# Reducing our pressure on nature

How Norwegian businesses can shape responsible use of biomass resources

WWF

BAIN & COMPANY


Preface

# Harvesting the change we need

The importance of preserving nature has finally taken center stage, with the introduction of the global biodiversity framework. Here, nature has finally got a UN deal on equal footing with the topic of climate change. The goal is to reverse the unprecedented loss of nature and biodiversity observed around the world.

The successful implementation of the agreement is not only essential for preserving unique biodiversity but also for sustaining our lifestyle and economic stability. The World Economic Forum has defined nature loss as one of the biggest economic risks facing the global economy.

Policy makers, businesses, and finance institutions are now starting to investigate the implications of the framework, its impact on business models, and how businesses can adapt to reduce their nature footprint.

For the WWF, it is important to contribute with knowledge and understanding of nature to inform and motivate the business sector. The aim is to support businesses transition towards new and nature-friendly business models that can continue to create value while respecting the boundaries of nature.

Bain & Company supports this mission, and firmly believes that businesses that manage their nature risks and capitalize on opportunities from nature-friendly business models will also gain competitive advantage.

In this report, WWF and Bain & Company zoom in on the bioeconomy in Norway. The use of biomass resources, such as forestry or agricultural products, has a significant impact on nature. Changing how we harvest, source, and consume these biomass resources is therefore pivotal to halt biodiversity loss.

Our aim is to inspire wider action in the business sector for the benefit of the nature. We welcome all interested parties to join the discussion on how we can realize the necessary transformation of our bioeconomy. Together, we believe that a better future is within reach.

Signature

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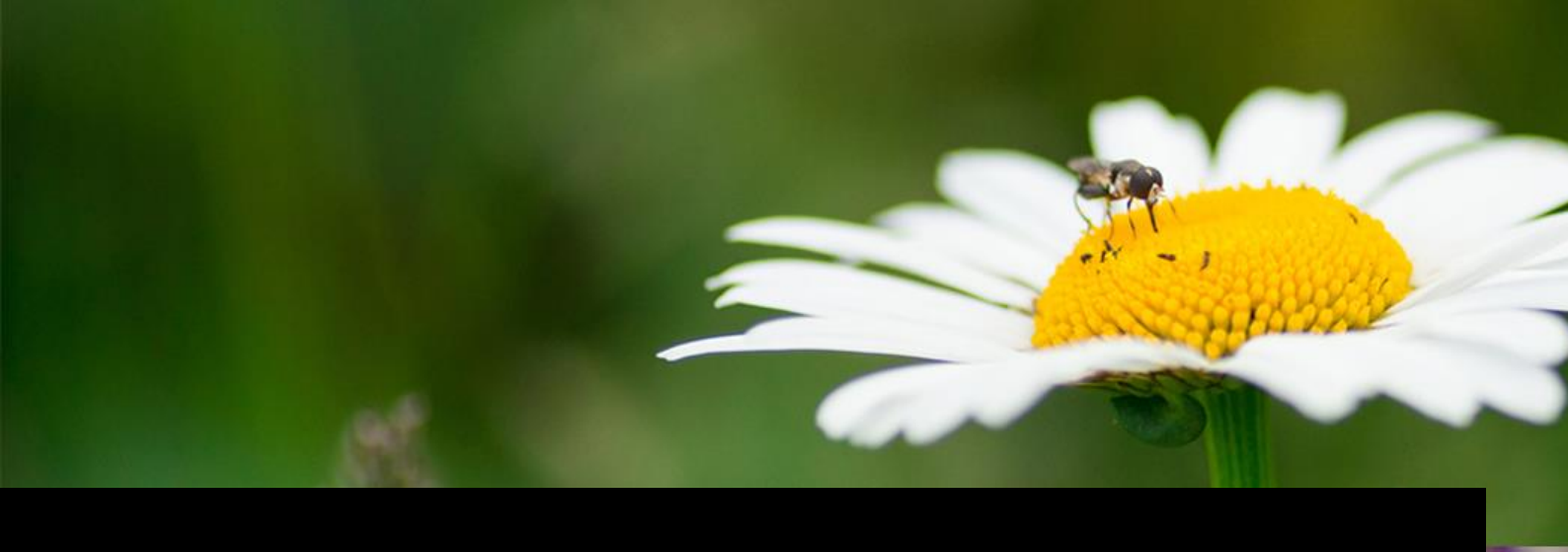
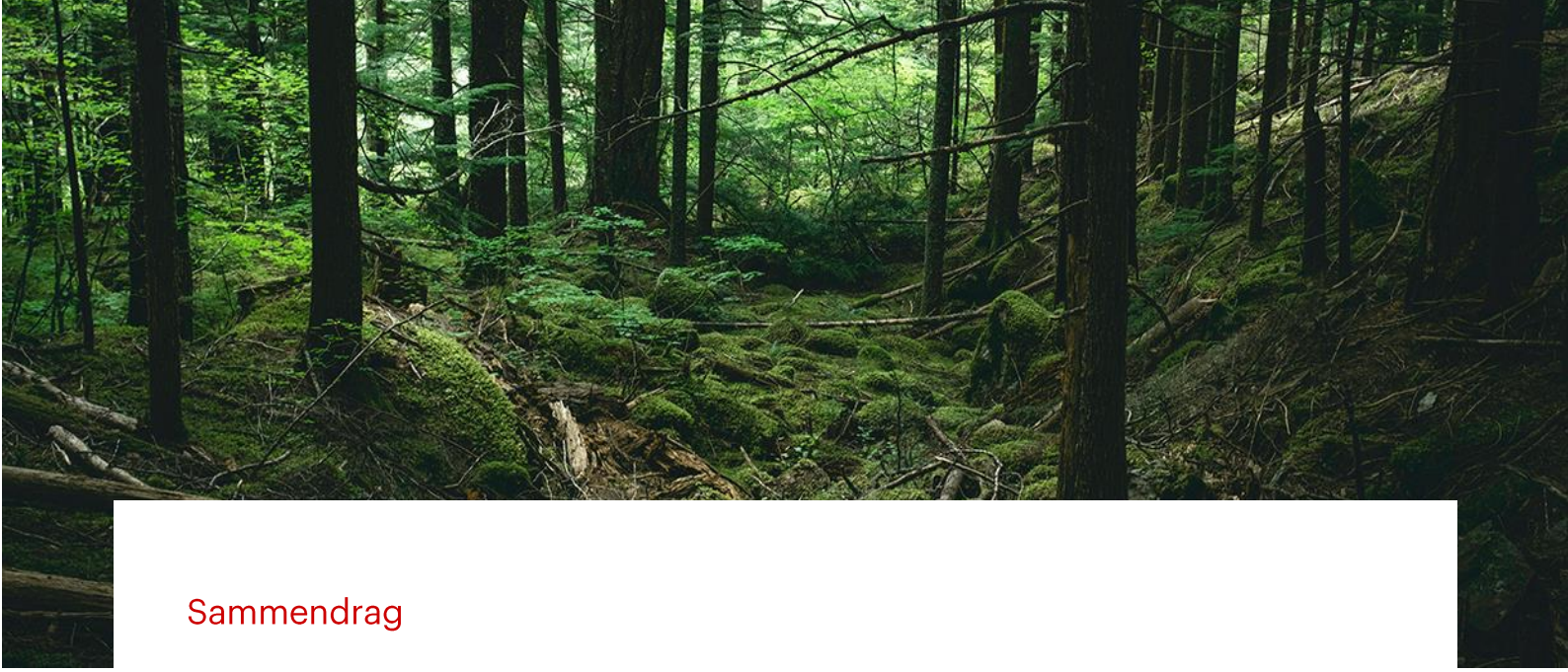






Sammendrag

# Hvordan norske bedrifter kan bidra til et mer ansvarlig forbruk av biomasse

Denne rapporten belyser de miljømessige utfordringene ved vår produksjon, import og overforbruk av biomasse, som er organiske ressurser som spenner seg fra mat til trevirke. Biomasse er definert som en fornybar ressurs og anses ofte som en løsning i kampen mot klimaendringer. Eksempelvis kan trevirke erstatte karbonintensive byggematerialer som stål og betong. Vårt forbruk av biobaserte ressurser er imidlertid høyere enn det naturen kan tåle. Globalt bidrar utvinning og forbruk av biomasse – det såkalte biomassefotavtrykket – til 80% av det totale tapet av naturmangfold og 15% av klimaendringene. WWF anslår at Norge må redusere sitt biomassefotavtrykk med nesten 50% innen 2030 for å være innenfor planetens tålegrenser.

Rapporten retter seg særlig mot norske selskaper i verdikjedene for mat- og trebaserte produkter: fra skogseiere og bygg- og anleggsbransjen til bønder og dagligvareaktører. Disse verdikjedene utgjør over 95% av Norges biomasseforbruk. Aktørene i disse verdikjedene har derfor et særskilt ansvar for å redusere de negative natur- og klimapåvirkningene forårsaket av deres produksjon, høsting, bearbeiding, import og forbruk av biomasse.

For **bønder, matprodusenter, dagligvarekjeder og serveringsbransjen** er det avgjørende å begrense matsvinn i egne prosesser, men også å legge til rette for redusert avfall i andre deler av verdikjeden. Dette krever økt samarbeid mellom aktører og at man adresserer årsakene til avfallet fra norske sluttforbrukere.

Produksjon av animalske matprodukter, og særlig rødt kjøtt, er ansett som en ineffektiv bruk av biomasse, særlig når det baseres på ressurser som mennesker kan spise. Det er imidlertid viktig å ha et helhetlig perspektiv når man vurderer miljøbelastningen av ulike typer animalske matprodukter. For eksempel krever storfeproduksjon store mengder fôr i «omgjøringen» til kjøtt og har et høyt klima- og miljøfotavtrykk. På den positive siden består fôret av mye ikke-spiselig biomasse samt at beiting påvirker naturmangfoldet positivt. Svin og kylling har lavere klima- og miljøfotavtrykk, mens fôret i større grad består av spiselige ressurser. Dette illustrerer kompleksiteten i avveiningen mellom animalske matprodukter. Det norske matsystemet bør uansett innrettes slik at det bidrar til et lavere biomassefotavtrykk. Dette vil kreve kostholdsendringer, tiltak rettet mot bønder for å bidra til en justering av driftspraksis, og økt tilbud av plantebaserte matvarer. Overgangen fra rødt kjøtt til andre proteinkilder må ikke medføre økt press på en sårbar natur. Eksempelvis må ikke en økning i sjømatkonsum føre til økt import av soya, ettersom dette bidrar til avskoging i land som Brasil.

Matindustrien kan bidra gjennom strenge innkjøpskriterier ved import av matvarer. Matimportører må øke sporbarheten i verdikjeden, og samarbeide med leverandører for å forbedre landbrukspraksisene der varene produseres.

Norsk landbrukspraksis kan også bli mer miljøvennlig. Til tross for at forbruket av rødt kjøtt må reduseres, vil Norge fortsatt produsere rødt kjøtt i fremtiden. Produksjonen må derfor gjøres mindre klimagassintensiv. Regenerativt landbruk er et annet virkemiddel som kan gjøre norsk landbruk mer bærekraftig. Dette kan bidra til forbedret jordsmonn og økt avkastning, samtidig som man beskytter naturmangfoldet.

**Bygg- og anleggsselskaper og møbelbedrifter** bør forlenge levetiden til sine produkter basert på trevirke og bidra til å øke etterspørselen etter kvalitetsprodukter samt øke sirkularitet av produktene. Bedrifter må sørge for at trebaserte produkter kan brukes og resirkuleres så mange ganger som mulig. Ved å utsette forbrenningen av treavfall til energiproduksjon og heller beholde materialet i verdikjeden så lenge som mulig, vil man kunne maksimere verdien av treet og minimere behovet for nytt trevirke. Slik minskes også biomassefotavtrykket.

Konvensjonelt skogbruk har negativ naturpåvirkning. Dette kommer særlig av omfattende flatehogst og etableringen av tette og homogene skogbestander som reduserer naturmangfoldet i skog over tid. Ansvaret for skogforvaltning ligger imidlertid ikke hos skogseierne alene. Selskaper innen bygg, anlegg og møbelproduksjon må anskaffe trevirke fra bærekraftig forvaltede skoger og sikre en sporbar forsyningskjede. Her gir internasjonale sertifiseringsordninger et godt grunnlag. Bedrifter bør også legge til rette for egne kontrolltiltak, kartlegge innkjøpsproblemer, velge strenge standarder, sette tilleggskrav og sikre overholdelse av kravene.

Som en hovedregel trenger vi å øke resirkuleringen og redusere produksjonen av biobasert avfall. Likevel vil man alltid ha noe avfall som ikke kan gjenbrukes og som vil gå til forbrenning. Selv om slik forbrenning gir en viss verdi i form av produsert energi (typisk elektrisitet eller varme), vil bruk av biomasseavfall til produksjon av avansert biodrivstoff ha en større verdi som et klimatiltak som kan redusere utslipp. Avansert biodrivstoff bør i første omgang brukes som et fossilfritt alternativ innen transportsektoren som ikke enkelt lar seg elektrifiseres, slik som luft- eller skipsfart. Norge er godt posisjonert til å utvikle avanserte biodrivstoffer basert på stor tilgjengelighet av biobasert avfall og velutbygd produksjonsinfrastruktur for drivstoff.

Flere av de foreslåtte løsningene i denne rapporten kan være krevende å gjennomføre. Å ta bærekraftige valg kan være motstridende med kortsiktig konkurranseevne eller å oppfylle nåværende forbrukerpreferanser, men være nødvendig for å forbli konkurransedyktig på sikt. Derfor krever mange av løsningene støtte eller tilrettelegging. Dette inkluderer målrettede politiske tiltak og subsidier, en finanssektor som tilbyr bedre vilkår til de som tar hensyn til naturen og et industrielt samarbeid som kan utvikle nye verdikjeder. Med riktig innretning kan mange av løsningene være lønnsomme: fra lavere kostnader gjennom økt materialutnyttelse til nye inntektsstrømmer fra resirkulerte produkter. Norsk industri bidrar i dag til overforbruk av biobaserte ressurser. Derfor må produksjon og forbruk endres slik at den negative påvirkningen på ressurser, naturmangfold og klima minimeres. Uten endring, setter vi naturens evne til å produsere naturressurser i fare.

Denne rapporten presenterer fakta og inspirasjon til hvordan man kan komme i gang, men ikke nødvendigvis alle svarene. Formålet med rapporten er å starte en debatt rundt de miljømessige utfordringene ved dagens biomasseforbruk og presentere løsninger for å håndtere noen av disse utfordringene. Til tross for kompleksiteten rundt tematikken, og enkelte begrensninger i kunnskap- og datagrunnlaget, finnes det allerede mange løsninger som er tilgjengelige for bedrifter. Vi håper dere tar utfordringen på strak arm. Vi mener norsk natur, samfunnet – og selvfølgelig planeten – fortjener det.

Executive summary

# How Norwegian businesses can shape responsible use of biomass

This report sheds light on the environmental challenges associated with our use of biomass – organic resources spanning from food to wood. Today, biomass is considered a renewable resource and is viewed as a solution to combat climate change, for example by replacing hard-to-abate materials like steel and concrete. However, our current extraction and consumption of biomass are not safe for nature. Globally, the biomass footprint is responsible for approximately 80% of biodiversity loss on land and 15% of climate change. WWF Norway estimates indicate that Norway needs to reduce its biomass footprint by almost 50% by 2030 to return within the safe planetary boundaries.

The report is addressed to Norwegian companies across the food and forestry value chain: from forest owners and construction companies to farmers and food retailers. These value chains encompass over 95% of biomass consumption in Norway through extraction, processing, and bringing biomass to the market. Hence, they need to take responsibility for associated negative impact on nature.

Norwegian companies can help our society to use, source, and extract biomass more responsibly, thus mitigating its contribution to biodiversity loss and climate change.

For **farmers, food manufacturers, and retailers**, it is critical to limit food waste within their own operations and beyond by collaborating to reduce waste at earlier stages of the value chain and addressing the root causes of the waste generated by Norwegian consumers.

The production of animal-based food, and in particular red meat, is an inherently inefficient use of biomass due to loss of biomass that occurs during the conversion from animal feed to human food. This is particularly true for animal feed that can be consumed by humans directly. When considering the environmental impact of different animal-based foods, it is important to have a holistic viewpoint. For example, red meat production requires large amounts of feed to produce smaller amounts of meat, while having high emissions. On the positive side, a large share of the feed is inedible for humans and grazing contributes positively to biodiversity. Pork and chicken production requires less feed and results in lower GHG emissions; however, it utilized feed that could be consumed by humans. This shows the complexity of the matter. Nevertheless, businesses should facilitate the shift to alternative proteins. This requires changing consumer dietary preferences, helping farmers in transitioning their practices, and growing the supply of seafood and plant protein. It is key to ensure

that red meat substitutes do not harm nature. For example, increasing seafood supply should not lead to increased soy import, as soy production is associated with major deforestation risks in countries like Brazil.

The food industry can also contribute by practicing responsible sourcing of products. To do this, food importers should increase transparency in their value chains and collaborate with suppliers to improve farming practices globally.

Farming practices in Norway can be made more environmentally friendly. One way to achieve this is by reducing red meat consumption. Additionally, we can work on making the remaining red meat production less GHG intensive. Another approach to consider is implementing regenerative agriculture practices that can enhance soil health and improve yield over time, while also guarding biodiversity.

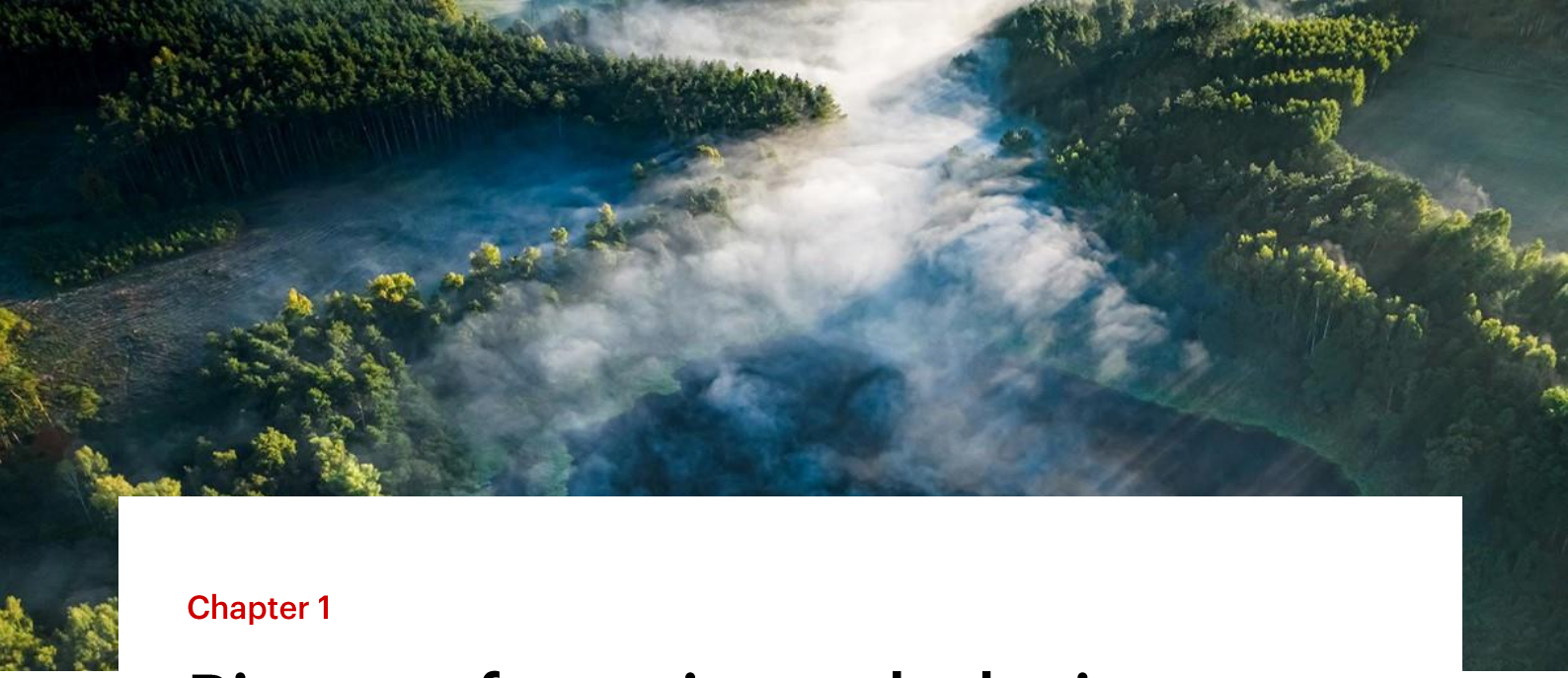
**Construction and furniture companies** should extend the lifetime of wood products in order to drive the demand for high-quality, long-lasting products with increased circularity. Businesses need to postpone the all-too-common incineration of wood waste and increase the longevity of each piece of wood.

Conventional forest management practices are harmful for nature. Extensive clear-cutting and the cultivation of dense and homogeneous forest stands reduces the health and biodiversity of Norwegian forests over time. However, the responsibility for forest management does not solely lie with the forest owners. Companies within sectors such as construction and furniture must source wood from sustainably managed forests and ensure a transparent supply chain. While international certifications provide a good base, businesses also need to implement their own control measures and build internal capability to identify sourcing issues, enforce stricter standards, and ensure compliance.

As a principle, we need to reduce and recycle waste within the original value chains. However, it is inevitable that some waste will always remain for incineration. This is where advanced biofuels come into play, using biomass waste as biofuel feedstock. This should primarily be used as a fossil-free alternative to prevent carbon emissions in sectors such as aviation and shipping. Norway is well-positioned to develop advanced biofuels based on available waste feedstock and production infrastructure.

We acknowledge that many of the suggested solutions are not easy. Making the right choices for nature can stand in the way of short-term competitiveness or be contrary to current consumer preferences, but they might be necessary to stay competitive in the long term. Therefore, this transition requires facilitation from the broader economic system. This includes targeted government policies and subsidies, a financial sector that incentivizes projects with low impact on biodiversity, and industry collaboration to develop new value chains. With the right support, many of the proposed solutions can generate economic value – from lower costs based on improved material efficiency to new revenue streams from recycled products. It is crucial that the Norwegian industry acknowledges its role in the overconsumption of bio-based resources. This implies fostering a production and consumption of biomass that is less harmful to the environment and biodiversity. Otherwise, we run the risk of irreversibly degrading irreplaceable nature, upon which we depend for natural resources.

This report aims to provide you with facts and ideas on how to get started, although it may not have all the answers. Its purpose is to initiate the dialogue around the environmental challenges behind biomass use and ways to address them. Despite the complexity of biomass as a sustainability topic, clear solutions are available to businesses, even if some frameworks and data landscapes are immature. We hope you will take on the challenge, as we believe that the Norwegian nature, society, and the planet deserve it.



Chapter 1

# Biomass footprint and why it matters

## The biomass footprint measures our use of organic resources

Biomass refers to organic materials derived from living organisms, including plants, animals, and microorganisms. The biomass footprint measures the amount of organic resources we use and is measured in terms of the total raw materials required to meet consumption needs within a country[1]. The primary sectors contributing to Norway's biomass footprint are agriculture, forestry, aquaculture, and fisheries. The secondary sectors include construction, manufacturing, retail, distribution, food services, and more. These sectors contribute to the extraction, processing, and consumption of biomass resources, thereby impacting the biomass impact.

## Biomass use is the primary contributor to global biodiversity loss and it accelerates climate change

Scientists have defined nine planetary boundaries as a safe operating space for humanity within the Earth's limits (exhibit 1). These boundaries are the thresholds beyond which significant and irreversible environmental events can occur, risking destabilization of Earth's life-supporting systems. Globally, we have exceeded the safe limits for six out of nine planetary boundaries. Our use of biomass affects several boundaries – especially biosphere integrity (biodiversity loss) and climate change. The biomass footprint is responsible for **approximately 80% of biodiversity loss on land and 15% of climate change globally[2].**

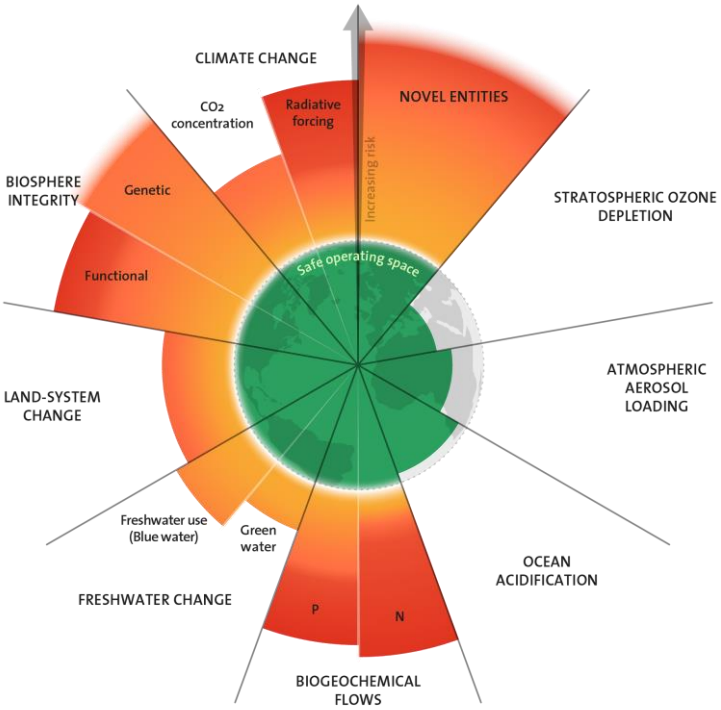
The biomass footprint indirectly puts pressure on other boundaries. For example, farming activities, which contribute to the biomass footprint, can lead to changes in freshwater availability and impact biogeochemical flows through fertilizer use. The planetary boundaries are connected, and any impact on one boundary often has ripple effects on the others. Recognizing these connections is crucial for developing effective strategies to bring us back into the Earth's safe operating space.

This report specifically focuses on the impact of the biomass footprint on biodiversity and climate, as these are considered the most pressing and significant environmental concerns. The report also examines the trade-offs and relationships between addressing the climate change and biodiversity impacts of biomass footprint.

[1] WWF (2022a)

[2] International Resource Panel (2019)

**Exhibit 1: Planetary boundaries framework**




Source: Stockholm Resilience Centre (2023)

## Biodiversity is the foundation of human life, and it is at serious risk

Biodiversity plays a crucial role in supporting humans, societies, and businesses by providing essential natural resources. In addition to the food we consume and the clothes we wear, biodiversity also enriches the diverse nature we inhabit and enjoy. Furthermore, biodiversity enhances the resilience of ecosystems, making them better equipped to withstand the impacts of natural disasters and climate change[3].

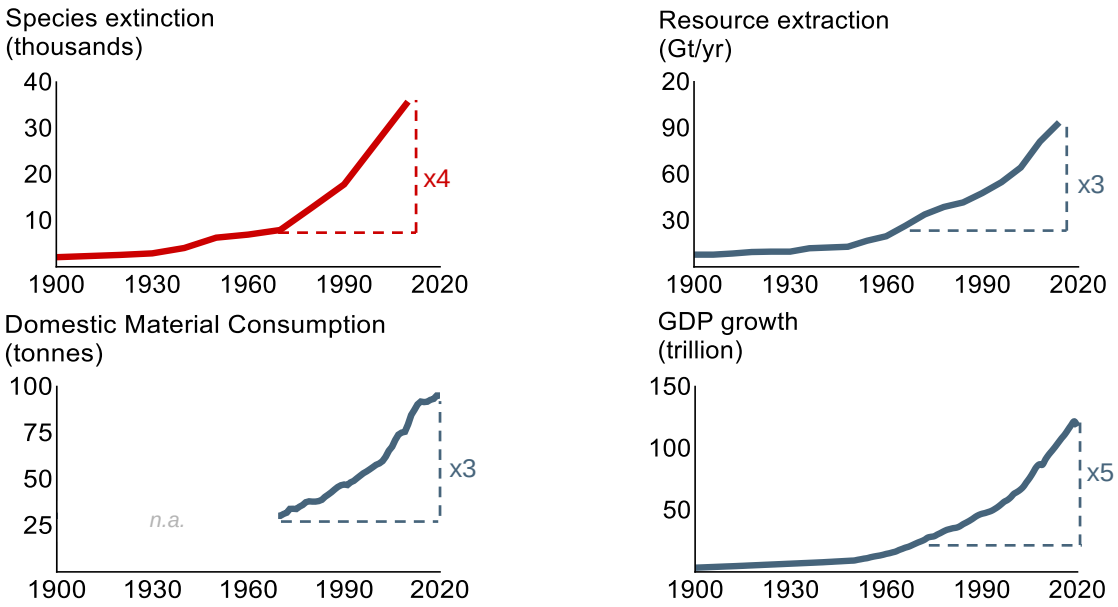
Unfortunately, human activity has caused significant harm to global ecosystems. Industrialization and excessive consumption of resources, including biomass, have contributed to an unprecedented loss of species and habitats on a global scale and within Norway.

Over the second half of the twentieth century, we witnessed the most rapid transformation of the human relationship with the natural world ever recorded, fundamentally altering the state of Earth's socioeconomic and biophysical systems[4]. One million species globally are now at risk of facing extinction[5], and the population sizes of mammals, birds, amphibians, reptiles, and fish have, on average, declined by 69% since monitoring began in 1970[6].

Resource exploitation is a major contributor to biodiversity loss, with biomass utilization being the main root cause. Our use of biomass adversely affects biodiversity by altering natural ecosystems and thereby limiting their ability to sustain life. This includes extensive transformation of land use, freshwater contamination, pollution, and the introduction of invasive species and diseases. Furthermore, climate change is further exacerbating the negative impact on biodiversity.

[3] WWF (2022b)
[4] Stockholm Resilience Center (2016)
[5] Intergovernmental Science Platform (2019)
[6] WWF (2022a)

**Exhibit 2: Overexploitation of natural resources accelerates species extinction**



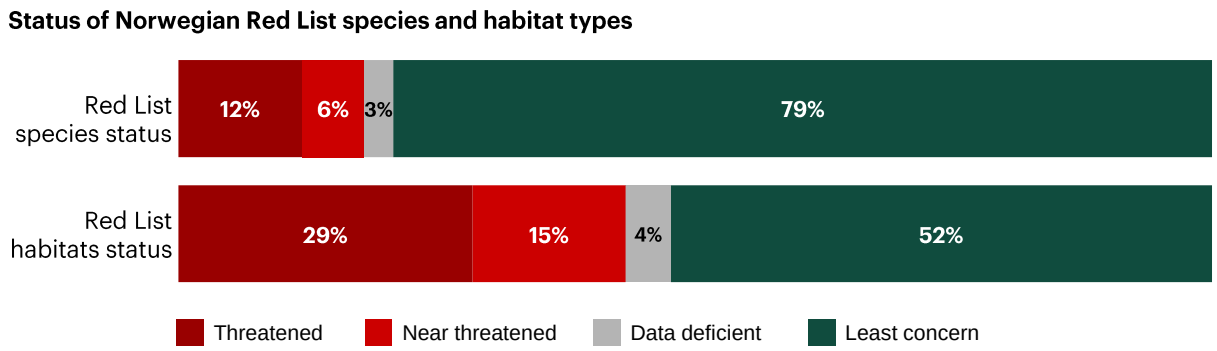

Source: Krausmann et. al (2018), Maddison Project Database/World Bank, United Nations Population Division (2019)

Despite the serious risks associated with this nature crisis, biodiversity has historically received less attention than other global threats, most notably climate change. However, this is now changing. As reported by the World Economic Forum, global experts expect global biodiversity loss and related environmental risks to become the most critical threats to the global economy within the coming decade[7]. In addition, studies indicate that failure to reverse degradation of nature before 2030 can push biodiversity beyond irreversible tipping points, resulting in the collapse of essential ecosystem services[8]. This underlines the pressing need for businesses to improve their understanding of the impact of this crisis, their role in reversing the current trend of biodiversity loss, and how to act.

While the degradation of biodiversity is a threat on a global scale, Norway is no exception. According to the Norwegian Red List for Species, 2,752 (about 12%) out of the 23,405 assessed species in Norway are classified as threatened, and 107 species are classified as regionally extinct. The state of Norwegian habitats is another lens through which the pressure on nature can be seen. Approximately 45% of all natural habitats in Norway are threatened or nearly threatened[9]. In addition, the proportion of undisturbed nature in Norway is constantly decreasing. At the beginning of the twentieth century, around 50% of Norway's mainland was characterized as wilderness, but today only 11% remains[10].

[7] World Economic Forum (2023)
[8] World Economic Forum (2020)
[9] Artsdatabanken (2021)
[10] Miljødirektoratet (2023a)

**Exhibit 3: Multiple species and habitats in Norway are threatened**




Note: The category 'Threatened' includes species or habitats that are considered 'critically endangered', 'endangered', or 'vulnerable'
Source: Artsdatabanken (2021)

## Our economic activity is dependent on nature and is exposed to nature risks

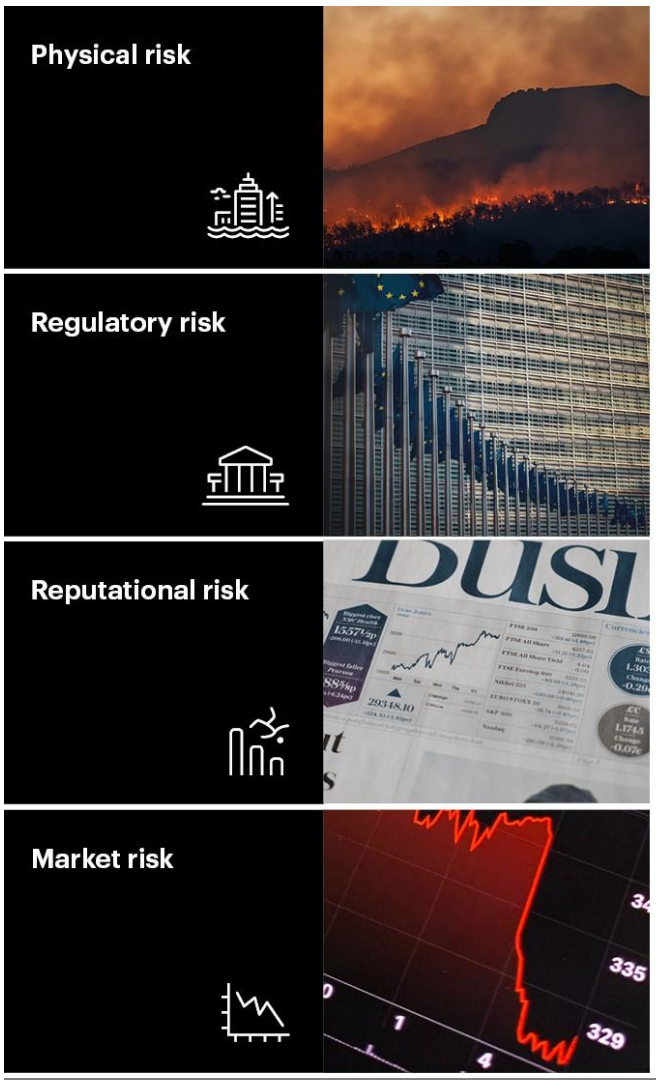
The loss of biodiversity destabilizes the Earth's ecosystem, increasing the risk of accelerating declines in the quality, quantity, and resilience of the natural capital that our economic activity relies on[11]. These nature risks will become more pronounced in the coming years.

The World Economic Forum estimates that more than half of the world's economic value generation is moderately or highly dependent on nature. Recent findings suggest that global biodiversity loss is expected to become one of the most critical threats to the global economy[12,13]. The value lost due to land degradation is already estimated at over 10% of the global GDP[14].

Many businesses in Norway are starting to see business risks materialize through new regulations, changes in consumer behavior, and reduced farm yield reliability, among others. While businesses are exposed to a range of sector-specific risks, WWF specifies four main types of business risk that stem from biodiversity loss: physical, regulatory, reputational, and market risks (exhibit 4). Businesses need to contribute to the mitigation of these risks but also adapt to them. Both lines of action can lead to positive economic outcomes through improved business resilience in the future.

[11] TNFD (2022)
[12] World Economic Forum (2020)
[13] World Economic Forum (2022)
[14] ELD Initiative (2015)

**Exhibit 4: Biodiversity loss poses major business risks**




Decline in ecosystem services and increased exposure to natural hazards. Can result in increased input costs, lack of natural goods, loss of productivity, as well as disruption of operations as resilience to climate-related natural hazards is reduced.

Additional costs and business disruption caused by tighter regulations, for example, through tougher reporting, licensing, industry standards, taxation, and penalties.

Loss of brand value due to biodiversity negligence or misconduct, and access to financing becoming more challenging due to increased investor scrutiny.

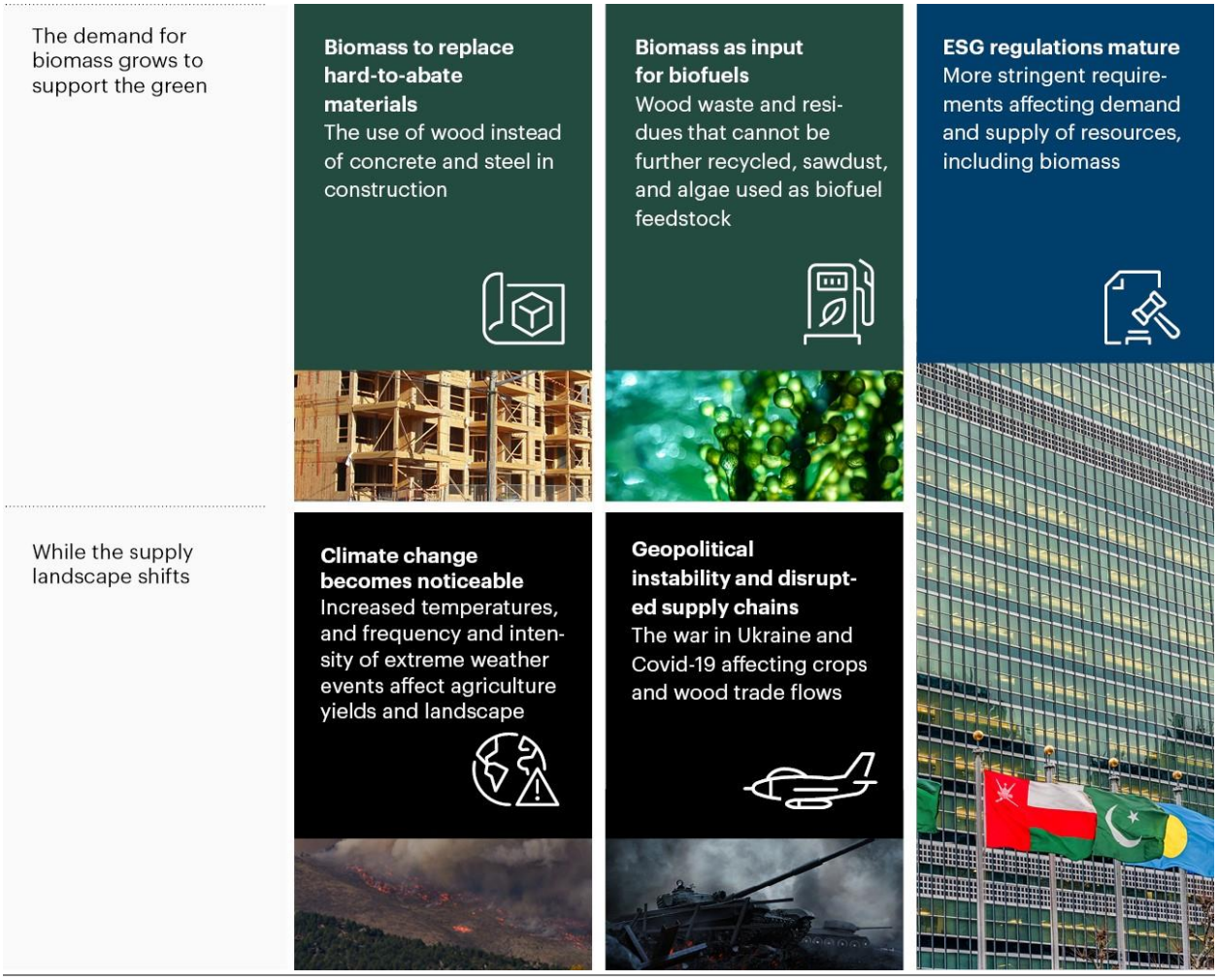
Increased costs or lost revenue due to unfavorable market dynamics for businesses not adapting fast enough.

Source: WWF (2015)

## The importance of biomass as a resource will continue to grow in the future

The demand for biomass continues to grow due to increasing consumption levels and its crucial role in the green transition. For example, the demand for wood is expected to rise as it is used as replacement for hard-to-abate materials like steel and concrete in the construction industry. However, while the demand for biomass grows, the supply landscape continues to shift, leading to increasing uncertainty surrounding future value chains. For example, climate change has resulted in more extreme weather events that have negatively impacted agriculture yields around the world. Moreover, geopolitical instabilities, such as the war in Ukraine and the Covid pandemic, have further destabilized supply chains. Given the dynamic nature of the market, both in terms of supply and demand, businesses need to proactively manage the role of biomass in their operations and anticipate the future evolution of biomass value chains.

**Exhibit 5: Key driving forces behind biomass demand and supply**



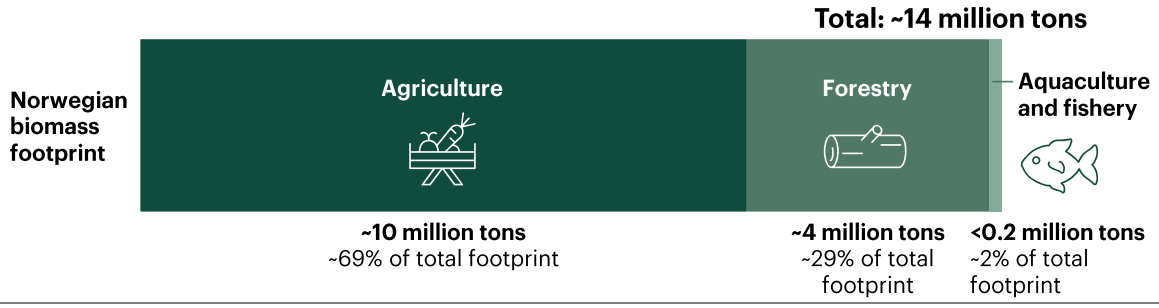

Source: Market participant interviews (2023), Market participant survey (2023)

## Norway's biomass footprint is over 14 million tons per year[15] - we need to consume, source, and extract biomass more efficiently

Norway's biomass footprint is composed of agriculture, forestry, and aquaculture/fisheries products. This report focuses on the agriculture and forestry value chains, which make up over 97% of the Norwegian biomass footprint. The standard way of measuring the biomass footprint considers the volume of resources needed to meet local consumption, including imports but excluding exports to avoid duplicating counts between countries[16]. The calculation considers the direct resources consumed, waste generated, and inefficiencies in the process. For example, it considers the amount of feed required to make one unit of meat. While Norway extracts a large volume of wild fish and aquaculture biomass (over 4 million tons), the national biomass footprint is limited because more than 95% of this extraction is exported[17]. The impact of marine biomass extraction on domestic marine ecosystems remains an important topic in Norway but falls outside the scope of this report.

[15] SSB (2021a)
[16] WWF (2022a)
[17] Norsk Sjømatråd (2023)

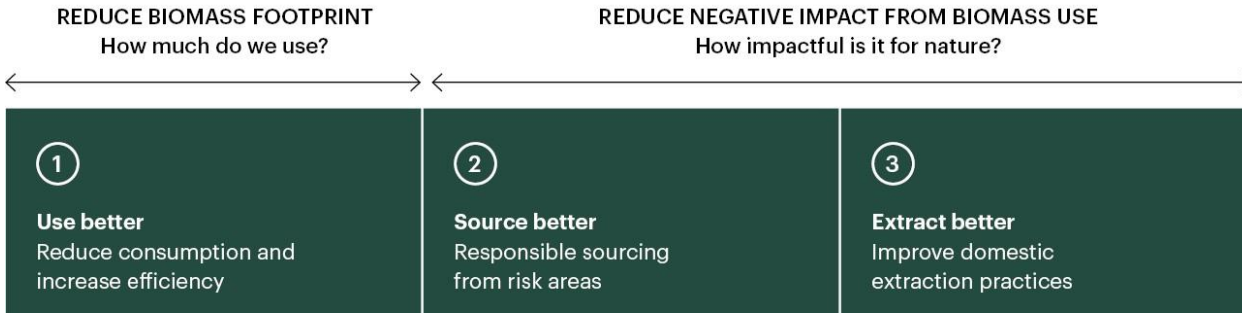
**Exhibit 6: Norwegian biomass footprint across different industries**




Note: It is assumed that ca. 70% of the statistical category 'products mainly from biomass' from SSB is products from the forestry value chain and ca. 30% is from the agriculture value chain. Aquaculture and fishery footprint based on annual Norwegian seafood consumption including waste and feed conversion ratio (kg of feed required to produce 1kg of seafood)
Source: SSB (2021a)

WWF estimates that Norway needs to reduce its biomass footprint by almost 50% by 2030 to be within the planetary boundaries[18]. Achieving a 50% reduction requires fundamentally rethinking how we extract, produce, and consume biomass. Norwegian businesses can lead this transformation. This report will introduce solutions that bring us closer to this goal, focusing on the levers that are ambitious and can make a difference, while also being achievable in the near-term. Specifically, we will consider three ways to use biomass resources more responsibly (exhibit 7).

**Exhibit 7: Three types of solutions are available for businesses**




- Consume less biomass intensive products
- Reduce waste
- Design products to maximize material efficiency
- Recycle waste and prioritize the most value-adding applications

- Diligence to map and manage nature impact from sourcing
- Supplier collaboration
- Certifications

- Improve harvesting practices to limit nature impact – from GHG emissions to biodiversity loss

While businesses have many levers available to them, effecting change is not easy – and relies on support from other actors to successfully implement the solutions at scale. This support includes cross-value chain facilitation (financial services, industry associations, pre-competitive collaboration, and market intermediaries), utilization of the latest technology, and assistance from non-economic actors (government policies, research, and certifications).

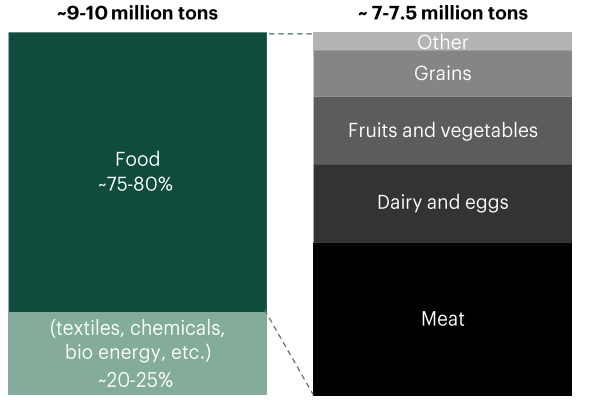
[18] WWF (2022a)

Chapter 2: Agriculture

# Transforming the food value chain

**Food makes up more than 50% of the Norwegian total biomass footprint. Therefore, the food industry plays an essential role in mitigating the negative impact from biomass use.**

**Exhibit 8: Norway's agriculture biomass footprint**




Note: Totals are based on SSB, but the split between food categories is based on FAO data. Includes waste from the full value chain. A feed conversion ratio is applied to find the biomass footprint, which is the amount (kg) of feed needed to produce one kg of food. Animal feed, pet food, and seafood are excluded.
Source: SSB (2021a), FAO (2023a)

Norway's agriculture biomass footprint is estimated to be 9-10 million tons, accounting for approximately 70% of Norway's biomass footprint[19]. Within the agricultural sector, the human food value chain is by far the largest contributor, accounting for over 7 million tons or about 50% of Norway's total biomass footprint (exhibit 8).

Agriculture products are also used in other industrial applications (e.g., textile, chemicals), but to a much lesser extent. While our focus is on the food industry, it is worth noting that there are opportunities to use biomass more responsibly in other agricultural applications. Norway's textile industry's contribution to the biomass footprint is small (less than 0.1 million tons), hence it is not focus of this report. Still, increasing circularity and moving away from fast fashion business models is crucial for the textile industry.

In this chapter, we recommend four prioritized solutions for the food industry: reducing food waste, limiting red meat consumption, mitigating the impact on biodiversity in the areas from which you source from, and making Norwegian farming less harmful for the environment and biodiversity. As the Norwegian food system is highly regulated, any change would require holistic government intervention on different levels, such as taxes, subsidies, control mechanics, standards, and research focus.

The following chapters provide detailed recommendations and outline the level of ambition that should be pursued. They also define the roles that different economic sectors should play in achieving these goals, identify key barriers for change, and propose strategies to overcome these barriers.

[19] SSB (2021a)

**Exhibit 9: Summary of key issues and recommendations for the Norwegian food industry**

| (1) USE BETTER | | (2) SOURCE BETTER | (3) EXTRACT BETTER |
|---|---|---|---|
|  |  |  |  |

## Key issues

### Large amount of food waste

- App. 0.45 M T of edible food waste per year, with >50% by consumers.
- Industries have agreed on a 50% reduction from 2015 level by 2030. Only a 10% reduction was achieved by 2020[20].
- Current progress primarily comes from reducing waste from own operations – most 'quick-wins' likely already done.

### Meat overconsumption

- Norwegians are consuming 55-60%[21] more red meat than the Nordic Nutrition Recommendations.
- Red meat has a significant biomass footprint and is a major contributor to GHG emissions.
- While other types of meat seem like alternatives, they rely on feed that could otherwise be consumed by humans.

### Food and feed sourcing from high-risk regions

- 40%[22] of the Norwegian human food supply is imported.
- App. 35%[23] of agriculture and app. 90%[24] of aquaculture feed is imported.
- Over 30%[25] of food and feed imports come from countries with biodiversity loss hotspots as defined by Conservation International[26].

### GHG emissions from cattle and farming impact on nature

- Ruminants contribute to app. 8% of Norway's Scope 1 GHG emissions[27], with cattle contributing the most.
- Norwegian cattle rely on grazing, which can be positive for biomass and biodiversity, but negative for GHG.
- Conventional farming practices lead to fertilizer and chemical pollution, soil erosion, loss of organic carbon, etc.

## Recommendations

### Reduce food waste by 50% by 2030

- Step up targets to reduce waste from own operations.
- Establish value chain cooperation to prevent food waste from farmer to retail.
- Address root causes of consumer waste (expiration date, etc.).

### Substitute 60% of red meat with fish and plant protein by 2035

- Promote the shift from red meat to seafood and plant-based proteins.
- Avoid substituting red meat with other white meats (e.g., poultry) produced in intensive industrial systems.
- Transition the food system to support new protein sources.

### Improve and adapt sourcing to limit biodiversity impact

- Increase the share of domestic sourcing.
- Run comprehensive due diligence on suppliers.
- Collaborate with international suppliers to help adapt farming practices.
- Adapt to climate change effects on supply chains.

### Lower GHG and apply regenerative agriculture

- Lower GHG emissions from cattle.
- Preserve grazing in livestock production.
- Introduce regenerative agriculture practices to improve soil health.

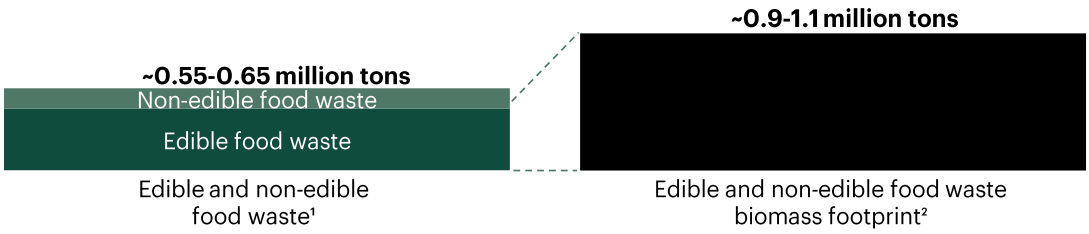
[20] Regjeringen (2021a): 50% reduction from 2015 baseline
[21] Nordic Council of Ministers (2023)
[22] FOASTAT (2021)
[23] Landbruksdirektoratet (2021)
[24] Aas et al. (2022)
[25] FAO (2023a)
[26] Conservation International (no date)
[27] Cicero (2020)

## Use better: Reduce waste

### Efforts to reduce waste in the food sector do not meet targets, proving the need for more drastic measures to achieve the ambition of a 50% reduction by 2030[28].

In 2020, **about 0.45 million tons of edible food waste** was generated in Norway from farm to consumer[29]. If including non-edible waste from food production, the combined waste amounts to **around 1 million tons of biomass, which represents 10-15% of the total Norwegian agriculture food biomass footprint**. This accounts for all raw materials, including the animal feed needed to produce wasted animal-based food.

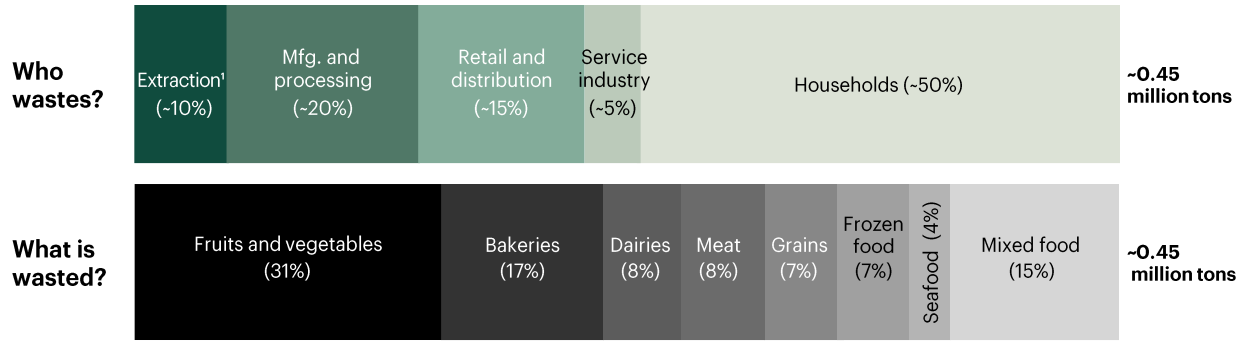
**Exhibit 10: Norwegian food waste (data from 2020, in million tons)**




Note: 1) Edible waste data based on Regjeringen, while non-edible waste data based on NORSUS. 2) Edible and non-edible food waste biomass footprint includes a feed conversion ratio to find the biomass footprint, which is the amount (kg) of feed needed to produce one kg of food.
Source: Regjeringen (2021), Landbruksdirektoratet (2021a), NORSUS (2021), Alexander et al. (2016)

Consumer waste is the single biggest contributor, accounting for nearly 50% of the total waste. However, food waste from manufacturing and processing, as well as distribution and retail, make significant contributions as well, accounting for app. 15-20% each. Perishable foods (fruits, vegetables, and bakery) are wasted the most.

**Exhibit 11: Reported edible food waste account from the Norwegian market (from 2021, in million tons)**



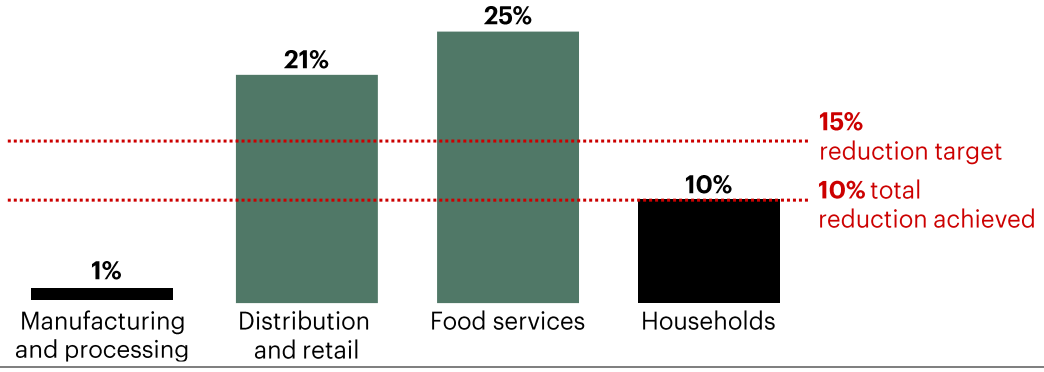

Note: Data includes waste generated after harvesting and slaughtering and excludes waste from seafood. Products for non-human purposes are excluded. Household waste includes food disposed of in mixed waste. Food services include restaurants, kiosks, canteens, and the public sector.
Source: Landbruksdirektoratet (2021), NORSUS (2021), SINTEF Ocean (n.d.)

In 2015, the food industry set a goal to reduce 50% of the food waste by 2030, in line with *Bransjeavtalen for reduksjon av Matsvinn*[30], with sub-goals of 15% by 2020. However, only a 10% reduction was achieved by the full food value chain between 2015 and 2020. Manufacturers and processers (such as dairy cooperatives, chocolate manufacturers, meal producers, etc.) saw the least reduction. Part of this might be driven by the

[28] Regjeringen (2021a), 50% reduction from 2015 baseline
[29] Regjeringen (2021a)
[30] Regjeringen (2021a)

increased production volumes and unpredictable demand caused by the Covid pandemic[31]. Despite this, some producers have surpassed the waste sub-goals. For instance, Tine reduced its waste by 37% from 2015-2022[32].

**Exhibit 12: Reported waste reduction across the Norwegian food value chain (data from 2015 to 2020, in %)**

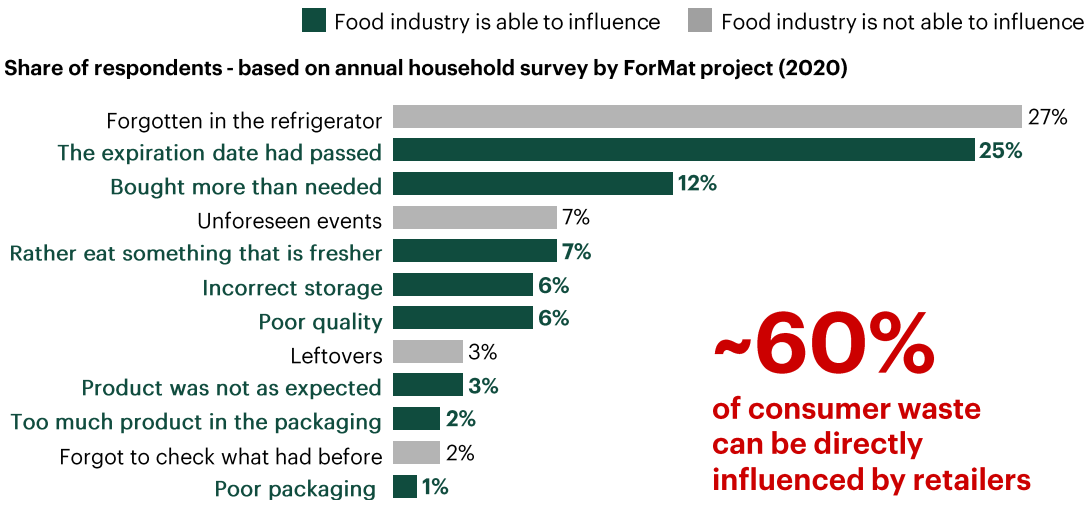



Note: Waste reduction is measured per capita. The primary sector (e.g., farmers) did not report waste prior to 2020. Therefore, there is no benchmark and it is excluded from the data. Waste reduction in food services is likely overstated due to Covid limiting business activity.
Source: Regjeringen (2021)

The goal of reducing food waste per capita by 50% from 2015 to 2030 is equivalent to a reduction of up to **0.5 million tons of biomass footprint.** This calculation considers both non-edible waste and the feed required to grow animals to produce animal-based food waste (e.g., meat, dairy, eggs)[33]**.** Achieving this target will require major waste reductions at every value chain step and collaborative efforts across the value chain. It is particular important to minimize waste of animal proteins (e.g., meat, fish), since they are more biomass-intensive.

Given that half of food waste is created at the consumption step, it is critical for the food industry to find solutions that address consumer waste. The causes for such waste are related to product design, packaging, promotions ('3 for 2' deals), and expiration dates. The food industry can influence these product features.

**Exhibit 13: Reasons behind Norwegian consumer food waste from household survey conducted in 2020**




Source: NORSUS (2021)

[31] Regjeringen (2021a)
[32] Tine (2023a)
[33] Regjeringen (2021a): 50% per capita reduction of edible and inedible waste from 2015-2030, accounting for pop. growth

A lot has already been done to reduce food waste, and many of the 'quick-win' solutions have likely already been explored. Moving forward, companies must implement more measures to reach their waste reduction goals. Exhibit 14 outlines the roles that businesses can play and offers specific solutions for them to consider.

**Exhibit 14: Roles to play to reduce food waste**

*Role to play:* Big Small

| FARMERS | MANUFACTURING AND PROCESSING | DISTRIBUTION AND RETAIL | FOOD SERVICES |
|---|---|---|---|
|  |  |  |  |
| **App. 25 K T GAP TO REACH WASTE TARGET**<br>**OWN WASTE:**<br>• Improve farming techniques for better harvest quality, reducing waste (e.g., chicken breeding).<br>• Limit overproduction via better forecasting and coordination across value chain (especially for meat).<br>• Minimize waste caused by unexpected events (e.g., power outage in barn) by improving processes and infrastructure.<br>• Enhance handling skills for fruits and vegetables (e.g., when one berry has mold, the entire package must be discarded). | **App. 45 K T GAP TO REACH WASTE TARGET**<br>**OWN WASTE:**<br>• Enhance production methods (e.g., burns, spills).<br>• Enhance cross-utilization of raw food ingredients across product portfolio and donate leftover food to food centrals.<br>**CONSUMER WASTE:**<br>• Adapt product design based on consumer analytics (e.g., portion size, packaging).<br>• Increase consumer awareness through labelling and marketing (e.g., "best before, often good after," leftover recipes, waste awareness campaigns).<br>• Extend expiry dates (e.g., milk expiry date has increased from 16 to up to 22 days). | **App. 30 K T GAP TO REACH WASTE TARGET**<br>**OWN WASTE:**<br>• Limit waste of food due to expiration through better in-store tracking (e.g., 2D-code).<br>• Re-purpose leftover/ unaesthetic food (e.g., discounts, own food line, charity giveaway).<br>• Prioritize sourcing fruits and vegetables with a longer shelf life.<br>**CONSUMER WASTE:**<br>• Eliminate promotions that lead to over-stocking of perishable food (e.g., '3 for 2' deals).<br>• Consumer campaigns to prevent waste (e.g., left-over recipes, labelling, marketing).<br>• Support waste-reducing consumer tech (e.g., smart-fridge to avoid unnecessary purchases). | **App. 10 K T GAP TO REACH WASTE TARGET**<br>**OWN WASTE:**<br>• Limit overproduction through better consumption forecasting (e.g., through software).<br>• Re-purpose leftovers or unaesthetic food (e.g., discounts, own food line, charity giveaway).<br>**CONSUMER WASTE:**<br>• Optimize portion sizes to prevent waste. |

**Actions that are relevant across the entire food value chain include:**

- Advocating for improved policy measures and stricter regulations in the food sector to create a level playing field, holding companies and value chain steps accountable for reduction responsibilities (e.g., new food waste law).
- Enhancing cooperation throughout the value chain to improve forecasting and product flow, ensuring market alignment between harvest volumes, food production, and demand from retailers.
- Whenever possible, promote increased consumption of frozen food and fresh produce with longer shelf life.
- Utilize more raw food materials and lower aesthetic standards throughout the value chain.
- Enhance packaging of food products to prolong shelf life and minimize damage due to poor handling (e.g., all strawberries need to be thrown if one berry in a box has mold). *(Note: tradeoffs with increased use of plastic need to be considered to ensure a net positive nature impact).*

Industries and policymakers are aligned on the ambitious target to reduce food waste. However, several barriers stand in the way. Exhibit 15 outlines the most significant challenges and how to overcome them.

**Exhibit 15: Overview of key barriers to reduce food waste and how to overcome them**

| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **Half of food waste is generated by consumers:** It is inherently challenging to influence individual consumer behaviors. | **Public campaigns:** Educate consumers through government campaigns to create waste awareness (limit over-shopping, etc.).<br>**New policies:** Improve clarity of root causes to waste, including quantification of levers, to develop waste reduction action plan (based on findings from *"Bransjeavtalen"*). |
| **Waste generation throughout the value chain is interconnected and hard to track:** Choices made at one stage may cause waste in other stages (e.g., if a retailer gives late notice to change the order volume from a farmer, it can lead to the waste of the harvest). | **New technology:** New technology can enhance visibility on food volumes, both upstream and downstream, improving accuracy of forecasting and enabling quicker decision-making in response to demand (e.g., 2D coding, forecasting tools, and food tracing).<br>**Pre-competitive collaboration:** Standardized systems or technologies help enhance visibility across the supply chain and facilitate more effective communication among stakeholders (e.g., implementing the same ERP system enables visibility upstream up to the farmer). |
| **Reducing food waste can be at odds with food safety:** For example, stringent quality requirements for donations hinder the repurposing of consumable food (e.g., if a strawberry package has just one berry with mold, the entire package often needs to be discarded). | **Policy advocacy:** Adjust Norwegian and EU policies where possible without compromising on food safety (e.g., Norwegian eggs have a longer shelf life than EU regulations permit).<br>**New technology:** Implement technology for better real-time information on food conditions (e.g., the "Keep-it" indicator that monitors temperature and shows the remaining shelf life of a product). |
| **Some foods are inherently highly perishable:** Fruits and vegetables and dairy products have short expiration dates, making it more challenging to prevent waste. | **New technology:** Facilitate improved manufacturing processes to prolong the lifetime of food products (e.g., Tine has increased milk expiration from 14 to 22 days[34]).<br>**Pre-competitive collaboration:** Collaboration between grocery retailers to sell edible products with lower aesthetic standards (within the limits of competition legislation).<br>**Market intermediaries:** Promote increased utilization of surplus food (e.g., Too Good to Go, charities). |
| **Significant cost of waste reduction solutions:** The investment cost required to reduce waste hinders implementation. | **New policy:** Introduce subsidies to incentivize waste reduction or increase the cost of waste generation.<br>**New technology:** Scale innovation to reduce production losses (e.g., Völur), enhance forecasting and supply chain predictions (e.g., Savvie), and leverage other production technologies. |

[34] Tine (2023b)


**CASE EXAMPLE: Reducing waste with 2D codes in grocery stores**

NorgesGruppen has started rolling out 2D codes on a selection of meat, fish, and fast-food products, with plans to extend to more items. They are the first retailer in the Nordics to use this technology[35].

Using 2D codes allows for the registration of a product's expiration date, batch lot number, and sustainability-related information in the barcode. This provides the store with a digital overview of products, locations, and expiration dates, which makes it easier to reduce food waste. It helps optimize sourcing and enables easier price adjustments on products nearing expiration. During a test period at MENY, a NorgesGruppen chain, in-store food waste was reduced by 18% for items with the new code[36].

2D codes also have the potential to reduce household waste in the future. Consumers can scan product information from the same code using their mobile phones. This makes it possible for consumers to receive notifications about products that are nearing their expiration dates in the refrigerator.

GS1, the global barcode organization, aims to implement 2D codes as a global standard by 2027[37]. 2D codes are one example of a standardized technology that can unlock significant progress in reducing food waste across the value chain.

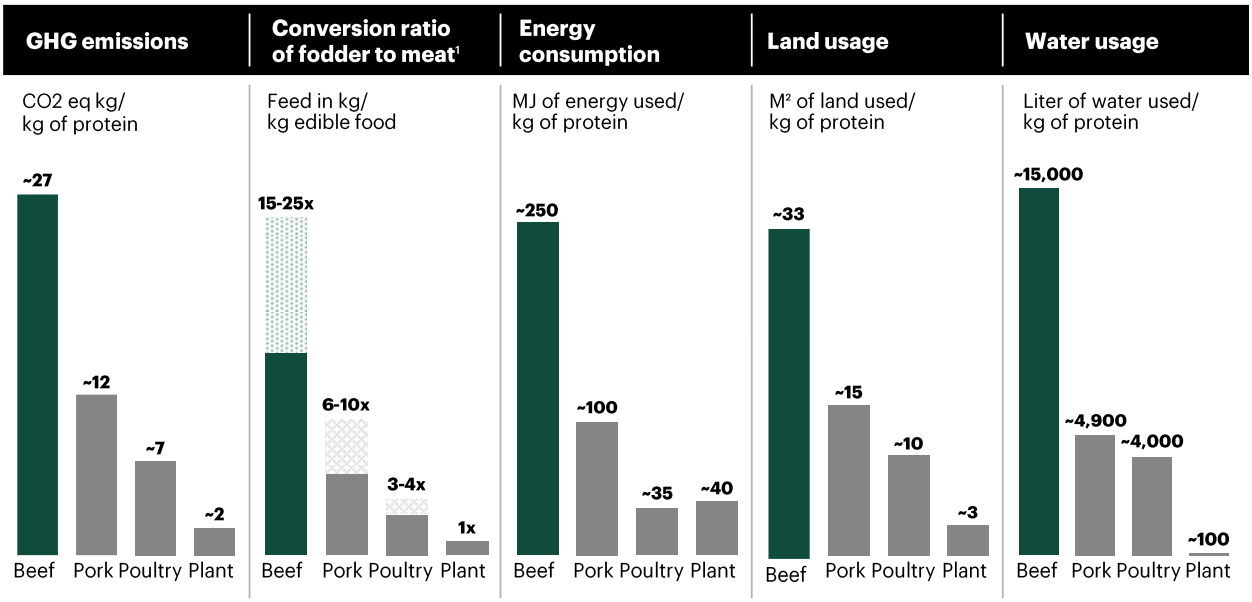
[35] E24 (2023)
[36] Meny (2023)
[37] GS1 (2023)

## Use better: Meat overconsumption

### The food industry needs to facilitate the reduction of meat consumption in Norway, with a particular focus on red meat. This will significantly reduce GHG emissions and the overall biomass footprint of the Norwegian food system.

Different protein sources have varying impacts on nature. These impacts are influenced by factors such as local conditions, animal raising practices, and agricultural methods. However, when evaluating the environmental aspects of protein alternatives, red meat clearly stands out as the most environmentally demanding protein source. Beef, lamb, and pork are all defined as red meat[38]. For instance, Miljødirektoratet has identified the reduction of red meat consumption as one of the most effective ways to achieve an 80% reduction in GHG emissions by 2035[39]. Livestock and feed production contribute to approximately 8% of Norway's direct GHG emissions[40], and they also place a significant strain on a range of environmental resources (exhibit 16).

**Exhibit 16: Sustainability assessment of selected protein types by global average**




Note: "Conversion ratio of fodder to meat" is a feed conversion ratio that is applied to find the biomass footprint, which is the amount (kg) of feed needed to produce one kg of food. Data is based on global estimates and are not specific to Norwegian production.
Source: Heller & Keoleian (2018), Environ. Sci. Technol. (2011), the University of Cambridge (2019), Environmental Working Group (no date), Alexander et al. (2016)

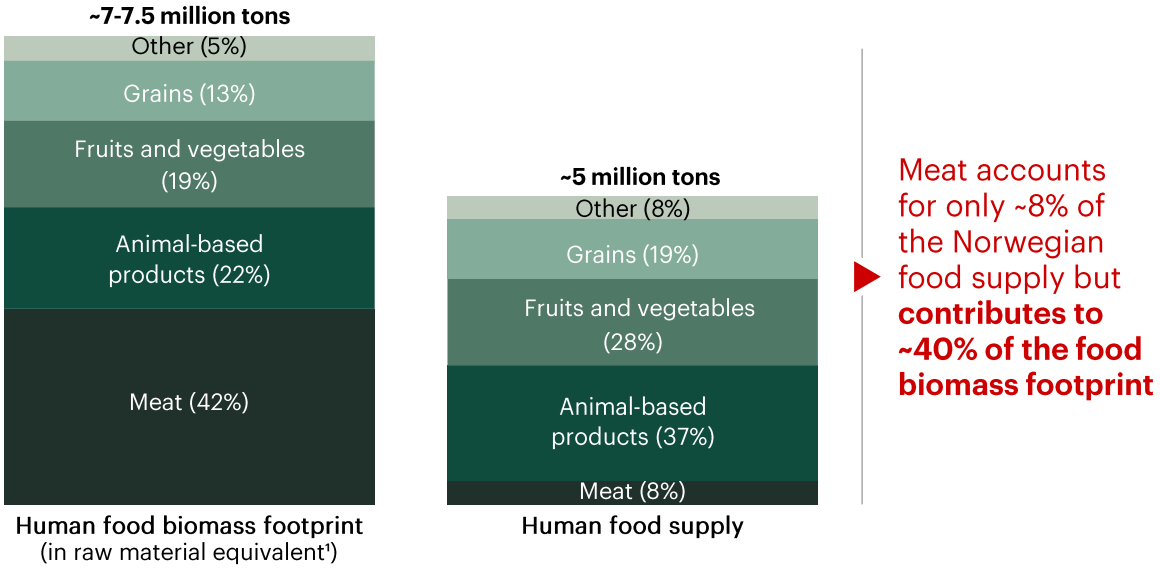
The consumption of food products that are inherently inefficient – where a significant part of the nutrients is lost in the conversion from food that could be consumed directly by humans to animal food – needs to be minimized. When considering this aspect, it is important to note that animal feed sources have varying environmental impacts. For example, 55-60% of cattle feed in Norway comes from grass, hay, and straw[41] (grovfôr). This animal diet efficiently converts non-edible biomass into human food. However, it is at the expense of more extensive land use and higher methane emissions. In contrast, Norwegian pig and chicken production relies on concentrated feed (kraftfôr)[42], which can often be consumed directly by humans, making it less efficient compared to cattle grazing. However, chicken and pig production demand less land use and

[38] Nordic Council of Ministers (2023)
[39] Miljødirektoratet (2023b)
[40] Cicero (2019)
[41] Animalia (2020)
[42] Animalia (2020)

have lower emissions compared to cattle. This complexity highlights the importance of taking a holistic approach when comparing the environmental impact of different protein sources.

Therefore, in addition to promoting a shift from red meat to alternative proteins, it is important for the Norwegian food system to prioritize utilizing feed ingredients that are not suitable for direct human consumption. This includes utilizing non-edible crops for concentrated feed and making use of available cultivated land and biomass that cannot be used for direct human food – such as grass – which also helps preserve cultural landscapes.

**Exhibit 17: Norwegian human food supply and food biomass footprint by category**




Note: A feed conversion ratio is applied to find the biomass footprint, which is the amount (kg) of feed needed to produce one kg of food. Waste generated to produce the finished food product is included. Animal feed (barley, wheat, soy, etc.), seafood, and pet food are excluded.
Source: FAO (2023a), SSB (2021), Alexander et al. (2016)

In 2021, Norway's meat supply was 0.35-0.4 million tons, including waste, with approximately 0.25 million tons being red meat. The Nordic Nutrition Recommendations suggest replacing 55-60%[43] of red meat consumption with fish or plant-based protein. White meat (poultry and turkey) should not be considered a direct nutritional substitute for red meat, as emphasized by the Nordic Nutrition Guidelines[44]. Shifting 55-60% of red meat consumption to plant-based proteins can reduce Norway's total biomass footprint by up to **1.2 million tons**, which is equivalent to **15-20% of the total food biomass footprint**[45,46,47].

[43] Nordic Council of Ministers (2023)
[44] Nordic Council of Ministers (2023)
[45] FAO (2023a)
[46] Alexander et al. (2016)
[47] USDA (2023): to take into account calory difference per kg between red meat and plant-based

Implementing changes in Norway's food system will require significant interventions by the government. Recent estimates show that approximately 94% of all agricultural subsidies are directed towards meat or other animal-based products[48]. Red meat products receive a significantly higher proportion of the production value from subsidies compared to other protein sources, resulting in lower consumer prices and increased consumption of red meat. The production value represents the combined income that farmers receive from product sales and subsidies.

Subsidies contribute to approximately 75% of sheep and lamb production value and 55-60% of cattle production value. In contrast, only 5% of subsidies are allocated to tomatoes and cucumbers[49]. Consequently, there is a need to adjust financial mechanisms like subsidies and taxation to incentivize a reduction in red meat production and consumption in favor of plant-based diets. Retailers can – and should – also encourage this shift through their in-store shelf pricing strategy.

Reducing subsidies to support red meat production will have major implications for the livelihoods of Norwegian farmers. According to Menon Economics, a projected 45% reduction in red meat consumption by 2027 could result in over 10 billion NOK in lost farmer income compared to the 2017 baseline[50]. Therefore, stakeholders across the food value chain and policymakers must support farmers in transitioning to alternative plant-based production. Estimates show that it is possible to significantly increase the local production of plant-based foods while meeting the requirements for energy, protein, and fat for Norway's population[51].

It is also critical that the red meat produced is mainly used as human food, that all edible animal parts are utilized to their maximum potential, and that waste is minimized. Currently, over 10,000 tons of meat is in cold storage[52], which is at risk of ending up as waste. Farmers and cooperatives must minimize overproduction in order to avoid this.

[48] Centre for Applied Research at NNH (2020)
[49] Centre for Applied Research at NNH (2020)
[50] Menon Economics (2019)
[51] Among others, NIBIO (2023a)
[52] Nortura Reguleringslager (2023)

The entire food value chain has a role to play in leading the transition of the Norwegian food system in line with nutritional and environmental recommendations (exhibit 18).

**Exhibit 18: Roles to play to reduce meat overconsumption**

*Role to play:* Big Small

| FARMERS | MANUFACTURING AND PROCESSING | DISTRIBUTION AND RETAIL | FOOD SERVICES AND OTHER BUSINESSES |
|---|---|---|---|
|  |  |  |  |
| • Transition from red meat production (sheep, lamb, cattle) to plant-based proteins (e.g., switching from concentrated feed crops to edible crops or other protein-rich plants).<br>• Avoid overproduction of meat. | • Develop alternative proteins products that are competitive in price and quality with red meat (e.g., pea-based, whole fungal).<br>• Continue to improve sales and operations planning to prevent overproduction of meat.<br>• Design food products and use new technology to utilize more of the animal carcass (e.g., improved cutting techniques, utilizing lungs in sausages etc.).<br>• Incentivize and support farmers in transitioning to alternative protein farming. | • Impact consumers by promoting sales of alternative proteins via in-store campaigns and shelf positioning.<br>• Stop the promotion of red meat ('3 for 2' deals, shelfing, discounts, etc.)<br>• Urge manufacturers to offer a broader selection and improve the quality of alternative proteins.<br>• Incentivize and support farmers in transitioning to alternative protein farming.<br>• Advocate for manufacturers to enhance the utilization of animal carcasses (e.g., utilize more edible parts and not just prime cuts). | • Companies should reduce the amount of red meat served to employees in line with Nordic guidelines (company canteens, schools, other public institutions).<br>• Stop red meat servings as part of the business offering (e.g., on flights).<br>• Restaurants should increase the variety and quality of alternative protein food options. |

Reducing red meat consumption is not easy and requires a major transformation of the Norwegian food system. This entails changing consumers' fundamental nutritional preferences and changing a fragmented landscape of farmers. Exhibit 19 highlights industry barriers and solutions.

**Exhibit 19: Overview of key barriers to reduce red meat overconsumption and how to overcome them**

| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **The livelihood of Norwegian farmers is dependent on the demand for red meat:** It will require a fundamental transition to different sources of income. The small scale of Norwegian farms makes it harder for them to make this transition. | **New policy:** Large-scale government program should create pathways for red meat farmers to transition to other economic activities, including protein-rich plants (e.g., beans).<br><br>**Financial services:** Financial institutions should support the transition through tailored financing solutions (e.g., loans with terms connected to the transition targets). |
| **Plant-based alternatives have not yet reached sufficient levels of taste and affordability:** Many consumers are currently not willing to substitute red meat for other protein-based alternatives. | **Future innovations:** Lab-grown meat, which can replicate red meat characteristics as full pieces, offers a promising alternative.<br><br>**Public campaigns:** Media, NGOs, and influential people to promote competitive alternatives like tofu or bean-based burgers and educate consumers on how to access them.<br><br>**New policies:** Adapt financial tools like subsidies or taxes to incentivize lower production and consumption of red meat in favor of fish or plant-based diets (e.g., lower subsidies lead to higher consumer prices and consequently lower consumption). In addition, improve the affordability of plant-based alternatives through subsidies or VAT exemption. |
| **Current incentives contribute to promoting red meat consumption:** Consumers are not sufficiently informed about the health and sustainability benefits of reducing meat intake in favor of other protein alternatives. | **Public campaigns:** Public health institutions (e.g., HelseNorge), NGOs, and influential people should promote seafood and plant-based alternatives and educate consumers on the health and environmental impacts of red meat overconsumption.<br><br>**New policies:** Redirect funds allocated from the "Information office for eggs and meat" to the "Information office for fruits and vegetables". |
| **Meat production generates by-products:** By-products have limited demand from the human food industry, despite their potential for human consumption. | **New technology:** New applications for non-edible meat parts (e.g., chemicals, biofuel) and improved production processes that increase carcass utilization (e.g., new cutting technologies).<br><br>**Public campaigns:** Manufacturers and retailers should introduce and promote products to consumers that make use of edible by-products (e.g., increase the use of internal organs and blood as ingredients in other food products rather than just using prime cuts from cattle[53]). |

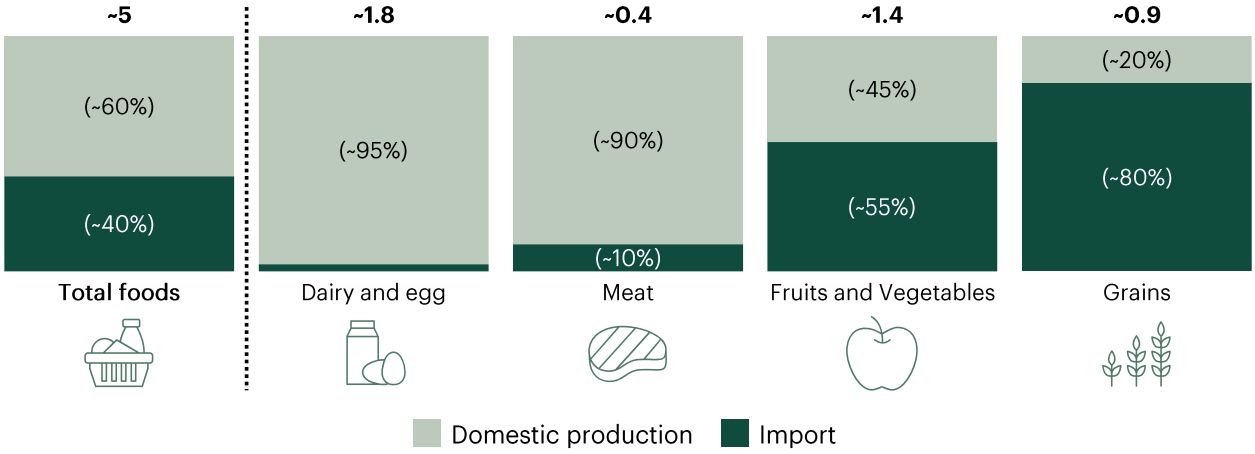
[53] Nofima (2021)

## Source better

### Increased transparency is critical for responsible sourcing. The food industry needs to overcome complex supply chains and a lack of data to improve and adapt sourcing practices to limit the environmental impact.

Approximately 40% of Norway's human food supply is imported[54], which underlines the importance of responsible sourcing. Although the majority of meat and other animal-based products are produced locally, Norway is heavily reliant on imported feed for livestock production and fish farming.

**Exhibit 20: Norwegian human food supply by source (data from 2021)**

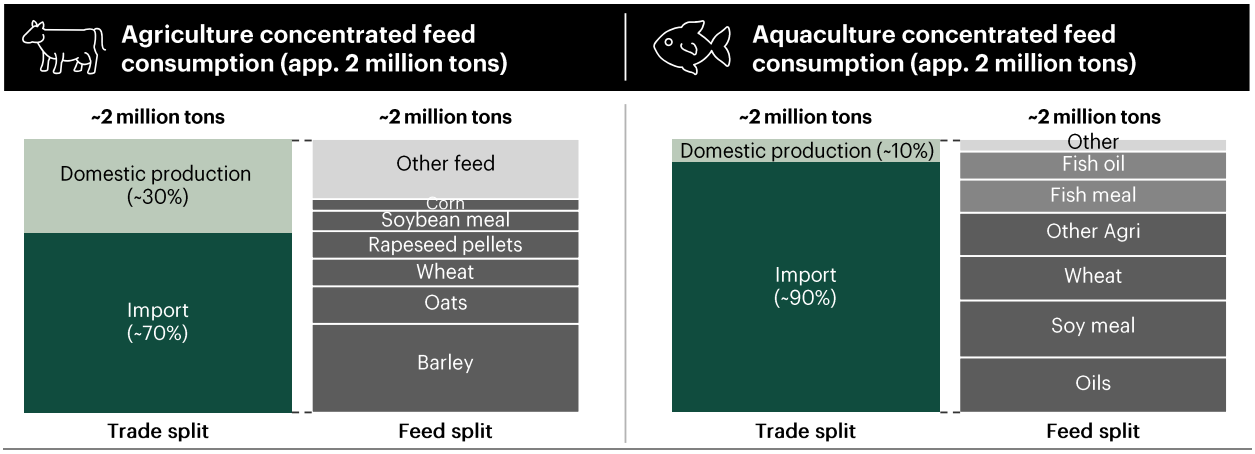



Note: The above data includes estimated waste from raw material to finished goods. Seafood, animal feed, and other non-food applications are excluded.
Source: FAO (2023a)

In 2021, Norway used approximately 4 million tons of concentrated feed[55,56] (exhibit 21). Around 65% of agricultural and 90% of aquacultural concentrated feed were imported. Soybeans and soy concentrate serve as a critical protein supplement for both sectors. Of this soy, 50% is imported from Brazil where soy farming is responsible for rainforest conversion and contributes to deforestation[57]. Most of Norwegian soy import is certified as deforestation-free. However, certification schemes are not always adequate, and the increased overall consumption of soy may create additional pressure on deforestation-linked soybean cultivation.

[54] FAO (2023a)
[55] Landbruksdirektoratet (2023)
[56] Fiskeridirektoratet (2023)
[57] Conservation international (no date)

**Exhibit 21: Norwegian agriculture and aquaculture feed split by source and ingredient (data from 2021)**




Note: Agriculture feed mix excludes grazing. Total volumes based on data from Landbruksdirektoratet and Fiskeridirektoratet. Feed split based on data from Landbruksdirektoratet and Aas et al.
Source: Landbruksdirektoratet (2023), Fiskeridirektoratet (2023), Aas et al. (2022)

Assessing foreign suppliers can be challenging due to limited transparency in global supply chains. Norwegian food companies need to conduct thorough due diligence of imported food and feed. International agricultural suppliers vary in farming practices and reporting standards, making it harder to ensure supplier accountability. Examples of problematic import categories include soybeans, banana, coffee, and rice[58].

Companies must map potential nature and social risks associated with their supply chain activities. Several frameworks exist to identify risks based on sourcing regions (exhibit 22). For example, applying Conservation International's framework, 30% of Norway's food and feed imports originate from countries with biodiversity loss areas[59,60]. The different schemes often focus on different risks and scales, as well as strengths and weaknesses. The best screening includes a variety of analyses. This due diligence should not be limited to products with well-known sourcing challenges (soy, palm oil, etc.) but also encompass high-volume items that are more difficult to trace (wheat, tomato, etc.).

**Exhibit 22: Examples of frameworks to help filter high-risk sourcing regions**

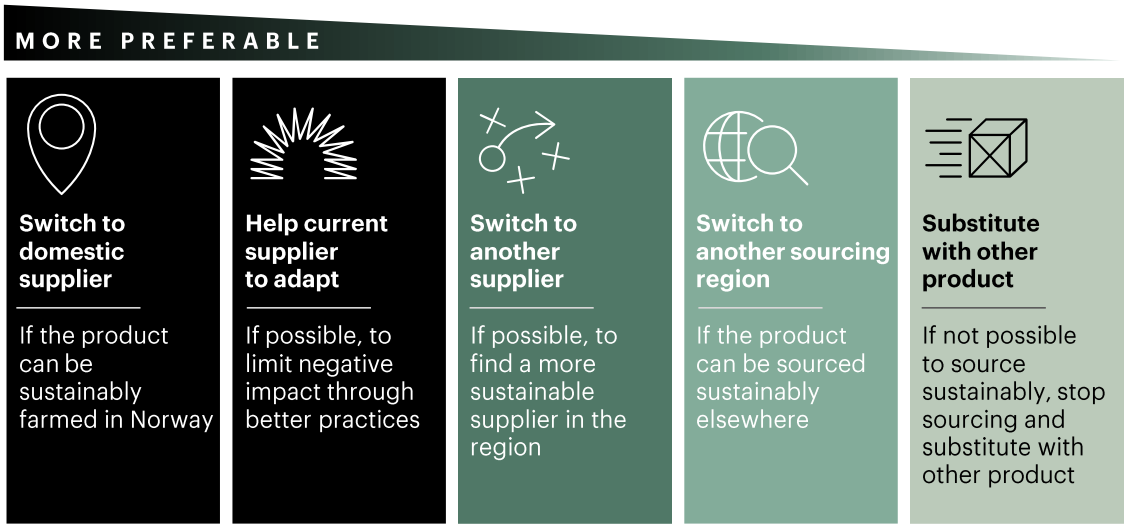
| Conservation International | WWF`s risk filter for biodiversity | High conservation value (HCV areas) | IUCN`s protected areas |
|---|---|---|---|
| Areas particularly important for **biodiversity** and **biodiversity loss** | Areas vulnerable to **biodiversity loss** | Areas vulnerable to future **destructive raw material production** | Areas that are crucial for **biodiversity and unique ecosystems** |
| Must have at least **1,500 vascular plants as endemic and 30% or less** of its original natural vegetation | Tool for companies and investors, **coverage depends on the industry, sector, and region** | It **covers 15% of the Earth's land surface** and 7% of the oceans | It is planned to **cover 30% of the Earth's surface** by 2030 |

Source: Conservation International (no date), WWF (no date), HCA (no date), IUCN (no date)

[58] FAO (2023a)
[59] FAO (2023a)
[60] Conservation international (no date)

As an additional step, companies should incorporate measures to manage the identified sourcing issues. Companies have several alternatives to this (exhibit 23). For products that can be produced in Norway with limited environmental impact, local sourcing is often preferred. This helps to reduce transport emissions, provides more control over a simpler supply chain, and supports domestic food security. Cucumbers, for example, are almost entirely sourced from within Norway[61]. Norwegian policymakers also have a role to play in incentivizing local production. However, most food import categories cannot be grown in the Norwegian climate. In these cases, collaboration with suppliers is the preferred approach for managing environmental sourcing challenges. Companies can offer financial support and share knowledge to help suppliers adapt their farming methods (e.g., by introducing regenerative agriculture).

**Exhibit 23: Options for companies to mitigate sourcing risk**




Note: The preferred options are ranked from left to right based on interviews with market participants, where the most preferred is to the left.
Source: Market participant interviews (N=8)

As climate change disrupts existing food supply chains, causing rising temperatures and more frequent and extreme weather events, the supplier landscape will undergo a significant transformation. Norwegian companies will need to explore alternative suppliers in new regions to maintain the availability of imported food assortment throughout the year. Collaborating with new, less familiar import regions and more complex supply chains will make it even more important to perform thorough due diligence of suppliers. This change could potentially lead to increased product prices since fewer regions become attractive for import or new regions prove to be less optimal. Consequently, Norwegian companies and consumers should be prepared for a greater reliance on seasonal and locally sourced products.

[61] Nationen (2023)

Stakeholders within each step of the value chain have a role to play in ensuring responsible sourcing. Distributors play a key role, but also retailers have a direct influence on what and from where distributors should source their products. Exhibit 24 highlights specific roles to play in each step of the value chain.

**Exhibit 24: Roles to play to ensure responsible sourcing**

***Role to play:*** Big Small

| FARMERS | MANUFACTURING AND PROCESSING | DISTRIBUTION | FOOD RETAIL |
|---|---|---|---|
|  |  |  |  |
| • Expand range of fruits and vegetables produced in Norway.<br>• Encourage and incentivize feed suppliers to source feed ingredients responsibly. | • Shift to local sourcing for products that can be farmed sustainably in Norway.<br>• Conduct due diligence on active suppliers to identify and manage environmental issues related to sourcing.<br>• Collaborate with international suppliers whenever possible to support them in adopting agriculture practices that improve nature outcomes (e.g., introduce regenerative agriculture).<br>• Use bargaining power to demand responsible sourcing from distributors.<br>• Refrain from importing from producers who are unable or unwilling to produce sustainably.<br>• Ensure sourcing from certified suppliers (e.g., lifecycle assessment, SBTI[62], other third-party sustainability assessments). | • Promote sustainably sourced products to consumers and rebalance prices across the product portfolio to absorb any additional costs (e.g., deforestation-free labelling).<br>• Impact suppliers by demanding visibility into upstream value chains, especially for imports (e.g., certification, lifecycle assessment, SBTI, other third-party sustainability assessments).<br>• Promote consumption of seasonal goods (e.g., through discounts, separate shelf placement).<br>• Increase value chain control through backwards integration (e.g., private label).<br>• Refrain from selling imported products if the producer is unable or unwilling to produce sustainably. |

[62] Science Based Targets initiative, SBTI (no date)

There are several barriers that make it challenging for Norwegian companies to ensure responsible sourcing. Exhibit 25 indicates these key barriers and how they can be addressed.

**Exhibit 25: Overview of key barriers for responsible sourcing and how to overcome them**

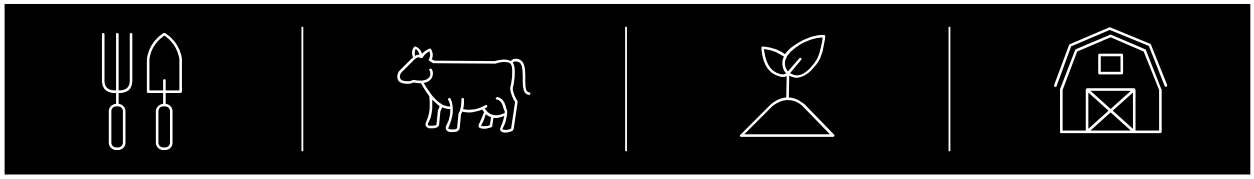
| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **Lack of standardized data and reporting:** Particularly prevalent in less developed economies where imports often originate. | **New policies:** Additional local, regional, or international regulations to ensure responsible sourcing (e.g., EU's CDSRD, Åpenhetsloven). These policies require companies to obtain data from their international suppliers in order to comply with reporting requirements, leading to increased supply chain transparency.<br><br>**Certifications:** Credible certifications and environmental assessments facilitate better decision-making and supplier comparisons (e.g., deforestation-free, SBTI, EcoVadis).<br><br>**New technology:** Solutions that improve traceability in the food value chain, enabling all participants to access accurate, up-to-date product information, including its origin and harvesting processes (e.g., tracing codes, ERP system, blockchain). |
| **Long and fragmented import supply chains:** The Norwegian food sector is often reliant on multiple importers with long and complex value chains, making responsible sourcing more challenging. | **New policies:** Incentives to boost local production of traditionally imported goods that can be farmed locally in a sustainable way (e.g., increased subsidies for tomatoes to lower retail prices).<br><br>**Pre-competitive collaboration:** Value chain collaboration between retailer and distributor to encourage consumer preference for seasonal products (e.g., promote Norwegian fruits and vegetables in stores during their respective seasons).<br><br>**Public campaigns:** Non-commercial organizations should persist in highlighting and raising awareness about the adverse environmental impact of food imports. |

## Extract better: Cattle GHG emissions and farming impact on land

### Norway should limit the ecological impact of local farming practices by lowering cattle GHG emissions to approach European best practices and selectively implement favourable regenerative agriculture principles.

Norwegian agriculture mainly revolves around livestock production, which is shaped by limited arable land, climate, and geographical landscape (exhibit 26). As outlined in the previous section on excessive meat consumption, the Norwegian food system needs to be rebalanced in order to decrease red meat consumption, optimize biomass resources and land use, and adhere to health guidelines while minimizing the biomass footprint. This chapter will specifically address limiting the environmental consequences of the remaining red meat production. The chapter will also explore the application of regenerative practices to further mitigate the environmental impact from Norwegian farming.

**Exhibit 26: Key facts about the Norwegian agriculture system**



| Only **~3%** of Norway's land area is currently **cultivated**[1] | **~90%** of cultivated land is used for **grazing and animal feed** | **~30%** of cultivated land is suitable for **growing food grains and vegetables** | Norwegian farmers are on average **small scale** |
|---|---|---|---|

Note: Cultivated land includes areas used for growing plants or raising animals for food production.
Sources: SSB (2021), Regjeringen (2021b), Matforhelsen (no date)

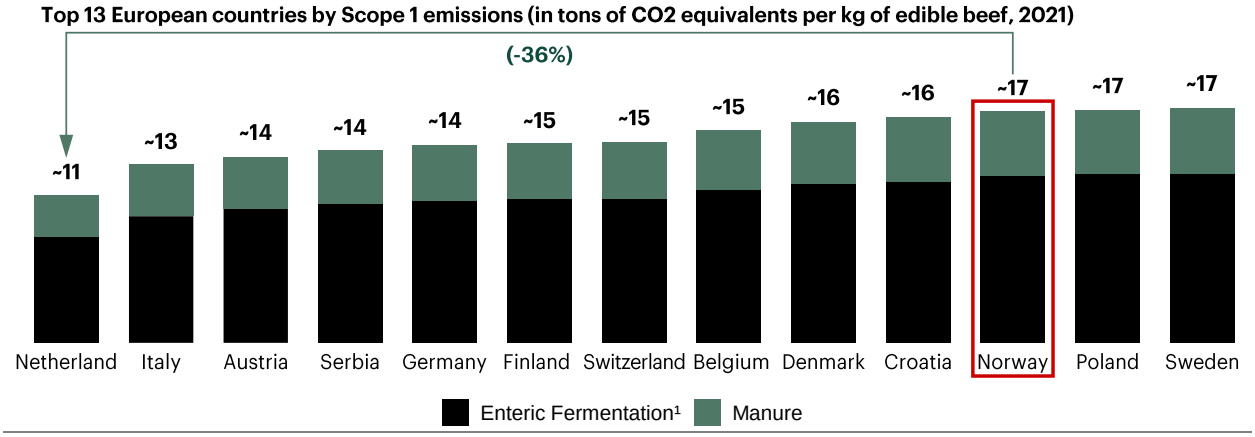
### Lowering cattle greenhouse gas emissions

Most meat (app. 95%) and dairy products (app. 90%) consumed in Norway are produced locally[63]. Ruminants account for roughly 90%[64] of agricultural and 7.5%[65] of Norway's total scope 1 direct GHG emissions, with cattle being the largest contributor and therefore the focus of this chapter. Scope 1 emissions for cattle production encompass those from enteric fermentation and manure management.

Norway's cattle production exhibits higher direct emissions per kilogram of meat compared to several European countries, with Dutch cattle production having almost 40% lower scope 1 emissions[66]. However, there are structural differences between Norwegian and Dutch cattle production, with the Norwegian production being more industrialized and more reliant on concentrated feed. These differences explain some of the variation in emissions.

[63] FAO (2023a)
[64] Cicero (2019)
[65] Miljødirektoratet (2023c)
[66] FAO (2023a)

**Exhibit 27: Norwegian non-dairy cattle scope 1 emissions relative to other European countries**




Note: Enteric fermentation refers to emissions from the digestive system. Energy consumption (scope 2) and land use change (scope 3) excluded. IPCC AR6 used for CO2 conversion (27.2 for CH4, 273 for N2O). Albania, Montenegro, and Moldova excluded due to low production (<8 K T) or data quality.
Source: FAO (2023a), IPCC (2021)

While less industrialized and extensive grazing in Norwegian cattle farming benefits local biodiversity[67], it leads to higher methane emissions compared to grain-based feed, which is due to digestion[68]. Still, there are opportunities to reduce these emissions. To achieve optimal feeding and reduce emissions from roughage (e.g., grass, maize, etc. in silage form), farmers can analyze the grass for factors such as digestibility and protein content. They can also determine the ideal time for harvesting and adjust the amount of roughage for different breeding stages[69]. Dairy and meat cooperatives in Norway are already offering this service to farmers. Furthermore, feed additives have been proven to decrease methane emissions by modifying the digestive processes in cattle stomachs. Examples of such additives include 3-Nitrooxypropanol (3-NOP), seaweed, and essential oils. Recently, Tine has explored the use of methane inhibitor 3-NOP to reduce methane gas emissions. Studies conducted in other countries have demonstrated a decrease in emissions of 20% to 30%[70].

In addition to nutritional adjustments, enhancing manure management practices can contribute to the reduction of cattle GHG emissions. Effective manure management involves various techniques, including manure treatment and processing and proper storage and handling. For instance, the Netherlands has enforced strict manure applications standards, such as low-emission manure storage[71].

Lastly, Norwegian cattle producers can increase feed diversity and efficiency, and continue to improve cattle breeding. Developing alternative feed protein sources, such as insects and single-cell proteins, is also a viable option. Selective breeding can also be used to cultivate cattle that emit less methane. However, it is important to consider animal health concerns and the preservation of local traditional breeds when making improvements to feed choices and breeding practices.

This chapter primarily addresses scope 1 emissions, but Norwegian farmers also need to consider scope 2 emissions from on-farm energy use and scope 3 emissions linked to land-use change, transportation and feed and fertilizer production. For example, when considering soil loss, including peatland cultivation for domestic feed production, the total GHG emissions from agriculture in Norway increase from 4.6 to 6.3 million tons[72].

[67] NIBIO (2021)
[68] Climate Nexus (no date)
[69] Tine (no date)
[70] Tine (2023b)
[71] Wageningen Livestock Research (2019)
[72] NIBIO (2014)

## Selectively applying regenerative agriculture practices

In addition to the discussed methods for reducing GHG emissions, incorporating regenerative practices can further mitigate environmental damage (exhibit 28). By using principles from regenerative agriculture, farmers can benefit from a healthier ecosystem and better financial outcomes. Research piloted on farms in Europe show that implementing regenerative agriculture principles can improve yield stability and resilience while reducing emissions[73]. Furthermore, the EU is investing in the transition to regenerative practices through its 'Farm to Fork' and 'Biodiversity Strategy for 2030'[74].

**Exhibit 28: Key facts about regenerative agriculture**

**DEFINING REGENERATIVE AGRICULTURE:** A system of nature-based farming practices, which can vary from field to field and aims to enhance the farm ecosystem through nature-based solutions instead of depleting it

| Main principles | Potential benefits for nature and to farmers |
|---|---|
| **Minimize soil disturbance**<br>Through minimum or no-tillage systems | **Reduced environmental impact**<br>By mitigating emissions through methods like carbon capture and better crop resilience for climate shocks |
| **Keep the soil covered**<br>By using cover crops to prevent soil erosion and improve soil health | **Lowers input costs**<br>Through reduced need for fertilizer and water input |
| **Nutrient recycling**<br>Reusing biomass and nutrients that would otherwise be lost | **Potentially higher crops premium**<br>Through selling a higher-value product and/or certification |
| **Foster plant and species diversity**<br>Through strategies like crop rotation and multi-cropping | **More secure yields**<br>Improved soil moisture and pest resistance, enabling better crop growth even during drought periods |

Note: Some sources (Climate Farmers, etc.) also regard livestock integration in crop rotations as a fifth principle. However, this is based on WWF's four regenerative agriculture principles. Examples of benefits for nature and to farmers are non-exhaustive.
Source: WWF (2021), Climate Farmers (2023), EA SAC (2022)

Regenerative agriculture encompasses a wide range of solutions that need to be tailored to specific climate conditions and farm set-ups. Given that regenerative agriculture is not defined by a given set of rules and practices[75], it is challenging to quantify how widespread the adoption of these farming practices is in Norway today and what the true potential is for the future.

Still, regenerative agriculture principles can help tackle the environmental challenges of Norwegian farming. For instance, Norwegian monoculture grain farming has contributed to a decrease in soil organic matter content, and the use of heavy machinery continues to cause compaction damage[76]. In addition, there have been occurrences of loss and overuse of artificial fertilizers (nitrogen and phosphorus)[77].

Regenerative agriculture principles, such as cover cropping, polyculture, nutrient recycling, and limiting soil disturbance, can all contribute to solving these challenges. Norwegian studies have shown that regenerative agriculture principles have improved soil structure, created more diverse soil microbiology, reduced weed growth, led to better water infiltration, and made soil more workable. In some places, it has even resulted in the darkening of the soil[78].

[73] Systemiq (2020)
[74] Reuters (2022)
[75] EA SAC (2022)
[76] NIBIO (2023b)
[77] NIBIO (2023b)
[78] VitalAnalyse (2021)

Farmers, despite being dependent on support from policymakers and the finance sector, undoubtedly hold a crucial position in implementing these strategies. It is also essential for other stakeholders in the value chain to take responsibility, as demonstrated in Exhibit 29.

**Exhibit 29: Roles to play to reduce GHG emissions and farming impact**

*Role to play:* Big Small

| FARMERS | MANUFACTURING AND PROCESSING | DISTRIBUTION AND RETAIL | FOOD SERVICES |
|---|---|---|---|
|  |  |  |  |
| **GHG EMISSIONS:**<br>• Conduct roughage analysis to optimize animal feed diet for improved cattle digestion to reduce methane emissions.<br>• Evaluate the use of cattle feed additives (e.g., 3-NOP, seaweed) to reduce methane GHG.<br>• Optimize the concentrated feed mix, including alternative feed protein sources.<br>• Prioritize cattle breeds with lower methane emissions.<br>• Enhance manure management practices to lower GHG (e.g., composting, anaerobic digestion).<br>**REGENERATIVE AGRICULTURE:**<br>• Selectively adopt regenerative agriculture (e.g., cover crops, no soil disturbances).<br>• Limit excessive nitrogen and phosphorus use, preventing soil erosion. | **GHG EMISSIONS:**<br>• Encourage dairy and meat producers to perform roughage analysis (e.g., reduce testing costs).<br>• Invest in R&D to create innovative animal feed proteins (e.g., kelp, insects, single-cell proteins).<br>**GHG EMISSIONS AND REGENERATIVE AGRICULTURE:**<br>• Split investment with farmers required to implement measures to reduce GHG and adopt regenerative practices.<br>• Advocate for sustainable agriculture practices (e.g., GHG labelling on packaging, sourcing targets from farmers with sustainable agriculture practices).<br>• Collaboration between dairy and meat cooperatives to share knowledge and provide training to farmers on how to lower cattle GHG emissions and introduce regenerative practices.<br>• Offer a price premium for farmers who have adopted GHG reduction or regenerative agriculture practices and adjust retail prices to ensure competitiveness. | **ACROSS SOLUTIONS:**<br>• Advocate for sustainable agriculture practices (e.g., GHG labelling on packaging, sourcing targets from farmers using regenerative agriculture practices).<br>• Offer a premium to farmers who have adopted GHG reduction solutions or implemented regenerative agriculture practices. Adjust costs between product categories to ensure competitiveness (e.g., same margin for products produced using regenerative practices compared to non-regenerative products). | |

Reducing cattle GHG emissions and changing farming practices are challenging tasks that will require facilitation from various sectors of the economy, such as the government, financial institutions, research and technology, and others.

**Exhibit 30: Key barriers to reduce GHG emissions and farming land impact, and how to overcome them**

| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **Lack of knowledge:** Implementing new solutions and ensuring adoption becomes challenging in a landscape of dispersed small-scale farmers. | **New policy for GHG emission restrictions and subsidies:** Set an upper boundary on emission levels and repurpose existing subsidies to make it more financially attractive to invest in low-GHG practices (e.g., less incentives on volume production).<br><br>**Pre-competitive collaboration:** Meat and dairy cooperatives should ensure that knowledge, technology, and innovations relevant to various agricultural food production types are shared across farmers (e.g., the application of new farming products, such as drones, improved fertilizer/pesticides, etc.).<br><br>**Policy advocacy to encourage adoption of new practices:** A joint push across farmers, cooperatives, producers, and retailers for policy changes (e.g., for incentives that support innovation similar to the EU's 'Farm to Fork' strategy). |
| **Norwegian climate and landscape:** Norway's limited cultivated and arable land, climate, and geographical features restrict the range of possible solutions. | **New technology:** Research institutions (e.g., NIBIO, NMBU) to assist in developing farming practices and alternative sources of feed proteins that are suitable for Norwegian conditions.<br><br>**Pre-competitive collaboration:** Cooperatives to ensure that local best practices are shared among their members. |
| **Insufficient financial support to facilitate necessary investments:** Investing in better farming practices may entail considerable upfront costs and reduced production in the early years, making it difficult for farmers to commit without access to "patient capital". | **Financial services:** Insurance should be adapted to provide better terms for those with practices that have less impact – and risk – on nature. Banks should offer favorable terms that reward those with better practices e.g., through better loan terms. |

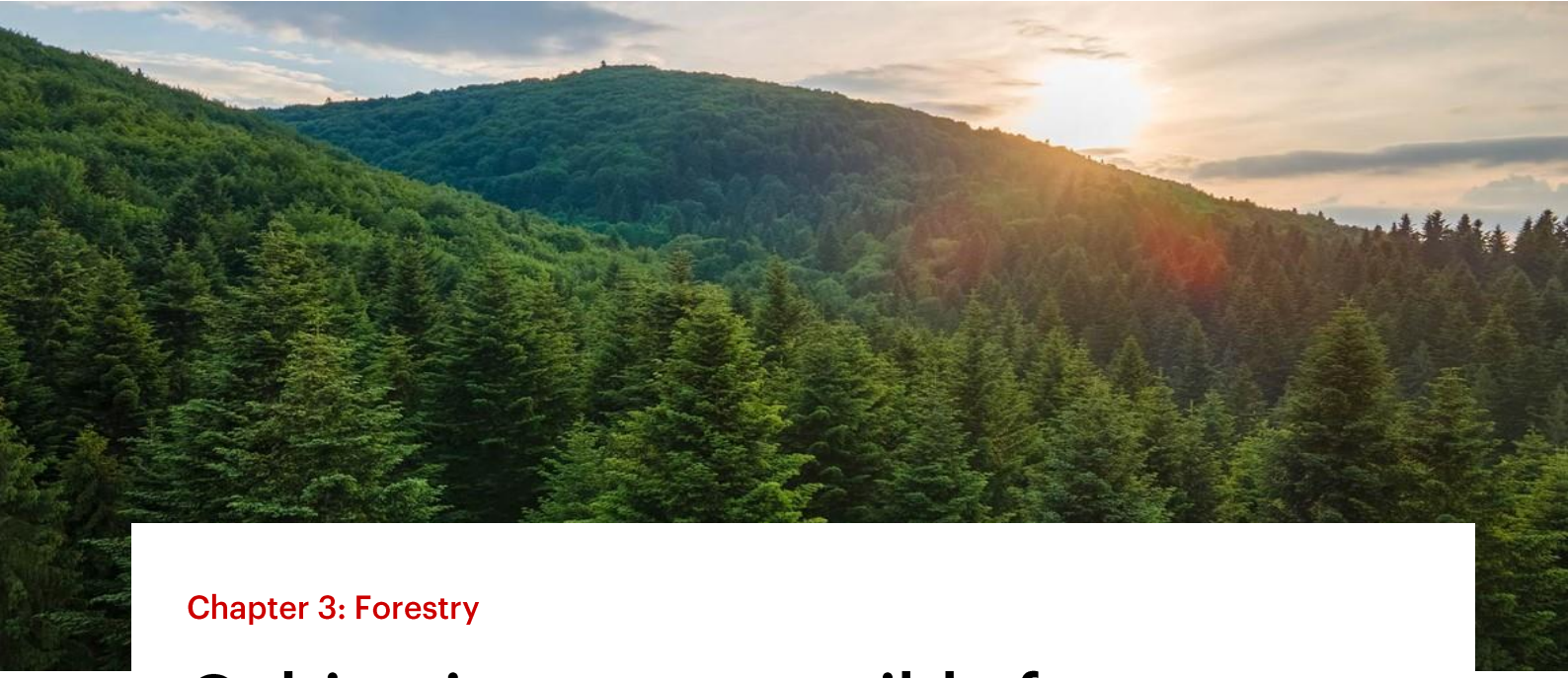
**CASE EXAMPLE: Reducing methane gas from ruminant production by performing analysis of roughage**

Several cooperatives and agricultural companies provide roughage analysis services to assist farmers in optimizing their feed planning, determining the ideal harvest time for roughage, and identifying the most environmentally friendly grass species and clover[79]. By analyzing grass silage and fresh grass samples in laboratories, Norwegian cooperatives can help farmers calculate energy and protein values for use in feed planning and simultaneously reduce the total methane emissions from the agriculture sector.

Roughage analysis can indicate whether the grass is "young" or "old." Recent tests conducted by Tine have demonstrated that cutting the grass at an earlier stage in a three-cut regime can reduce methane intensity by over 7% compared to "older grass" cut in a two-cut regime[80]. Consequently, roughage analysis can serve as a tool for estimating methane production levels associated with different roughage qualities and adjusting feeding practices accordingly.

Roughage analysis can also be used to make informed decisions about grass species and clover. For example, research by Tine found that perennial ryegrass results in about 5.5% higher methane intensity than timothy using the same cutting regime (three cuts)[81]. Through roughage analysis, farmers can make informed decisions to plant more grass species that lead to lower methane production from enteric fermentation in ruminants, and less of those with higher emissions.

[79] Weiby et al. (2022), Weiby et al. (2023)
[80] Weiby, Kim viggo Paulsen (2024)
[81] Weiby, Kim viggo Paulsen (2024)



Chapter 3: Forestry

# Cultivating a responsible forestry value chain

**To promote responsible use of biomass from forests, it is crucial to extend the lifetime of wood products and enhance their circularity. Additionally, raising the standards for forest management and sourcing is essential.**

**Exhibit 31: Norway's biomass footprint from the forestry value chain**


Forestry biomass footprint
(million tons, 2021)

Note: Totals are based on SSB, while the split between sectors is based on FAO. Incl. 70% of "products mainly from biomass" from SSB.
Source: SSB (2023a), FAO (2023b)

Norway's annual biomass footprint from the forestry value chain is approximately 4 million tons, which includes all consumption of wood and paper products in the country. Wood products, mainly used in construction, furniture, and as wood fuel, make up about 90%, with the construction sector accounting for about 45% of the total footprint. The remaining 10% comes from paper products[82], which despite substantial production in Norway, have a small footprint due to large exports.

There is a growing demand for wood and paper products in Norway, driven by Norway's green transition and increasing consumption. This highlights the importance of responsibly extracting, sourcing, and consuming biomass, and prioritizing applications with the greatest environmental effect. The Climate Committee 2050 report reinforces the idea that biomass is a scarce resource and should be prioritized for uses other than energy production[83].

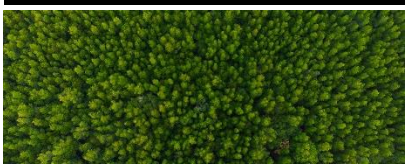
This chapter presents key solutions to mitigate the negative impact of the biomass footprint from the forestry value chain. The solutions focus on using biomass more efficiently to limit the demand for virgin material and maximizing the utilization of each tree. Moreover, we explore solutions to ensure the products we source, both domestically and internationally, adhere to stringent environmental standards. Lastly, the chapter discusses how we can optimize forest management practices to support biodiversity.

The forestry value chain is defined as the complete value chain of products made from trees. Paper products include all products made from pulp and pulpwood (i.e., office paper, cardboard, etc.) whereas wood products include all products made from wood (i.e., furniture, boards, wood fuel, etc.).

[82] FAO (2023b)

[83] The 2050 Climate Change Committee (2023)

**Exhibit 32: Summary of key issues and recommendations for the Norwegian forestry value chain**

| (1) USE BETTER | (2) SOURCE BETTER | (3) EXTRACT BETTER |
|---|---|---|
|  |  |  |
| **Key issues** | | |
| **Large volume of wood waste is being incinerated, with limited circular applications** | **Insufficient control of supply chain** | **Domestic forest extraction practices have negative impacts on forest biodiversity** |
| • Approximately 0.8 million tons of wood waste are generated annually, with nearly 95% of it being incinerated, effectively ending the wood product lifecycle.<br>• Less than 5% of wood waste is recycled in more advanced applications[84,85]. | • Downstream businesses have limited visibility and awareness of how forestry practices impact our nature.<br>• International certifications (e.g., FSC, PEFC) are helpful, but not sufficient to enforce all the requirements for preventing negative impacts on nature and biodiversity loss resulting from forestry practices. | • Clear-cutting is a common practice in Norway, which degrades biodiversity and contributes to CO2 emissions.<br>• Planted forests are often dense and homogenic in species and age, which encourages clear-cutting in the future.<br>• Dense and homogeneous forests are less resilient to climate change in the future. |
| **Recommendations** | | |
| **Extend wood lifetime by designing for longevity and recycling in line with the cascading principle** | **Step up sourcing responsibility using certifications but also go beyond these** | **Strengthen focus on biodiversity in Norwegian forest management practices** |
| • Buildings and furniture should be designed to facilitate recycling and reduce waste by creating higher quality products and using modular or prefabricated parts, or similar.<br>• Postpone incineration of wood waste by directing it to higher value applications through the cascading recycling approach (which can extend the lifespan of up to 50% of the wood waste currently incinerated in Norway). | • Certifications are the first step in ensuring sourcing from sustainably managed forests (e.g., PEFC, FSC).<br>• Businesses need to go beyond certifications by building internal capabilities, requirements, and control mechanisms to ensure their wood and paper comes from sustainably managed forest. | • Shift to low-impact practices like continuous cover forestry.<br>• Increase protection of biodiversity-rich forest areas.<br>• Promote less dense planting and encourage natural regrowth for a more diverse habitat.<br>• Diversify species and ages of trees, supported by industries that inform forestry companies of their interest in more diverse Norwegian forest products. |

The following chapters provide key recommendations and the desired level of ambition, while providing the roles that each economic sector should play. Additionally, they address key barriers for change and propose strategies to overcome them.

[84] SSB (2023c)

[85] SSB (2023d)

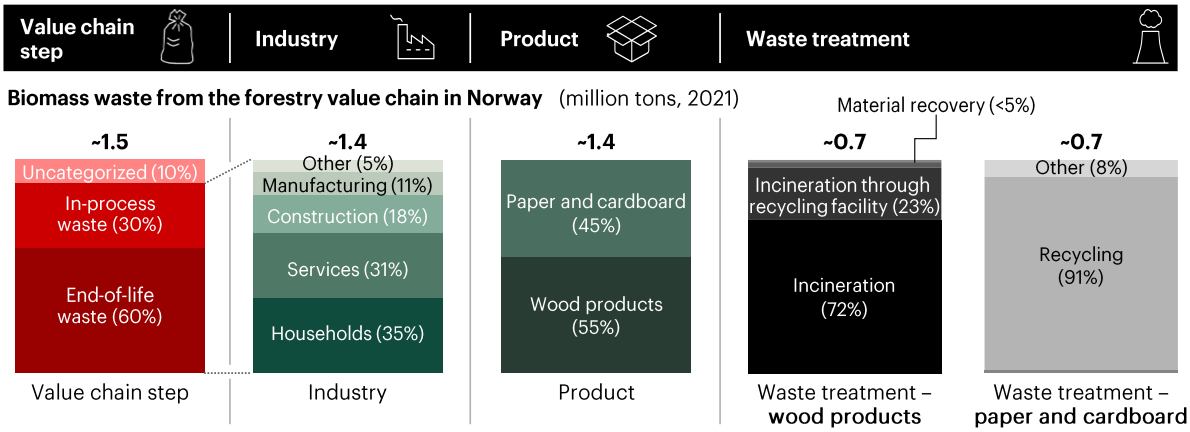
## Use better: Wood and paper waste

### While paper products are mostly recycled, large amounts of wood waste are incinerated with limited circular use.

Various solutions exist that can reduce the extraction of virgin biomass from forests. According to the Waste Framework Directive set by the European Commission, the ideal solution is to prevent waste from being created in the first place[86]. For wood and paper products, this can be done, for example, by extending the lifetime of furniture through reuse or by reducing the density of paper packaging for a product.

The waste that cannot be avoided must be reused for new applications in a circular manner, which will reduce the demand for virgin biomass. Currently, circular materials account for only 3% of all materials used in the Norwegian economy[87]. This very low percentage shows that there is a lot of untapped potential in using materials like wood and paper in a circular way.

**Exhibit 33: Overview of biomass waste from the forestry value chain, including all products derived from**




Source: SSB (2023a, 2023c, 2023d), FAO (2023b), Avfall Norge (2021), Market participant interviews (2023)

Exhibit 33 shows that Norway generates approximately 1.5 million tons of waste throughout the entire forestry value chain each year, including uncategorized (mixed) waste. Among the categorized (sorted) waste, wood waste accounts for around 55% and paper waste for 45%[88]. Overall, paper products have a high recycling rate of around 90% and are often recycled up to six times[89]. Conversely, wood products are mainly incinerated for energy directly at production facilities (app. 70%) or through recycling facilities (app. 25%), and only a small portion is used for material recovery (less than 5%).

[86] European Commission (2023a)
[87] Circular Norway (2020)
[88] SSB (2023a)
[89] Market participant interviews (2023)

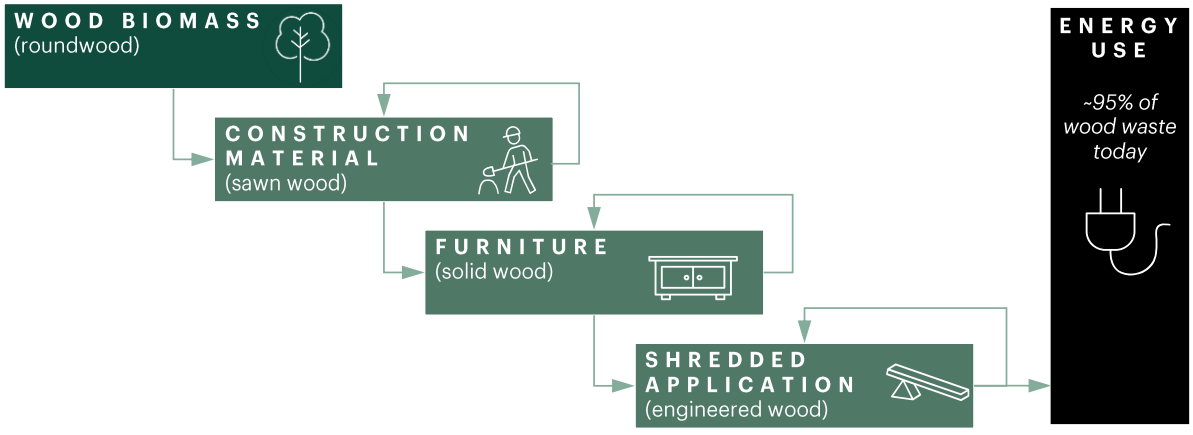
## Use better: Solutions for wood

### We need to design wood products for longevity and recycle wood waste based on the cascading principle to make more use of the valuable wood resource.

In this sub-chapter, the solutions will focus on wood products. As mentioned earlier, it is recommended to avoid waste wherever possible when aiming to reduce our consumption of biomass. Therefore, it is critical to design wooden products with minimal material input and waste during production and at the end of their lifecycle. Additionally, we should strive to prolong the lifespan of the products, such as through implementing a sharing economy model, such as furniture rental for offices, to maximize the use of wood resources.

When wood waste cannot be avoided, it is important to design products in a way that makes it easy for the wood material to be recycled. The concept of cascading is a recycling principle that aims to maximize the value of wood waste by using it in high-value applications as many times as possible before resorting to incineration for energy generation (exhibit 34)[90]. The idea behind cascading is to keep the wood in its highest solid form for as long as possible, but in new applications. This means that the wood waste goes through a series of uses within the same sector or even in different sectors. For instance, wood waste from a demolished building can be repurposed in the construction of a new building, where it can be used for windows, cladding, or structures made of glued laminated timber (glulam). It can also be used in other industries, such as furniture or particle board manufacturing. By adopting the cascading approach, the lifetime of the wood material is extended, and the incineration of wood waste is delayed. This cycle can be repeated every time a wood product reaches the end of its useful life.

**Exhibit 34: Example path for cascading recycling from wood biomass to shredded application**




Source: Nova Institute (2014)

According to our estimates, implementing cascading practices in Norway could **extend the lifespan of up to 50%** of the wood that is currently being incinerated across various sectors. This has the potential to reduce the biomass footprint from the forestry value chain by nearly **0.4 million tons** per year, which is a significant impact equivalent to almost **10% of the total waste generated.**

[90] WWF (2016)

Scaling up cascading in Norway requires strong collaboration across the industry to establish new value chains for recycled waste. Exhibit 35 outlines the roles that each sector would play in this process.

**Exhibit 35: Roles to play to implement more circular use of wood products** *Role to play:* Big Small

| 1. FORESTRY COMPANIES | 2. SAWMILLS | 3. BUILDING MATERIAL PRODUCERS AND RETAILERS |
|---|---|---|
|  |  |  |
| • Provide high-quality wood that has a longer lifespan and promotes circular use, for example, through continuous cover forestry, where trees grow slower, resulting in harder wood (see sub-chapter "Extract better"). | • Ensure that waste (e.g., edges from cutting) is recycled using the cascading principle, finding applications beyond energy recovery whenever possible.<br>• Facilitate collaboration both upstream and downstream to minimize waste through better planning, for example through better coordination of order quantities with supply capabilities. | • Design building products that can be easily repaired, reused, or recycled.<br>• Explore alternative applications for waste generated during the production process apart from just energy recovery.<br>• Prioritize recycled wood in the sourcing process and set recycling targets for suppliers. |

| 4. CONSTRUCTION AND ARCHITECTURE COMPANIES | 5. FURNITURE COMPANIES | 6. WOOD-BASED PANEL AND BOARD COMPANIES |
|---|---|---|
|  |  |  |
| • Design buildings with cascading in mind, considering modular units and pre-cut parts to minimize material loss during demolition.<br>• Use construction materials made from recycled or cascaded wood by selecting board manufacturers that utilize these materials or contribute to recycling schemes.<br>• Enhance the demolition process to ensure the quality of the wood materials is preserved for future cascading. | • Design furniture that can be easily repaired, reused, and recycled; this may involve less standardized manufacturing processes to accommodate variations in the size and shape of the materials used (highlight the uniqueness of each product to consumers).<br>• Prioritize recycled wood in the sourcing process and set recycling targets for suppliers. | • Set more ambitious targets for the share of recycled materials in the panel board material mix, which will require adjustments in the production process.<br>• Prioritize recycled wood in the sourcing process and set recycling targets for suppliers. |

While the solutions presented here are within reach of Norwegian businesses, there are barriers that limit their ability to act. Below are the most critical barriers and ways to overcome them (exhibit 36).

**Exhibit 36: Overview of key barriers to enhance use and how to overcome them**

| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **Lack of economic incentives:** The current economics of wood products favor linear consumption. There is a lack of economic incentives for businesses to invest in cascading recycling and to overcome the costs for collecting, sorting, and cleaning wood waste for recycling. | **New policy:** Implement incentives to promote the use of recycled materials for relevant applications. This could be a regulatory target that requires a minimum percentage of input material from recycled sources (e.g., linked to BREEAM standard for construction industry[91]).<br><br>**Financial services:** Encourage institutions to offer attractive financing options based on the share of recycled wood. |
| **Fragmented recycled material supply and demand require close collaboration:** Diverse wood waste needs a matching mechanism to enable different players in the value chain to deliver and receive waste for cascading recycling. For example, a plank producer generating waste can coordinate the amount of waste (e.g., off-cuts and chips) and collaborate with a particle board producer who can utilize the waste for making particle boards. | **Market intermediaries:** Establish market-matching entities that connect companies and waste. Intermediate entities can aggregate and sort wood to make it easier to repurpose. For example, Omtre aggregates wood waste from construction sites.<br><br>**Pre-competitive collaboration:** Direct off-take agreements between businesses can create value chains for wood waste. For example, a construction company can sell its wood waste to a furniture company, which can then use it as a resource for specific product lines. |
| **Real and perceived lower quality of recycled wood:** The quality of recycled wood is generally lower than that of virgin wood due to wear and tear from prior applications or demolition processes. This lower quality can affect both the functional performance and aesthetic appeal of the wood. | **Market intermediaries:** Establish standards for recycled wood in order to match it with applications that have the appropriate functional requirements.<br><br>**New policy:** Incentives for the construction industry to carry out careful demolitions, resulting in higher quality wood waste.<br><br>**Public campaigns:** Launch campaigns from NGOs or government agencies to raise awareness about the importance of reusing wood, while also educating the public about the quality potential of recycled wood, such as its ability to store carbon in long-lasting wood products. |
| **Recycled materials are less compatible with standardized manufacturing processes:** It is more expensive for manufacturers to use recycled wood bits and pieces of varying sizes instead of standardized roundwood or planks. | **New policy:** Incentives and subsidies for new value chains and equipment that facilitate the production of products made from recycled input materials that are less standardized. |


**CASE EXAMPLE: SirkTRE aims to quadruple the reuse of wood in Norway within the next ten years**

SirkTRE is a research and development initiative in Norway that addresses knowledge gaps in the availability and quality of recycled wood. The project explores various aspects of wood utilization, with a particular focus on wood reuse in construction and the integration of recycled wood as a primary raw material. By bringing together key players in the value chain, such as forest owners, timber processing industry, architects, contractors, waste and recycling operators, SirkTRE aims to enhance the reuse of recycled wood and facilitate the transition to a circular economy.

SirkTRE focuses on the sorting of residual and demolition wood, conducting quality assurance, and repurposing it as structural timber. This process converts wood waste into recycled wood, which extends its lifespan. The project expects to provide emission reductions of around 0.5 million tons of CO2 by 2024 and three million tons of CO2 by 2030, thereby indirectly contributing to 8% of Norway's carbon reduction commitments[92].

[91] BRE Group (2023)

[92] Sirktre (2023)

## Use better: Solutions for paper products

### Circularity is well-established in the value chain for paper products in Norway, with over 90% of paper being recycled[93]. However, there are still opportunities to reduce the paper material intensity through responsible product design.

Globally, paper is becoming more popular as a sustainable packaging material[94]. At the same time, regulations are becoming more common worldwide to reduce total packaging volume and improve recycling, with a particularly strong push in the EU.

Several solutions are available for companies to proactively transition towards more sustainable packaging and reduce the biomass footprint of paper applications. Below are some key examples:

- **Do more with less:** Solutions that reduce the biomass used per packaging unit, for example by avoiding excess space in hard paper packaging or shifting from hard to soft paper packaging. While these solutions can lead to material savings and subsequent cost savings, they are also supported by recent EU regulations that restrict unnecessary packaging[95]. Technologies already exist to better tailor packaging sizes to the product size, but further research is required to use softer material for products that require higher levels of protection.
- **Shift from single-use items to reusable products** whenever possible, such as substituting disposable paper cups with reusable ones in fast food establishments or replacing single-use paper packaging with refillable alternatives, like milk or oatmeal containers.
- **Design paper products for recyclability whenever possible** by reducing packaging that consists of inseparable layers of paper and other materials, such as plastic. Using pure paper packaging (mono-packaging) increases recyclability and reduces the need for virgin materials. However, this must always be weighed against the upsides of plastic packaging, which in select cases might improve food conservation and lower food waste and effectively the biomass footprint.
- **Use recycled content as input material for paper products** to minimize the amount of virgin material needed.
- **Improve the sorting process of paper waste** by reducing the amount of paper thrown into mixed waste and limiting contamination with other materials, such as plastic.

[93] SSB (2023c)
[94] Bain & Company (2023)
[95] European Commission (2022)

## Source better

### The responsibility for forest management does not lie solely with forest owners. Construction and furniture companies, among others, have a responsibility to source wood from sustainably managed forests.

Players operating within the value chain, who source wood and paper products at various stages of processing, bear the responsibility of ensuring that the products they procure originate from sustainably managed forests.

Certifications are a first good step in ensuring that sourced products come from sustainably managed forests. When relying on certifications, WWF recommends the Forest Stewardship Counsel (FSC). According to WWF's assessment, FSC has stricter requirements and provides the most credible scheme[96]. In Norway, PEFC is the most common forest certification, with almost all of Norway's forest being PEFC-certified[97].

While certification schemes serve as valuable frameworks to use as a starting point, they have their weaknesses. Firstly, they are not always sufficient, as they might only cover certain ecological, economic, and social elements of forest management while excluding others. Secondly, they are not always regarded as strict enough in upholding biodiversity and sustainability, and they might be used as a "cover" for companies to continue unsustainable practices. Moreover, some schemes, such as PEFC, are not consistent across countries, which reduces the reliability of the certification on an international level. Lastly, there is a risk of issues such as fraud, breaches, and lack of reviews. However, there are ways to ensure legitimacy. For example, certifications that use the "chain of custody" tracking provide more certainty in the quality of the certification. A "chain of custody" is a certification process that tracks the flow of raw materials from the forest to the end product, verifying that each stage in the supply chain adheres to specific sustainability standards.


**CASE EXAMPLE: Ensuring responsible sourcing through on-the-ground assessment of extraction practices**

As a global leader in home furnishings, IKEA places a strong emphasis on responsible forest management and wood sourcing. With a reliance on wood from approximately 50 markets worldwide, IKEA acknowledges its significant influence on global forests and the forestry industry.

Since 2020, IKEA has committed to only using FSC-certified or recycled wood, ensuring that the wood used originates from sustainable sources. In addition, IKEA has a dedicated team of more than 40 wood supply and forestry specialists worldwide who are responsible for directly examining and managing forestry supply chain operations.

[96] WWF (2023)

[97] NIBIO (2023c)

It is important for companies to recognize the unique conditions of their local operations, tailor their approaches accordingly, and go beyond certifications where necessary. This may require businesses to incorporate additional social and environmental requirements and monitoring methods when sourcing materials. Moreover, businesses may need to build internal capabilities to track and assess the environmental impact of their extraction practices.

While forestry companies need to implement sustainable practices, companies throughout the value chain should support them by providing economic incentives. These incentives could include securing off-take agreements or marketing products from sustainably managed forests as premium goods to end consumers. Overall, there is still more that can be done to ensure responsible sourcing among Norwegian businesses beyond just certification. This will not be easy but can be accomplished with the right facilitation (exhibit 37).

**Exhibit 37: Overview of key barriers to improve sourcing and how to overcome them**

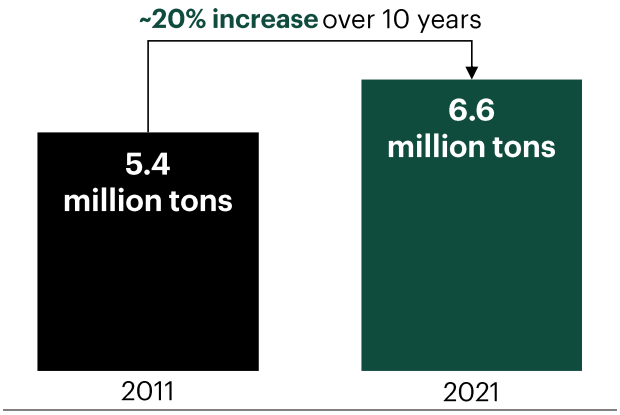
| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **Lack of transparency and strict legislation for sourcing practices:** While certifications provide some level of transparency on forest management, they are not bulletproof. Businesses should possess internal capabilities to track and assess their impact on forests. | **New policy:** The forestry law and "Bærekraftsforskriften" should include more specific requirements and considerations for forest management.<br><br>**Technology:** Improved transparency in the value chain can increase trust and reliability of certifications for sourcing wood from less mature markets. Satellites can also be used to track deforestation directly.<br><br>**New policy:** Public entities can incentivize the use of certified products through public tender requirements, tax reliefs, or subsidies. |
| **Responsible sourcing is costly:** Companies that commit to responsible sourcing must incorporate the costs of monitoring and managing their supply chain (e.g., invest in labour and training to build internal capabilities to assess forest management practices). Additionally, certified forestry products may be more expensive due to the higher cost of extraction with continuous cover forestry practices, which involve harvesting less volume per harvest. Lastly, the certification process itself adds to the overall cost of producing certified forestry products. | **Financial services:** Financial institutions can support responsible sourcing, for example by offering favorable financing terms to construction and furniture companies that adhere to stringent sourcing standards and have effective control mechanisms in place to lower nature risk.<br><br>**Pre-competitive industry collaboration:** Collaborate on setting higher standards for sourcing across construction, furniture, and other industries to create a fair and level playing field.<br><br>**Public campaigns:** Public marketing campaigns can enhance the desire to pay a premium for sustainably sourced wood and paper. This strategy allows companies to transfer the increased cost of responsibly sourced wood and paper to consumers. |

## Extract better

### Conventional extraction practices have adversely affected the health of Norwegian forests over time. As the demand for forestry products is expected to increase, it is crucial to strengthen the focus on biodiversity in forest management practices.

The extraction of Norwegian wood has increased by about 20% over the last decade and further expansion is expected (exhibit 38). Continuing with conventional forest extraction practices can have irreversible consequences for biodiversity and the health and resilience of Norwegian production forests. Forestry companies have made some advancements in enhancing forest management practices with increased environmental considerations in recent years. However, further actions could be taken to protect our forests.

**Exhibit 38: Increase in domestic extraction of wood**




Source: SSB (2023a)

Approximately 75% of Norway's production forests have been subject to clear-cutting at least once, a practice where most trees in an area are harvested to maximize output. Clear-cutting leads to habitat loss, soil degradation, water cycle disruption, and potentially lower carbon sequestration capabilities[98]. Therefore, it is crucial to protect the remaining 25% from further clear-cutting.

Two potential solutions should be considered here: increased forest protection and improved forestry practices. Firstly, it is crucial to escalate the protection of Norway's valuable forests, aiming towards the national goal of 10% of the total forest cover. This is particularly relevant for old forest with limited human interference as well as for productive biodiversity-rich forest areas with a high number of threatened species. Moreover, large and old continuous forest areas hold significant value for carbon capture and storage, as well as for mitigating the impacts of extreme events caused by climate change.

For forests that have already been clear-cut, the optimal solution is implementing continuous cover forestry. This is a low-impact extraction practice in which trees are selectively logged. Forest stands are constantly maintained with an irregular structure to minimize the negative effects of logging. This practice lessens the nature impact on biodiversity, while improving soil health and reducing carbon emissions.

Nevertheless, continuous cover forestry is less economically attractive than clear-cutting. Norwegian forestry is a low-margin industry due to intense international competition, which exacerbates the competitive disadvantage of transitioning to continuous cover forestry. Therefore, economic incentives are needed to make continuous cover forestry competitive and ensure that it does not result in unwanted environmental impact (e.g., the construction of excessive roads to support continuous cover forestry).

The predominant tree species in Norwegian forests are Norway spruce, Scots pine, and four varieties of birch, which vary with latitude. Due to their climate, northern forests naturally have a low diversity of tree species.

[98] Framstad & Sverdrup-Thygeson (2015)

Additionally, the most common forest management practices in Norway typically prioritize maximizing the volume production of a single economically valuable tree species, like spruce or pine. This is often achieved using clear-cutting, which results in creating monocultures and leads to dense and same-aged forests. These uniform and thick forests have minimal understory vegetation diversity and typically offer limited habitat diversity for species. Moreover, they create a forest structure that is less suitable for continuous cover forestry, which requires an extended period for conversion. Therefore, it is crucial to promptly adjust forest management practices after clear-cutting, emphasizing diversity and aiming for continuous cover forestry over time, if immediate conversion is not feasible.

Potential solutions include planting less densely, adjusting the care for young stands, and modifying thinning regimes to enhance tree species diversity. This will increase light penetration and promote a more varied understory, encouraging the natural regrowth of native species for a more diverse habitat structure. Additionally, enhancing environmental considerations, such as raising the number of retention trees and setting aside more areas, can also help increase biodiversity in production forests. It will also be important to create domestic demand for a broader range of products, such as different quality levels and types of wood.

While the forest management sector has the largest role to play in implementing sustainable extraction practices, other sectors can contribute too, for example by securing offtake or showing an interest in sustainably managed forestry products (see exhibit 39).

**Exhibit 39: Roles to play by industry to improve extraction practices**

*Role to play:* Big Small

| FORESTRY COMPANIES | SAWMILLS | WOOD VALUE CHAIN<br>Construction companies, furniture companies, building material producers and retailers, and wood-based panel and board companies | PAPER VALUE CHAIN<br>Pulp and paper companies, packaging companies, consumer product companies, and others using paper |
|---|---|---|---|
|  |  |  |  |
| • Intensify the use of continuous cover forestry.<br>• Lower planting density.<br>• Adopt practices that favor a wider range of Norwegian species.<br>• Protect not yet clear-cut areas from clear-cutting and endorse low-impact practices.<br>• Optimize forestry practices for long-term forest health, considering impacts of climate change. | • Secure wood offtake and demand from responsibly managed forests in Norway by enhancing the diversity of wood-based products. This can be achieved by setting more explicit requirements for suppliers during procurement, developing products that require more sustainably sourced wood, replacing imported wood with sustainably sourced Norwegian wood whenever possible, demanding certifications, or advocating for stricter forestry regulations to ensure a level playing field, amongst others. There is a slightly higher impact potential expected for sawmills given their particularly large volume and consequent significant potential to effect change.<br>• The value chain of paper has a significant potential to impact domestic extraction practices, despite having large export shares, since a significant quantity of fast-growing and lower-quality wood is used for paper products. | | |

There are several barriers to be overcome in order to implement better forestry practices, as indicated in exhibit 40. Importantly, these measures need to consider the substantial time frame required for changes in forestry practices to take effect (most Norwegian forests are cut down after a span of 60 to 120 years).

**Exhibit 40: Overview of key barriers to improve extraction practices and how to overcome them**

| KEY BARRIERS FOR CHANGE | WHAT IS NEEDED TO OVERCOME THE BARRIERS |
|---|---|
| **Continuous cover forestry is not economically attractive:** Clear-cutting forests is significantly more economically attractive, yielding higher volumes of wood at a faster rate and a lower cost. | **New policies:** Incentives for continuous cover forestry, for example through subsidies to offset the increased costs for forestry companies.<br><br>**Research and development:** Research within environmental science to discover more economic strategies for transitioning towards continuous cover forestry and increasing forest diversity in Norway.<br><br>**Public campaigns:** Increase awareness about the environmental advantages of continuous cover forestry, which may inspire customers to pay a higher price. |
| **No strict requirement for continuous cover forestry:** Current certifications do not strictly mandate a shift to continuous cover forestry. | **Improved certifications:** Tighten the standards of current certifications for better optimization of biodiversity outcomes and profitability. For example, introduce stricter limitations on clear-cutting, which is currently only recommended. Consider the potential of a new certification layer for wood derived from continuous cover forestry. |
| **Lack of infrastructure, equipment, and training for continuous cover forestry:** Continuous cover forestry requires specialized equipment, infrastructure, and trained personnel. Transitioning from clear-cutting practices to continuous cover forestry therefore requires significant investment. | **Technology:** Enhanced technology in equipment that optimize logging yield while still preserving biodiversity in continuous cover forestry. The use of technology can also find superior ways to develop infrastructure, such as improved roads.<br><br>**Training and knowledge sharing:** Training available for companies on the best practices in continuous cover forestry. |
| **Lack of market demand for more diverse wood products:** Forest management that promotes biodiversity can produce a wider selection of wood species, qualities, and ages, albeit in smaller volumes. Nonetheless, this varied output does not align with the current demand. Today, demand for wood in Norway is focused on large, fast-growing species like pine and spruce, which are typical in Norwegian production forests. A significant portion of this wood is exported to Sweden for pulp and paper production. | **New policy for diversity:** Policies that promote the increase of different types of wood qualities and tree species in Norway, potentially by way of grants or subsidies.<br><br>**New policy for demand:** Policies that incentivizes players who occupy the latter part of the value chain to buy less commercial tree species. This approach can help retain more generated value within Norway. |

Chapter 4: Biofuels

# The role of biofuels in using biomass responsibly

**Not all waste can be avoided or further recycled. Using this residual waste as biofuel feedstock can derive additional value from biomass that would otherwise be incinerated, while helping to decarbonize hard-to-abate sectors.**

Bioenergy is the largest source of renewable energy in Europe, accounting for app. 60% of the total[99]. Biofuels, as a form of bioenergy, are perceived as a low-carbon fuel alternative for hard-to-abate sectors. Regulations in the EU and Norway are gradually phasing out first-generation biofuel feedstock (i.e., crops) to prevent fuel crops from competing with food crops to avoid land use change. The future demand will thus be fulfilled by second-generation biofuel feedstock (i.e., waste and residues). Key regulations include:

- The EU just introduced a 7% cap on first-generation biofuels as a share of all energy used in transport.
- By 2030, 3.5% of all transport fuel (incl. aviation) in the EU must be second-generation biofuels[100].
- Currently, Norway has biofuel blend-in mandates of 33%, 28%, and 18% for road, machine, and fishing/maritime fuel by 2030[101]. From 2023, at least 12.5% of the biofuel must be second-generation biofuel.

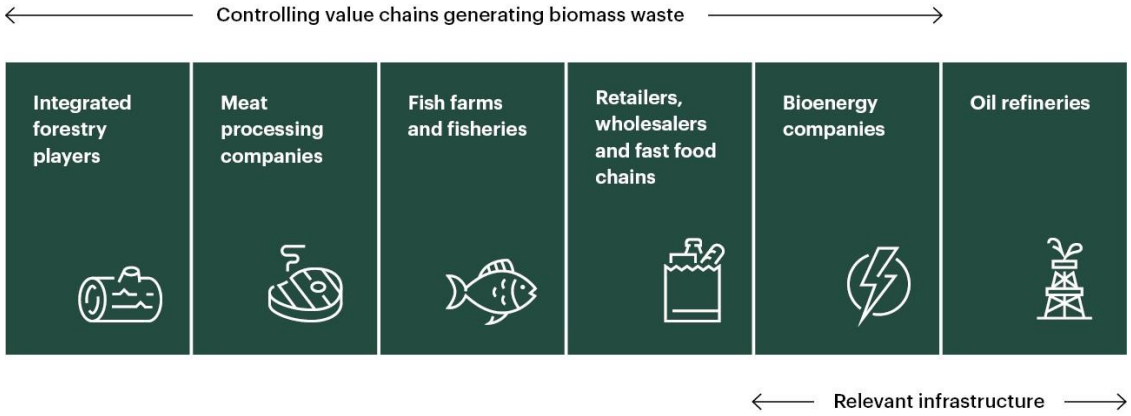
According to the cascading principle, biomass waste should only be used as biofuel feedstock if it cannot be further recycled. Hence, feedstock supply is limited and should be prioritized for uses where it can have the best environmental impact. Specifically, advanced biofuels should be used in applications that are difficult to electrify or that cannot easily use hydrogen derivatives[102]. For example, aviation and shipping require high fuel density and incur significant costs when switching technologies. In these cases, biofuels can be used as a transitional solution until technology advancements allow for electrification or hydrogen use.

Norway is ideally positioned to take advantage of the biofuel opportunity in the future. We have a robust supply of second-generation feedstock due to our extensive forestry and human food protein sectors (e.g., aquaculture). Norway has a relatively advanced bioenergy infrastructure (e.g., app. 40 biogas plants[103] and some second-generation feedstock biofuel pilot plants, including Silva Green Fuel). Notably, waste-to-energy companies import large amounts of biomass waste for biogas and heating (e.g., from the UK).

[99] European Commission (2023b)
[100] European Commission (2023c)
[101] Energi og klima (2023)
[102] The 2050 Climate Change Committee (2023)
[103] Biogassbransjen (2023)

There are two types of players that are best positioned to capitalize on the biofuel opportunity: Norwegian companies in control of the value chains that generate biomass waste at scale (e.g., forestry companies) and companies with relevant infrastructure (e.g., refineries and bioenergy companies) and customer interface.

**Exhibit 41: Norwegian sectors best positioned to take advantage of the biofuel opportunity**




## Pathways for biofuel feedstock in Norway

Biofuels encompass a variety of fuels, with the ideal feedstock depending on the application. Several application pathways for feedstock are relevant to the Norwegian market:

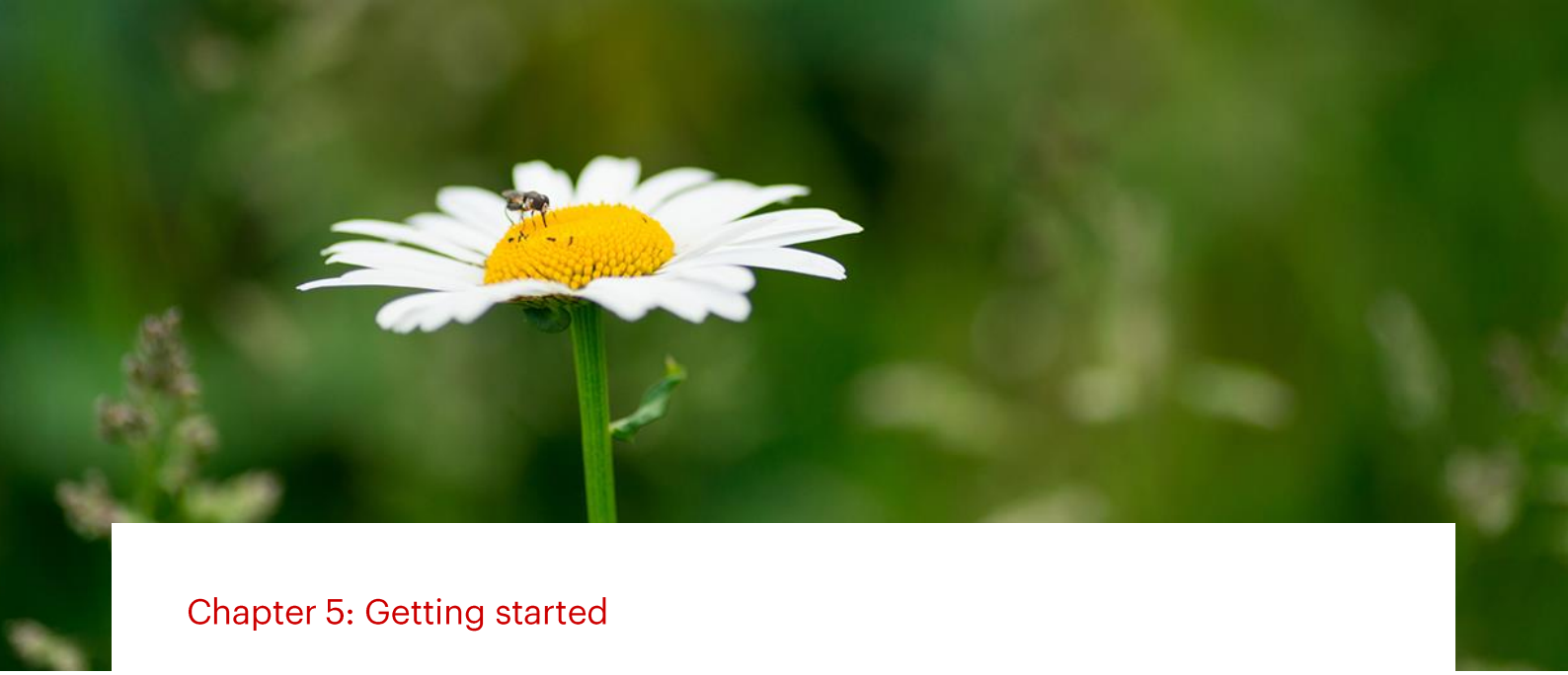
**Exhibit 42: Key pathways for second-generation biofuel feedstock in Norway**

| FEEDSTOCK | FEEDSTOCK EXAMPLES |
|---|---|
| Wood waste | Unrecyclable post-consumer wood (particle boards), sawmill residue, etc. |
| Food waste broadly | Post-consumer waste, including nuts, coffee grounds, baked goods, fruits, vegetables, dairy, meat, and processing residues. |
| Oils, tallow, and fish residue | Cooking oils, fats, tallow, and residue from fish farms and fisheries. |

Several barriers must be overcome to ensure stable biofuel feedstock value chains:

- **Fragmentation of feedstock:** Waste feedstocks (especially food waste) are fragmented and require an infrastructure for collection. Certain sectors in Norway, such as forestry, provide a more consolidated feedstock from sources such as sawmills with established procedures for wood waste collection.
- **Security of supply:** Need for a stable and consistent supply and quality of feedstock.
- **Investments:** Producing biofuels requires substantial investment into facilities, implying economic risk. Norway has the potential to use some of its existing oil refineries for biofuel production.
- **Regulatory uncertainty:** Dependence on long-term consistent support from regulatory bodies.
- **Technology uncertainty:** Biofuel is one of many technologies aimed at decarbonizing fossil fuels alongside electric vehicles, synthetic fuels, etc. The future fuel technology mix remains uncertain.

The utilization of residual biomass waste as a biofuel feedstock provides an opportunity to **increase the value of biomass waste**, while **supporting the decarbonization of the transportation sector.**



Chapter 5: Getting started

# Accelerating change

**The biomass footprint accounts for approximately 80% of the global biodiversity loss on land, which has major implications for nature. Therefore, it is crucial to take prompt actions to prevent irreversible effects on biodiversity.**

Now is the time for Norwegian businesses to halt biodiversity loss by extracting, sourcing, and using biomass more responsibly. Numerous frameworks and resources can be used to address this issue. Nevertheless, defining an overall approach to mitigate the impact of biomass footprint on biodiversity should not come at the expense of immediate, concrete actions, but rather complement them.

In order to understand the level of awareness and action among Norwegian businesses, we conducted a survey involving CEOs, COOs, and Heads of Sustainability across various sectors, from small national companies to large international corporations. The results of the survey emphasize that while businesses are starting to recognize the importance and opportunities linked to addressing biodiversity issues, the topic is still in its nascent stages. More than half of the respondents acknowledge the economic benefits of using biomass more responsibly and were able to suggest concrete solutions. However, only about 35% of the respondents have already begun taking action, with just about 20% having established quantitative targets.

**Exhibit 43: Key insights from Norwegian market participant survey**

There is a need for **increasing the awareness of biomass** and the impact it has

*~40% of respondents are familiar with the concept of biomass*

Solutions that use biomass more efficiently are **often profitable** for businesses...

*~60% of respondents see economic benefits from using biomass more efficiently*

...and here, there is an **underutilized potential** with great potential for doing more

*~35% of respondents have implemented solutions of some kind*

Source: Market participant survey (2023)

## Key points to consider when accelerating change

While it is crucial for a company to examine its frameworks, understand its impact, and map limitations, it is equally important to start implementing initiatives instantly. Most companies are already aware of their biomass-related issues and subsequent solutions that they can get started on right away. These are often "no-regret" moves that often are easy, and important, to implement promptly. Moreover, these initiatives will bring about learnings, which can feed into and accelerate the long-term planning and implementation of further initiatives. Coupled with the immediate initiation of solutions, the following points will help reinforce the implemented solutions:

A. Frameworks that guide businesses in structuring their biodiversity efforts are currently being developed, and comprehensive draft versions are already available.
B. Understanding their impact on biodiversity is a crucial first step for companies. A variety of tools are available to support these activities and ensure companies get started.
C. Engaging with credible certification schemes can allow companies to start addressing their biomass footprint and biodiversity impact. However, it is important to understand the limitations of these schemes.

## A. Use frameworks to structure biodiversity efforts

Businesses can benefit from existing frameworks as a guide for their biodiversity efforts. These guides assist businesses by defining their approach and strategy, building knowledge, and finally, defining a clear course of action. Some key examples can be seen in exhibit 44. These frameworks typically provide a step-by-step methodology for businesses to assess their environmental impact, execute on solutions, and set up the right process for monitoring and follow-up.

## B. Identify and assess biodiversity impact using existing tools

The first crucial step for companies is to map their impact on biodiversity to provide a solid foundation for action. Several tools and resources can help in this process.

Appendix 1 lists established tools and resources for conducting impact and risk assessments across the entire value chain. Sector-level materiality screening tools can help identify sector-specific impacts and dependencies. Value chain assessment tools fall into two categories: 1) assessing pressures on nature from business activities across the value chain, and 2) assessing the state of nature in areas where a company or their suppliers are operating. Additionally, some guiding resources offer overviews of available tools and measurement approaches.

## C. Credible certifications help companies take immediate action

Companies can advocate for change within their supply chains by using credible certifications. As previously discussed in this report, certifications do have limitations and should only be viewed as an initial step, where further actions could be needed to ensure sustainable practices.

Some of the challenges with certifications include lack of traceability, the complexity of incentivizing action among supply chain stakeholders, and the difficulty of conducting or following through with compliance audits. However, certifications are a crucial starting point for companies seeking to promptly instigate changes in their supply chain. Additionally, they can help companies sell sustainably sourced products at a premium price, improve stakeholder relations, and manage reputational risks. The WWF has been promoting and co-designing credible certification schemes for more than 30 years. For the food and forestry value chains, appendix 2 provides relevant examples of credible certifications.

**Exhibit 44: Examples of frameworks that define approaches to addressing impacts on nature**

Science-Based Targets for Nature (SBTN): A collaboration between leading NGOs and the Science-Based Targets Initiative. It aims to guide companies in setting science-based targets for nature. The framework outlines a five-step guide for companies to proactively address their impact on nature. The 'Initial Guidance for Business' was released in 2020, and the first release of Science-Based Targets for nature was launched in early 2023.

Taskforce on Nature-related Financial Disclosures (TNFD): A framework for financial institutions and corporates providing guidance on assessing and disclosing nature-related risks and opportunities. The latest beta version of the framework was released in November 2022, and the final version was launched in September 2023.

WWF's Biodiversity Stewardship Approach: A roadmap developed by the WWF for companies to find meaningful ways of achieving their science-based targets and developing nature-positive business models. The roadmap consists of five iterative steps and it closely aligns with the approaches of SBTN and TNFD.

Natural Capital Protocol: A framework developed by the Natural Capital Coalition to help companies identify, measure, and evaluate their direct and indirect impacts and dependencies on natural capital. The protocol was published in 2016 and is publicly available.

EU's Corporate Sustainability Reporting Directive (CSRD): A regulatory framework mandating large companies to disclose non-financial information related to environmental, social, and governance (ESG) aspects. By necessitating disclosures concerning impacts and risks related to biodiversity, the CSRD encourages companies to adopt sustainable practices.

Source: Science-based Targets Network (2020), WWF (2022c), Natural Capital Coalition (n.d.), TNFD (2020)

## Next steps

The solutions presented in this chapter provide companies with additional tools to reduce their impact on biodiversity by using, sourcing, and extracting biomass more responsibly. Considering the urgency of the biodiversity crisis, immediate action is required to halt ecosystem degradation. Here, Norwegian companies have a critical role to play in minimizing their impact on biodiversity. By doing this, we can ensure a viable planet for future generations.

The purpose of this report is to initiate a discussion and bring forth ideas on how Norwegian businesses can resolve environmental problems related to biomass. We trust that businesses in Norway will rise to the occasion and implement the suggested solutions, frameworks, and initiatives to make a significant impact. We believe it is possible, but immediate action is needed. Now.

# Appendix

## Tools for assessing biodiversity impacts, dependencies, and risks

### Sector-level materiality screening

- Encore: A tool to understand the exposure to natural capital risks by identifying how changes in the environment impact the economy, and how business activities affect biodiversity.
- SBTN Sectoral Materiality Tool: A tool to understand the types of environmental impacts that are materially relevant to a company's sector and activities.

### Value chain assessment: state of nature

- WWF Biodiversity Risk Filter: A tool to address biodiversity risks and opportunities within operations and the value chain. The tool includes a module for assessing sector-level impacts and dependencies, and was launched in January 2023.
- Integrated Biodiversity Assessment Tool (IBAT): A tool to help to identify geographical biodiversity risks for projects and sourcing regions and to help develop action plans.
- GLOBIO: A tool that calculates human-induced changes in terrestrial biodiversity expressed by the Mean Species Abundance (MSA) indicator.
- Global Forest Watch: An online platform that provides data and tools for monitoring forests and land use.
- Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST): A model used to report on the supply, use, and value of terrestrial, freshwater, marine, and coastal ecosystem services in a specific territory.

### Value chain assessment: pressures

- Biodiversity Footprint for Financial Institutions (BFFI): A tool that provides a biodiversity footprint of the economic activities in which financial institutions are invested. Its methodology is based on calculating the environmental pressures posed by the investment portfolio or parts of it.
- Bioscope: A tool that offers businesses and financial institutions a simple indication of the key impacts on biodiversity caused by their supply chain or financial products.
- Exiobase: A global database used for analyzing environmental impacts associated with the final consumption of product segments. It is a detailed Multi-Regional Environmentally Extended Supply-Use Table (MR-SUT) and Input-Output Table (MR-IOT).

## Resources for exploring other tools

- Natural Capital Toolkit: A toolkit that lists tools for measuring and valuing natural capital, including a filter of sector-applicable tools (including value chain boundaries).
- Finance for Biodiversity: A guide that presents various approaches for measuring biodiversity, providing an overview and real-life case examples of measurement approaches in use and underway, mainly targeted at financial institutions. Published in July 2022 as a part of the EU Business and Biodiversity project.
- Assessing Portfolio Impact (WWF, 2021): A report that provides an overview of the currently available tools for portfolio investors to measure the environmental impact of their investment portfolios.

Source: ENCORE (n.d.), Science-Based Targets Network (2022), Integrated Biodiversity Assessment Tool (n.d.), Global Biodiversity Model for Policy Support (n.d.), Global Forest Watch (n.d.), Stanford University (n.d.), The Netherlands Enterprise Agency (2021), Bioscope (n.d.), Exiobase (n.d.)

## Appendix 2: Examples of credible certifications

FORESTRY PRODUCTS

**Forest Stewardship Council (FSC)**
Forest products, including paper

SEAFOOD PRODUCTS

**Aquaculture Stewardship Council (ASC)**
Seafood from aquaculture

**Marine Stewardship Council (MSC)**
Seafood from fisheries

AGRICULTURE AND CONSUMER PRODUCTS

**Better Cotton Initiative (BCI)**
Cotton products

**Roundtable on Sustainable Biomaterials (RSB)**
e.g. biobased fuel, textiles, fibres, and plastics

**Roundtable on Sustainable Palm Oil (RSPO)**
Palm oil and palm oil derivatives

**Rainforest Alliance**
e.g. coffee, tea, bananas, and cacao

Source: Forest Stewardship Council (n.d.), Aquaculture Stewardship Council (n.d.), Roundtable on Sustainable Palm Oil (n.d.), Better Cotton (n.d.), Roundtable on Sustainable Biomaterials (n.d.), Rainforest Alliance (n.d.)

# Glossary

**Biodiversity**: the variety of life on the planet, spanning across genetic, species, and ecosystem levels

**Bioeconomy**: the sustainable use of renewable biological resources to produce goods and services

**Biofuel:** fuels using biomass as feedstock

**Biomass:** organic material derived from living organisms, encompassing materials such as plants, animals, and microorganisms – mostly originates from food and forestry value chains

**Biomass footprint:** counts the volume of biomass consumed within a country – including domestic extraction and import but excluding export

**Carbon sequestration**: the process by which carbon dioxide is captured from the atmosphere and transformed, e.g., into biomass through photosynthesis

**Clear-cutting**: practice where all or most of the trees are simultaneously removed in a specific area

**Concentrated feed:** animal feed characterized by its richness in carbohydrates, proteins, digestible nutrients, and low fiber content. Examples include barley, wheat, soybeans, and sugar beets

**Continuous cover forestry:** low-impact extraction practice where forest stands are continuously being maintained in an irregular structure to limit negative impact from logging

**Crop monoculture**: the farming of a single crop or organism

**Decarbonization**: the process of reducing the release of carbon gases into atmosphere

**Degradation** (environmental): the process by which the natural environment is deteriorated in a way that reduces its biodiversity

**Ecosystem:** a community of animals and plants interacting with each other and their physical environment (e.g., soil, water, nutrients, and living organisms in the environment)

**Edible feed conversion ratio**: amount (kg) of feed needed to produce one kg of edible food

**Enteric fermentation:** the digestion process in animals like cows and sheep, where microbes break down food, creating gases like methane

**Manure management:** the handling and treatment of animal waste to reduce environmental impacts, such as greenhouse gas emissions and water pollution, while improving soil fertility and crop production

**Land use change:** conversion of land from one use to another, e.g., forests to farmland, primarily for human use, often leading to the loss of the habitats and animals that were part of the original ecosystem

**Logging**: the process of cutting, processing, and moving trees

**Natural capital:** the world's natural assets, including water, air, all living things, soil, and geology

**Nature risk:** risks related to the loss of nature and natural assets

**Regenerative agriculture:** approach to farming that restores degraded soils and takes environmental factors such as biodiversity impacts into account

**Roughage feed:** animal feed distinguished by its high fiber content and low levels of total digestible nutrients. Examples include pasture grass, hay, silage, and straw

# About WWF and Bain & Company

## WWF

WWF is the world's largest and most experienced independent conservation organization, with over six million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature. The aim is to do this by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable and promoting the reduction of pollution and wasteful consumption.

## Bain & Company

Bain & Company is a global consultancy that helps the world's most ambitious change makers define the future. Across 65 offices in 40 countries, We work alongside clients as one team with a shared ambition to achieve extraordinary results, outperform the competition, and redefine industries. Bain combines tailored, integrated expertise with a vibrant ecosystem of digital innovators to deliver better, faster, and more enduring outcomes. The company's 10-year commitment to invest more than $1 billion in pro bono services brings their talent, expertise, and insight to organizations tackling today's urgent challenges in education, racial equity, social justice, economic development, and the environment. Moreover, Bain has collaborated with clients on more than 1,350 sustainability and responsibility projects over the past five years, covering various aspects such as strategy, operations, investing, disruptive models, and results acceleration.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