



Sustainable growth towards 2050

The journey so far

PwC Seafood Barometer 2021





Photo: Michael Blann

Preface

Dear reader,

At PwC Seafood, we want to use our knowledge to shed light on key industry topics. By engaging in, and raising important questions, we seek to create debate that can contribute to increased value creation from the seafood industry. This aligns with our PwC purpose - to build trust in society and solve important problems.

Our very first edition of PwC's Seafood Barometer, in 2017, we discussed the Norwegian government's ambitious vision towards 2050 - five million tonnes of sustainable aquaculture production. Only ~30% of industry leaders in our seafood survey supported this vision, and our estimates indicated that a production of 3.3 million tonnes would be more realistic. Our analyses and point of views, combined with the industry's foresight, created an important debate about future growth for aquaculture.

Since then, little has been mentioned about the five million vision. Globally, the high level panel for a sustainable ocean economy, led by the Norwegian Prime Minister Erna Solberg, just launched "The future of food from the sea." This is the first in a planned series of 16 blue papers that will set a new ocean narrative for the future. The key takeaway is that better management and innovation in technology can enable a sixfold increase in the supply of food from the ocean, compared

to current levels. Aquaculture has a great potential to grow. Therefore, we wanted to revisit sustainable growth in Norwegian aquaculture - what has changed since 2017, and is the vision of five million tonnes more or less realistic today?

We will present our updated growth prognoses, and discuss major changes since 2017. Sustainability and technology are devoted extra focus as they are important, and potential enablers of future growth. As in previous editions, our insight is shared through PwC's Point of View. The most important insights come from industry representatives, collected through our bi-annual Seafood Survey, which was finalised before the global outbreak of Covid-19.

I hope you enjoy the read, and find inspiration on how to utilise technology and sustainability as strategic advantages in your own (seafood) business. Please contact me if you want to discuss the content.



Best regards,

A handwritten signature in blue ink that reads "Hanne S. Johansen". The signature is written in a cursive, flowing style.

Hanne S. Johansen
Partner
Assurance Bergen

Executive summary

Developments since our first barometer in 2017 call for an update on our growth scenarios towards 2050

We don't believe in the 5 million vision with the current regulatory framework

We agree with the industry. Based on developments the last three years, it is still unlikely that Norway as a seafood nation will reach the vision of 5 million tonnes of aquaculture production in 2050 with today's regulatory framework. In the big scheme of things, three years is not a long time. Still, many initiatives that were started in 2017, have now been implemented. For instance, the traffic light system and new post-smolt production. Development licences have been granted, where a few companies have already harvested their first generation of fish. We've also seen increased investments in sustainability, technology and infrastructure. The aforementioned developments call for an update on where we stand as a world leader in salmon production.

Three updated growth scenarios

The uncertainty of predicting future growth is high, but we have made an effort anyway. Our

three growth scenarios from 2017, pessimistic, base case, and optimistic, have been updated based on new developments in Norway.

The key takeaway? Our optimistic scenario is even more optimistic, it estimates a scenario that exceeds 5 million tonnes in 2050. But let's be realistic, our base case estimates a production of 3.7 million tonnes in 2050. And if we take on the current mood of the global pandemic, which is rather pessimistic, we estimate a worst-case production of 1.8 million in 2050. Let's hope it doesn't come to that.

Aquaculture - not yet on the EU taxonomy radar

The taxonomy will steer capital in the direction of green and sustainable investments. Less capital will be available to activities that are not classified as sustainable in the EU taxonomy. As of now, we do not know when, or what, criteria will be set for aquaculture. It is vital that the industry influences these and position themselves well in advance.

Covid-19 - a black swan?

In 2017, we predicted a "black swan" which could halt the roadmap to 5 million tonnes. A black swan is something so rare that it from a statistical point of view should not exist, yet it turns up from time to time. Covid-19 is the black swan that has halted the value of salmon and trout, short-term.



Photo: Michael Blann

Sustainability and technology, two enablers that can positively impact volume and value growth

Recent developments that have impacted volume or value

The last three years, pre-Covid-19, we've seen historically high investments in line with sky-high salmon prices. The limitations to grow in Norway, primarily due to sustainability concerns, has "forced" the industry to be more innovative in order to grow in value or volume.

In 2020, a majority of industry representatives confirmed through our survey that they would invest heavily in new technology to improve biology, sustainability and profitability. Since 2017, we've seen investments to decrease emissions, in feed and technology. We've also seen the industry becoming increasingly more focused on sustainability. Other developments since 2017 can be seen in how the industry combats sea lice, and a new segment, called stun and bleed vessels, has sprung out of high mortality rates and the need to improve fish welfare. Land-based aquaculture is the new "promised land," but is it a risk or an opportunity for Norway as a seafood nation? And perhaps data collection and advanced analysis will create giant production leaps this decade?



Photo: Michael Blann

Recent developments, and enablers, on the path to 5 million tonnes of aquaculture production in 2050:

Sustainability



Sustainable production as a driver - key to increased seafood demand



Maturity in sustainability is increasing, but we're not quite there yet



Increased emissions in aquaculture - potential to eliminate air freight



Increased attention to climate risk

Technology & infrastructure



Combatting sea lice with a combination of treatments



Land-based projects, at-home and abroad, opportunity or threat?



Stun and bleed vessels can increase harvest volume and value



A movement from reactive to proactive decision making

- **The industry now views sustainable production as a top** driver for increased seafood demand, a big shift since our barometer in 2017
- **The industry is not fully mature when it comes to sustainability**, but we see an overall increased focus on improving sustainability
- **The industry worries about climate risk**, and is already experiencing the effects of climate change
- **The carbon footprint of Norwegian salmon has increased**, mainly due to increased mortality and reduced growth
- **Sea lice are still the main reason for volume growth stagnation**, but the focus has shifted from a belief in a few delousing methods to a combination of many methods
- **The new segment, stun and bleed vessels, has improved value creation and sustainability**, and have saved an estimated 52.5 million meals, and fish worth approximately 600 million NOK in 2019
- **Ambitious land-based projects close to end-markets**, can represent a capital flight of 65 billion NOK, and a potential threat to Norway as the global leader in salmon and trout
- **A subtle change from reactive to proactive decision making** by investing in data platforms and advanced analysis

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Photo: Michael Blann





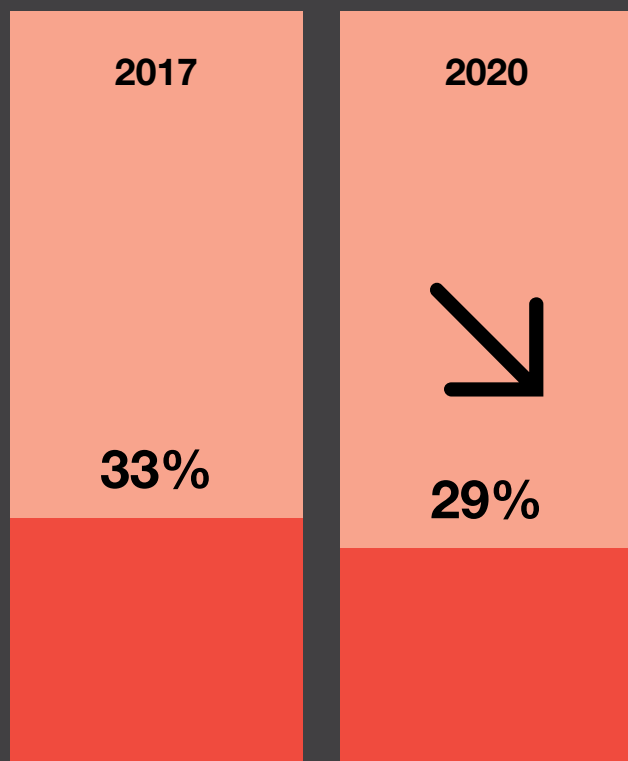
Growth:

The vision of 5 million tonnes of aquaculture production is still unlikely

01

Slightly less belief in the 5 million tonnes production vision in 2020 compared with 2017

Fewer respondents in 2020 (from 33% to 29%) believe that the Norwegian production of salmon and trout will reach 5 million tonnes in 2050. **PwC's seafood survey**



«If the industry is to grow, we must use sustainable technology that allows the industry to develop gradually from where it is today.»

Industry representative, PwC's seafood survey

Although uncertainty of predicting future growth is high, recent developments have inspired us to update our 2017 growth analysis

Stagnation in production volumes since 2012

Following a period of rapid growth from 2008 to 2012, the industry has experienced a stagnation in production volumes. Fish welfare challenges, and particularly stricter regulation on lice levels, have caused decrease in MAB*-utilisation of existing licenses.

It's time to update our growth scenarios towards 2050

We have seen several changes since our first barometer in 2017. The traffic light system has been adjusted, including two auctions for capacity. The Directorate of Fisheries has finalised the evaluation of development licenses. We have also seen the realisation and planning of new post-smolt and land-based, full-cycle projects. These adjustments call for an update on our 2050-production estimates.

Uncertainty of predicting future growth is always high

In reality, the uncertainty of future, sustainable growth is high and depends on many variables, including: 1) the success of new production technologies like closed cages and offshore farming, 2) cost efficiencies of new production technologies, 3) government initiatives, and 4) development in fish welfare challenges. Development in future traffic light indicators must be positive, and new licenses must be granted.

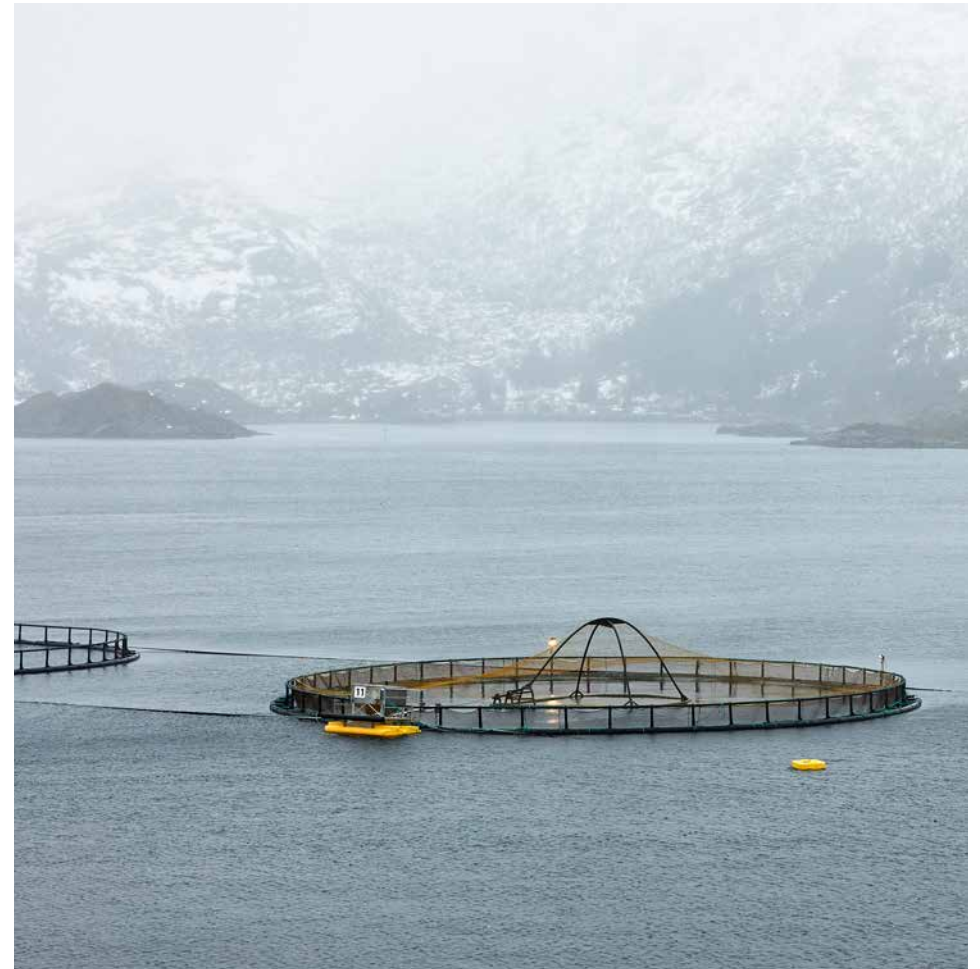


Photo: Michael Blann

Our updated growth scenarios support the industry’s lack of optimism on future growth

The industry is a little less optimistic about the 5 million tonnes vision in 2020

We have seen a slight decline in the optimism on the question: “Will the Norwegian production of salmon and trout reach a production volume of 5 million tonnes (WFE*) in 2050?” In 2020, 29% of respondents answered “yes” when asked if the 5 million tonnes vision is realistic, versus 33% in 2017.

The optimistic scenario exceeds 5 million tonnes in 2050

The **optimistic scenario** assumes three main growth drivers: 100% green lights from the traffic light system, on-land post-smolt with average weight of 1 kg in 2050, and land-based, full-cycle production accounting for approximately 50% of Norway’s current production. In this highly optimistic scenario, we are able to reach a production volume of 6.3 million tonnes WFE in 2050.

The current base case exceeds the 2017-base case

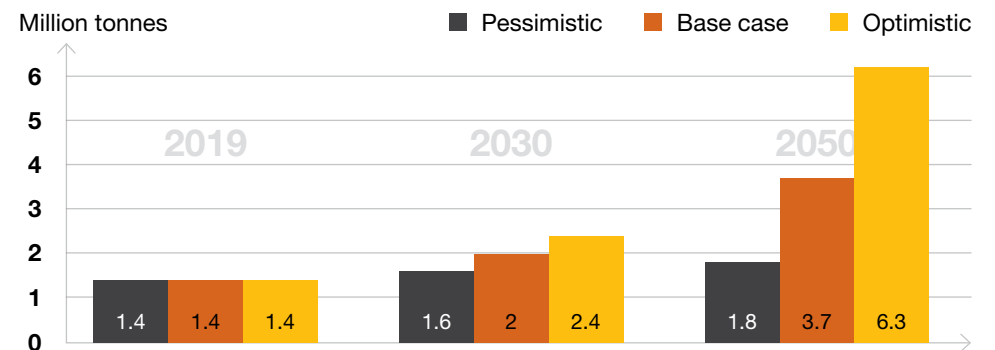
The **base case scenario** assumes main growth from the traffic light system, at approximately 50% green lights, and moderate investment rates for land-based, full-cycle production. The optimistic and base case scenarios assume low to moderate growth from improved operations, and low growth from new licences in open net pens (not included in traffic light growth). Growth from new licenses is expected to come from onshore, offshore and closed sea-based systems, though at higher rates in the optimistic scenario.

*WFE: Whole Fish Equivalent

The pessimistic scenario is a little less pessimistic this time around

As in 2017, the **pessimistic scenario** assumes that biological conditions improve very slowly, and that the shift towards use of new technology is slow, resulting in limited growth from new licences with new technology (closed containment, offshore and on-land). The traffic light system provides little or no growth as there are several red zones reducing MAB throughout the forecast period. We assume no improvements in mortality and harvest weight. The only difference is a marginal growth between 2017 and 2019 that we did not foresee in 2017.

Three growth scenarios towards 2050



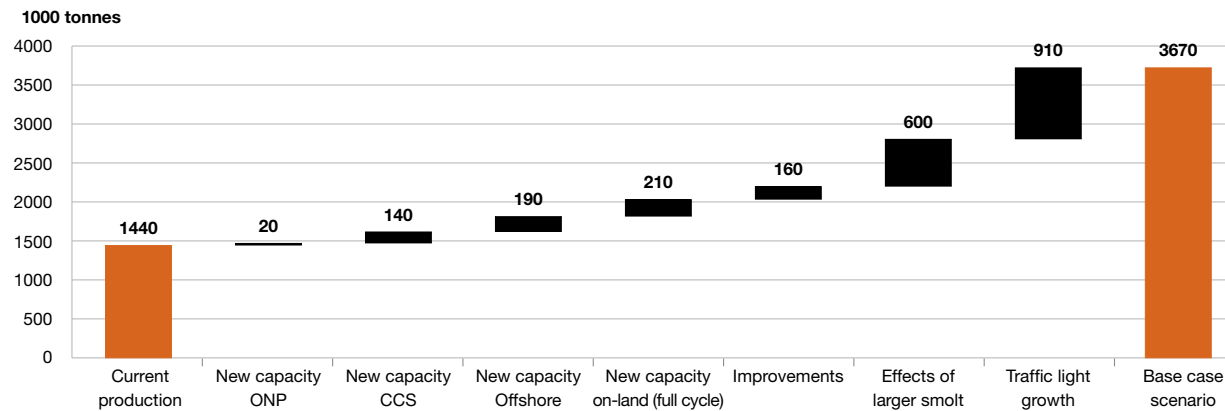
Source: PwC analysis

PwC’s point of view:

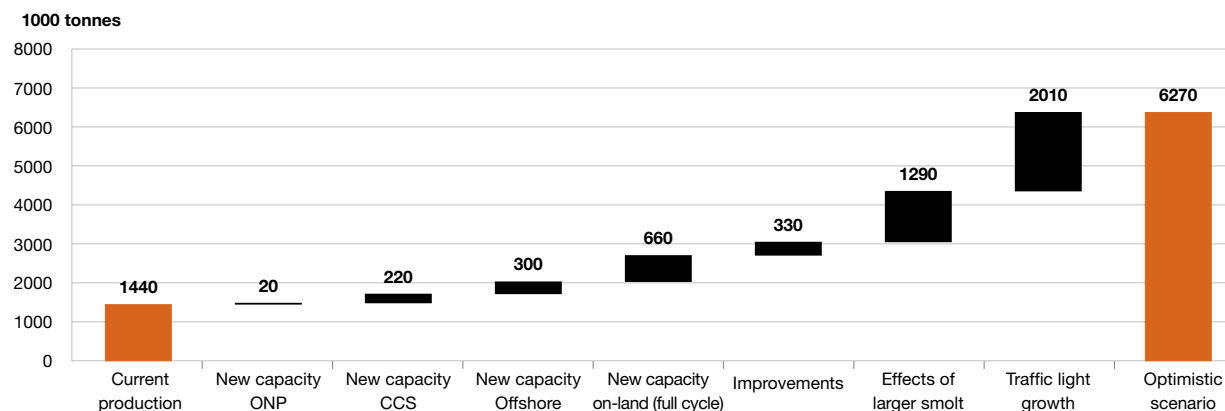
The decline in optimism is in line with our point of view, and without significant regulatory changes or incentives to facilitate further growth, we still believe the vision of 5 million tonnes is unrealistic.

Further volume growth in Norway strongly depends on government initiatives and MAB utilisation in the 13 production areas

Base case: bridge from current production to 2050



Optimistic case: bridge from current production to 2050



Based on our current knowledge, we expect volume growth to come from larger smolt and stable traffic light growth

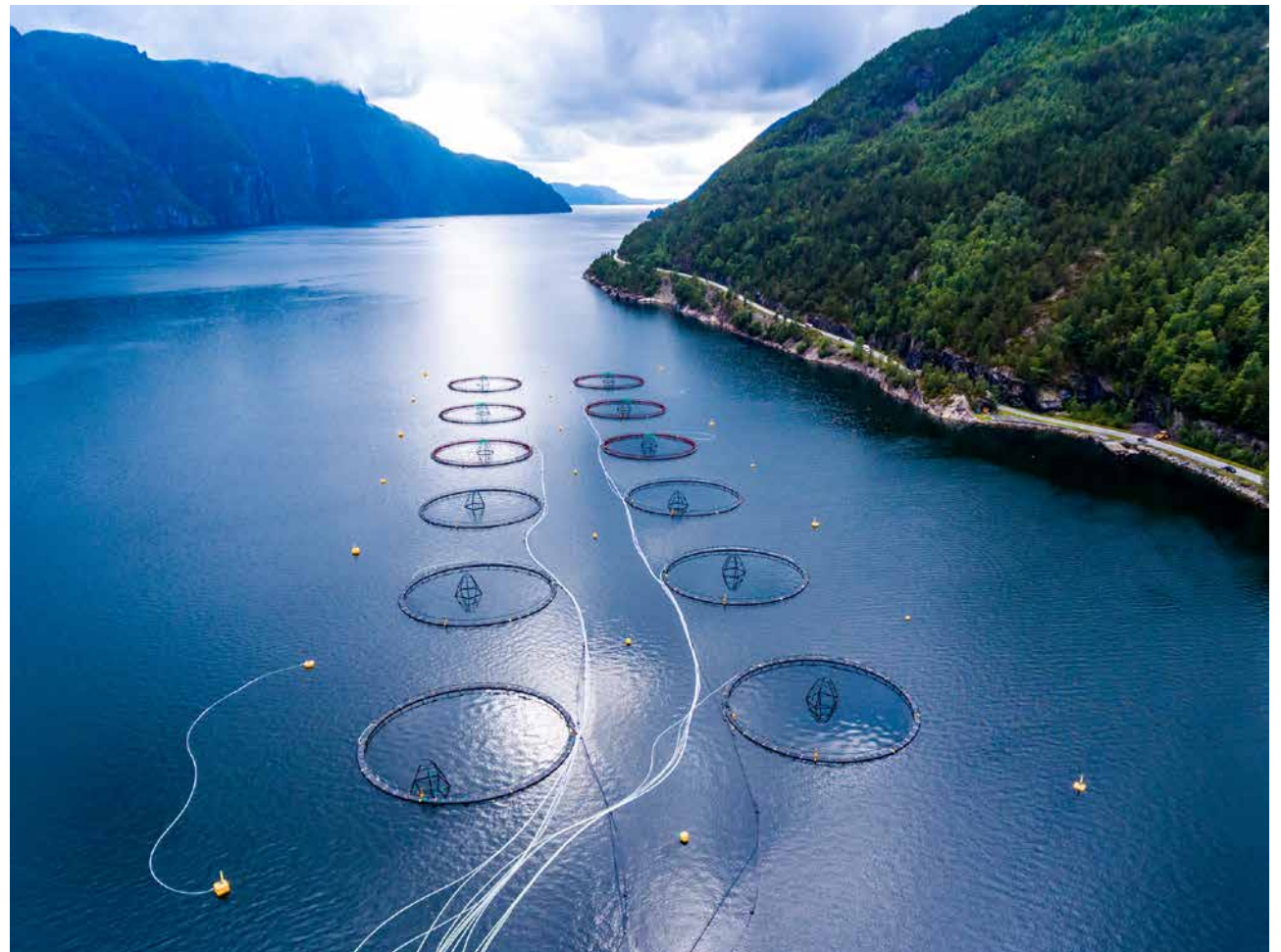
In our base case, our updated estimates for 2050 is about 400,000 tonnes above the 2017-calculations. This is mainly due to our strengthened belief in smolt production developments which increase MAB utilisation. However, we have calculated a considerably lower approved license volume for development licenses than estimated in 2017. Only 77,000 tonnes MAB have been granted in this round, and although it is expected that new schemes will follow, the bar set by the Directorate of Fisheries has made us more pessimistic about growth from such schemes.

We still see a great focus on land-based, full-cycle projects, and we expect a rapid increase in land-based production this decade.

Our estimates for traffic light growth are in line with our 2017 estimates; our base case sees an average total growth rate of 3.3% per evaluation (every second year). We have seen high demand for production capacity growth for the two periods, with an average auction price of approximately NOK 194,000 per tonne MAB for the 2020 auction.

Can open net pens facilitate this rate of growth?

It is highly debatable that open net pens in the fjords are capable of facilitating this rate of growth. We expect future growth to be found in more expensive, semi-closed systems. This will increase production costs and is expected to have a negative effect on the auction price for new capacity. In our 2020 survey, we see an increase in the expected production technologies from open net pens in the ocean to alternative production technologies.



Sustainability:

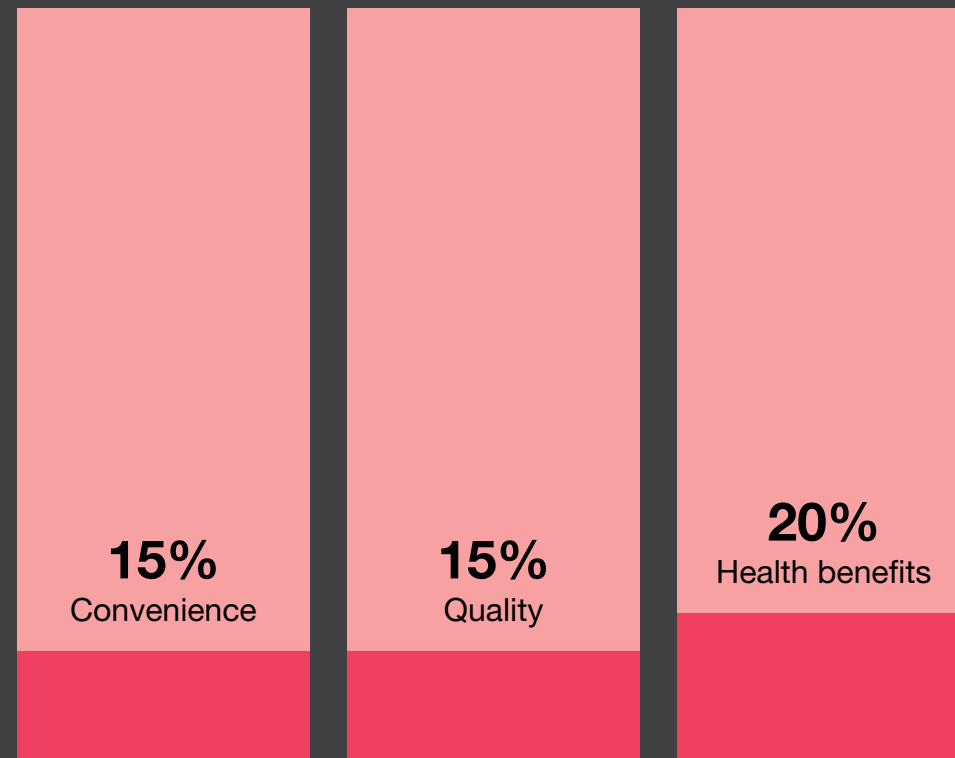
From words to action - an overall improvement since 2017

02

The industry now views sustainable production as a top driver for increased seafood demand - a big shift since 2017

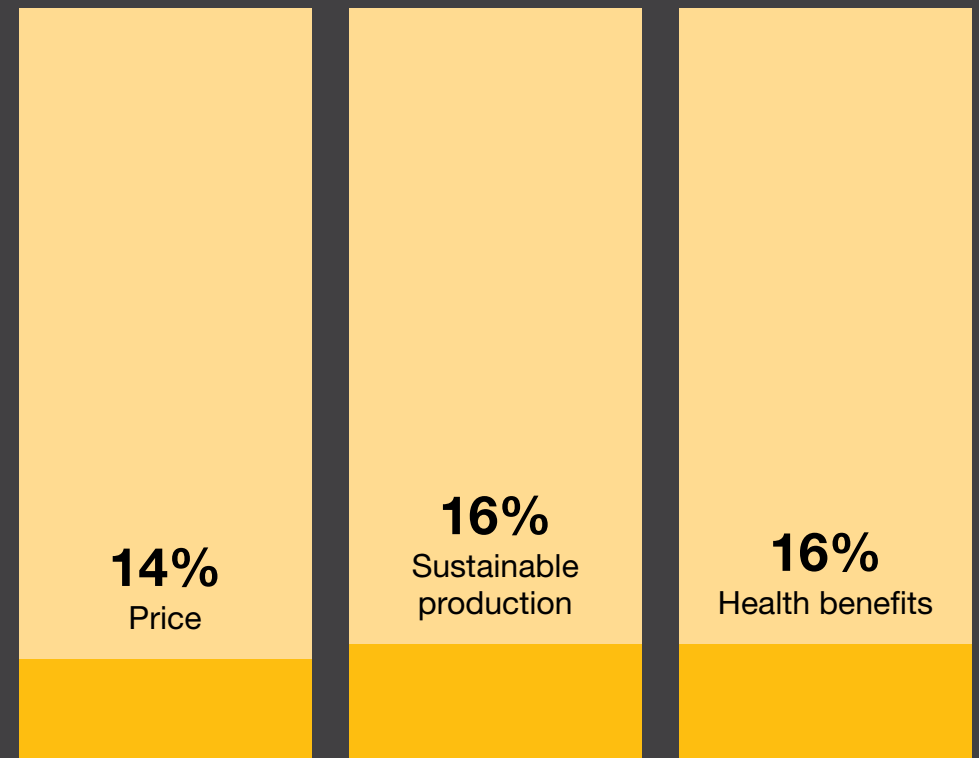
Top three drivers in 2017 for increased seafood demand

Sustainable production was not viewed as an important driver for increased seafood demand, and was placed as one of the bottom three drivers (10%) in 2017. **PwC's seafood survey**



Top three drivers in 2020 for increased seafood demand

A majority of respondents view sustainable production as one of the most important drivers for increased seafood demand, in 2020. **PwC's seafood survey**



Sustainability, higher on the agenda in 2020, and viewed as an important driver for increased seafood demand

Sustainability is higher on the agenda now compared with 2017

Companies that excel in sustainability have higher operating margins and returns, and lower volatility - and aquaculture is catching on.

Our survey indicates that the industry now views sustainable production as a top driver for increased seafood demand. In 2017, however, drivers such as health, quality, convenience and availability were viewed as more important.

Large Norwegian salmon producers top global sustainability ranking

When comparing SDG-scores* of the largest Norwegian salmon producers in 2017 and 2020, there has been a slight improvement in reporting and transparency (PwC's Sustainable 100-index). Mowi, Lerøy and Grieg have performed well on ESG-issues** and have dominated the Collier FAIRR protein producer index every year since its launch in 2018.

Small to medium farmers call for a common framework on sustainability

In 2018, the Norwegian Salmon Group network launched their feasibility study on sustainable farming. They see a need for knowledge based, honest indicators and criteria that can be used across the



Photo: Michael Blann

«The company already has significant investment plans for the next 4-5 years. It's embedded in the company's plans for sustainable development - financially, socially and environmentally.»

Industry representative, PwC's seafood survey

«Today's solution is not sustainable with desired growth. If larger coastal areas are to be used, we must use sustainable technology for fish welfare and the environment.»

Industry representative, PwC's seafood survey

whole aquaculture industry. This way, it will be clearer where the real challenges lie and how the individual company compares. The same year, Lingalaks was the first farmer in the network to launch their own sustainability status report.

Aggregated data on sustainability publicly available in new portal

Another important change since 2017, is the launch of the "Sustainability in Aquaculture" web portal* by Nofima, Sintef Ocean and BarentsWatch. The aim is to make aggregated data on environmental, economic, and social sustainability in Norwegian aquaculture more accessible to everyone, by reporting, year on year, certain sustainability indicators.

Source: *<https://www.barentswatch.no/en/havbruk/>



Photo: Michael Blann

PwC's point of view:

For Norway to reach its 5 million tonnes vision, we believe it is vital for companies, NGOs, and government, to better balance the three pillars of sustainability (economical, social, environmental). It goes without saying that sustainability issues prevent the industry from growing. Only when important stakeholders, that have been polarised on how to tackle sustainability in aquaculture, agree on a way forward, can Norway as a seafood nation begin to realise the very ambitious growth vision of 5 million tonnes.

The first hand-value of salmon represents the most significant leap in economic sustainability since 2017

The most significant, positive change in sustainability indicators is the improved first-hand value of salmon

Are there any key takeaways in the “Sustainability in Aquaculture” web portal? Selected indicators that are publicly available with development from 2017 to 2019 can be seen in the figure. There has been a slight decline in the number of farm locations with diseases, and the economical feed conversion ratio has decreased. Although not a huge leap, it still represents a positive development. The amount of Global GAP, ASC and Debio certifications have increased, and the first-hand value of salmon grew by NOK 7 billion from 2017 to 2019.

Upward trend in mortality and escapes

Unfortunately, there has been an upward trend in sea lice, salmon escapes and mortality from 2017 to 2019. This development in escapes and mortality is most likely triggered by increased lice treatment and complex technical operations by the net pens.

Non-exhaustive list of sustainability indicators (2017 - 2019)

Indicator	2017	2019	Trend
Mortality	15%	16%	↗
Salmon lice*	21.6 locations	23.3 locations	↗
Salmon escapes	17,000 salmon	300,000 salmon	↗
Disease	139 locations	124 locations	↘
Discharge status	Approx. same	Approx. same	—
Economic FCR	1.34	1.30	↘
First-hand Value salmon	61 Billion NOK	68 Billion NOK	↗
GAP Certifications**	91 companies	104 companies	↗
ASC Certifications***	12%	19%	↗
Ecological Certifications****	40 companies	52 companies	↗

Sources: Barentswatch.no, Kontali, Statistics Norway. Note: *Aquaculture sites above threshold - on average per week, **Number of companies, Global GAP, ***Percentage of certified locations in Norway, ASC-certification, ****Number of companies, Debio

Climate risk keeps the seafood industry awake at night

Why care about climate risk?

Climate change, and society's increased focus on it, is a climate risk that can affect your company's goal achievement. Therefore, climate risk must be understood in the same way as all other business risks that are assessed and measured. Climate risk is normally divided into physical risk, transition risk and responsibility risk.

Physical risk is damage as a result of climate change, either acute events (storms, floods, etc.) or chronic changes (temperature rise, sea level rise, and drought).

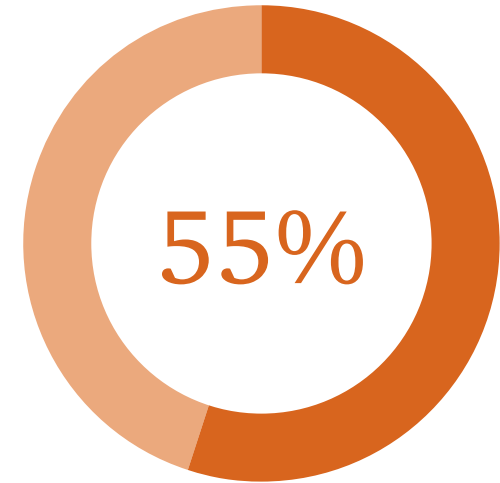
Transition risk is the risk of societal changes as a result of climate change (e.g. climate-smart technology, new expectations from customers and other stakeholders, changes in laws and regulations, and reputational risk if an organisation does not care about the climate).

Responsibility risk concerns who is responsible when something is destroyed due to climate-related incidents, mainly related to legal issues.

Which climate risk factors worry the industry?

The industry believes that increased sea temperature and more frequent extreme weather will be the most important climate risk factors in the future. Both are related to physical risk: Rising sea temperatures are considered a chronic change, whilst extreme weather occurs as acute events.

According to our survey, several other risk factors will become more important in the future. For example, increased consumer requirements and changes in regulatory climate, and environmental requirements. These factors are linked to transitional risk.

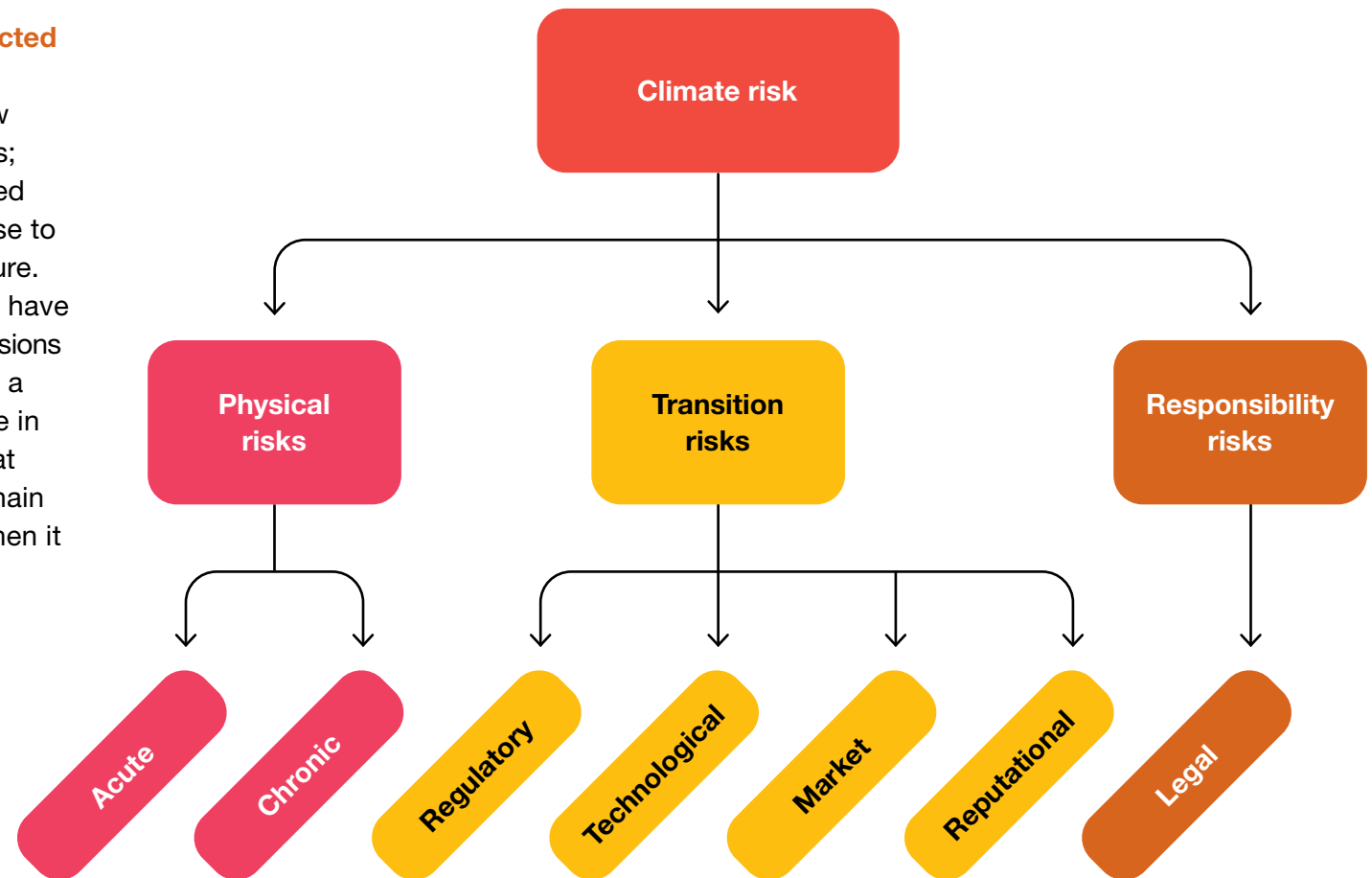


believe that climate risk will affect the Norwegian seafood industry in a negative direction over the next 20 years

PwC's seafood survey

Aquaculture's sleep quality is more affected than fisheries'

Aquaculture has already experienced how climate change affects farming conditions; more frequent extreme weather at exposed locations and landslides dangerously close to wiping out smolt facilities and infrastructure. Both aquaculture and the fishing industry have taken steps to reduce greenhouse gas emissions in recent years. While fisheries have seen a decline, aquaculture has seen an increase in emissions. Adding to the challenge, is that aquaculture has a more complex value chain in the climate risk picture, for instance when it comes to fish feed.



The carbon footprint of Norwegian salmon has increased, mainly due to increased mortality and reduced growth

Increased interest in feed with novel ingredients, and debate on soy

Scalability of novel ingredients are increasing as farmers are testing feed with algal oil and insect meal. The rationale is to become more sustainable and less dependent on fish oil, and to stand out in the market (as first movers).

There are two fractions in the debate on sustainable soy in feed. One fraction sources ProTerra-certified, GMO-free soy from Brazil, arguing that a ban will worsen deforestation in the country. Another fraction has replaced Brazilian soy with European, arguing that, although more expensive, it improves the feed's carbon footprint and decouples it from deforestation risk and claims.

The first climate neutral farmer

The most urgent political goal is to reduce our carbon footprint. Eide Fjordbruk became the world's first climate neutral farmer in 2020, by investing about 10 million NOK



Photo: AdobeStock

in electrification, buying local, clean energy, sourcing feed with European soy, and compensating for own emissions by supporting carbon-reducing projects.

Overall, the aquaculture industry has increased its emissions since 2009

While fisheries have managed to reduce greenhouse gas emissions, aquaculture's emissions have increased (kg CO₂e/kg edible product delivered to wholesaler). This is

«There is no doubt about the facts: in order to reduce climate change, we must all stop using aircraft to transport goods.»

Atli Gregersen, CEO, Hiddenfjord

mainly due to increased mortality and reduced growth, which in turn has led to increased feed use and lice treatment.

Reducing or changing mode of transport can heavily impact emissions. Approximately 81% of fish for consumption was exported (HOG*) out of Norway in 2017, and about 20% of fresh salmon was transported by air in 2020. Air freight emits about 50 times more CO₂ than sea freight. By using sea freight, and increasing pre-rigor filleting in Norway, salmon could become a more sustainable food choice abroad. In 2020, Faroese farmer Hiddenfjord was the first aquaculture company, globally, to stop the use of air freight of fresh salmon, which has reduced their CO₂-emissions from international shipping by 94%. A new independent consumer survey in the US shows that Hiddenfjord's salmon have maintained the same quality, and they expect to attract interest from new customer segments.

PwC's point of view:

In our 2019-barometer, we calculated that the industry could potentially reduce its emissions by half if all salmon (HOG) was filleted as pre-rigor in Norway before export. An additional, proactive step would be to use sea freight instead of air freight. We see an increased focus and pressure by governments to decrease emissions, and we would advise all aquaculture companies to start calculating their emissions throughout the value chain (direct and indirect) and set concrete goals for reduction. Prevention is better than cure.

The Norwegian government is forcing the industry to become more environmentally sustainable

Governments push companies to become more sustainable

Not just consumers drive sustainability. Governments play an active role in disrupting the industry, sometimes with unintended effects. In 2020, we've seen the implementation of the traffic light system, where two zones are forced to reduce production due to lice levels above the permitted threshold.

The government is currently reviewing the disease infection risk of holding pens next to harvesting facilities. They're also proposing to standardise discharge regulations for fish farms, which can lead to stricter documentation requirements.

Perhaps the changes that will affect farmers the most, are the proposed new regulations on lice. In addition to the existing lice limit per location, there will be a lice limit per net pen. Fish can only be treated if a veterinarian or fish health biologist has found the treatment justifiable, and must be transported by closed

vessels if the unit's lice number exceeds the location's lice limit.

The circular economy is "on a roll"

The circular economy is slowly replacing the linear economy. Three principles are central. The first is to restore natural systems by protecting and actively improving the environment. The second is to minimise waste and pollution by designing products and services in a new way. The latter is to keep products and materials in use for as long as possible.

The government wants Norway to become a pioneer in developing a circular economy. The knowledge base for the national strategy has recently been developed, and aquaculture has been identified with an especially large potential for increased circularity. Increased production of novel ingredients for feed, increased utilisation of byproducts, optimised production through new technology and big data, and increased collection and recycling

of nutrients, are listed as opportunities. One recommendation in the knowledge base-report, is to strengthen regulatory requirements for the collection of discharge.

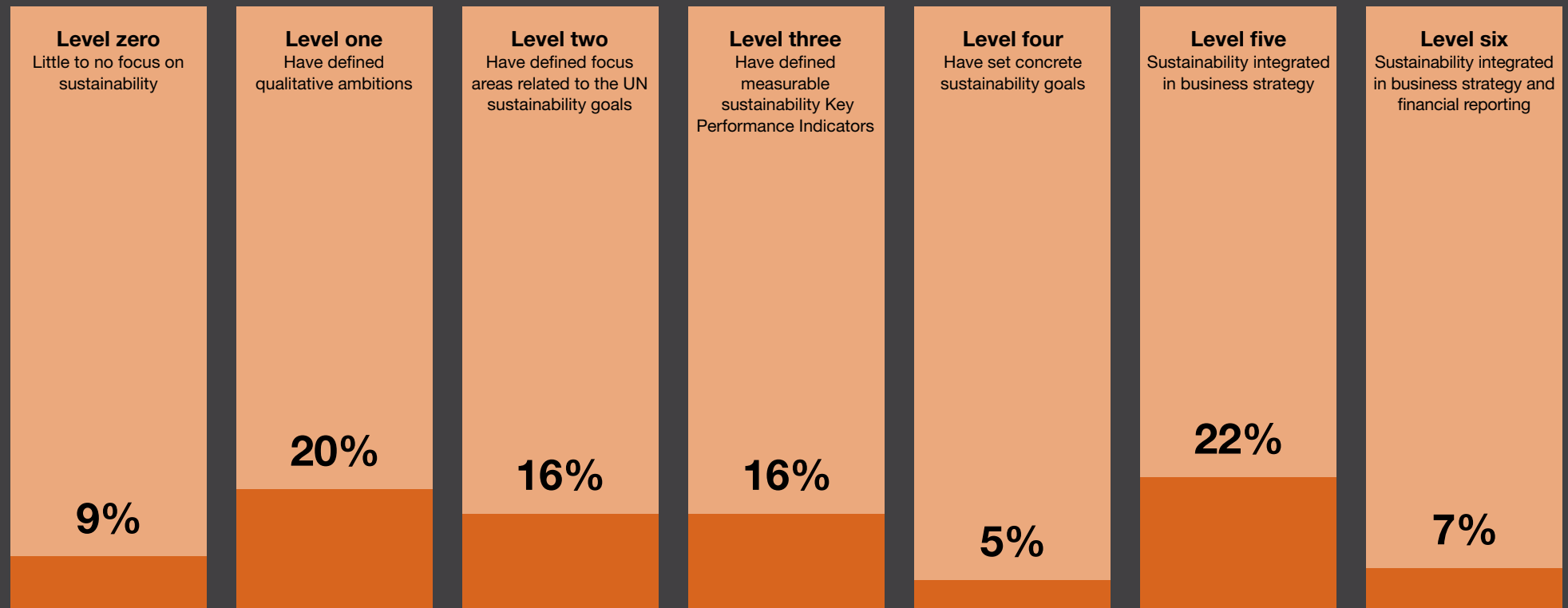


Photo: AdobeStock

Not yet fully mature when it comes to sustainability

Question: How mature is your company on sustainability?*

PwC's seafood survey



*5% answered «I don't know» to this question

Two-thirds of respondents in our survey have not made sustainability an integrated part of their business strategy

All companies, have knowingly or unknowingly, taken a position on sustainability

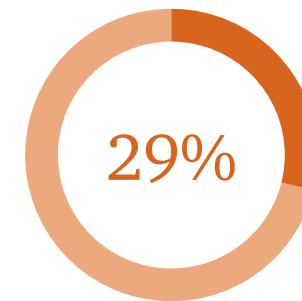
We asked the industry: How mature is your company on sustainability? About 9% report that they have no, or little, focus on sustainability. About 36% report that they have qualitative ambitions and/or focus areas, and about 21% have defined KPIs* and/or concrete goals. About 29% have integrated sustainability in their business strategy.

Perhaps without knowing it, you've already taken a stance. Let's use sea lice as an example. Companies that have little focus on sustainability, mainly follow laws and regulations. For example, by keeping lice levels below the threshold limit. The next level up, is risk management. You focus on reducing risks and protecting your reputation, but this has little impact on your strategy or business model. For example, by moving away from chemical lice treatment.

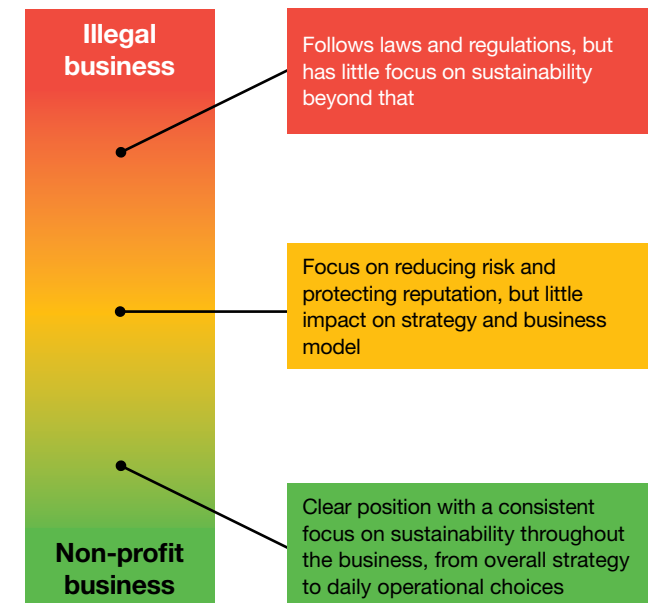
The highest level is strategic sustainability, where the focus on sustainability permeates your entire business. For example, if you decide to move away from the traditional way of farming in open net pens by investing in closed containment systems in sea, as a way of ridding your salmon of lice.

Strategic sustainability can reduce your costs and create new revenue streams

There are many advantages of approaching sustainability in a strategic way. The lowest hanging fruit is increased efficiency and reduced costs. For example, by electrifying all your farm locations in sea. Perhaps the most attractive, and most challenging benefit to achieve, is to facilitate growth, new revenue streams and customer loyalty. Ecological salmon is a trend that is catching on, and one that can create new revenue streams if successful.



report that sustainability is integrated in their business strategy
PwC's seafood survey



What does it take to be strategically and holistically sustainable?

Holistic and strategic sustainability, what does it take?

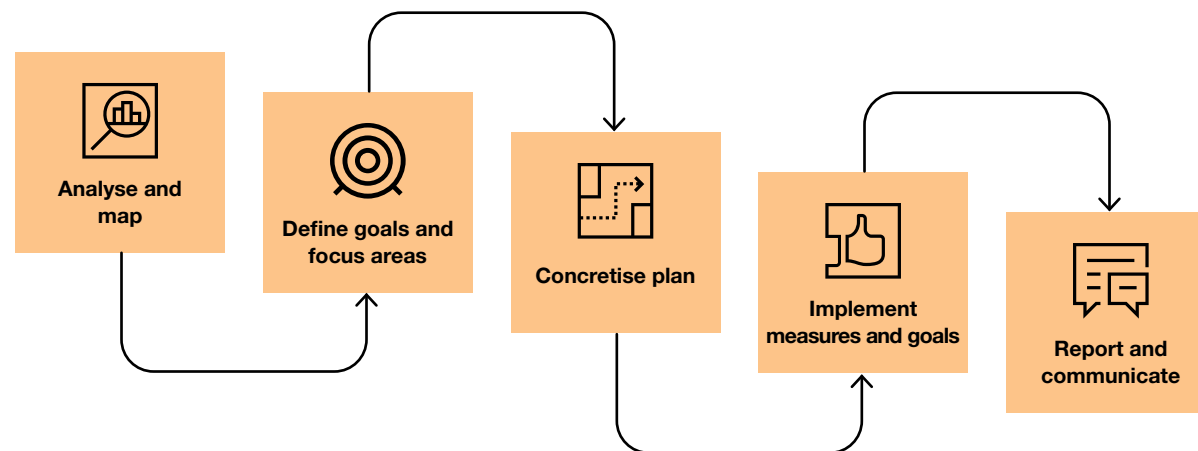
Becoming strategically sustainable is a long-term commitment. But where to start? A holistic approach to sustainability builds on stakeholder engagement; thus begin by analysing which stakeholders are significantly affected by your activities, for example customers, employees, NGOs, owners, and local community. Then analyse what sustainability topics are important to you and

likewise to your stakeholders, by defining the material sustainability topics.

Analyse where the largest sustainability impacts are in your production process and value chain. For instance, where are the carbon emission hotspots in your value chain? Marine littering, where and when does it occur? Escapes, how often and why does it happen? Plastic usage?

Define goals and focus areas that are specific, measurable, achievable, relevant and time-bound, and concretise them into a realistic plan and roadmap.

Unfortunately, many perfectly good plans end up in a drawer. Ensure that your goals and Key Performance Indicators are implemented and communicated to stakeholders. Reporting progress, year on year, will improve loyalty and transparency.



PwC's point of view:

If the remaining two-thirds, that have not yet made sustainability an integrated part of their business strategy, become strategically sustainable, we believe this will contribute positively towards the 5 million vision. Why? Because new opportunities to grow volume or value will spring out of their new strategic focus, which can facilitate growth, new revenue streams, and customer loyalty.

Aquaculture - not yet on the EU taxonomy radar, possibly resulting in less available capital for the industry

The taxonomy will steer capital in the direction of sustainable investments

The EU taxonomy, launched in 2020, is the very foundation of EU's Action Plan for sustainable finance. It is a tool that can help investors, companies, issuers and promoters navigate the transition to a low-carbon, resilient and resource-efficient economy. The taxonomy determines what can be defined as sustainable activities for investment purposes in the EU.

In order to be considered sustainable, an economic activity must: 1) substantially contribute to one or more of the EU's six environmental goals, 2) not do any significant harm to the remaining environmental goals, and 3) meet minimum criteria for social conditions and management.

The six environmental goals are: climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular —

economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems.

Companies that contribute to emission reduction and to slow down climate change will be the winners. The taxonomy will steer capital in the direction of green and sustainable investments, which applies to both private and public capital. This means that less capital will be available to activities that are not aligned with the taxonomy.

Aquaculture - not yet on the EU taxonomy radar

The technical expert group (TEG) has prioritised sectors that have the greatest potential to reduce EU's greenhouse gas emissions. Sustainability criteria have not been defined for any type of aquaculture, and aquaculture is yet to be evaluated. Additional sectors will be gradually covered by the taxonomy. However, the technical screening criteria related to the environmental

goal on use of water and marine resources will be published in March 2021. They will most likely set the standard for a number of aquaculture-specific requirements.



Photo: AdobeStock

«It is central to Mowi, and other listed companies in the Norwegian aquaculture industry, that aquaculture companies are considered sustainable according to the EU taxonomy framework. Therefore, it is important that aquaculture is included in EU's further work, and that good criteria are developed for what is considered sustainable and responsible.»

Ola Helge Hjetland, Mowi - interview in iLaks

Can aquaculture use the same taxonomy screening criteria as for agriculture?

PwC's point of view:

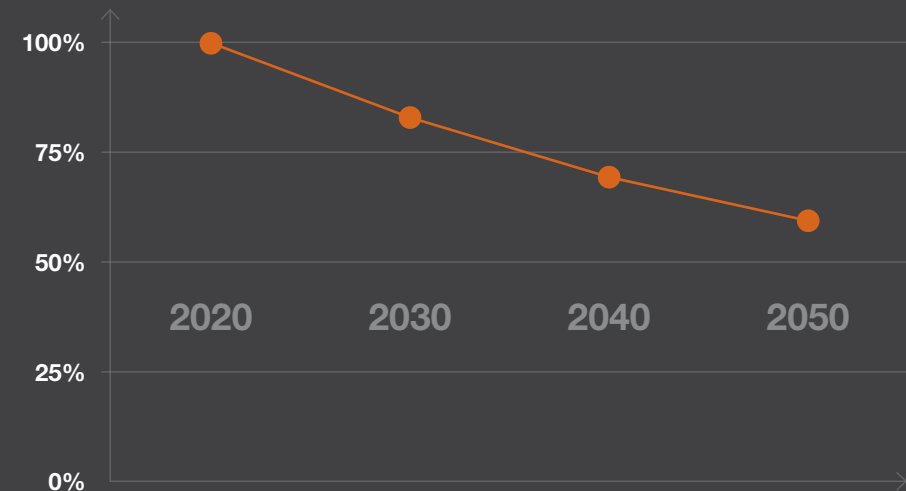
We do not know what the requirements for aquaculture will look like; but in agriculture, the screening criteria are primarily based on having a strategy to reduce emissions over time, whilst maintaining land-based ecosystems and soils. A good overview of greenhouse gas emissions and a strategy for decarbonisation would prepare a company for the introduction of similar climate criteria for the aquaculture sector.

Aquaculture has a strong climate argument compared to beef and various other farmed food products. However, it is not unlikely that the origin of the feed may play a role. Feed from fish stocks that are overexploited or from species that may be used directly for human consumption, may be negative criteria.

There are some guidance in the criteria for “organic salmon.” But at present, there are no clear signals as to how these criteria will be put together and when published. It is essential that aquaculture companies work together to influence them, and position themselves well in advance. The disadvantage to Norwegian aquaculture is that Norway is not a member of the EU, and the industry may lose its right to be called “green” by the taxonomy.

We call on Norwegian politicians, and members of the industry, to come together and lobby the EU technical expert group. Especially if Norway as a seafood nation is serious about reaching its 5 million tonnes vision for 2050.

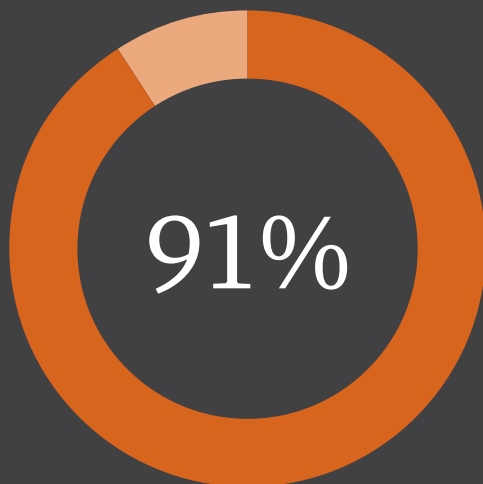
Emission reduction for agriculture in the EU:



Technology and infrastructure:

Increased investments in vessels, land-based aquaculture, and data collection tools since 2017

In 2020, a majority of the industry would invest heavily in new technology to improve biology, sustainability and profitability



state that it is likely or very certain that they will invest **heavily in new technology**
PwC's seafood survey

«The industry undergoes rapid development and the set requirements mean we must invest in new technology.»

Industry representative,
PwC's seafood survey

«New technology and methods must be used to improve biological operations and reduce production costs.»

Industry representative,
PwC's seafood survey

«During the last five years, we have invested significantly in electrification of barges and boats, laser technology, processing boats, and emergency preparedness for lice handling, and this will only continue in the coming years.»

Industry representative,
PwC's seafood survey

«Investments in machines/ robots to improve profitability and to increase production/volume, not lay off employees, is necessary for Norway, with our wage level, to compete against foreign competitors. Then it is quality, efficiency and delivery rate that count globally.»

Industry representative,
PwC's seafood survey

Historical investments in aquaculture have increased in line with sky-high salmon prices, driven by biological challenges

Environmental and fish health challenges, high prices, and new regulations drive aquaculture investments

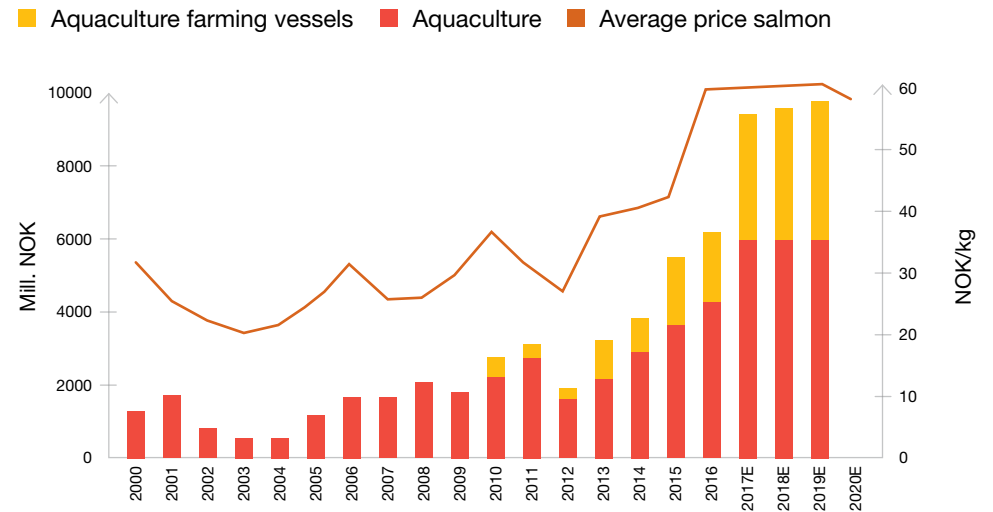
For the fourth year in a row, 2019 was a year of high profitability in the aquaculture industry, with record high prices. This alongside handling environmental and fish health challenges, and new regulations for hatcheries and lice control, represent important drivers for investments in the industry. These investments, however, can be challenged by cost-efficient, land-based or offshore farms, solutions to the salmon lice problem, as well as larger and more robust smolt that decrease production time in sea.

Regulations, treatment frequency, drug resistance (lice) and mechanical treatments drive investments in vessels

There has been a massive investment increase in farming vessels.* These investments are driven by stricter lice regulations, increased treatment frequency, drug resistance (lice) and transitions to mechanical treatments. In recent years, a discussion about taxation of the aquaculture has emerged. An increase in taxation can dampen investment and innovation, redirecting investments to other countries. Other challenges for future investments may be affected by uncertain or changed framework requirements, increased bureaucracy, and the complexity of dealing with fragmented regulatory bodies.

Sources: NORCE, PwC analysis. Note: *Farming vessels: service vessels, wellboats, stun and bleed, harvest boats

Gross fixed capital formation in aquaculture and aquaculture farming vessels (figures in mill. in current prices) and average salmon price in NOK/kg



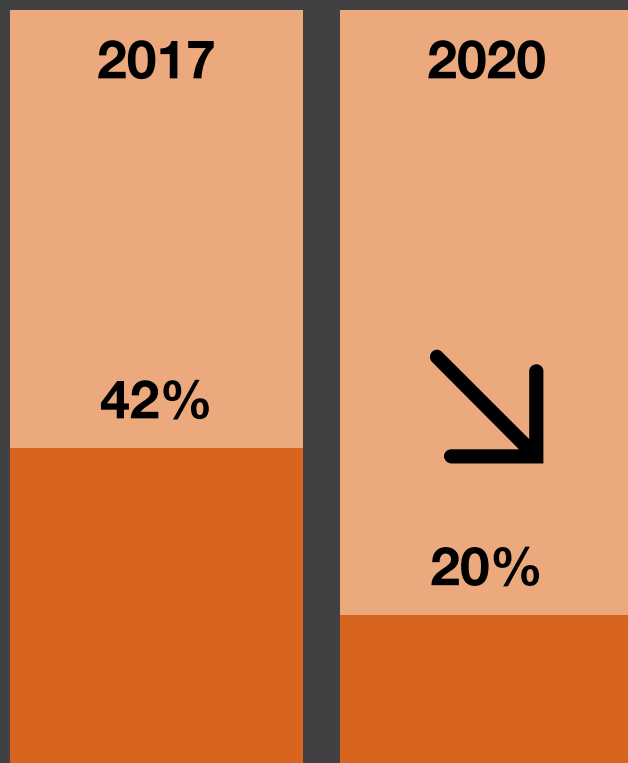
Figures for 2017-2019 are estimates based on interviews by NORCE with the aquaculture industry. Investments in aquaculture include: smolt and post-smolt, grower fish in sea, and excludes land-based grower fish.

PwC's point of view:

How will salmon prices affect investments in the future? As investments in aquaculture increase in line with the development in salmon prices, can we predict a decline in future investments due to a negative trend in salmon prices as a result of Covid-19? Suppliers in the aquaculture industry acknowledge that low salmon prices have given «some uncertainty» about customers' willingness to invest. It may be natural for the willingness to invest to decline somewhat in the future given the uncertainty in the market. However, farmers have built a solid buffer over several years with good earnings. Thus, the willingness to invest should not completely disappear.

Less belief in biological treatment as delousing method in 2020 compared with 2017

Fewer respondents in 2020 (from 42% to 20%) believe biological treatment will be the most important delousing method the next five years. **PwC's seafood survey**



«We believe in a combination of several delousing methods and preventive measures.»

Industry representative, PwC's seafood survey

Lice control drives technology investments. Biological treatment is still seen as the most important tool, although less favourable compared to 2017.

Why is lice a problem?

The sea lice is a big headache for the Norwegian aquaculture industry as it is the main reason for volume growth stagnation, and a key cost driver for farmers. Strict lice regulation drive investments in solutions and technology that can get rid of the lice.

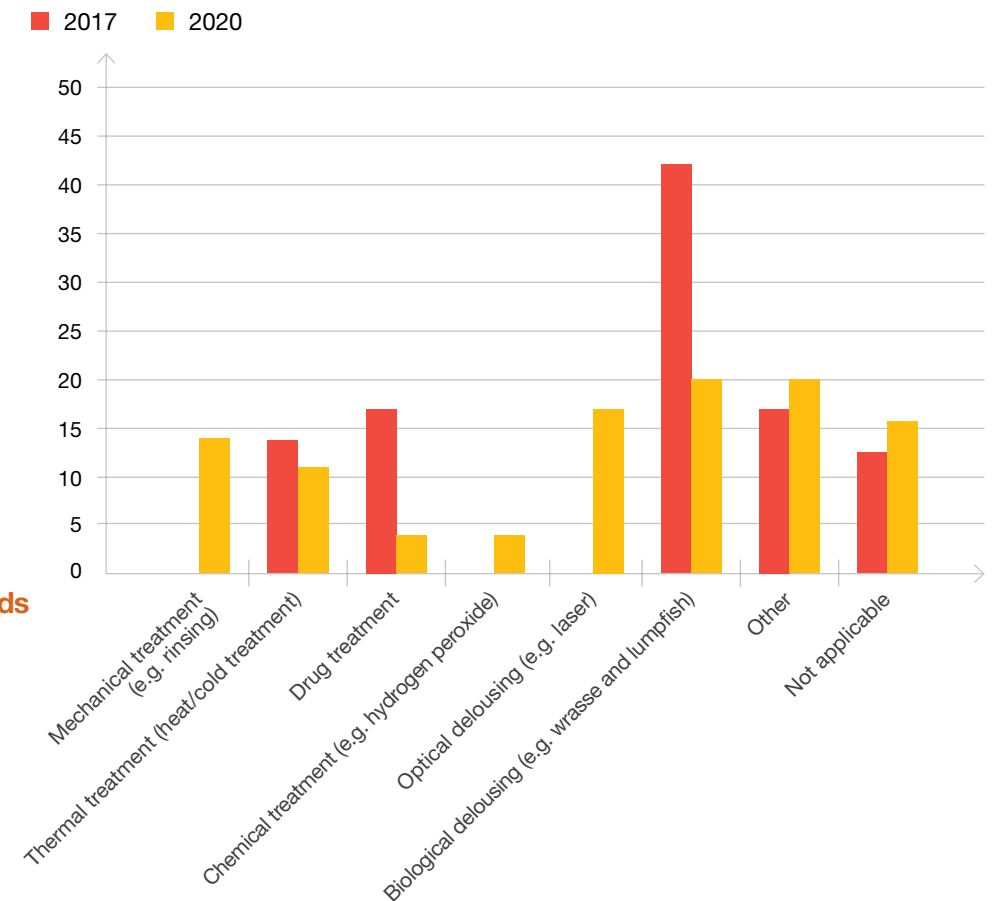
The industry believes in biological, optical, mechanical and thermal treatment

We have asked the industry which technology (solution) they believe will be the most important for their companies in the next five years. Interestingly, biological treatment (with wrasse and lumpfish) is viewed as the most important tool, closely followed by optical delousing (laser), mechanical delousing (e.g. flushing), and thermal delousing. Other solutions (not shown specifically in the bar chart) include freshwater, closed and/or submersible cages, vaccines, breeding, preventative production measures, and a combination of many different methods.

Going from a belief in a few solutions to a combination of different methods

There has been a change in opinion since our first survey in 2017. Now, three years later, fewer industry representatives believe in biological, medicinal and thermal treatment as the most important tools. It seems like the industry is now more favourable towards mechanical, chemical and optical treatments. However, in reality, it may be because companies now believe in a combination of different treatments.

Question: Which technology (solution) for lice treatment do you believe will be the most important for your company the next 5 years?



Stun and bleed vessels have saved about 52.5 million meals and fish worth an estimated 600 million NOK in 2019

Stun and bleed is a new and growing segment within farming vessels

In 2015, there was a spike in farming related vessels* built and delivered - an 80% growth from 2014. Since then, the annual number of new-builds has varied between 50 and 70, and reached an all time high in 2019 with 70 vessels. About 15 - 20 represented stun and bleed vessels. In short, these vessels stun, bleed and process the fish next to the ocean net pen, and transport them to the nearest harvesting facility.

Stun and bleed sprung out of high mortality rates from operations

In 2019, the fish mortality rate was about 16%. Delousing operations can lead to sudden mortality due to increased stress or lack of oxygen making some fish more vulnerable. These vessels are able to stun and bleed vulnerable fish, preventing deaths caused during delousing operations. An increasing amount of vessels are owned by farmers, and the vertical integration is driven by the need

for: value chain control, emergency readiness and flexibility, technology know-how, and decreased supplier pricing.

Stun and bleed improve the industry's value creation and sustainability

Stun and bleed vessels can increase fish welfare and quality as there is less fish handling, and therefore less stress to the fish when harvesting. They decrease mortality and increase the fish' market value. Overall, these vessels contribute to value creation for harvesting facilities, exporters and farmers due to increased harvesting volume, and for shipowners due to economic growth. The result is improved economic and environmental sustainability.

New regulations can drive new investments in stun and bleed

From January 2021, it is forbidden to transport salmon and trout with suspected or proven pancreas disease to open holding pens by the harvesting facility. This will increase costs of

using well-boats as they must deliver directly and dock by the facility. Well-boat capacity will decrease, further incentivising farmers to utilise and invest in stun and bleed, or similar inventions. A possible future ban on holding pens can add to the demand.



Photo: Adobestock

Case: how many meals of salmon, and at what value, have stun and bleed vessels helped the industry save in 2019?

- Based on PwC's analysis, we estimate that stun and bleed vessels saved the equivalent of 52.5 million meals of salmon in 2019. The estimated number of vessels (emergency preparedness) in 2019 was between 10 and 15. Each vessel is assumed to have an annual stun and bleed capacity of around 1000 tonnes, hence saving about 10,000 - 15,000 tonnes of salmon in total.
- We used 15,000 tonnes of salmon, and a yield of 70% as the basis for our calculation. This was converted from whole fish into fillets, and then again from fillets into 200-gram portions, equalling 52.5 million meals.
- The market value of saved salmon is estimated to 600 million NOK, by applying 40 NOK per kg (production fish).



We have assumed:

- Vessel utilisation of 100%
- 70% yield on all sizes of fish
- One meal equates to a portion of 200 grams

Note: stun and bleed have led to improved economic and environmental sustainability for the industry due to decreased mortality, and the fish is now used as food for humans, instead of food for animals.

PwC's point of view:

Stun and bleed vessels undoubtedly serve a purpose by saving fish that otherwise would have become "waste," whilst creating value for the industry. Such inventions can contribute positively, although in small quantities, towards the 5 million vision by decreasing mortality and securing a higher utilisation of the fish. We expect new and creative methods of tackling mortality and fish welfare in the future.

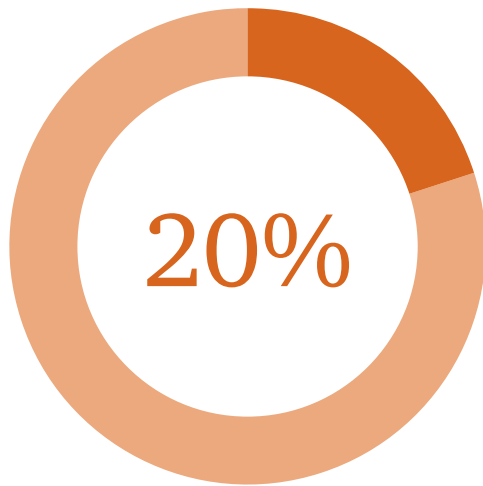
Less belief in traditional net pens as future farming method, but not clear cut that land-based is the solution

Fewer respondents in 2020 (from 33% to 24%) believe that over 90% of their company's production volume will be in traditional net pens in the next ten years.

PwC's seafood survey



Land-based projects - great opportunity for industry, but capital flight of 65 billion NOK for Norway as a seafood nation?



Believe that **closed, on-land systems** (incl. post-smolt) will be a key driver for growth in the future
PwC's seafood survey

What are the benefits to Norwegian farmers investing abroad?

Land-based production abroad is an opportunity for individual Norwegian farmers, as it provides potential growth that is not accessible in Norway due to MAB limitations. It can also represent a diversifying opportunity as farmers are able to spread their risk across different countries, climates and regulatory frameworks. There are additional benefits such as closer proximity to the market, lower employee salary levels, and reduced transportation time and costs. In PwC's seafood survey, 20% of the respondents believed closed, on-land systems would be a key driver for future growth.

What are the risks to Norway as a seafood nation?

Further competition from land-based salmon produced abroad, in addition to the current ocean farmed salmon from Canada, Chile,

Scotland and the Faroe Islands, increases the risk of reputational damage to the image and brand of "Salmon from Norway." Will we lose our competitive advantage if salmon can be produced on land anywhere in the world?

What are the current investment plans abroad?

As of January 2021, there are at least 55 global projects in land-based fish farms. 13 out of the 55 have Norwegian ownership or involvement. A rough estimate indicates that this involvement equals 65 billion NOK in capital flight. Investments which alternatively could have been deployed in seafood projects in Norway.

Case: how much has Norway lost in capital flight due to land-based, full-cycle projects abroad with Norwegian ownership interests?

- Based on PwC's analysis, we estimate that Norway has lost approximately 511,000 tonnes of potential production, equating to around 65 billion NOK in potential investment.
- We arrived at these figures by performing a case study in which we analysed the total investment and production capacity of 31 land-based farming projects in Norway. We then estimated the total investment cost for 13 similar projects abroad that are subject to Norwegian ownership interest, by using comparable investment costs from similarly sized projects in Norway.

We have assumed:

- Had the investors/owners not sought investment opportunities abroad, their investment would have been made in Norway
- Building costs to be similar abroad as in Norway for similarly sized projects
- All projects raise funding and receive a green light
- All projects reach their planned production capacity



Photo: Michael Blann

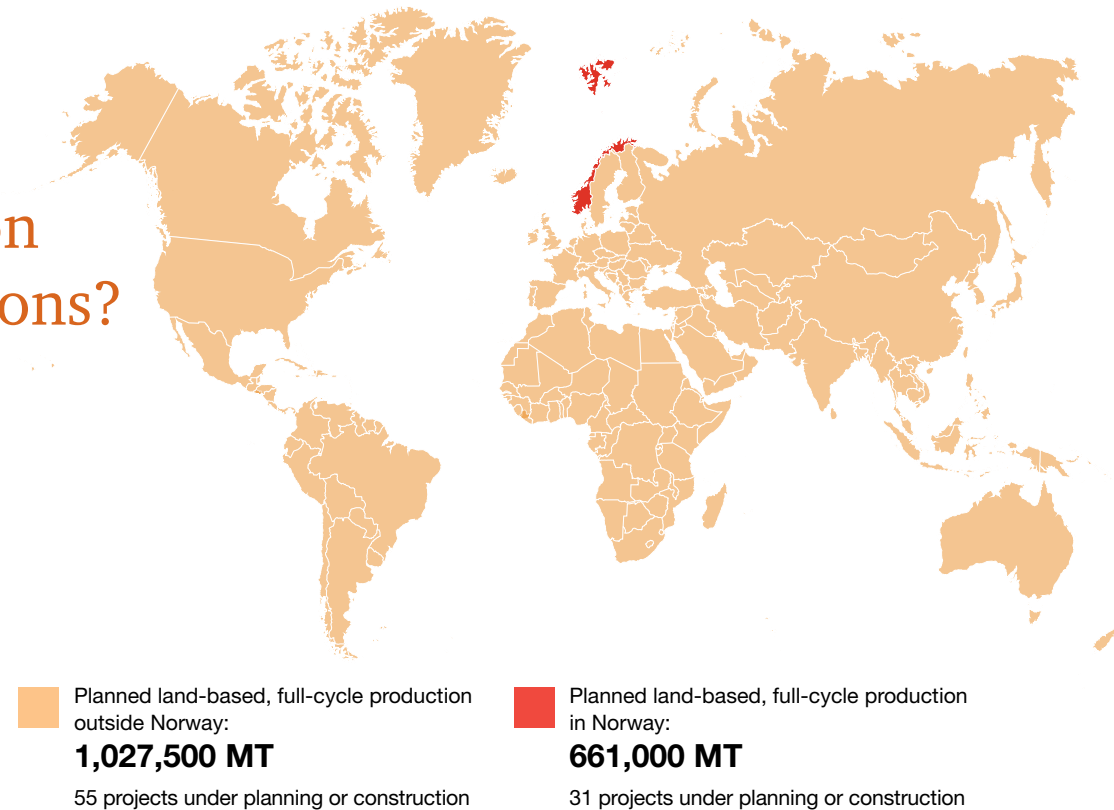
Will the reality of land-based salmon farms live up to investors' expectations?

Land-based, full-cycle fish farming is here to stay

Make no mistake, based on the ambition level, land-based salmon farming is here to stay. In the last years, numerous new projects have evolved, in Norway and abroad. As of January 2021, 31 projects are under planning or construction in Norway with an estimated production capacity of 661,000 tonnes. Total investment costs are estimated to 65-75 billion NOK. 55 projects are under planning in other parts of the world, with an estimated production capacity of 1,027,500 tonnes. To put this into perspective, Norway produced, in total, about 1,440,000 tonnes of salmon in 2019.

What will happen to the price of salmon?

The price structure of salmon is volatile, and it is difficult to predict how the emergence of land-based salmon will affect the price. Will they be able to differentiate their product from sea-farmed salmon and therefore achieve higher prices? Or will the general price level be stressed due to the introduction of larger quantities of salmon from countries with lower production costs, and therefore the overall price level will be shifted downwards?



PwC's point of view:

From the Norwegian farmers' perspective, should they jump on the bandwagon and invest in land-based projects close to end-markets to diversify? Especially considering the fact that ocean farming in Norway is a difficult and expensive way of growing at the moment.

Or should they keep calm and not rock the boat to observe whether land-based projects become successful?

As a late mover, will it be too late to invest in land-based projects close to markets as the marketplace becomes more saturated?

Are owners/investor of land-based projects blind to history and historical lows and downturns as many lack prior farming experience, or are they great visionaries who dare to risk it? Will they be able to achieve a higher price for their product?

These questions will most likely be answered in the next 10 years. However, it is clear that if successful, the increase in on-land production in Norway will aid in achieving the vision of 5 million tonnes of seafood within 2050.

Low added value from standalone hardware investments, but when combined with data platforms and advanced analysis - the added value potential is huge

New investments in aquaculture to improve decision making

The fish farming industry is making advancements when it comes to data collection and the use of data in decision making. Investments in technology continue to increase and additional suppliers are entering the market with new solutions, including:

- Sensors and camera technology to gather data;
- Data platforms to interpret and analyse data;
- And optimisation and prediction tools enabling proactive and data driven decision making.

Based on farmers' willingness to invest in new solutions, as well as ongoing initiatives within the sector, it appears likely that proactive and data driven decision making will materialise in the future.

Why are farmers investing in these new industry solutions?

Farmers are making significant investments in sensors and camera technology to improve operational efficiency and to reduce their mortality rates. This is a key first step in order to change farmers' decision making from reactive to proactive. It should be followed by investments in data platforms that gather and enable data between hardware supplier and production system.

The hardware is under constant development and multiple market players are competing to successfully develop good solutions for autonomous lice counting and measurement of biomass on an individual level; among them large established players like AKVA group and Scale AQ, as well as smaller challengers like Aquabyte, Stingray, Optoscale, Alphabet and Sealab.

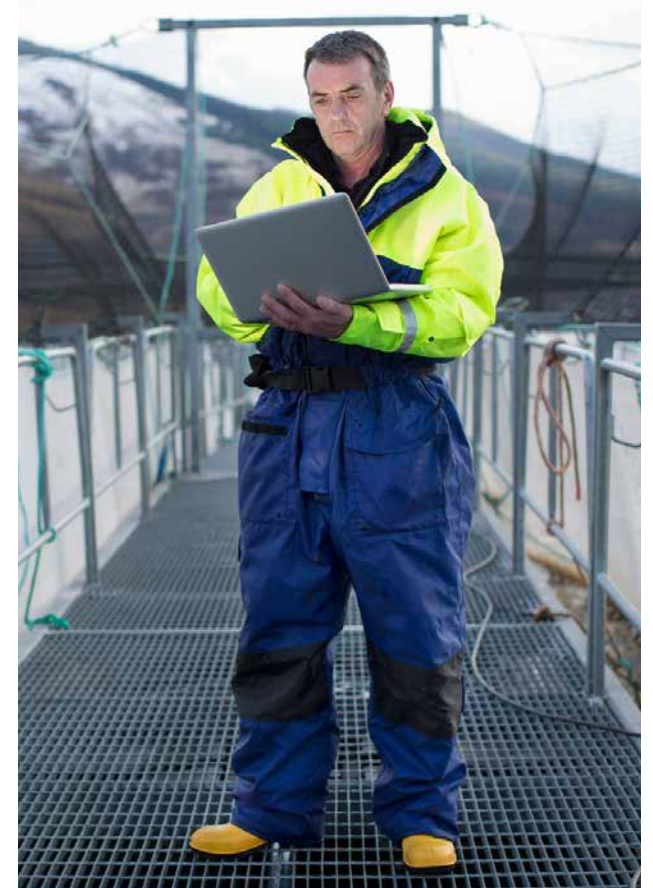


Photo: Adobestock

Control over own data will enable advanced analysis

A data platform will give farmers control over data from their own farms. It will also enable them to cooperate with third parties who will be given data that in turn can be used to develop advanced and precise optimisation and prediction tools.

The overall objective is that these tools can contribute to reducing production costs, reducing mortality rates and improving quality over time. Farmers will be able to better predict when appetite is higher or when the fish are full and feeding should stop. This will lower feed consumption and improve growth, while also reducing the feed factor on produced goods.

Further, farmers could be able to predict when lice is likely to appear and perform preventative measures to reduce impact.

Lastly, it might be possible for farmers to reduce mortality due to better real-time data. By knowing more about the state of their fish, or reaction pattern, farmers might be able to learn quicker if diseases are breaking out on their farm, allowing them to react before it spreads to other locations. These are some of the returns farmers hope to receive from their investments.

Players like Optimeering, Manolin, Aquabyte, Fiizk, Searis, AKVA group and Scale AQ offer optimisation and prediction tools.

PwC's point of view:

PwC believes the fish farming industry has come a long way, but biological complexity makes optimisation and prediction tools more challenging and time consuming than suppliers had originally predicted.

It is essential that farmers offer available data from their own production to enable third parties in developing successful optimisation and prediction tools. This will in turn allow farmers to change their action pattern from reactive to proactive.

Although it might not lead to an increase in production on its own, optimisation and prediction tools have great potential in reducing loss of fish, as farmers are more closely connected to the current state of their fish. This will in turn lead to a higher yield of production, further contributing towards the 5 million tonnes vision.

2020 and beyond:

Covid-19, the black swan we have been
dreading?

04

Covid-19 - the black swan that disrupted the seafood industry with falling prices and loss of the HORECA-segment

Struck by a world pandemic - Covid-19

A world pandemic has dramatically affected the salmon price and demand. As Covid-19 forced governments to shut its cities, we have seen the HORECA-market effectively going into hibernation. This has contributed to a reduction in the salmon price.

Fortunately, some of the decline in volume from the HORECA-market has been shifted to retail consumers due to Europeans quarantining at home. Norwegian farmers have seen a decline in export to the US, as Chile has been slashing prices in order to move quantities. Chile and Norway have an increasing amount of frozen salmon in stock, which will inevitably come back into the market at some point, potentially stressing future prices.

Before Covid-19, it was possible to predict future prices based on seasons. 2020 has reminded us that this is not always the case. The market uncertainty is greater now and predictions change from week to week, rather than in conjunction with the season.

Will consumer habits be affected?

Millions of people are now quarantining around the globe, many are without a government retention scheme or other social safety nets.

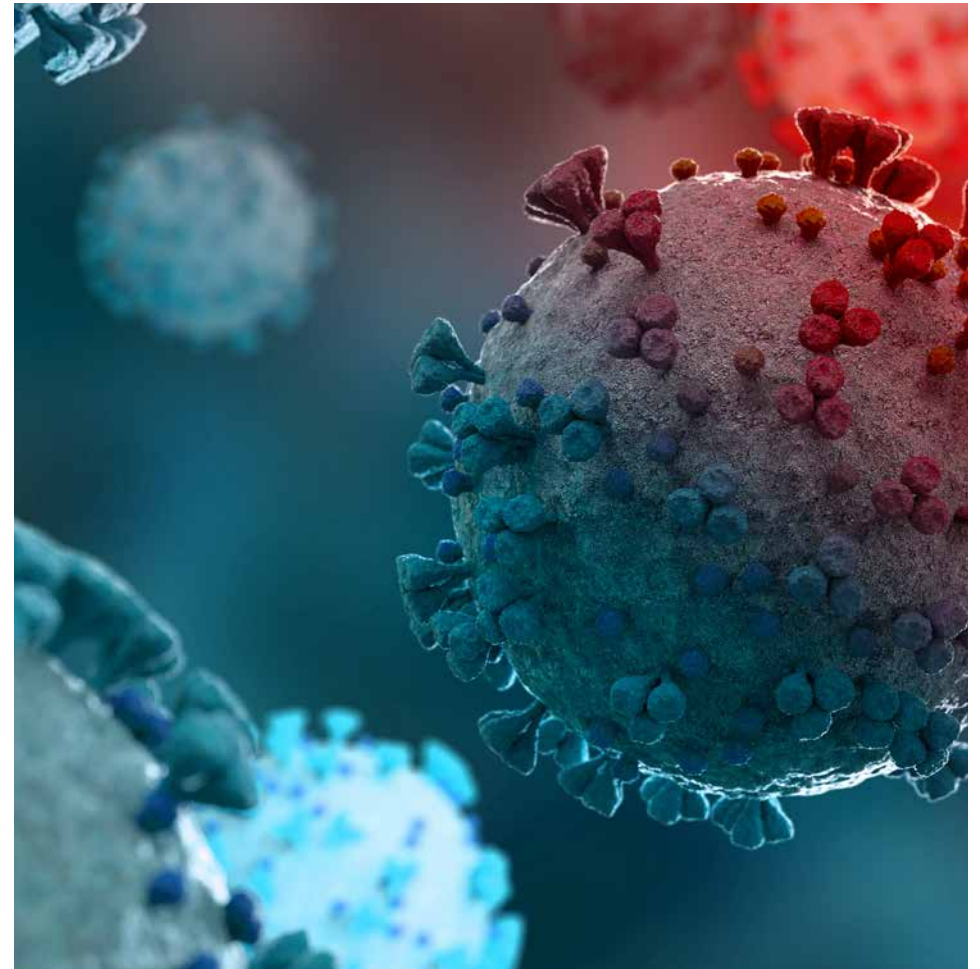


Photo: AdobeStock

What will happen to their consumption habits if the pandemic stretches out far into 2021 or beyond? Is it possible that a long-lasting pandemic will have a more profound impact on people's spending as their budget constraints tighten? Even with falling salmon prices, this could lead to a situation where salmon is excluded from their shopping list, because it is just too expensive.

Alternatively, the lower salmon price, and the loss of the HORECA-segment could have the complete opposite effect on consumer habits. Maybe some consumers will prefer salmon, due to the lower price at the moment? If these consumers choose to substitute their normal meats and fish with salmon, we could see an increase in the demand for salmon post-Covid-19.

What will happen to the new attempt on cod farming?

We have mostly focused on salmon in this barometer, however, there has recently been increased interest in a renewed endeavour to farm cod. Last time cod farming was attempted, the efforts proved unsuccessful due to the financial crisis and a simultaneous increase in the catch of wild cod, causing the price of cod to plummet.

Because of the renewed interest in farming cod, many in the industry are speculating if the financial uncertainty and impact from Covid-19 will play the same role in cod farming's downfall as the previous financial crisis. Or will cod farmers prevail this time? It is hard to predict, but it is possible that new cod farming projects will have a harder time securing financing, as a direct result of Covid-19's impact on the financial markets.

PwC's point of view:

How will Covid-19 affect the long-term vision of 5 million tonnes of aquaculture production in 2050? This is very hard to predict, but in the short-term we believe the current situation with lower prices and demand, mainly through retail, will continue for some time. In the long-term, we expect to see an increase in demand, exceeding what it was before Covid-19.

Potential negative risks of Covid-19



Lack of manpower

Uncertainty regarding potential local lockdowns or employees having to quarantine poses a risk for a shortage of manpower in production.

Challenging logistics

Challenging logistics due to border restrictions and limited flight freight capacity poses as a risk of not getting the goods to their end destination.

Market uncertainty

Loss of Horeca market, fall in the US market and a general uncertain market outlook poses as a risk for the future price level.

Change in consumer habits

Potential risk that consumers will change their eating habits as a result of Covid-19, and reduced income, causing uncertainty regarding future demand.

Reduction in new investments

Risk of investors and current players in the sector, having to reduce their investments in new RAS-facilities, technology or new ONP-capacity, due to increased market uncertainty.



Appendix

05

Methodology - seafood survey

About the survey

The purpose of the survey has been to obtain the industry's views on important challenges and opportunities for the Norwegian seafood industry, over time. In this year's survey, we have asked the industry about markets and profitability, future prospects, technology, development in costs and production, and sustainability. PwC's Seafood Survey-2020 was conducted in January 2020, and has been distributed via personal email and in digital channels.

Sample size

Sector	Respondents	Share of leaders and owners
Aquaculture	55	89%
Fisheries	25	80%
Total	80	86%

Composition and structure of the survey:

The survey was divided into 8 parts. See overview below:

Aquaculture	Fisheries
Affiliation (1-4 questions)	Affiliation (1-4 questions)
Markets and profitability (4 questions)	
Future prospects (3 questions)	Future prospects (3 questions)
Technology (4 questions)	Technology (2 questions)
Developments in costs and production (7 questions)	Developments in costs and production (1 questions)
Sustainability and climate risk (3 questions)	Sustainability and climate risk (2 questions)
Tabloid questions (4 questions)	
Final questions (2 questions)	

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processing



Grower
fish



Feed



Smolt



VAP/sales

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