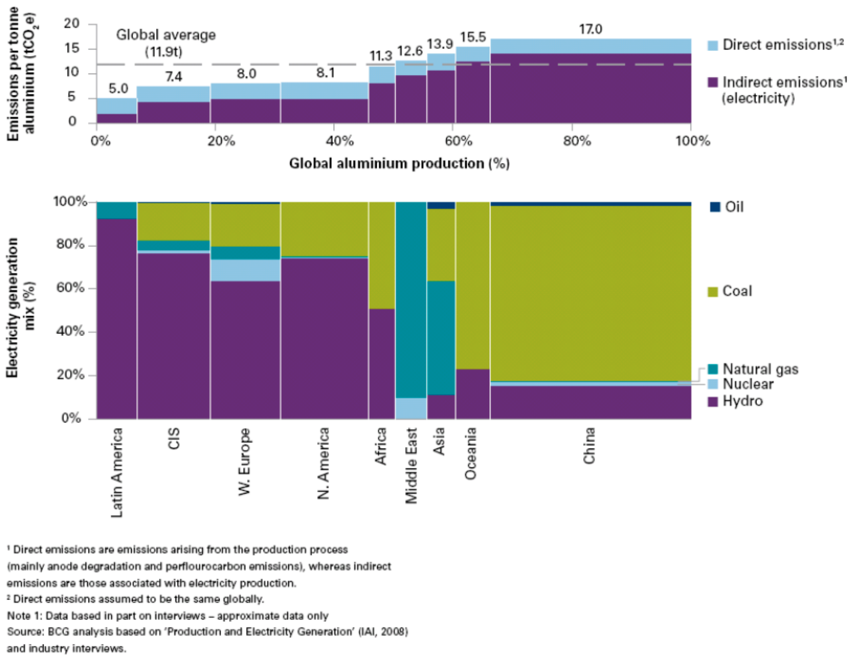


Figure 3: Emissions per ton by region. source: Carbon Tracker (2011)

Climate-relevant data sources

- Emission intensity (CO2eq/t aluminum produced) and electricity consumption (kWh/t aluminum produced) data is available from some companies
- Intensity of electricity consumption for electrolysis (kWh/t aluminum produced)
- Average carbon intensity of the electricity used for primary aluminum production
- Electricity grid factors

Potential difficulties in attaining / using existing data

- Data is available from a limited number of aluminum producers.
- Emissions data is reported differently across aluminum producers. Some companies disclose emission intensity, others disclose total emissions.
- In most cases, emission intensity can be calculated, provided data for total emissions and total production is available.
- Carbon intensity of the electricity used can be calculated from the grid factors.

Indicators which would improve climate risk disclosure[8]

Preliminary indicators and metrics
Share of production from renewable energy sources for electricity generation in the electrolysis process
Renewable energy assets or power perchance agreements (PPA) for renewable energy
Measures implemented to enhance climate risk resilience (ex. reinforced structures)
Absorption and implementation of most recent commercially available technologies
Participation in R&D efforts towards zero or low emission technologies
Disclosure of carbon footprint from aluminium production across the life cycle

Indicators providing information on the scale of climate hazard (e.g. heavy precipitation) could be relevant for the individual plants. Some indicators of physical climate risk are being developed by the CICERO lead CimINVEST project and will be presented in an open access data portal. The project has also developed factsheets on climate risks that provide guidance on physical risk assessment.

8 Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment.

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Key analyst questions for all companies in this sector

1. What is the source of electricity generation in your production plants?

2. What is the company's view on inert anodes and future low emissions technology? Is the company's R&D budget committed to low carbon solutions/ zero emission scenario? Is the company currently testing any low carbon solutions (see Fact box)?

3. What are planned investments into new production facilities? How will the company mitigate lock-in risks for these operations?

4. How does the company report emissions: emissions intensity or total emissions?

5. Do the company have targets related to specific energy consumption? How are they working to achieve the targets?

6. What are the company's climate change targets? Does the company only have targets for emission intensity or are total emissions included? In case of total emissions reporting, what does that mean for the future activity levels of the company? Are these targets better than what you would expect from historic EE improvements?

7. What are the considerations for environmental impacts (incl. environmental contamination risks) throughout the value chain? What does the company do to assess and manage these risks?

8. What is the share of production based on post-consumer scrap recycling?

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Sustainable Edge
Sector Brief: Agriculture

Year 2020

Sector definition

This brief describes the Norwegian agricultural sector. The sector mainly consists of farms with crop and/or animal production, but also some directly related support services, totaling around 40,000 individual businesses.

In this definition, the sector comprises the following NACE codes:

- A1.1, Growing of non-perennial crops
- A1.2, Growing of perennial crops
- A1.3, Plant propagation
- A1.4, Animal production
- A1.5, Mixed farming
- A1.6, Support activities to agriculture and post-harvest crop activities

Summary

The agricultural sector can contribute significantly to emission reductions and to reaching the goal of achieving a net zero carbon economy, primarily by reducing emissions of greenhouse gases other than CO2 (such as methane), maintaining carbon sinks, and increasing sequestration. Establishing detailed emission benchmarks is difficult due to lack of data and large variations in emission intensity and mitigation potential at the farm level. The EU taxonomy therefore identifies a series of "essential management practices" that, when implemented, are taken to indicate the delivery of substantial mitigation benefits.

Main climate and environmental risks[1]

Happening now → Production is highly vulnerable to changes in rainfall and temperature

Likely in short term → More stringent emission regulation very likely over the next decade

Likely in medium term → Risk of substantial demand changes driven by policies and norms

→ Further physical risks include pests and invasive species

[1] The selection of key risks and categorization of those is based on expert judgement. Short-term refers to impacts that are likely in the next decade.

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Physical risk exposure

- Strong temperature rise will present the most dramatic challenges for the sector, which is already impacted by increased variability in rainfall and temperature
- More extreme precipitation may damage crops and farm infrastructure, and will require substantial hydrotechnical investments
- Longer and more intense drought periods reduces output and increases costs related to irrigation and animal feed, possibly forcing early slaughtering
- Increased long-term risks of pests and invasive species
- Temperature increases may also provide productivity gains due to longer growth season in some areas. Utilizing this will likely require enhanced R&D, competence building and new farm-level investments

Transition risk exposure

- More ambitious mitigation policies increase transition risks in the sector, as emissions so far have not been heavily regulated
- As a consequence of Norway's new climate policy targets, further regulation of agricultural emissions are likely over the next decade
- Farm-level measures and sector-wide R&D can contribute to emission reductions, but requires substantial investment and competence building
- There are large potential emission reductions in dietary changes away from the most emission-intensive production. In the medium term, meat and dairy demand may fall as a consequence of norm-driven behavioral changes, potentially amplified by policy change
- The sector is highly regulated and thus very sensitive to changes in domestic support structures

Key statistics & background figures

- 8.6 % of Norway's total GHG emissions are agricultural, with slightly falling trend since the 1990s (1)
- The sector is different from most others in that greenhouse gas emissions are largely due to gases other than CO_2: Primarily methane from livestock production, as well as nitrous oxide (N_2O) from fertilizers and crop production
- Close to 80% of Norwegian farms produce meadows for grass; around 30 and 35% producing cattle and sheep respectively, and just over 25% produce grains.

Contents

About this brief

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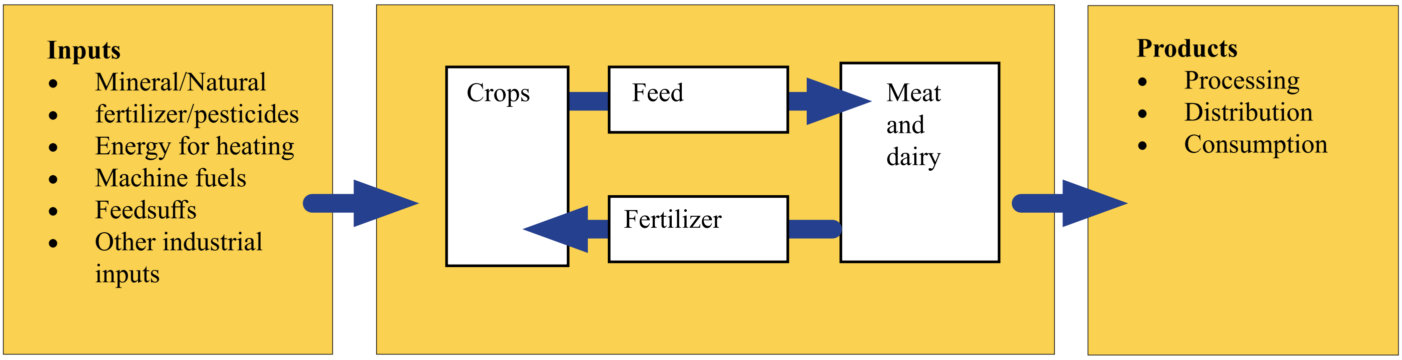
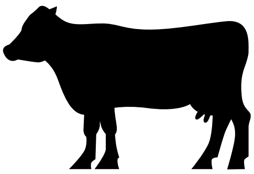
Emissions

Main sources





NOTE: Emissions vary greatly among production types. Meat and dairy production is most emission intensive due to ruminant methane emissions, but with large internal variations. Meat from cattle raised exclusively for beef is 80% more emission intensive than meat from combined meat/dairy cattle (2)

Scope 1

Relevant emissions:

- Livestock methane (digestive processes and natural fertilizer: 2.63 Mt CO2e (1)
- Nitrous oxide from fertilizer storage and use: 1.74 Mt CO2e (1)
- Emissions from conversion of wetland to croplands:
- 0.40 Mt CO2e (3)
- Fossil fuels for machinery:
- 0.33 Mt CO2e (3)

Potential: to reduce scope 1 emissions

Largest potential in production shifts towards less emission-intensive products
Farm-level measures on a technical level:

- Improved feed and manure handling
- Biogas capture
- Avoid wetlands conversion
- Fossil fuel substitution

Practices to enhance soil carbon in agricultural land
Sector-wide measures include R&D and breeding to improve productivity

[3] Key source: Winther et al. (2020)

Scope 2

Relevant emissions:

- Purchased electricity and heat for buildings and operations (not estimated)
- Fossil fuel energy for heating: 0.05 Mt CO2e (1)

Potential: to reduce scope 2 emissions

- Energy efficiency and fossil fuel substitution in buildings, especially in greenhouse horticulture production

No specific targets for scope 2

Scope 3

Relevant emissions:

- Industrial fertilizer production
- Production of herbicides and other industrial inputs
- Indirect land-use change potentially associated with imported feedstuffs (soy etc.)
- Processing industry and distribution-related emissions
- Consumption and waste management

Potential: to reduce scope 3 emissions

- There are large opportunities for emission reductions in food waste, estimated at 1.3 Mt CO2e in total over the 2021-2030 period.
- Indirect emissions from imported feedstuffs are to some extent being addressed by feed importers.

Targets

- Target to reduce food waste included in aspirational target mentioned under Scope 1 (comprising the main part of this target)

Climate risk management

Current risk management

- There is high awareness of physical climate risk in most industry bodies, but not necessarily of likely changes in risk-factors at the farm level
- The industry has acknowledged the need to reduce emissions, and is working for the establishment of incentives to enable technical mitigation measures
- There is less willingness to accept new regulation, or to encourage or prepare for dietary changes that may impact production levels for some products (meat in particular)
- Insurance and compensation systems are in place to cover climate-related damages, but these systems may be put under pressure if weather extremes increase dramatically
- There is also a lock-in of certain production forms and types in the industry due to investments and loans for equipment and buildings. Horticulture has been less vulnerable to drought as irrigation systems were in place

Key opportunities

- Increasing consumer awareness on the environmental impact of food may increase demand for specific products and favor responsible producers
- If warming remains within manageable limits, it may contribute to productivity gains due to longer growth season and to the viability of new production forms. Utilizing this will likely require enhanced R&D, competence building and new farm-level investments

Key pitfalls

- Changes in agricultural production and food prices globally may impact Norwegian agriculture in unforeseen ways, e.g. by increasing the price of feed and other imported production inputs
- Growing need for biomass and biofuels for climate mitigation measures in other sectors may increase competition for land

Disclosure and integration of climate risk

- Disclosure of climate risk and environmental impact
- Farms provide extensive reporting on their production through the domestic support system
- Some emission-specific reporting is required to receive support for environmental measures (such as improved manure handling)
- There are currently no requirements to assess or disclose climate risks at the farm level

Integration of climate risk in operations / decisions

- The industry-standard quality control tool (KSL) incorporates some basic physical risk aspects in its farm-level quality audit procedures
- An industry-wide effort («Klimasmart landbruk») is under way to make targeted climate Agricultural Counselling (production-specific capacity building and quality control) available to farmers, including a calculator tool to assess emissions and mitigation potential
- Agricultural Counselling is or will be made available through existing agricultural consulting providers (e.g. NLR or Tine, depending on production type)

Regulations and scenario information

Policies in Norway

- So far, Norwegian agriculture has been exempted from CO2 pricing and most other climate regulation
- By 2030, Norway will be required to reduce emissions not covered by the EU ETS by 40% from 2005 levels
- As the second largest emission sector outside of the EU ETS, the agricultural sector will be under increasing pressure to reduce emissions over the next decade
- A non-binding agreement between the government and main agricultural producer organizations was signed in June 2019, committing all parties to work towards lowering emissions during the 2021-2030 period
- The government has established an aspirational goal of achieving cumulative emission reductions of 5 Mt CO2e in the agricultural sector over the same period
- The sector is highly regulated and thus very sensitive to changes in domestic support structures. Climate policy targets may trigger structural changes in production support

EU Taxonomy

The March 2020 version of the EU Taxonomy includes three sub-sectors of shipping: A1.2 Growing of perennial crops, A1.1 Growing of non-perennial crops and A1.4 Livestock production. The following activities are included in in taxonomy:

A1.2 Growing of perennial crops and A1.1 Growing of non-perennial crops that meet the following principles:

1. Demonstrate substantial avoidance or reduction of GHG emissions from production and related practices[2] ; and
2. Maintain and increase existing carbon stocks for a period equal to or greater than 20 years through the application of appropriate management practices.[3]

Production on wetlands, continuously forested areas, peatland and land spanning more then one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 % [4].
A1.4 Livestock production that meet the following principles:

1. Demonstrate substantial avoidance or reduction of GHG emissions from livestock production (including animal management, storage and processing of manure and slurry, and management of permanent grasslands)[5]
2. Maintain existing sinks and increase sequestration (up to saturation point) of carbon in permanent grassland.[6,7]

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2. This can be demonstrated in either of the following ways: The essential management practices are deployed consistently over the applicable perennial crop production area each year OR Reduction in GHG emissions (gCO2e) in line with the following trajectory For example, a 20% reduction in GHG emissions would be required by 2030 compared to emissions in 2020, and a 30% emissions reduction would be required by 2040 compared to 2020
3. This can be demonstrated in either of the following ways:
-The essential management practices^ are deployed consistently over the applicable perennial crop area each year
OR -Above and below ground carbon stocks (tC/ha) to be increased progressively over a minimum 20-year period*
* Noting the following exception: For soils specifically, where it can be demonstrated that saturation levels have been reached, no further increase in carbon content is expected. In this case, existing levels should be maintained
4. See taxonomy for detailed description and exceptions
5. This can be demonstrated in either of the following ways: -The essential management practices are deployed consistently over the applicable livestock operation each year OR- Reduction in GHG emissions (gCO2e) in line with the following trajectory. For example, over the 10 year period of 2020-2030, a 20% reduction in GHG emissions would be required. Over the 20 year period of 2020-2040, a 30% reduction in GHG emissions would be required.
6. Permanent grassland is land used to grow grasses or other herbaceous forage, either naturally (self-seeded including ‘rough grazing’) or through cultivation (sown), and which is more than five years old.
7. Specifically, Maintain and increase existing carbon stocks for a period equal to or greater than 20 years through the application of appropriate management practices. This can be demonstrated in either of the following ways:
-The essential management practices are consistently deployed over the applicable permanent grassland area each year OR-Above and below ground carbon stocks shall increase progressively over a 20-year period*
* Noting the following exception: For soils specifically, where it can be demonstrated that saturation levels have been reached, no further increase in carbon content is expected. In this case, existing levels should be maintained

Where livestock production does not include permanent grassland, only principle 1 applies.
Production on wetlands, continuously forested areas, peatland and land spanning more then one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 % .[8]
The current EU taxonomy draft sets additional requirements in the area of "Do no significant harm" in terms of physical risk assessment, building materials, water consumption etc.

The current draft also requires minimum social safeguards, currently defined as meeting the International Labour Organisation (ILO) Core Labour Practices

Global scenarios

IPCC reports cover the agricultural sector in two ways: Physical risk to food production systems is described in the WGII report (ch. 7), while mitigation options are discussed in the WGIII report (ch. 11). The recent special reports on 1.5C and land use both cover agriculture. IEA scenarios do not include the agricultural sector.

8. See taxonomy for detailed description and exceptions

CICERO Shades of Green & analyst perspective

CICERO Dark Green for the sector[9]

- The largest emission reduction potential is in shifting production towards less emission-intensive products.
- Meat and dairy production is far more emission intensive than other types of production
- Production change would however require corresponding dietary change among consumers to avoid leakage, and there are also large variations among different forms of meat production
- (e.g. combined meat and dairy vs suckling cows, types of feed and breeding, etc.)
- Flexibility in production may be the best way of meeting potential changes in demand and regulation
- A number of optimization measures at the farm level can also contribute to emission reductions, including improved manure handling, drainage, soil carbon sequestration, and reduced or delayed tilling
- Relevant measures vary widely depending on geography, production type and other factors. Farm-specific assessments and plans are required – no «one-size-fits-all» path to dark green
- Sector-wide R&D and breeding programmes will be necessary to further decrease emission intensity within each production type

Current best practice -activities

★ Farm resources should be directed towards the least emission-intensive production types possible

★ Biogas capture and fossil fuel substitution are direct, technical measures that reduce emissions and should be implemented wherever possible

★ No wetlands should be converted for crop production or other purposes

Current best practice - governance

★ Targeted Agricultural Counselling on physical risk as well as emission reduction options at the farm level. Established Agricultural Counselling providers will increasingly be able to provide this, but no certification system exists as of yet

★ Certification is available for conversion to organic farming (Debio). However, the climate benefits of organic farming are uncertain and not well documented, so this certification is by itself insufficient

9. The Shades of Green methodology assesses alignment with a low-carbon resilient future. CICERO Dark Green is allocated to projects and solutions that correspond to the long-term vision of a low carbon and climate resilient future. For more information see: https://www.cicero.green/our-approach

Data and indicators for climate risk disclosure

Historic data

Figure 1 illustrates how greenhouse gas emissions from the agricultural sector (yellow, right axis) has been relatively constant despite overall growth in production value (blue, left axis) over the last 20 years, indicating improvements in overall emission intensity. Figure 2 on the right shows agricultural emission sources (in kt CO2eq.), illustrating the dominant role of methane and other livestock-related emissions in overall sector emissions. (Note: These figures are for 2015, source (4))

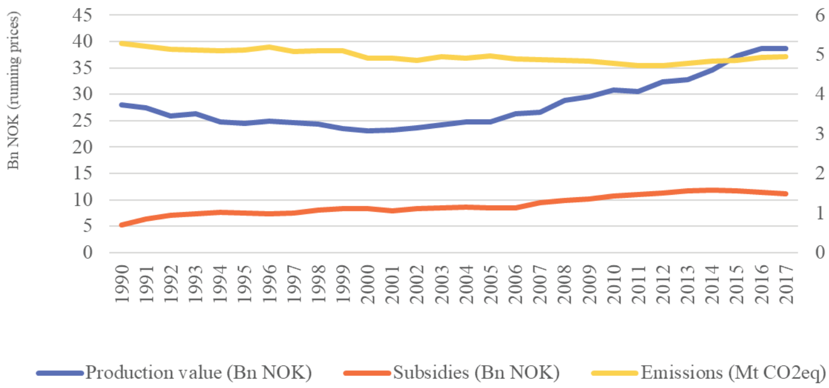

Figure1: greenhouse gas emissions from agriculture

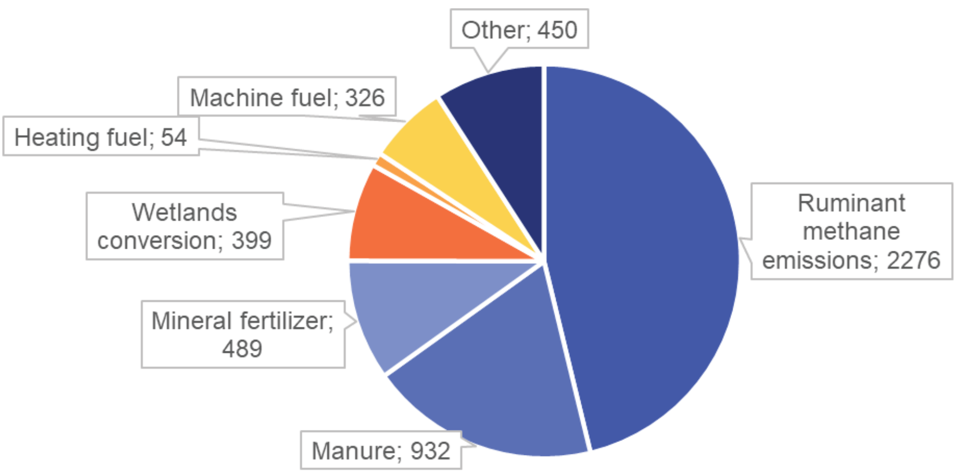

Figure 2 agricultural emission sources

Available types of data

Sectoral emissions at the national level

- Statistics Norway: https://www.ssb.no/klimagassn

Calculator for farm-level emissions and reduction potential

- Developed under “Klimasmart landbruk”

*Official estimates of emission reduction potential*l

- Report from government expert group (“Teknisk arbeidsgruppe jordbruk og klima”)

Potential difficulties in attaining / using existing data

- Reliable farm-level emission data are not available.
- So far, the calculator being developed under “Klimasmart landbruk” is only available through agricultural counsellors, and only for some production types.

Indicators which would improve climate risk disclosure[10]

Transition risk

Preliminary indicators and metrics
Improved farm-level emission data, e.g. from land use, ruminants and equipment
Information on potential for production shifts in response to demand-side changes
A farm-level plan for reducing emissions and managing risk, with farm specific indicators. Agricultural Counselling, Agricultural Extension Services, or equivalent should be used assess emission reduction potential and physical risks, and a plan should be developed to address these.

Physical risk

Preliminary indicators and metrics
Estimates on hydrotechnical investment needs (drainage, irrigation etc)
Information on the use of counselling to assess physical risk

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Key analyst questions for all companies in this sector

1. What is the emission intensity of your production and are you taking any steps to reduce this? (note that a calculator for farm-level emissions and reduction potential has been developed under "Klimasmart landbruk)
2. What are your options to diversify in a less emission-intensive direction, e.g. in response to demand-side changes or new regulation? (note that this could include changes to the current crop/ husbandry practices as well as shifting away from the most emissions intensive types of production. Diversification is impacted by physical factors (land availability and suitability for different production forms) as well as training and competence.)
3. What are the key physical risks for your farm? Are you aware that there is consulting available to assess physical climate risks and/or emission reduction potential? Have you received or considered this for your farm?

9. Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment.

Notes and Sources

(1) Emission figures from 2018. Source: Miljøstatus.

(2) Source: Bob van Oort & Nina Holmelin (2019). Klimagassutslipp fra norsk mat. CICERO Report 2019:05.

(3) Note: These emissions are not counted as part of the agricultural sector's emissions in Norway's national GHG inventory, but are directly attributable to agriculture as part of other sectors (the LULUCF sector for wetlands conversion and transportation/mobile sources for machinery). Emission figures are from 2015. Source: Norway's National Inventory Report (2017).

(4) Source: Norway's National Inventory Report (2017).

Sustainable Edge
Sector Brief: Shipping

Year 2020

Sector definition

NACE Level 2 Code H50: Water transport

This includes the transport of passengers or freight over water. Also included are the operation of towing or pushing boats, excursion, cruise or sightseeing boats, ferries, water taxis etc.

Summary

Emissions from shipping account for 3% of global GHG emissions and have increased in recent years. Zero-emissions technologies are available only for short distances and small ships, while the majority of emissions are from long-distance freight. To reach GHG reduction targets set by the International Maritime Organization (IMO), zero-emissions technologies for long distance trade must be developed, as improvements in fuel efficiency will not suffice. For ships built today, there is a significant risk of lock-in to fuels that become uncompetitive during the ship's lifetime due to emerging regulations.

Main climate and environmental risks[1]

Likely in medium term:

1. Lock-in to emitting fuels that become less competitive during ship's lifetime
2. Climate change may reduce GDP growth, thereby lowering trade volumes due to physical risk impacts on freight owners
3. Changing consumption patterns may change trade volumes

Likely in short term:

4. Compliance with emerging international regulation could be difficult for many companies

Happening now:

5. More frequent/severe storms

[1] The selection of key risks and categorization of those is based on expert judgement. Short-term refers to impacts that are likely in the next decade.

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Physical risk exposure

- Physical risks are not expected to have major direct impacts on shipping in the next 20-30 years (KLP).
- More severe storms may raise costs in the following ways (IPCC 2014):
  - ► Additional safety measures
  - ► Longer routes that are less storm prone
  - ► Destruction of port infrastructure connecting to road or rail
  - ► Maintenance costs for ships and ports
- More frequent weather-related delays
- Ports will in addition be affected by higher temperatures, sea level rise, and increased precipitation.
- Inland shipping affected negatively (IPCC 2014), through e.g., more flooding but also longer periods of low flow in some inland rivers and lower water levels in some lakes..

Transition risk exposure

- Significant risk that for a vessel built in 2020, the most competitive fuel in the ship's early life will not be the same as when it is scrapped (DNV GL 2019).
- Likely emerging regulations regarding emissions to air (DNV GL 2019)
- Ships with outdated technologies may be denied access to certain waters and ports. Fossil fuel cruise ships may no longer be welcome in all ports (e.g., Oslo).
- Climate policies may favor more local value chains hence decoupling economic growth from marine transport (KLP).
- Increasing scrutiny from customers seeking to cut supply chain emissions.
- Increasing pressure from investor groups, and increased cost of capital for companies not responding to investors' climate concerns (e.g. not implementing the Poseidon Principles*).
- Shipping's share of emissions is expected to increase as other sectors can decarbonize more easily, likely leading to more pressure and scrutiny.

Key statistics & background figures

- International shipping is not covered by the Paris Agreement, but regulated through the IMO.
- GHG emissions from shipping (international, domestic, and fishing): 2.9% of global (IMO 2020). Emissions have increased by 10% since 2012 but are still 10% below the peak level from 2008.
- Improvements in fuel efficiency have slowed since 2015, with annual improvements of 1-2% (IMO 2020).
- Deep-sea (long haul) segment accounts for more than 80% of the sector's emissions.
- Shipping transports at least 80% of international trade (IPCC 2019).
- Ship-related health impacts include ~400,000 premature deaths from lung cancer and cardiovascular disease and ~14 million childhood asthma cases annually (Sofiev et al 2018).
- Emissions from Norwegian domestic shipping and fisheries: 3.2Mt CO2e = 6% of total (SSB, 2018). Slight decrease in absolute emissions over last 20 years.
- Domestic shipping is subject to the general Norwegian CO2 tax, which will be 544 NOK/ton CO2e in 2020 (increase of 5% from 2019 in real terms). An exemption for liquefied natural gas (LNG) is removed in 2020.

**The Poseidon Principles are a voluntary framework for assessing and disclosing ship finance portfolios' alignment with the IMO GHG strategy.*

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Emissions

Main sources[2]

Construction (S3)	Operations (S1)	Maintenance (S1)	Dismantling (S3)
~2% of emissions	>90% of emissions	~1% of emissions	~1% of emissions
Production, transport & processing of steel Antifouling (used under the waterline) and other paint	Fuel combustion.	Same sources as for construction, but much lower quantities of steel.	Steel recycling May pose severe threats to human health and local environment

Note that scope 2 emissions are currently negligible. With conventional fuels, the vast majority of emissions are scope 1. With alternative fuels, scope 2 emissions will be much more relevant.

Scope 1 (S1)

Status:

- On-site fossil fuel combustion is the largest source of emissions for the sector
- Shipping accounts for 2.9% of global GHG emissions (IMO 2020).
- New mandatory reporting schemes under both IMO and EU.
- IMO has set targets, but policies are not yet in place for achieving them.
- European Commission will propose to extend EU ETS to shipping. Current tax exemptions will be reconsidered (EC 2019).

Potential and challenges: to reduce scope 1 emissions

- Currently only few technically viable alternative fuels for deep-sea segment (LNG and biofuels).
- Emissions reductions from LNG are modest and uncertain. Methane emissions have increased by 150% from 2012 as number of LNG ships have surged (IMO 2020). Not a long-term decarbonization option (Victor et al 2019).
- Batteries are presently limited to trades ≤1h and small ships.
- Hydrogen is a realistic option for short-sea shipping in medium-term.
- Ammonia is the tentative frontrunner for deep-sea (Victor et al 2019).
- Main challenge for hydrogen and ammonia: pilot and prove technology at scale.
- Fuel-efficiency improvements not sufficient for achieving IMO targets; zero-emissions technologies also needed.

Targets

- IMO Strategy on reduction of GHG emissions from ships:
  - ▶ Reduce CO_2 intensity by ≥40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008.
  - ▶ Reduce total GHG emissions by at least 50% by 2050 compared to 2008.
- Paris Agreement goals would require steeper decarbonization.

2 (example of life cycle emissions shares for an oil tanker from Chatzinikolaou and Ventikos 2018)

Scope 2 (S2)

Status:

- With conventional fuels, the vast majority of emissions are scope 1, but with alternative fuels, scope 2 emissions will be much more relevant.
- IMO will develop guidelines for lifecycle GHG intensity for all relevant types of fuels.

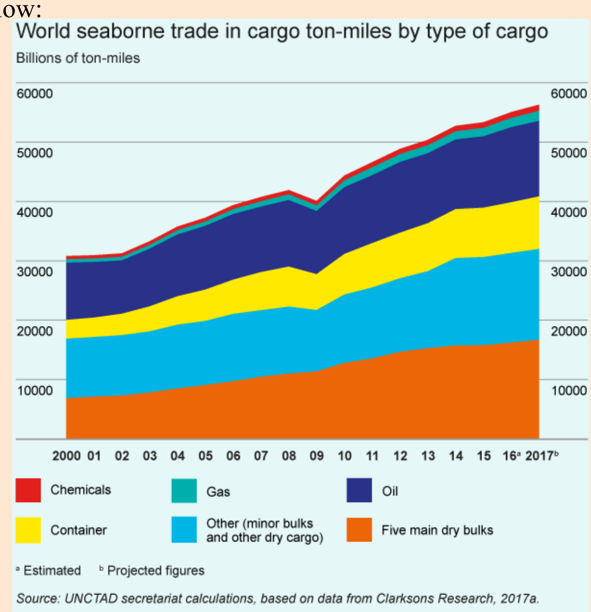
Potential and challenges:
- While switching from conventional to alternative fuel would reduce scope 1 emissions, the effect on lifecycle emissions is more uncertain.
- Scope 2 emissions are more difficult to quantify and are not included in current reporting schemes.
- Therefore, the IMO guidelines will be important.

No existing targets

Scope 3 (S3)

Status:

- Emissions from construction and dismantling are minor compared to scope 1 emissions. Dismantling could have large negative impacts on the local environmental, old shipyards can be a source of local pollution and toxins.
- Emissions embodied in the cargo could be large. Petroleum products account for a large share of cargo, see figure below:



(Five main dry bulks are iron ore, grain, coal, bauxite/alumina and phosphate)

Potential and challenges:
- No reporting scheme for scope 3 emissions.
- Investors should demand reporting on cargo and revenue / type cargo

No existing targets

Current risk management

- The IMO has recently adopted a target to reduce GHG emissions by 50% by 2050 compared to 2008. While some policies are in place and scheduled to be strengthened, new policies are needed to reach the target (IEA 2018). New proposals are under discussion in the IMO and the EU. The regulatory environment for international shipping is therefore expected to change significantly over the coming years, i.e., well within the lifetime of ships entering the market today.
- New reporting requirements have recently entered into force, under IMO (from 2019) and the EU (from 2018).
- Norway has no specific emissions target for the shipping sector. However, several policies are in place, including a carbon tax, procurement policies, and support for low-carbon technologies.
- Recently, a framework has been launched for investors to assess and disclose shipping finance portfolios' alignment with the IMO GHG strategy (Poseidon Principles).
- The world's shipping heavyweights are not investing in key technologies to reduce their carbon footprint, with the sector at risk of not meeting the IMO target for 2050. Only a few of the largest companies show evidence of collaborating to develop zero-carbon fuels. Technology adoption is challenged by low margins and high debt (CDP 2019).
- Only one green bond in the sector has been issued in Norway (Teekay, 2018, total volume of USD 125 million)

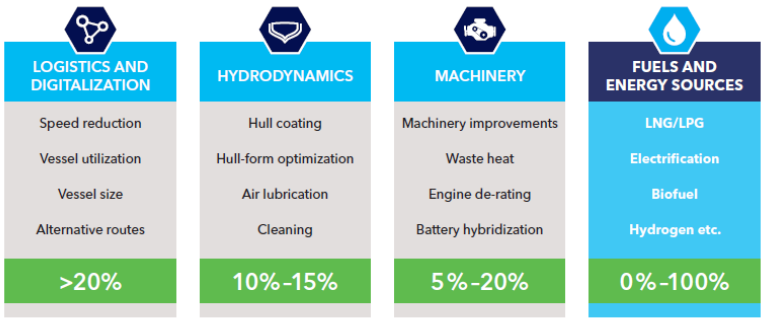
Key opportunities

- Decarbonization and digitalization are the most transformative forces in shipping (DNV GL 2019). Thus, reducing emissions is key to long-term financial competitiveness.
- Forward-leaning charterers have begun paying premium rates for energy efficient ships (DNV GL 2019).
- Shipping is more energy efficient than air and road transport. Short-haul shipping may therefore benefit from climate policies. Shifting cargo from road to sea is part of Norwegian transport policies and the European Green Deal.
- Deep sea shipping faces relatively low risk of losing business to other transport modes. So, the costs of decarbonization could be passed on to the consumer, if a level playing field could be created within the sector (Victor et al 2019).
- The Norwegian shipping sector may serve as a laboratory, in which the government supports development of green solutions which may later provide export opportunities (KLP).
- Shorter sea routes will become available with Arctic sea ice reductions (IPCC 2019).

Key pitfalls

- Investing in technologies that reduce emissions but not enough to be in line with IMO targets. E.g. LNG.
- For "zero-carbon" fuels, scope 2 emissions can be large (e.g., biofuels, Hydrogen, Ammonia batteries).
- Energy efficiency improvements generally reduce shipping costs and could therefore lead to higher trade volumes. If the cargo is emissions intensive, that could lead to increased emissions from other sectors.
- Lower Sulphur fuels will have health benefits and reduce acid rain, but also reduce cooling from aerosols, hence increase the sector's contribution to climate change.
- Arctic sea routes compete with traditional shipping corridors - Black carbon emissions (soot) have greater climate impact when emitted in the Arctic

Overview of technologies and fuels and their GHG-reduction potential (%)



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Disclosure and integration of climate risk

Disclosure of climate risk and environmental impact

- The shipping sector has poor rates of disclosure – only 5 out of the 18 largest publicly listed shipping companies participated in CDP's 2018 Climate Change questionnaire, and only 4 officially support the Task Force on Climate-related Financial Disclosures (TCFD).
- Only 3 of 18 companies have a formal climate committee at the board level (CDP 2019), low compared to other sectors.
- 12 of the 18 companies have disclosed emissions reductions targets.
- New mandatory IMO Data Collection System (DCS): Ships ≥5,000 gross tonnage (GT) (~85% of emissions from international shipping) are required to collect fuel oil consumption data for annual reporting to IMO, from 1st January 2019. Individual ship data is not publicized by the IMO.
- Ships ≥5000GT must report emissions for voyages to/from EU ports to EU MRV scheme from 2018. Individual ship data is available at https://mrv.emsa.europa.eu/#public/emission-report
- No public disclosure of cargo carried.

Integration of climate risk in operations / decisions

- A Ship Energy Efficiency Management Plan (SEEMP) is a practical tool for monitoring and improving ship and fleet efficiency performance over time and encourages the ship-owner to consider new technologies and practices at each stage of the plan. Mandatory for ships >400GT. Shall be developed following IMO guidelines.
- ISO 50001 is a voluntary best-practice standard for energy management that outlines a framework for improving energy efficiency. Becoming more commonly used to demonstrate achievements in reducing consumption to third parties.
- Commercial tools are available for optimizing fleet performance to save emissions and costs.
- Only a few of the largest companies collaborate to develop zero-carbon fuels. Technology adoption is challenged by low margins and high debt (CDP 2019). The sector is at risk of not meeting the IMO target for 2050.

Regulations and scenario information

Policies in Norway

(see Norwegian Ministry of Climate and Environment 2019)

- Domestic shipping is not covered by EU ETS. Along the EU's NDCs (Paris Agreement), Norwegian non-ETS emissions shall be reduced by 40% by 2030 relative to 2005. Government's ambition is to reduce emissions from shipping and fishing vessels by 50% by 2030 and promote development of zero- and low-emission solutions for all vessel categories. Domestic shipping is subject to the general Norwegian CO2 tax, which is 544 NOK/ton CO2eq in 2020 (set to increase by 5% annually). An exemption for liquefied natural gas (LNG) will be removed in 2020.
- Covered by the nitric oxide (NOx) tax & NOx fund[3].
- Biofuel quota under consideration.
- Low- or zero-carbon technology is required in public procurement of ferry services.Support to develop low- or zero carbon technologies through Enova, Innovation Norway, Research Council, 'Klimasats'.

EU Taxonomy

The March 2020 version of the EU Taxonomy includes two sub-sectors of shipping: H50.3.0 Inland passenger water transport and H50.4.0 Inland freight water transport. The following activities are included in the taxonomy:

- Zero direct emissions inland waterway vessels are eligible.
- Vessels that run exclusively on advanced biofuels or renewable liquid and gaseous transport fuels of non-biological origin[4], guaranteed either by technological design or ongoing monitoring and third-party verification. In addition, for investments in new vessels, only those below emissions thresholds are eligible.[5]
- Other inland waterways vessels are eligible if direct emissions are below 50 gCO2e emissions per passenger kilometre (gCO2e/pkm) (or 92.6 g per passenger nautical mile (gCO2e/pnm)) or direct emissions per tkm CO2e emissions per tonne kilometre (gCO2e/tkm) or per tonne nautical mile (gCO2e/tnm) are 50% lower than the average reference value defined for HDVs (Heavy Duty CO2 Regulation).

Note that vessels that are dedicated to the transport of fossil fuels or any blended fossil fuels are not eligible even if the above criteria are met.

The current EU taxonomy draft sets additional requirements in the area of "Do no significant harm" in terms of physical risk assessment, building materials, water consumption etc.

The current draft also requires minimum social safeguards, currently defined as meeting the International Labour Organisation (ILO) Core Labour Practices.

3 For more information about the Nox fund see: https://www.nho.no/samarbeid/nox-fondet/the-nox-fund/
4 As defined in Art. 2 (34) and Art. 2 (36) in line with Directive (EU) 2018/2001)
5 Direct emissions below 95g CO2 e /pkm (including biogenic CO2) for passenger transport, and below the average reference value defined for freight HDVs (Heavy Duty CO2 Regulation) are eligible.

Global scenarios

- Initial IMO Strategy on reduction of GHG emissions from ships (2018, to be revised in 2023):
    - Reduce carbon intensity by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008.
    - Total GHG emissions should peak as soon as possible and fall by at least 50% by 2050 compared to 2008.
    - Phase out emissions as soon as possible within this century.
    - The demand for seaborne trade is projected to grow by 39% until 2050 (IMO 2018).
    - The 2050 target thus requires approximately:
        - 30%–40% share of carbon-neutral fuels in world fleet energy, in addition to improving energy efficiency (IMO 2018).
        - 50-70% carbon intensity improvement for ships built in 2020-2030 relative to 2008 (the official 2008 baseline pending).
    - BAU emissions in 2050 are projected to be 90-130% of 2008 levels (IMO 2020).
    - IMO regulatory tools to improve energy efficiency of ships (2013):
        - Mandatory design requirements (EEDI) for new ships, which set increasingly strict carbon intensity standards.
        - Mandatory Ship Energy Efficiency Management Plan (SEEMP) to improve energy efficiency of all ships > 400GT.
    - These tools do not regulate methane emissions.
- Proposal under discussion in IMO: National Action Plans, Energy Efficiency Existing Ship Index with standards; power limits; and a carbon tax earmarked for R&D fund.
- IMO Sulphur regulation: max 0.5% sulphur content applies universally from 2020. Previous limit was 3.5% outside emissions control areas. In emissions control areas, including Baltic and North Sea, the limit is 1% (scrubbers needed if exceeded).
- In IEA New Policies Scenarios (2018), shipping and aviation are the only sectors where oil demand in advanced economies is projected to grow from 2017 to 2040. (These scenarios are not consistent with the IMO strategy).
- Paris Agreement's well-below 2°C objectives would require a steeper decarbonization trajectory than the IMO absolute target. The IMO intensity targets imply less steep decarbonization (Poseidon Principles 2019).

CICERO Shades of Green & analyst perspective[6]

CICERO Dark Green for the sector

Considerations for main activities

- The only zero-carbon technology currently suitable for deep-sea shipping is sustainable biofuel. This is a "drop-in" fuel, requiring no technological innovation into ships.
- Innovation into alternative zero-carbon fuels is the most important long-term policy for deep-sea shipping. Energy efficiency improvements are also needed to cater for these fuels, as they have lower energy density.
- For short-distance shipping, batteries are an available technology.
- Technological innovations in fuels or design should be made available to the entire market

Considerations for upstream and downstream factors

- Life-cycle emissions from "zero-carbon" fuels must be assessed.
- Could petroleum products be included in the cargo? Is the cargo in other ways part of a carbon-intensive supply chain? If yes, what is the share and does the investment add capacity or replace existing ships?
- Transparency regarding ship dismantling should be required.

Current best practice – activities

- ★ Battery-electric vessels are available for short-distance shipping.
- ★ Sustainable biofuels is currently the only low carbon technology suitable for deep sea shipping.
- ★ To date, Maersk, HMM and Norden are the most ambitious among the 18 largest companies in setting long-term targets to reduce carbon emissions, consistent with the IMO's strategy (CDP 2019).
- ★ ISO 50001 is a voluntary best-practice standard for energy management.
- ★ Best practice means including current or future battery capacity, a substantial efficiency strategy, innovation and fuel switch ambitions..

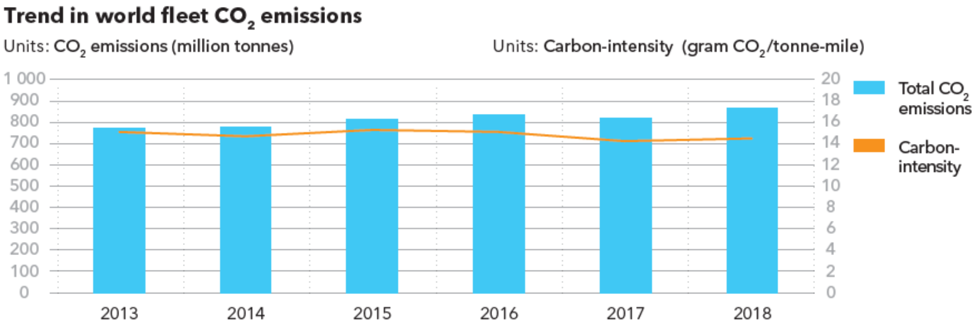
Current best practices – governance

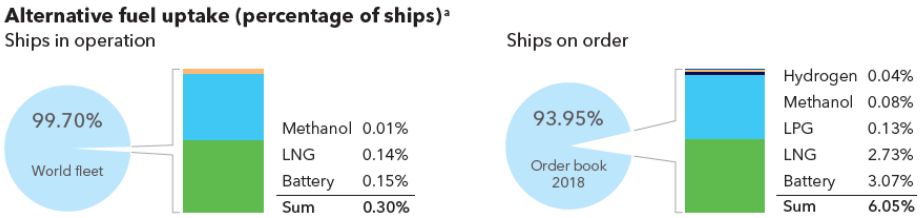
- ★ The Poseidon Principles are a voluntary framework for assessing and disclosing ship finance portfolios' alignment with the IMO GHG strategy. Banks representing 20% of the global shipping portfolio have signed up. Launched in June 2019. Borrow from the Equator Principles. Supportive of the TCFD and the Climate Disclosure Project (CDP).
- ★ Best practice for governance in the shipping sector includes setting relevant and ambitious climate targets, measuring and managing GHG emissions as well as fuel switch ambitions considering current and future battery capacity, rebound and lock-in effects. In addition, participating in or contributing to R&D efforts on new low-emissions technology, implementing climate considerations into the upstream and downstream activities (e.g. aiming to reduce or remove any petroleum products as cargo and having safeguards in place for vessel recycling process)

6 The Shades of Green methodology assesses alignment with a low-carbon resilient future. CICERO Dark Green is allocated to projects and solutions that correspond to the long-term vision of a low carbon and climate resilient future. For more information see: https://www.cicero.green/our-approach

Data and indicators for climate risk disclosure

Historic data





[a] Source: DNV GL's Alternative Fuels Insight (AFI) portal, https://www.dnvgl.com/services/alternative-fuels-insight-128171

Climate-relevant data sources

- The Energy Efficiency Design Index (EEDI) = CO2 per capacity mile. Minimum standards for new ships since 2013.
- The Energy Efficiency Operational Indicator (EEOI) is a monitoring tool for managing ship and fleet efficiency performance over time.
- IMO Data Collection System: Fuel oil consumption reported to IMO for ships ≥5000GT annually from 2019.
- Ships ≥5000GT calling on EU ports must report emissions to EU MRV scheme from 2018.
- 18 largest companies are ranked in terms of climate risk by CDP (2019)

Potential difficulties in attaining / using existing data

- IMO DCS does not measure cargo carried, but instead assumes full load. EU MRV is therefore better for estimating efficiency.
- IMO DCS data is aggregated to national level. Not verifiable by third parties.
- Cargo is typically anonymized, making it difficult to include shipping emissions when calculating life-cycle emissions of final goods.

Indicators which would improve climate risk disclosure

Transition risk

Preliminary indicators and metrics[7]
Carbon intensity, which measures CO2 emissions per unit of transport work. (Should be compared with the competing fleet.)
The Annual Efficiency Ratio is one measure of carbon intensity, which uses vessels' designed deadweight as proxy for carbon carried. Thus, only fuel consumption and distance sailed must be measured, which means it can be calculated from IMO DCS data. However, this assumes ships are always fully loaded.
The Energy Efficiency Operational Indicator (EEOI) includes a true measure of transport work. Calculation requires data on cargo, which is not included in IMO DCS.
Climate alignment (Poseidon Principles): a measure of the degree to which a vessel, product, or portfolio's carbon intensity is in line with a decarbonization trajectory that meets the IMO strategy. Standard trajectories are produced by the Secretariat of the Poseidon Principles for each ship type and size class.
Distribution of cargo carried by fleet.
Share of different low-carbon technologies in fleet.
Lifecycle GHG (note that The IMO will develop guidelines for all relevant types of fuels.)
Absolute annual GHG emissions by vessel
Disclosure of IMO DCS data plus weight and type of cargo.

7 Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment.

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Key analyst questions for all companies in this sector

1. Is the investment/activity compatible with the IMO GHG reduction strategy (See Poseidon Principles (2019) for methodology)?
2. Will carbon intensity be measured and reported annually?
3. How does carbon intensity compare with competing fleet? Note that it is important to compare with a similar fleet. E.g. emissions are generally lower in container segment than in bulk segment.
4. Does the investment facilitate retrofitting for future alternative fuels? / Does the vessel allow for modifications to install greener alternative engine systems once these become available?
5. How ambitious is the SEEMP? Are emissions reductions targets and measures to achieve it included?
6. What cargo is shipped? Is this type of cargo compatible with the green transition?
7. Are fleets being extended or are older vessels replaced?
8. What energy efficiency measures are they taking? Note that larger ships have better efficiency. Note also that energy efficiency improvements can only be verified with post-issuance reporting.
9. For which speed is the vessel optimized, and which measures have been taken to achieve fuel efficiency at this speed (slow-steaming has great fuel saving potential)?
10. For LNG ships, how are methane emissions considered?

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Sustainable Edge Sector Brief: Land transport of freight and suburban passengers

Year 2020

Sector definition

NACE codes H49.4, Freight transport by road and removal services, and **H49.391** “Non-urban or suburban passenger land transport. **Geographical scope: Norway.**

This brief provides a climate assessment of freight land transport of goods and suburban passenger land transport, as according to the EU defined NACE codes detailed above. The typical company is a third-party transportation company that transports goods on behalf of customers. The sector includes distribution of smaller items over shorter distances with vehicles under 3.5 tonnes (vehicle + cargo), dry and wet goods over longer distances with trucks between 3.5 – 7 tonnes and transportation with vehicles of over 7 tonnes. Terminologies for vehicles vary between countries and languages. We refer to vehicles under 3.5 tonnes as distribution vehicles. We use the term “truck” to describe vehicles over 3.5 tonnes with fixed transportation space as well as vehicles specifically designed to pull one or more trailers. This brief also includes the non-urban transport of passengers, typical companies in this segment would be bus companies offering transportation outside urban and suburban areas.

Excluded from the scope of this brief are personal passenger cars, inner-city public transportation, rail transport and vehicles involved in construction work.

Summary

As of latest IPCC figures, the transport sector comprised 23% of energy-related CO2 emissions in 2014. In the period between 2021-2030, heavy-duty and light commercial transport are expected to make up 53% of emissions within the transport sector. In Norway, as in many other countries, electric vehicle uptake is expected to grow exponentially for light distribution vehicles, while hydrogen and advanced biofuels could be good solutions for heavy-duty trucks and inter-urban passenger buses. The Norwegian hydrogen and electric truck industries are fast-growing, but still in early phase. Advanced biofuels are a good solution, particularly in the near-term. Concerns of indirect land use change and emissions accounting exist. Expected major drivers in the decarbonisation of this sector include technology focused measures such as improving energy efficiency and fuel switching, as well as structural changes that avoid or shift transport activity.

Main climate and environmental risks[1]

Happening now

1. Increased traffic interruption and road diversions due to more frequent weather and extreme weather events e.g., flooding, heavy precipitation (rain and snow), and freeze-thaw weathering[2]
2. Higher road tolls and restrictions for diesel powered internal combustion engines, especially in cold weather when diesel exhaust is most polluting

Likely in short term

3. Increasingly stringent regulations for emissions not covered under the EU emissions trading system and implementation of zero-emissions urban environments
4. Increasing demand for alternative fuels/engine types in tenders from public institutions and large corporations

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Physical risk exposure

- Climate change impacts over the next 10-20 years are determined by emissions which are already in the atmosphere. Impacts in this period are therefore independent of policy changes.
- Expected increase in extreme weather may lead to: more floods, higher risk of mud- and rockslides, storm-surges in urban areas, more snow and freeze-thaw weathering in Northern regions and at high altitudes. This impacts key supply routes by increasing the risk of more frequent traffic interruptions and necessity for road diversions.
- Physical risks may impact the supply chain for transport companies, e.g., renewable energy installations and lithium and other metal ore mining for battery production

Transition risk exposure

- Transition risks are high in scenarios limiting warming to 20C, given necessary implementation of ambitious policies and tighter regulations.
- Local and regional administrations will establish stricter zero-emission regulations, which would affect transport routes and delivery to final customers. This includes increased road tolls for higher carbon intensity vehicles, or increased taxes and fees on diesel, would give an advantage to non-diesel-powered vehicles.
- Increasing scrutiny from customers seeking to cut supply chain emissions. Tenders from public bodies and large corporations may demand bidders to have alternatives to internal combustion engines

1 The selection of key risks and categorization of those is based on expert judgement. Short-term refers to impacts that are likely in the next decade.
2 Flooding and heavy precipitation will have large local impacts but will likely have limited impact on long-term national transport trends, as the road network is such that road diversions are almost always possible.

Key statistics & background figures

- In 2019, emissions from road transport (8.4m tCO2eq) constituted 16.7% of total Norwegian emissions (50.3m tCO2eq) (SSB, 2019a). ¾ of total transport of goods in Norway is done by road transport (SSB, 2019c).

- To achieve climate neutrality, transport emissions will need to decrease by 90% from 1990 levels by 2050 (EU Taxonomy, 2020). The Norwegian government has an ambition to cut emissions by 90-95% by 2050 (Regjeringen, 2020a). The transportation sector is not included in the EU Emissions Trading System (ETS). However, Norway reached an agreement with the EU and Iceland to cut non-ETS emissions by 40 % compared to 1990 levels by 2030 (Regjeringen, 2019).

- According to Klimakur 2030, a third of non-ETS emissions in Norway between 2021-2030 will come from the land transport sector. Of these emissions, 36% are associated with heavy duty transport (trucks and busses) and 17% with light distribution vehicles (Miljødirektoratet, 2020).

- Between 1990 and 2019, Norwegian emissions from road transport have increased by 16.4%, however, the past several years since 2019 have exhibited emissions reductions. Between 2018-2019 emissions decreased by 7.7% (SSB, 2019a).

- Goods transport is still predominantly fossil fuel based. So far in 2020 (as of September 2020), zero-emissions vans have constituted only 6.6% of new van purchases (OFV, 2020). In comparison, zero-emission personal cars have made up 50% of new personal car registrations in Norway.

- Transport of goods and related activities is a large economic sector in Norway, with over 15 000 businesses, over 74 000 employees and a turnover of ca. 87 billion NOK in 2017 (SSB, 2019b).

- The first electric truck in Norway was operative in September 2016. At the end of 2018, there were 13 electric trucks in use in Norway, most of which were used as waste collection trucks (Hovi et al., 2019). Hydrogen-based truck industry is fast growing, but still very early-phase.

Contents

About this brief

This sector brief was developed by CICERO as a part of the Sustainable Edge research project. The purpose of the brief is to outline the key material climate-related issues for the sector. The audience for the brief is the financial sector, either as potential investors or lenders to the sector. The reader is expected to have background knowledge of the sector and of climate risk assessment. The analysis methodology is rooted in CICERO's climate science and build on CICERO Shades of Green's methodology for green bond frameworks. This brief is to be considered a science-based opinion.

CICERO Shades of Green AS is a subsidiary of CICERO established in November 2018. CICERO Shades of Green AS has commercialized a corporate climate risk assessment based partially on the Sustainable Edge research, in addition to their own methodological development.

The Sustainable Edge project is financed by ENOVA SF and our financial sector partners: Oslo Pensjonsforsikring, CICERO Shades of Green AS, Nysnø, Sparebank 1 SMN, Sparebank 1 Nord-Norge, SR-Bank, Samspar and Sparebank 1 Østlandet. Thank you also to our partners Finans Norge and Schjødt.

Please note this assessment focuses on climate-related issues and risks. Other environmental and social aspects may be noted, but assessing material social, ethical and governance issues are outside the scope of the assessment. We discuss governance specifically in the context of climate governance, this should not be viewed as a substitute for a full evaluation of the governance of the sector and does not cover, e.g., corruption.

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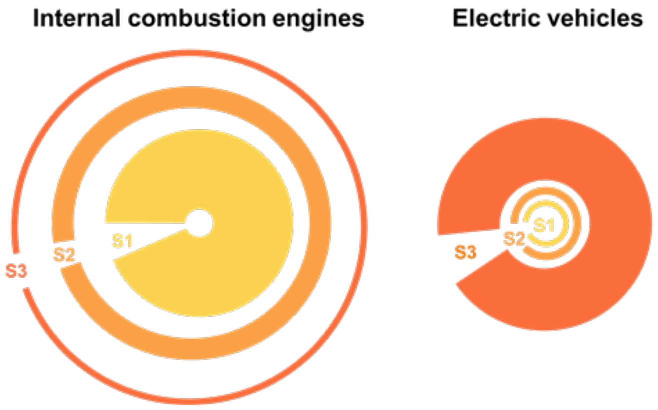
Emissions



This diagram illustrates the distribution of emissions by scope for internal combustion engines and electric vehicles. The relative width of the circles conveys the relative share of Scope 1, 2, and 3 emissions. The total size of the whole circle indicates the total absolute emissions of ICE and EVs (total emissions are lower for EVs than for ICEs). The share of Scope 2 emissions depends on grid emissions factors. Scope 3 emissions are similar for both ICE and EVs but will depend on the size and type of vehicle (heavy-duty truck vs commercial distribution van). Note: available research on life cycle emissions of EV vs ICE cars varies greatly.

Scope 1 (S1)

Scope 1 emissions are direct emissions arising from sources owned or controlled by the company, e.g., emissions of CO2 and H2 from trucks.

Status:

- Fuel use is the largest contributor to life-cycle emissions of a globally averaged vehicle (IEA, 2020).
- Fuel switching away from diesel and petroleum is gaining momentum but is not yet demonstrating benefits on a scale consistent with 1.5-degree pathways (IPCC, 2018).
- Hydrogen produced in Norway is mostly 'grey hydrogen', meaning it is produced with fossil fuels and without CCS. (Regjeringen, 2020b).
- EVs are cleaner than diesel (22%) and gasoline (28%) counterparts, even in the most carbon intensive scenario: battery produced in China and vehicle used in Poland (most carbon intensive EU grid) (T&E, 2020).

Potential and challenges: to reduce scope 1 emissions

- Electrification can cut 1.9m tonnes CO2 by 2030, assuming 90% electric delivery trucks, electric city busses and some electrification of heavy trucks (Veikart, 2016). Norwegian battery EVs offer a three- to fourfold energy efficiency improvement compared to internal combustion engines (Fridstrøm et al, n.d.).
- The hydrogen economy for land transport faces challenges in cost reduction through upscaling and mass production. (Philibert, 2020). Hydrogen can also be sourced from existing industrial processes that produce hydrogen as a biproduct. (Regjeringen, 2020b)
- Leakage of hydrogen from synthesis, storage and use could have significant climate effects. Hydrogen is an indirect GHG as it affects the tropospheric distribution of methane and ozone, which are the second and third largest contributors to global warming respectively. The climate impact of a global hydrogen economy is 0.6% of global fossil fuel economy (assuming a leakage rate of 1%) (Derwent et al, 2006). Further research in this field is required to fully understand all climate impacts.
- Advanced liquid biofuel has high potential for short-term Scope 1 emission reductions in the sector (Miljødirektoratet, 2020). The resulting scope 3 emissions depend heavily on type of biofuel: biodiesel from waste wood leads to around 90% emissions reductions, while biodiesel from palm oil leads to a 150% increase in emissions (ICCT, 2011). Concerns of indirect land use change, limited supply and emissions from biofuels necessitates further decarbonisation beyond biofuels toward electric and hydrogen technology.
- Increasing regulations to reduce NOx and PM concentrations from combustion engines; opportunity to incorporate Euro VI or higher engines, and HVO/2 generation or higher biofuels (Hagman, 2019).
- The potential for improving the efficiency of the internal combustion engine (ICE) is limited. But there is significant potential in improving structural efficiency (logistics, supply chains, routing) (IPCC, 2018).

Targets

- Industry target to reduce emissions by 50% to 2030, aiming for zero emissions 2050 compared to 2005 (Veikart, 2016). 50% of new trucks in 2030 should be zero-emission (Regjeringen, 2019). The EU targets a 40% cut in non-ETS sectors, which includes transportation.
- The Norwegian National Transport Plan assumes 1.7 bn liters available biofuel in 2030 (Veikart, 2016)
- The Norwegian government has outlined an escalation plan for both biofuel and hydrogen (Regjeringen, 2020b).

Scope 2 (S2)

Scope 2 GHG emissions are indirect emissions from sources owned or controlled by the company, this includes generation of electricity, heat or steam purchased by the company.

Status:

- As of June 2020, 94.6% of electricity is produced from hydropower in Norway (SSB, 2020).
- The grid electricity emission factors are low in Norway compared to other European countries. For example, one estimate is 0.01 kgCO2e/kWh (Carbon footprint, 2019).

Potential and challenges:

- Trend towards electrification and digitalization (e.g., in logistics planning) in the goods transport sector, which increases the use of electricity and prompts the need for greater renewable electricity generation (TØI, 2018).
- Opportunity to install renewable energy e.g., small, run-of-river hydro power plants, wind or solar for own use for charging vehicles.
- Electric vehicles face a challenge in that they have lower engine power. Electric trucks have higher requirements for range and power and are not yet commercially available; as of the end of 2018, only 13 were in use.
- Battery costs are expected to decline, providing the potential for growth in the EV industry and increased electrification.
- The production of hydrogen has varying Scope 2 emissions, depending on how it is produced. Green hydrogen is produced with renewable electricity, while blue hydrogen is produced with natural gas and CCS. Blue hydrogen can produce a significantly greater volume of hydrogen per day (120-240 tonnes) than green hydrogen (8 tonnes) (Regjeringen, 2020b).
- The cost of electricity for electrolysis in Norway is low due to the exemption of production of hydrogen from electricity fees (Regjeringen, 2020b).
- Opportunity to cleanly produce own zero-carbon hydrogen fuel (e.g., ASKO produces its own hydrogen fuel) (ASKO, 2017).

Targets

- The Norwegian government supports R&D within hydrogen sector, including in ensuring energy efficiency and cost effectiveness through Enova, Innovasjon Norge and Forskningsrådet (Regjeringen, 2020b).
- Hydrogen is a key area of prioritisation for the EU, specifically developing renewable hydrogen in a gradual trajectory towards 2050. In the short and medium term, the EU will also invest in low-carbon hydrogen (European Commission, 2020).

Scope 3 (S3)

Scope 3 emissions comprise of indirect emissions incurred by a transport company through their upstream and downstream value chain. For example, embedded emissions in purchased goods and services, distribution of manufactured vehicles, and end-of-life treatment of vehicles.

Status:

- EV batteries are carbon intensive to manufacture due to high electricity demand and mining activities. Carbon intensity is therefore dependent on production location and grid emissions factor, as well as on type and concentration of materials (e.g., cobalt content) in the battery. However, a recent study has shown that battery footprints are two to three times lower than commonly used estimates (T&E, 2020).
- Hybrid and EV technologies increase the demand for certain minerals, such as lithium, gallium, and phosphates (IPCC, 2014). There are concerns of local (incl. water) pollution from lithium mining.
- Lithium-ion battery production requires extracting and refining rare earth metals, which is energy intensive due to the need for high heat and sterile conditions. In 2016, most batteries from European EVs were manufactured in Japan and South Korea, where approx. 25-40% of electricity generation is from coal (ICCT, 2020).
- Vehicles at end-of-life have value as a source of spare parts and materials such as aluminum. The EU requires 95% recyclability for vehicles. In 2017, Norway had a recovery rate of 98%, and a recycling rate of 85% (Eurostat, 2020).
- Cargo can generate Scope 3 emissions. Transport of fossil fuels or blended fossil fuels is not eligible under the EU Taxonomy (EU Taxonomy).

Potential and challenges:

- Potential to use aluminium to reduce the weight of vehicles and therefore reduce fuel required. However, the increase in GHG emissions from increased aluminium production could under specific circumstances be larger than the GHG savings from vehicle weight reduction. Studies have, however, indicated that in about two decades, closed-loop recycling can significantly reduce the impacts of aluminium-intensive vehicles (IPCC, 2014).
- Circular economy and life-cycle considerations must be accounted for. Note that there is large variation in life cycle analysis methodology. Recycling of batteries is rarely included in LCAs due to significant uncertainty about how recycling affects carbon footprints (ICCT, 2020).
- Vehicle end-of-life, potential for recycling and recovery of materials and parts.
- Optimization of cargo and transport routes.
- Many suppliers of trucks are located outside Norway, where climate targets may less ambitious.

Targets

Klimakur 2030 includes considerations for suppliers, and logistics. EU Taxonomy Do-No-Significant-Harm criteria have multiple regulations to limit the environmental impact of batteries etc. and promote circular economy thinking. Better planning of order frequency and volume can reduce transport requirements. As could, developing a tool to allow smaller, local companies to make collective orders and share logistics solutions.

Current risk management

- Norges Lastebileier-forbund (NLF) publishes a yearly report focused on climate and environmental factors, emphasising the role of the whole value chain in reducing environmental impacts. NLF is engaged with reducing emissions to air of CO2, CO, NOx and PM and has a strategic goal to ensure that member companies use most advanced technologies and maintain a high replacement rate for fleets to switch to lower carbon alternatives.
- According to the EY Climate Risk Barometer report, the transport sector is amongst the top performers globally for TCFD reporting. However, the report specifically highlights that Norwegian transport companies are underperforming in terms of risk management (EY, 2019). This likely means they are lacking in reporting on how climate risks are integrated in overall risk management of the company and/or how they conduct materiality assessments.

Key opportunities

- Decarbonization and digitalization are considered the most transformative forces in road transport (Hovi et al, 2019).
- Production of own renewable fuel (e.g., solar power, hydrogen, biofuel) and concurrent development of infrastructure for charging/fueling. Green hydrogen will be cheaper than blue hydrogen in many global locations within the next 5-15 years (IRENA, 2020).
- Research on dynamic charging concepts, as well as demonstrations of catenary line solutions, may enable expansion of the range of operations for heavy-duty and long-distance operations for regional buses and long-haul trucking. (IEA, 2020) Hydrogen-based trucks have a faster refueling time than electric trucks (Regjeringen, 2020b).
- Optimisation of transport routes for freight and suburban passenger transport, including implementation of hybrid transport routes that combine road and rail to reduce emissions.
- Heavy-duty vehicles are produced in smaller series than passenger cars, which increases the opportunity to influence the market with a smaller number of orders.
- Electrification results in lower fuel use and resulting cost reductions.

Key pitfalls

- For "zero-carbon" fuels, scope 1, 2 and 3 emissions can be large. Hydrogen may be either 'green' (produced with renewable electricity) or 'blue' (based on fossil fuels with CCS). Note that blue hydrogen has a higher yield than green hydrogen but is more carbon intensive. Certain biofuels may be linked to deforestation and irresponsible land use change and battery production has a high carbon intensity.
- Circular economy principles should apply; materials used for vehicle production and waste handling should be considered. E.g., biofuel, hydrogen and batteries must be responsibly and sustainably sourced and must minimise climate impact.
- Energy efficiency improvements to fossil fuel-based fleets generally reduce transportation costs and could therefore lead to higher trade volumes (rebound effects) and increased long-term prevalence of fossil fuel assets (lock-in).
- The long vehicle lifespan of a diesel-fueled truck may lead to lock-in of fossil fuels. Electrification of fleets needs to happen urgently to have the desired decarbonisation effect.
- In the long run, insurance coverage might be insufficient to cover climate impacts on supply chain and communication infrastructure.
- Smaller transport operators, mainly SMEs or micro enterprises, are currently missing out on fuel savings and reduced fuel bills, as policies are mostly directed at heavy-duty vehicles (European Commission, 2018).

Disclosure and integration of climate risk

Disclosure of climate risk and environmental impact

According to the EY Climate risk disclosure barometer, which reviewed 65 transportation companies, there is good coverage of TCFD implementation across the entire transportation sector, but quality of implementation varies significantly. Norway was listed as a high performer in the targets and metrics category, meaning they report well on Scope 1, 2, and 3 emissions, the methodology used and targets for reductions of emissions. Note, however, that this report also includes other transportation modes out of the scope of this brief, like heavy industry shipping.

There is precedent for public reporting on progress in the sector. ASKO, a food delivery service, reports on the share of biofuel in its fuel-mix as well as the number of zero-emissions vehicles. ASKO is also certified by ISO 14001, which requires regular reviews of environmental impact. Kolonial, also a food delivery service, discloses its carbon emissions (as well as statistics on their food waste). Other logistics companies like DB Schenker are lacking on publicly disclosed climate risk analyses, however most report on carbon emissions.

Integration of climate risk in operations / decisions

Companies are making investments in electric and hydrogen vehicles. Norwegian companies have pre-ordered around 70 new hydrogen trucks from Nikola Motor. These are not yet in production but are planned for release in 2023 (Regjeringen, 2020b).

Multiple Norwegian distribution companies have integrated clear environmental strategies in their operations. ASKO has already reached its ambition to reach carbon neutrality by only using renewable fuels (biofuel, hydrogen and electric) and undertakes other initiatives such as reducing impact of food packaging and supply chain considerations. Bring and Posten plan to reach zero emissions by 2025 for both their distribution fleet and storage buildings. DHL has undertaken a pilot project to replace light distribution vans with distribution bicycles and in connection with this initiative has established a centrally located micro-terminal for intermediate storage. DB Schenker has invested in electric trucks in order to reach their target of 100% electric goods distribution within Ring 3 of Oslo by 2020. They also have a climate goal to reduce specific CO2 emissions by 30% by 2020 compared to 2006 levels, and by 50% until 2030. The company is reducing transport miles by consolidating goods, shifting to lower-carbon modes of transport and increasing the efficiency of fleets through continuous fleet renewals. They also allow customers to reduce or compensate for CO2 emissions along the entire supply chain (DB Schenker, 2020).

Regulations and scenario information

Policies in Norway

Currently electric and hydrogen vehicles are exempt from multiple fees and taxes, including engangsavgift, merverdiavgift, trafikkforsikring as well as exemptions from tolls and free ferry passage. While these decisions are now made by local authorities, the national government has set the limitation that zero-emissions vehicles should not pay more than half price for toll roads and ferry passage (Regjeringen, 2020b).

The Norwegian government has committed to including the following targets in the National Transport Plan 2018-2029: all new light distribution vehicles will be zero-emission vehicles in 2025. By 2030, all new heavier vans, 75 % of new long-distance buses and 50 % of new trucks will be zero-emission vehicles to facilitate low emission distribution of goods in the largest urban centres (Regjeringen, 2019).

The Norwegian government will follow the national action plan to reach carbon neutrality in the road transport sector by increasing the share of zero-emissions vehicles, as well as the share of hydrogen and advanced biofuel for heavy duty transport, which is harder to decarbonise. Hydrogen is an area of prioritisation for heavy duty transport and is seeing massive growth. Norsk Hydrogen Forum has a goal to reach 1000 hydrogen heavy duty trucks on Norwegian roads by 2023. The current target is to increase the share of biofuels blended into fossil fuels to 40 % by 2030, depending on the rate of technology development and the development of alternative fuels (Regjeringen, 2019).

The EU has approved a new fuel economy standard for cars and vans for the time period 2021-30, and a new CO2 emissions standard for heavy-duty vehicles. Aggressive targets for 2030 will contribute to increasing adoption of EVs. A revision of the Clean Vehicles Directive also aims to accelerate the adoption of electric buses and other public vehicles.

EU Taxonomy

There are multiple categories in the EU Taxonomy relevant to the scope of this brief.[3] For all categories, vehicles with zero direct tailpipe emissions (or less than 1g CO2/kWh for heavy-duty vehicles) are automatically eligible. Additional criteria, including within biofuels and alternative fuels, for each category are summarized below:

Light commercial vehicles

- Vehicles with tailpipe emission intensity of max 50g CO2/km (WLTP) are eligible until 2025. From 2026 onwards only vehicles with emission intensity of 0g CO2/km (WLTP) are eligible.

Freight transport services by road:

- Zero-emission heavy-duty vehicles (vehicles without an internal combustion engine, or vehicles that emit less than 1g CO2/km)
- Low-emission heavy-duty vehicles with specific direct CO2 emissions of less than 50% of the reference CO2 emissions of all vehicles in the same sub-group are eligible.
- Fleets of vehicles dedicated to transport fossil fuels or fossil fuels blended with alternative fuels are not eligible.

Suburban and interurban passenger land transport:

- Vehicles that have zero direct tailpipe emissions are eligible.

Infrastructure for low carbon land transport may also be eligible, as long as it is fundamental to the operation of the transport service. Please see the taxonomy eligibility criteria for further details.

The current EU taxonomy draft sets additional requirements in the area of "Do no significant harm" in terms of circular economy considerations in maintenance and end-of-life management, as well as local and global pollution (air and noise) and ecosystem concerns. In Norway, this may include considerations for environmental impact of winter spikes on tires and the recycling/upcycling of used tires.

The current draft also requires minimum social safeguards, currently defined as meeting the International Labour Organisation (ILO) Core Labour Practices.

3 The thresholds and categories in this sector brief are based on the draft Delegated regulation report for climate change mitigation published in November 2020. The full EU Taxonomy is not yet finalized, so thresholds are subject to change.

Global scenarios

Electric vehicles (including personal passenger cars) are one of the few technologies currently on track to reach the IEA Sustainable Development Scenario, which predicts an exponential increase from 0.8% of global stock in 2018 to 13.4% in 2030. The SDS incorporates the targets of the EV30@30 campaign to collectively reach a 30% market share for electric vehicles in all modes except two-wheelers by 2030. Historical growth has mostly occurred due to supply-side regulations and standards, but more comprehensive regulation is required to maintain the trajectory. To date, 17 countries have announced 100% zero-emission vehicle targets or the phase-out of internal combustion engine vehicles through 2050 (IEA, 2020).

The International Renewable Energy Agency (IRENA) reports that freight transport currently comprises more than 40% of transport sector's total energy demand, and projects in their Planned Energy Scenario (PES) that energy demand will further rise by 20% from 25 EJ in 2016 to 30 EJ in 2050 (IRENA, 2020). In their Transforming Energy Scenario (TES), CO2 emissions decline by almost 75% compared to the PES.

According to the IEA, most medium- and heavy-duty electric trucks on the road are in China, where the sales rose over 6 000 units in 2019. In Europe, a group of original equipment manufacturers (OEMs) have delivered electric medium-freight trucks to selected fleet operators for commercial testing. (IEA, 2020). However, trucks that operate on regional and long-haul basis show the lowest sales and stock shares among all vehicle categories in the IEA scenarios.

With battery production required to increase about eighteen-fold by 2030 in the IEA SDS, significant battery cost reductions can be expected through the conjunction of increasing battery pack size, battery chemistry changes and economies of scale thanks to larger manufacturing plants.

CICERO Shades of Green & analyst perspective[6]

CICERO Dark Green for the sector

Considerations for main activities

- Zero-emission vehicles, such as electric or hydrogen vehicles.
- Use of alternative fuels (i.e. hydrogen or biofuels) for heavy duty vehicles e.g., passenger buses (regional bus services) and trucks. Life cycle emissions assessments (incorporating production method) should be used to determine relative emissions from green/blue hydrogen and advanced biofuels/biogas.
- Infrastructure for low-emission vehicles (e.g. electric chargers). Account for grid emissions factors to determine environmental impact.
- Emphasis on optimisation of logistics to reduce number of trips taken by trucks, while ensuring no lock-in of fossil fuel truck infrastructure (e.g., logistics improvements for 100% zero-emissions fleet).
- Emphasis on a circular economy approach, including recycling of materials, and longevity and reparability of vehicles.
- Investments in clean road transportation should primarily replace existing conventional fuel fleets.
- Storage facilities run on renewable energy.

Considerations for upstream and downstream factors

- Upstream: electricity generated from renewable energy and advanced biofuels with sound environmental management (avoiding indirect land-use changes). Use of hydrogen fuel-cell systems for heavy duty transport.
- Digital solutions: enabling avoidance of transport and/or enabling utilization of low carbon transport (EU Taxonomy).
- Construction of enabling infrastructure: accessible chargers for electric vehicles, access to hydrogen filling stations and advanced biofuel for heavy duty vehicles (EU Taxonomy).
- Accounting for full life-cycle emissions throughout the vehicle manufacturing supply chain, including ensuring sustainable sourcing of batteries, biofuels, hydrogen.
- Factories powered by renewable energy.
- Freight transported is limited to Dark Green goods.

Current best practice – activities

- Early electrification of fleet and heavy prioritisation of zero-emission vehicles and related zero-emission infrastructure.
- Production of own renewable fuels e.g., ASKO producing its own hydrogen (ASKO, 2017)
- Investments in infrastructure that supports decarbonization of road transport sector (e.g. chargers for electric vehicles)
- Streamlined and optimized solutions for logistics. Includes increasing the load factor of cargo, suburban off-loading sites where heavy-duty vehicles can be replaced for electric distribution vehicles into the city. Additionally, combining road freight with rail transport, which has a lower carbon intensity due to higher loading capacities.
- Energy efficiency improvements to fossil fuel-based fleets generally reduce transportation costs and could therefore lead to higher trade volumes (rebound effects) and increased long-term prevalence of fossil fuel assets (lock-in). Investments in energy efficiency screen for and mitigate these effects.
- Circular economy approach to batteries and manufacturing materials. Ensure vehicles are built to be easily reparable and recyclable.
- Conducting full life-cycle analyses to determine environmental impact (with consistent methodologies)[4]. Projects should also consider emissions and environmental impacts associated with the production and end-of-life phase of vehicles.
- For heavy-duty vehicles, concurrent investments in hydrogen and electric trucks to drive further industry maturity, while also implementing using sustainably sourced advanced liquid biofuels with a low carbon intensity.

Current best practices – governance

- The Poseidon Principles are a voluntary Includes setting intermediate and long-term science-based targets for reducing GHG emissions, undertake scenario stress-testing, align with TCFD recommendations to incorporate climate risks and opportunities in the company strategy.
- Reporting on life-cycle emissions and impact, broken down by vehicle-type, as well as consideration of types of goods being transported and distance travelled.
- Environmental considerations integrated in supply chain decision making. This includes ensuring materials used for batteries are responsibly sourced, and end-of-life re-use or recycling.
- Consider both current weather variability and future climate change, including uncertainty.
- Governance measures and policies should be consistent with the expected lifetime of the activity and vehicle, e.g., by appropriately considering fossil fuel lock-in effects of investing in fossil fuel-based vehicles.

4 Due to uncertainty in LCA methodologies, there is value in promoting the consistency of LCAs across the sector.

Data and indicators for climate risk disclosure

Historic data

According to the Veikart report from 2016, emissions from commercial mobile sources has increased from 8 million tonnes in 1990 to more than 10.5 million tonnes in 2014 in Norway. Note: personal passenger cars and mopeds have been omitted. Heavy-duty diesel road transport has experienced significant growth and currently makes up the largest share, while rail transport and heavy machinery also take significant portions. Other light diesel-driven vehicles have also experienced significant growth. This indicates the importance of focusing on land and rail transport for emissions reductions.

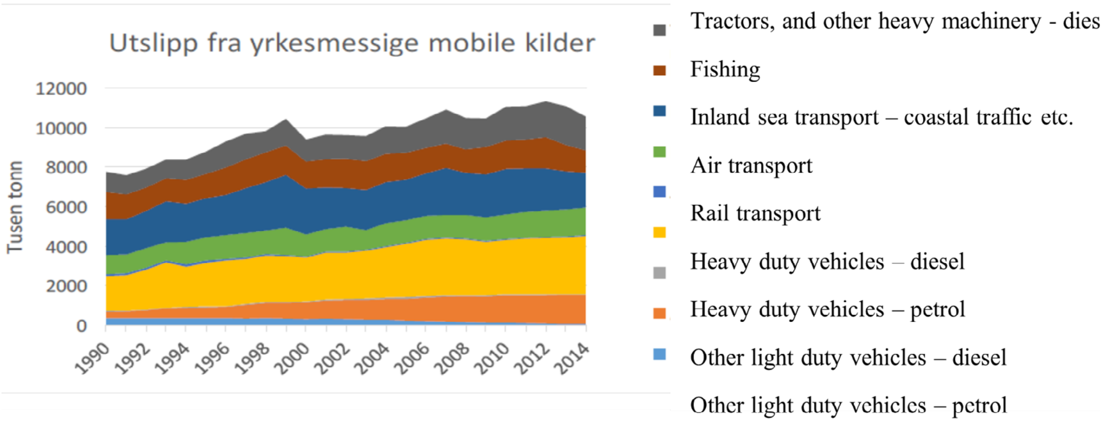


Figure 1 Emissions from commercial mobile sources in Norway. Source: Veikart, 2016

Figure 2 below illustrates the emissions reductions contributions from various measures planned for adoption in the road transport sector under Klimakur 2030. The two largest contributions are 'improving the use of advanced biofuels in road transport' and '100% of new personal passenger cars are electric in 2025', both contributing to reductions of around 2.5 million tonnes of CO_2e. Note that beyond 2030, it will be important to switch away from advanced biofuels towards electric and hydrogen.

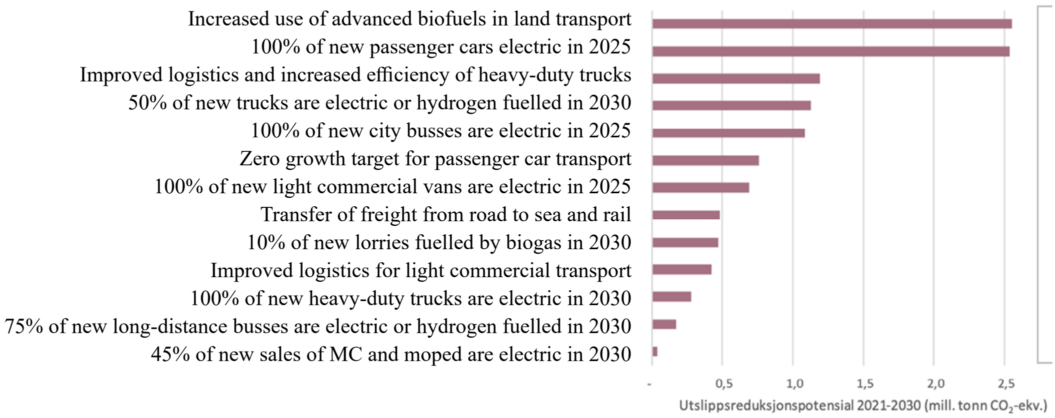


Figure 2 Emissions reductions contributions from various Klimakur 2030 measures in Norway. Source: Klimakur 2030 (Miljødirektoratet, 2020)

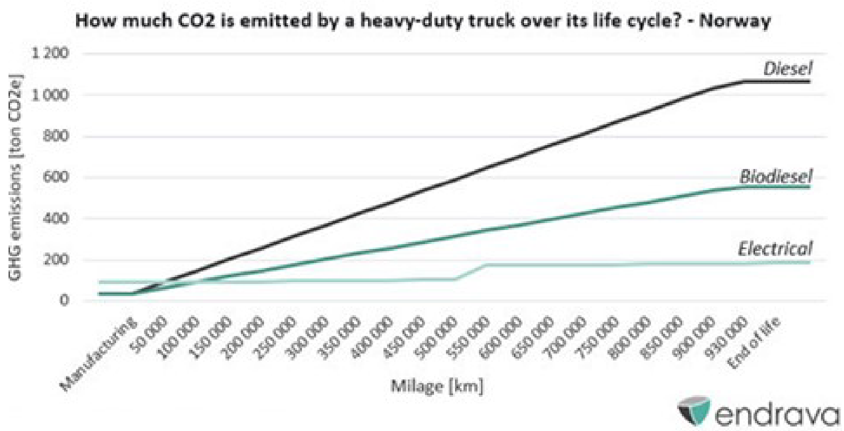


Figure 3 CO2 emissions over life cycle for electric, biodiesel and diesel-powered heavy-duty trucks. Source Endrava, 2020

Figure 3 indicates that life cycle emissions for heavy duty trucks depend significantly on type of fuel used. For electrical heavy-duty trucks, scope 1 emissions and scope 2 emissions are negligible in Norway, and emissions remain fairly constant throughout the truck's lifetime. After 500,000km, emissions increase, presumably as the battery has to be changed. Both biodiesel and diesel emissions increase linearly with greater distance as scope 1 emissions increase with usage. Emissions for all three truck types flatten out as the cars reach end-of-life. Biodiesel emissions increase slower than diesel emissions because part of the scope 1 emissions are offset as biofuels also include an inherent carbon sink.

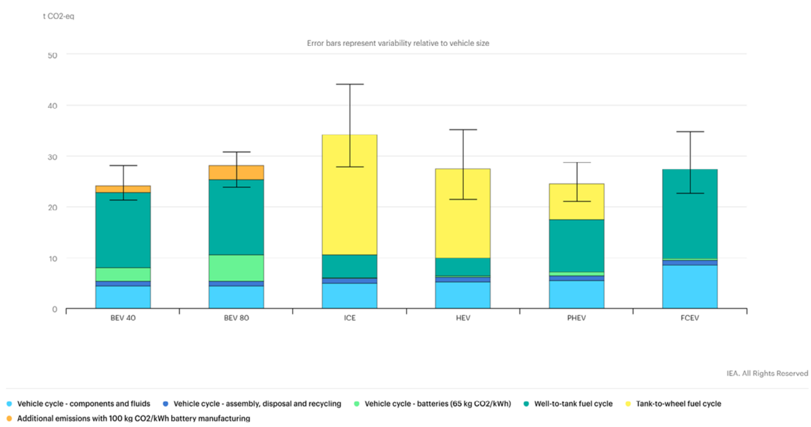


Figure 4 Comparative life-cycle greenhouse gas emissions over ten-year lifetime of an average mid-size car by powertrain, 2018. (IEA, 2018, Last updated June 2020).

Figure 4 illustrates life cycle emissions for globally averaged vehicles. Life cycle emissions are currently comparable on for all types of vehicles (BEV – battery electric vehicles where BEV 40 refers to a 40kWh battery while BEV 80 refers to a 80 kWh battery, ICE – internal combustion engines, HEV-hybrid electric vehicles, PHEV – plug-in hybrid electric vehicles and FCEV- fuel cell electric vehicles). BEVs and FCEVs have the highest share of emissions in the well-to-tank fuel cycle due to the high carbon intensity of manufacturing. The BEVs have an additional emission of 100 kg CO2/kWh for battery manufacturing. This trend is decreasing however, as manufacturing processes are increasingly decarbonising. Note: this graph is constructed for global trends and scope 2 emissions will vary based on the energy mix of electricity in different countries. For example, in Norway, scope 2 emissions are considered negligible.

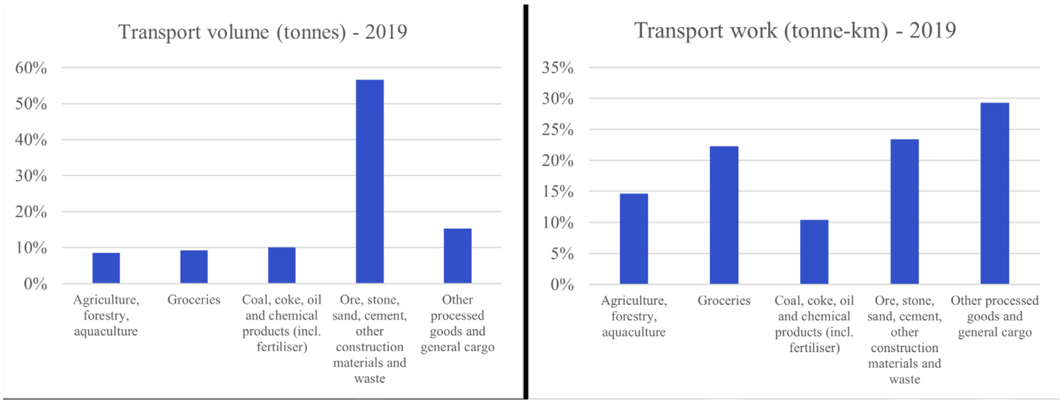


Figure 5 Transport volume (tonnes) and transport work (tonne-km) by freight transport in Norway in 2019. Source: SSB, 2020b

In 2019, total "transport work", which accounts for both total volume of goods transported as well as distance travelled by Norwegian trucks, was 19389 million ton-km. 10% was in coal, oil and chemical products, 15% in agriculture, forestry and fish products, 22% in groceries, 23% was in ore, rock, cement and other construction materials, and 29% was in "other processed goods and general cargo". However, without accounting for distance travelled, ore, rock, cement and other construction materials makes up 57% of total transported goods, while consumables make up 9% (SSB, 2020b). This indicates that these construction materials are mostly locally sourced, and that groceries (food and drink) are transported longer distances.

Considerations for main activities

- Miljøstatus Klimagassutslipp Veitransport
- SSB.no – GHG emissions by sector, public transportation usage
- IEA.org – outlook and trends for transport sector

Considerations for upstream and downstream factors

- Inconsistency and uncertainty on LCA methodology and reporting
- Large variation within transport sector in emission sources. The carbon footprint of BEVs (Battery Electric Vehicles) is majority Scope 3, while ICEs (Internal Combustion Engines) are majority Scope 1. Similarly, electric trucks have much larger Scope 3 emissions than electric cars and vans.

Indicators which would improve climate risk disclosure[5]

Transition risk

Preliminary indicators and metrics
Carbon intensity (CO2eq / km)
Life cycle emissions for both production and use-phase of vehicles.
Zero-emissions vehicles in fleet: absolute number and share
Number of charging and hydrogen filling stations installed (/km2)
Load factor – average load to total vehicle freight capacity (tonnes/vehicle-km)
Type of freight
Increased mobility (area covered per unit time)
Cost of electric vehicles (NOK or USD)

Physical risk

Preliminary indicators and metrics
Number of disruptions due to e.g., floods, extreme precipitation, urban overflow, avalanche, landslides (total events and working hours lost)
Relevant indicators for heat: past and projected mean and max temperatures for different emission scenarios (e.g. RCP 8.5 and RCP 4.5), Heat Wave Magnitude Index daily (HWMId), Wet Bulb Globe Temperature (WBGT)
Relevant indicators for precipitation: Frequency and consecutive number of extremely wet days, maximum daily rainfall daily and over 5 consecutive days or total wet day precipitation
Lost income due to extreme weather/natural disasters (NOK or USD lost)

5 Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different business models and different indicators and metrics may be more relevant depending on the company under assessment.

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Key analyst questions for all companies in this sector

1. What is the share of zero-carbon vehicles in the company's fleet?
2. What are the company's targets and strategies for decarbonisation? Does the company have a strategy for full electrification of its fleet by 2050, in line with global goals?
3. How does the company account for life cycle emissions?
4. If financing electric vehicles, will this also include the expansion of vehicle charging infrastructure?
5. For alternative energy vehicles (biofuel, hydrogen), how is the fuel sourced?
6. How are climate resilience factors determined and integrated into company activities?
7. What regions does the company operate in? Long vs short distance transportation?
8. What are the environmental policies for suppliers and sourcing of materials related to production of vehicles and associated infrastructure?
9. What goods are being transported? And how exposed are these goods to physical and transition risks? (e.g., transport of oil and gas**)**

7 Please note that these are preliminary indicators and metrics that will be further developed. As the methodology and data availability evolves, we expect adjustments to the list. Also note that within the sector there are many different busines models and different indicators and metrics may be more relevant depending on the company under assessment.

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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.

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