## Engineering the Blue Future:

# Germany’s Role in European Aquaculture Tech

### Hatch Blue

Hatch Blue is a global investment firm specializing in aquaculture. We build leading aquaculture companies worldwide through strategic investment, complemented by our consulting and venture programs arms. We support innovation throughout the aquaculture and seafood value chain from initial concept to commercialization, investment, and deployment.

Hatch Blue was founded on a vision of advancing sustainable seafood solutions that benefit oceans, ecosystems, and future generations. Our distinctive global footprint spans all major aquaculture markets and is supported by a broad network of experts and portfolio companies.

### Rentenbank

Landwirtschaftliche Rentenbank is Germany's development agency for agribusiness and rural areas. In addition to agriculture, aquaculture, forestry, and the entire food value chain, its promotional mandate includes expanding renewable energy and promoting the bioeconomy. Particular focus is placed on promoting innovation. This ranges from research and development at universities to early-stage financing of agri-related start-ups and venture capital investments.

The bank is an institution under public law whose share capital was raised by the agricultural and forestry sectors of Germany. Rentenbank refinances itself on the international financial markets and is one of the few triple-A-rated institutions in Germany.

## Acknowledgment

This report was prepared by Hatch Blue on behalf of the Landwirtschaftliche Rentenbank. We extend our gratitude to the numerous experts, industry representatives, and institutions whose expertise and insights have substantially informed this report.

We especially thank the companies and research institutions that participated in our interviews, surveys, and field study. Their practical experience provided a critical foundation for the analysis and for identifying future growth opportunities.

We also thank the staff of the Landwirtschaftliche Rentenbank for their support and dedication to advancing innovation within the German aquaculture sector.

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# Foreword

**Georg Baunach**
**Hatch Blue**
Managing Partner & Co-Founder

“Aquaculture has reached a historic turning point, with production now surpassing wild-capture fisheries as the primary source of aquatic animal protein. In a resource-constrained world, this shift represents a vital, sustainable pathway for protein production and a significant economic opportunity.

Germany is in a position to leverage its technical expertise and research strength to capitalize on this global demand. While the gap between high consumption versus low domestic production likely means that imports will continue to fill the supply, local innovation and technology capabilities highlight the potential for the country to become a global solution provider.

Our report concludes that Germany's competitive advantage is built on three pillars:

- Engineering Excellence: Leveraging deep expertise in mechanical and automotive engineering to develop next-generation farming and upstream technologies.
- Leading R&D: World-class research institutions driving innovation in feed additives, genetics, and digital monitoring.
- Proof of Concept: Technologies that prove viable within Germany’s strict regulatory and high-cost environment are uniquely positioned to succeed globally.

With global aquaculture production relying increasingly on technology, Germany's competitiveness increases as both a supplier to the global industry and a premium producer of seafood. Realizing this potential requires a strategic shift in financing. To bridge the gap between research and commercial scale and to incentivize entrepreneurs, the sector needs a comprehensive funding approach that includes early-stage grants, infrastructure financing for capital-intensive startups, and milestone-based funds to de-risk innovation for institutional investors.

At Hatch Blue, a global investment firm specializing in aquaculture, we recognize that the German blue economy is rich in innovation. We hope this report supports Germany in becoming a cornerstone of a resilient food system and a leading exporter of the technologies shaping the future of aquaculture.”

**Nikola Steinbock**
**Rentenbank**
Chairwoman of the Management Board

“Food security and self-sufficiency are gaining importance in Germany and across Europe, especially in light of recent global developments. To become more independent and adaptable, we need to focus more on promising but less recognized sectors in Germany. Aquaculture is one such sector.

Nevertheless, local aquaculture faces a paradox: Although Germany is among Europe's largest seafood consumers and possesses outstanding technical expertise, the sector remains underdeveloped compared to other European countries. High operating costs, regulatory hurdles, and a shortage of skilled workforce are just a few of the many challenges that limit the sector's expansion. Operating costs are strongly driven by energy costs, which have therefore become a decisive economic factor for German aquaculture. Innovative approaches, such as integrating aquaculture with other agricultural systems, can play an important role. The use of waste heat from biogas plants, for example, offers opportunities to reduce operating costs while strengthening the circular economy.

As a promotional bank for the agricultural sector, including aquaculture, Rentenbank's mission is to support innovation that drives the industry's transformation. In this report, we collaborated with Hatch Blue to conduct a comprehensive analysis to identify current hurdles and propose suitable solutions.

The analysis clearly shows that, despite excellent conditions driven by strong innovation, outstanding research, and a solid industry, growth and value creation in Germany remain elusive. To ultimately have an impact, a functioning environment is needed: access to venture capital, further direct research and industry collaborations, suitable testing conditions, and, last but not least, policymakers who actively support and promote this path. The potential of aquaculture is enormous – yet it is currently underutilized.

I want to thank everyone who contributed their time and expertise to this report. Let's work together to better seize the potential of aquaculture and build a more efficient, resilient, and forward-thinking agricultural and food sector.

Let us sow the good seeds.”

# Abstract

This report provides a comprehensive assessment of Germany's aquaculture industry, benchmarked against Europe, offering insights to guide investment and strategic decisions. It reviews global trends, European market dynamics, and key production systems before examining Germany's output, industry structure, and the shift toward industrialized farming. The study also explores upstream segments, including health, genetics, feed additives, alternative seafood, and algae, highlighting Germany's R&D sector, biotech capabilities, and collaborative networks. Findings are based on extensive primary and secondary research, including interviews, site visits, European and German market studies, academic, and government data.

## Introduction

Aquaculture, the farming of aquatic organisms, is one of the most resource-efficient, environmentally sustainable sources of animal protein, outperforming many livestock systems in feed efficiency, water use, greenhouse gas emissions, and playing a key role in future food security. In Europe, the sector has transitioned toward more technologically advanced, environmentally conscious production, driven by regulations, innovations, and market demand for transparent, responsible food production.

Within this landscape, Germany emerges as a compelling paradox: a nation with high seafood consumption and world-class technological expertise, yet an underdeveloped aquaculture sector that has seen limited investment. This gap signals a powerful opportunity. By harnessing digitalization, precision technologies, and forward-thinking R&D, Germany is uniquely positioned to unlock substantial growth and redefine its role in modern aquaculture.

## Local Production State

While still smaller than fishery and imports volumes, aquaculture in Germany is an important sector, rooted in freshwater and dominated by small- and medium-sized farms, producing ~33,000 tonnes in 2024, split mainly between mussels and finfish. While traditional trout and carp farms still form the backbone, there is a shift from pond systems to more intensive tank and constructed pools operations, leveraging Recirculating Aquaculture Systems (”RAS”) water treatment technologies.

For investors, RAS offers a scalable, tech-driven opportunity. For policymakers, its expansion underscores the need for clearer regulations to position aquaculture as a cornerstone of sustainable food systems.

## Upstream & Startup Innovation Landscape

Germany is a global innovation hub for upstream industries, including advanced aquafeeds and feed additives, fish health and genetics, and a fast-growing alternative seafood segment. Strong industry–academia collaboration is driving breakthroughs in functional feed ingredients, diagnostics, vaccines, selective breeding, genome mapping, and AI-driven tools, with startups and research institutions leading the way. At the same time, microalgae, fermentation, and cell-based alternative seafood ventures are leveraging Germany’s strengths in biotech and foodtech. These present a high-growth opportunity. Policymakers and investors can play a direct role by providing strategic funding, shared infrastructure, and smarter regulations to unlock rapid commercialization and scalability, positioning Germany at the forefront of sustainable aquaculture.

## Key Findings

**Curent Status**
German aquaculture output has been mostly stagnant over the past decade. While the total market size for aquaculture products is projected to grow, domestic production remains modest. The German seafood market relies on imports to meet approximately 90% of its demand. Advanced production systems development is driven by strong environmental regulations and growing consumer demand for certified sustainable seafood.

**Challenges**
Further growth in domestic aquaculture is constrained by challenges such as high CAPEX and OPEX, regulatory barriers (a complex, unpredictable, and fragmented regulatory framework), and inconsistent sector classification (aquaculture is not often treated as agriculture for planning/building purposes).
These highlight the need for coordinated policy and public-private investment.

**Opportunities**
Germany is a global leader in RAS engineering and systems integration, with a large number of permitted RAS facilities, aquaculture tech suppliers, and innovative companies across the supply chain, driven by high technical engineering standards that push efficiency, reliability, and quality. Furthermore, Germany’s world-class R&D tackles real-life challenges across traditional and novel species, collaborating directly with industry to deliver advanced applied research.

## Looking Ahead

Opportunities lie in leveraging local proficiency to address farmers' needs domestically and globally. Germany's strengths in monitoring technology, digitalization, big data, and AI can help reduce labor and energy costs inherent in aquaculture operations. For example, AI-based solutions can optimize growth rates, improve feed conversion ratios, and generate substantial cost savings. Harnessing these tools, combined with RAS know-how, will create more resilient, efficient operations, improving sustainability and competitiveness.

More opportunities for local production growth rest in combining these systems with traditional agriculture, where agri-farmers offer land, technical skills, supply chains, and potentially waste heat to reduce RAS costs. Additionally, strategically locating these in urban or rural areas can deliver fresh, sustainable seafood to local markets with minimal transport.

Financial institutions can drive growth by connecting ventures to capital and early-stage support. Policymakers, meanwhile, can simplify Germany's regulatory framework by adopting a unified federal system, reducing complexity, fostering growth, and therefore boosting innovation and long-term planning.

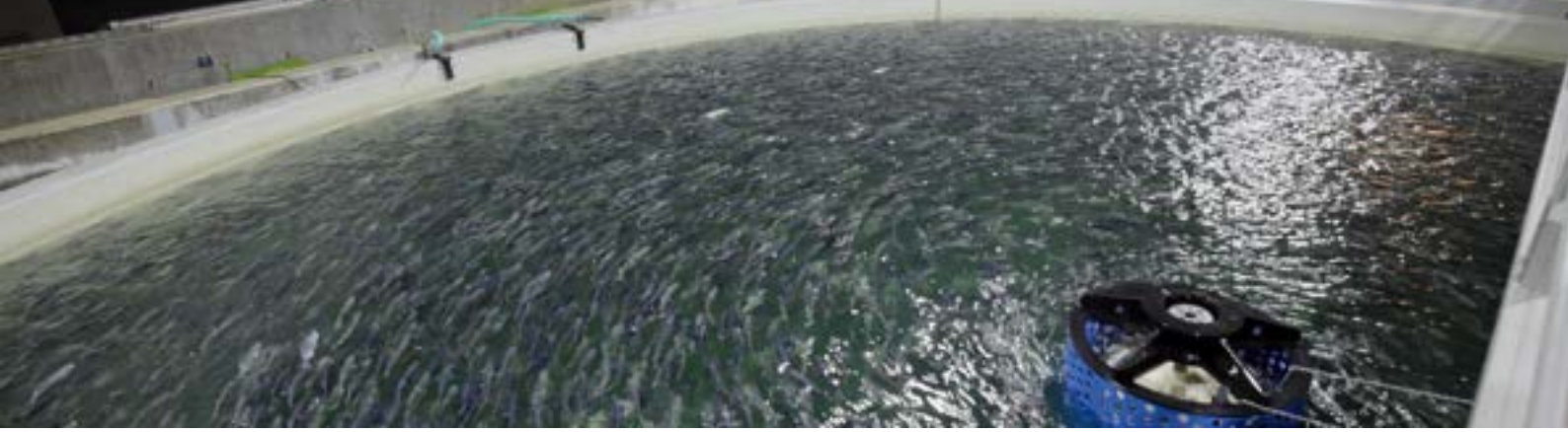
## **Strategic Recommendations** for sustainable growth and long-term competitiveness

**Collaborate with federal and state governments** to standardize regulations, create unified permitting processes, or develop national, cross-state guidelines for aquaculture (standards for water quality, disease control, licensing, etc). Recently, acting on a proposal from the Bundestag's budget committee, the Thünen Institute began a preliminary analysis for a potential Aquaculture Competence Center. This includes a legal study to harmonize fragmented state regulations and streamline permitting across Germany.

**Introduce low-interest loans or government-backed guarantees** to bridge the gap for startups that cannot get adequate financing due to regulatory risks. Offer similar financial mechanisms to farms looking to diversify into aquaculture (longer repayment periods, grace periods, favorable terms for those adopting sustainable or high-tech aquaculture practices, grants for new facilities).

**Move projects beyond the pilot stage** by turning research into market-ready start-ups and by integrating entrepreneurial expertise into research institutions. Dedicated commercialization, business, and IP programs within academia and research centers, providing targeted support to emerging innovators.

**Strengthen the sector's perception** through success stories, and introduce proactive efforts to inform and educate investors as well as the general public about the benefits of aquaculture across economic, environmental, health, and social perspectives.



# 01

# Global & European Aquaculture Landscape

## Key Insights

Globally, aquaculture production has surpassed wild-capture fisheries, and its share of Europe's total fish production continues to grow, driving innovation in the sector and highlighting expansion opportunities in countries such as Germany.

Europe's aquaculture is mainly marine, but varies by country. Coastal countries focus on marine, while landlocked ones focus on freshwater. Germany's relatively small, balanced production highlights its greater potential as a market for both local and foreign producers.

Aquaculture spans a spectrum from low-cost, nature-dependent systems to capital-intensive, highly controlled setups, with trade-offs between infrastructure costs and exposure to environmental variability.

Technologies like RAS, closed containment, submersible cages, and offshore systems are designed to lower environmental impacts and reduce pressure on natural ecosystems.

RAS provides better control over water quality, higher stocking density, and biosecurity, but requires more advanced technologies and higher capital investment.

# 1.1. Global Trends and the Shift to Sustainable Protein

Aquaculture is the farming of fish, shellfish, algae, and other aquatic organisms in controlled water environments in both freshwater and marine settings. In recent decades, it has become increasingly important, as wild fisheries have not been able to keep up with rising demand. Aquaculture represents one of the most sustainable forms of animal protein production in an increasingly resource-constrained world. With global population growth and rising protein demand, aquaculture offers significant advantages over other terrestrial animal production systems in terms of feed conversion efficiency, land and freshwater usage, and carbon footprint.

For decades, the global seafood supply was dominated by wild-capture fisheries. However, since the early 1990s, wild-capture production has plateaued due to overfishing and strict sustainability quotas. In a historic turning point, recent data confirm that aquaculture production has now surpassed wild-capture fisheries (Figure 1) as the primary source of aquatic animal protein for human consumption (FAO, 2024), accounting for 94 million tonnes, or 51% of total aquatic animal production.

This paradigm shift reflects growing recognition of aquaculture's potential to meet animal protein demand while addressing environmental concerns, including depleted wild stocks, greenhouse gas emissions, and the need for sustainable sourcing practices.

**Figure 1: Development of global aquaculture and wild catch volumes 1990-2023**
Source: FAO Fishstat Database (accessed 2025)

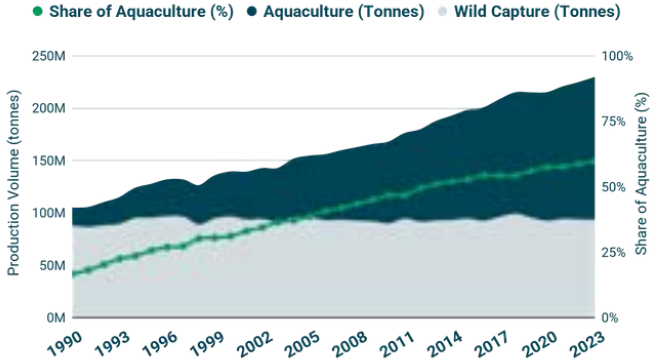
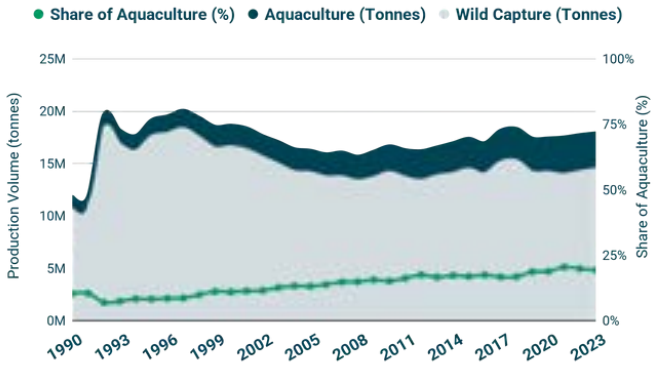



**Figure 2: Development of European aquaculture and wild catch volumes 1990-2023**
Source: FAO Fishstat Database (accessed 2025)




While European wild capture fisheries still account for the majority of volume, the share of aquaculture in total fish production has shown a consistent upward trend over the last two decades, standing at ~20% (FAO, 2024) (Figure 2).

In recent years, Europe has witnessed remarkable advancement in aquaculture development, transitioning from traditional fisheries and inland pond farming toward more controlled and intensive production systems.

The European aquaculture sector has fueled this trend through innovation across the entire value chain, from genetics and feed development to production systems and marketing. The European Commission's Strategic Guidelines for a more sustainable and competitive EU aquaculture (2021-2030) emphasize knowledge and innovation as critical cross-cutting objectives, highlighting the sector's commitment to sustainable growth through technological advancement (EATiP, 2021).

Within this broader European context, Germany presents an interesting case study. Despite being Europe's largest economy with significant technological capabilities, its aquaculture production remains relatively modest compared to leading European producers. However, the country possesses considerable potential for growth through innovation, particularly in areas such as Recirculating Aquaculture Systems (RAS)*, digital technologies, and feed development.

**RAS is a controlled production technology in which part of the water is treated and reused in a closed loop.*

# 1.2. European Supply and Demand: Market Dynamics

On the surface, the industry appears highly diverse, with more than 100 species reported to be farmed across 40 countries in the region (Figure 3). In practice, however, production is strongly concentrated among a handful of high-volume producers and a smaller number of key species. This concentration is also reflected in the business landscape, where the number of companies producing major species such as salmon at scale has been steadily decreasing over the past decade.

**Figure 3: European aquaculture key metrics**
Note: Data represents full year production in 2023
Source: FAO Fishstat Database (accessed 2025)

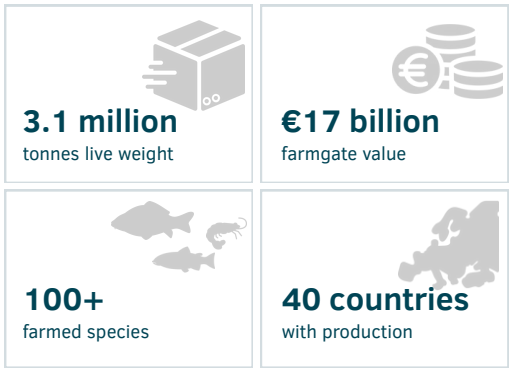
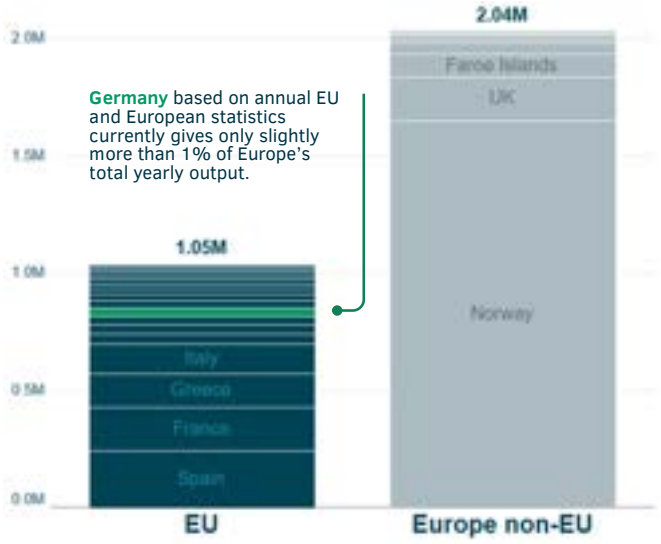



**Figure 4: European aquaculture volumes in 2023 by country (tonnes)**
Highlighting **Germany** among nations
Source: FAO Fishstat Database (accessed 2025)




The four largest producers in Europe are Norway (clear primary leader), Spain, the UK, and France, which together account for around 70% of European output. While these countries farm many species, production is typically dominated by a few core ones, such as salmon in Norway and the UK, mussels in Spain, and oysters in France. Other notable producers include Italy and Greece (Figure 4), with substantial mussel, seabass, and sea bream aquaculture, and the Faroe Islands, which supports large-scale salmon farming despite its small size. Other countries typically produce less than 50,000 tonnes annually, with some producing as few as 1,000 tonnes.

While Europe's aquaculture sector provides local, sustainable, and high-quality seafood for consumers, production trends over the past two decades have not grown uniformly across the region. When divided into EU and non-EU segments, an approach that reflects differences in trade dynamics, regulations, and currencies, reveals clear contrasts. Non-EU production has followed a steady growth trajectory, largely driven by Norway's salmon sector, while EU output has remained relatively flat (Figure 5). Official statistics show EU production fluctuating between 1 and 1.3 million tonnes, whereas non-EU output has nearly tripled since the early 2000s, driving the region's overall growth.

**Figure 5: European aquaculture volumes in 2000 to 2023 (tonnes)**
Source: FAO Fishstat Database (accessed 2025)

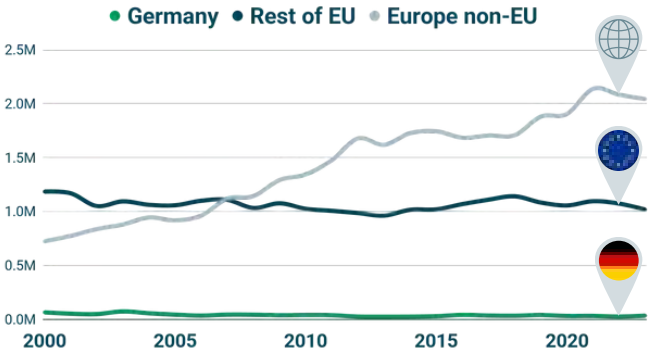
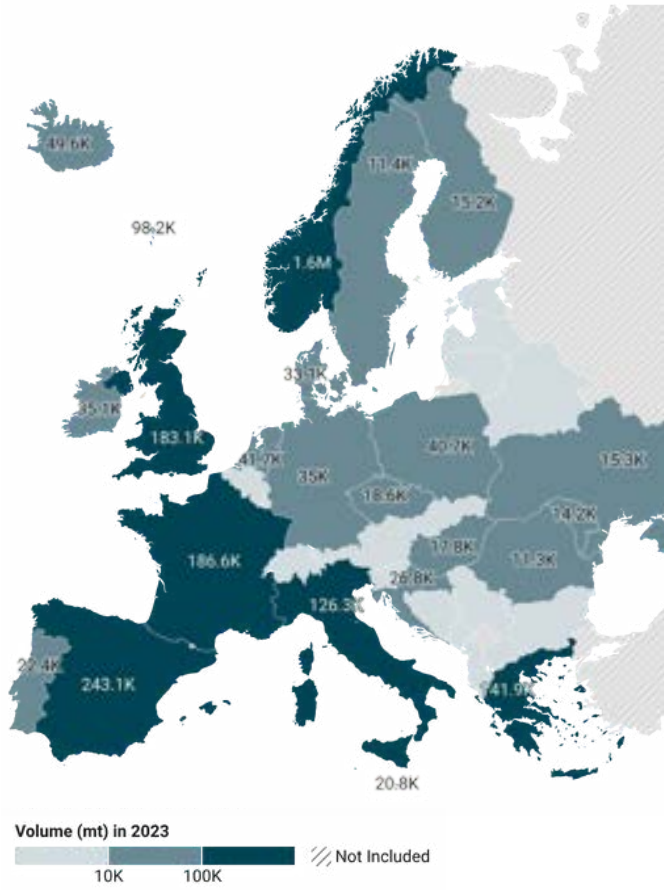
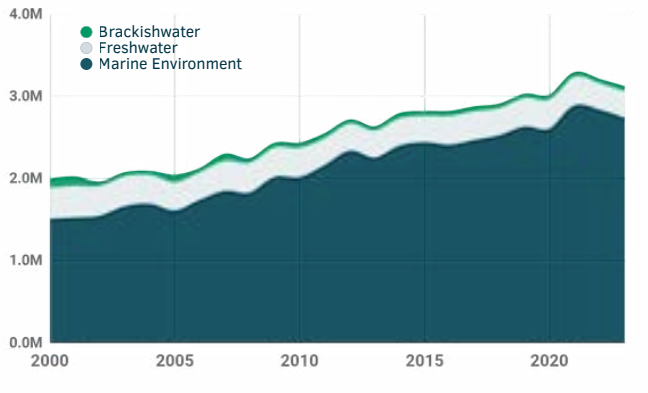


**Figure 6: Map of European aquaculture output**
Source: FAO Fishstat Database (accessed 2025)




Aquaculture is diverse not only in species but also in production environments, resulting in a range of practices and technologies. In Europe, the main producing countries all have extensive coastlines (Figure 6), and most output comes from marine aquaculture, while freshwater and brackish-water production remains comparatively small (Figure 7). In 2023, marine production reached roughly 2.7 million tonnes, largely driven by large-scale salmon, mussel, and oyster farming. Freshwater and brackish-water aquaculture contributed around 400,000 tonnes, with trout and carp accounting for the largest share.

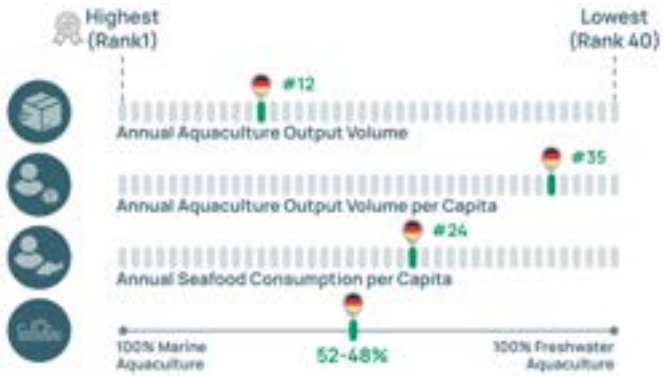
**Figure 7: European aquaculture volumes (tonnes)**
Source: FAO Fishstat Database (accessed 2025)




The balance between production environments has remained largely stable, with marine aquaculture playing a leading role. However, this regional picture masks significant national differences. Coastal countries tend to rely heavily on marine production, while partially or fully landlocked countries depend mainly on freshwater farming. These differences are important, as each environment and species requires distinct farm structures, equipment, and processes, shaping the role of innovation and new technologies applied in different environments.

To put Germany into context, four metrics were used. In 2023, Germany ranked 12th among the 40 European aquaculture-producing countries, with ~35,000 tonnes of harvest (Figure 8). Per capita aquaculture output is relatively low, at less than 0.5kg/cap/year. Annual per capita seafood consumption (including both wild and farmed) places Germany 24th in the continental ranking, in the lower half. In terms of the ratio of marine to freshwater harvest, Germany shows a fairly balanced mix of freshwater and marine-produced volumes, while most other countries lean strongly toward either marine or freshwater production.

**Figure 8: Aquaculture rankings in Europe (2023)**
Note: Highlighting **Germany** among 40 assessed countries
Source: Multiple FAO Databases (accessed 2025 & 2026)

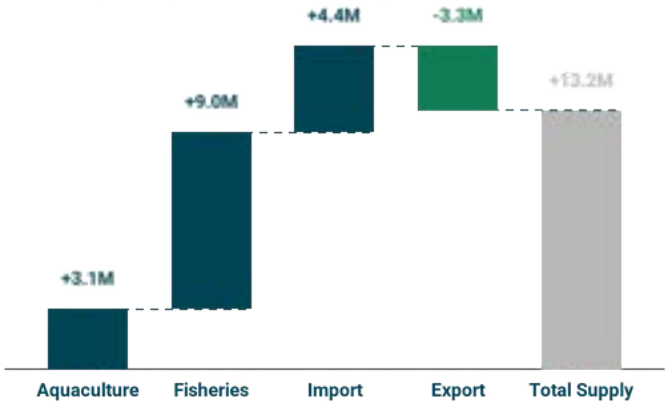



As Europe's largest economy, Germany currently offers greater market opportunities rather than as a producer contributing to the region's seafood supply. While the next chapter explores the details of German aquaculture, it is clear that the sector has considerable room to expand both domestically and within the broader European landscape.

Europe's largest seafood export is whole Atlantic Salmon (and fillet for overseas markets), with Norway and the UK supplying over 50% of global farmed volumes to more than 100 countries. Key imports include shrimp in various product forms, as well as substantial volumes of tuna, pollock, and other finfish products.

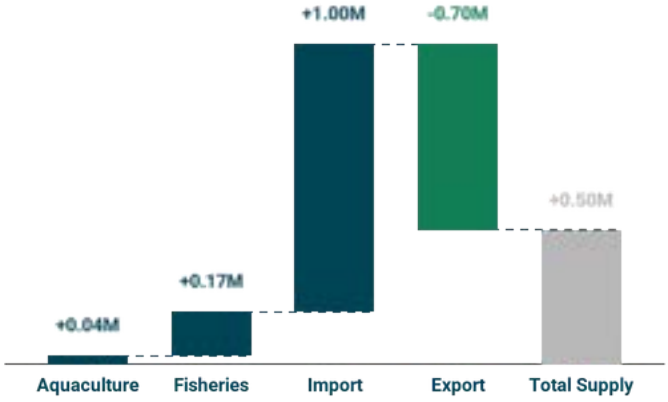
A closer look at Europe's seafood balance (how much seafood is available for consumption within a certain region) shows that local aquaculture contributes only a small share of regional supply. Despite a sizable aquaculture sector and an even larger wild-catch (fisheries) sector, Europe remains dependent on imports. Recent data indicate that Europe produces around 12 million tonnes of seafood (farmed and wild), with 4.4 million tonnes imported from outside Europe in 2023 (not including intra-Europe trade) and 3.3 million tonnes exported (Figure 9). This results in a net import of roughly 1.1 million tonnes, underscoring the region's continued reliance on external supply. These figures highlight the role of trade in meeting Europe's seafood demand and the limited ability of current production alone to close the supply gap.

**Figure 9: European seafood supply (tonnes, 2023)**
Note: import & export excludes trade among European countries
Source: FAO Fishstat Database (accessed 2026)




Europe's seafood market is also shaped by extensive intra-regional trade, making the dynamics less straightforward than they appear. While Europe's total imports are 4.4 million tonnes from outside Europe, the EU imports 5.9 million tonnes from outside the EU, reflecting the large volume of trade between countries in the region. Intra-European trade accounts for a large share of Europe's seafood flows, yet standard charts showing net imports and exports do not capture the billions of euros exchanged between countries, for example, between Norway and Poland. Understanding Europe's seafood supply requires considering both internal trade and broader international flows.

**Figure 10: Germany's seafood supply (tonnes, 2023)**
Note: import & export includes trade with all other countries
Source: FAO Fishstat Database (accessed 2026)

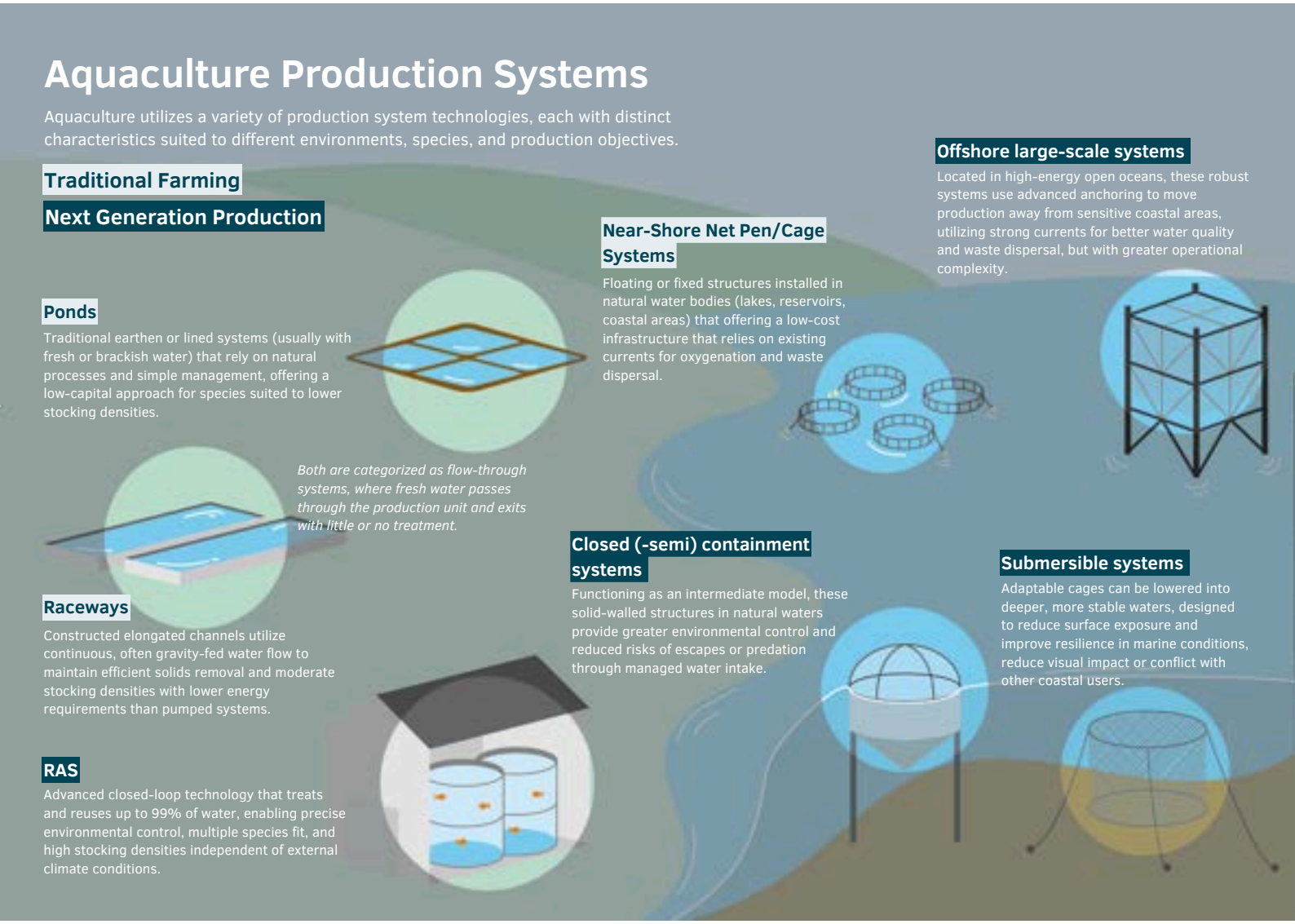



Germany's seafood balance is strongly import-dependent, even though it also exports significant volumes, mainly to other European countries (Figure 10). Compared to its annual imports, Germany's local farmed and wild seafood supplies are minor. While some imported species cannot be produced or caught locally due to biological or production cost constraints, advances in aquaculture technology and practices offer opportunities to shift the balance between locally produced and imported seafood.

***DISCLAIMER for charts:*** *1) Figures for aquaculture and fisheries are in "live weight" while figures for import and export are "net product weight". This means the actual available seafood supply, in terms of net edible weight, is somewhat lower than the figures presented. 2) All figures presented are rounded values of the official statistics to make it easier to understand proportions and remember key figures.*

# 1.3. Aquaculture Production Systems

The global industry is moving away from nature-dependent farming methods, such as extensive earthen ponds and coastal open-net pens, due to escalating biological and environmental challenges. Traditional open-net pens are increasingly constrained by spatial limitations, strict regulatory frameworks, and public opposition, while also struggling with high mortality rates caused by sea lice, viruses, and climate change. Similarly, traditional pond systems suffer from poor water quality control, weather vulnerability, and disease outbreaks. To address this, the sector is exploring and investing in next-generation farming systems that rely more on advanced technologies and engineering. While traditional methods will continue to supply most seafood in the near future, these new systems offer the promise of stable, sustainable, and precision-controlled environments.



# 02

# Profiling German Aquaculture
A Sector in Transition

## Key Insights

Germany's aquaculture remains relatively small-scale and geographically concentrated, with the sector gradually shifting from traditional, pond-based systems toward more intensive, efficient production methods.

The sector also faces declining small-scale farms but has strong growth potential by leveraging RAS technology, local and decentralized production, and integration with existing agricultural systems to efficiently and sustainably produce high-value species.

German aquaculture is consolidating, with a declining number of mostly small farms, while a few larger, more productive operations now account for the bulk of output; this varies by region and species, with carp farming remaining fragmented and mussel production concentrated among a few specialized companies.

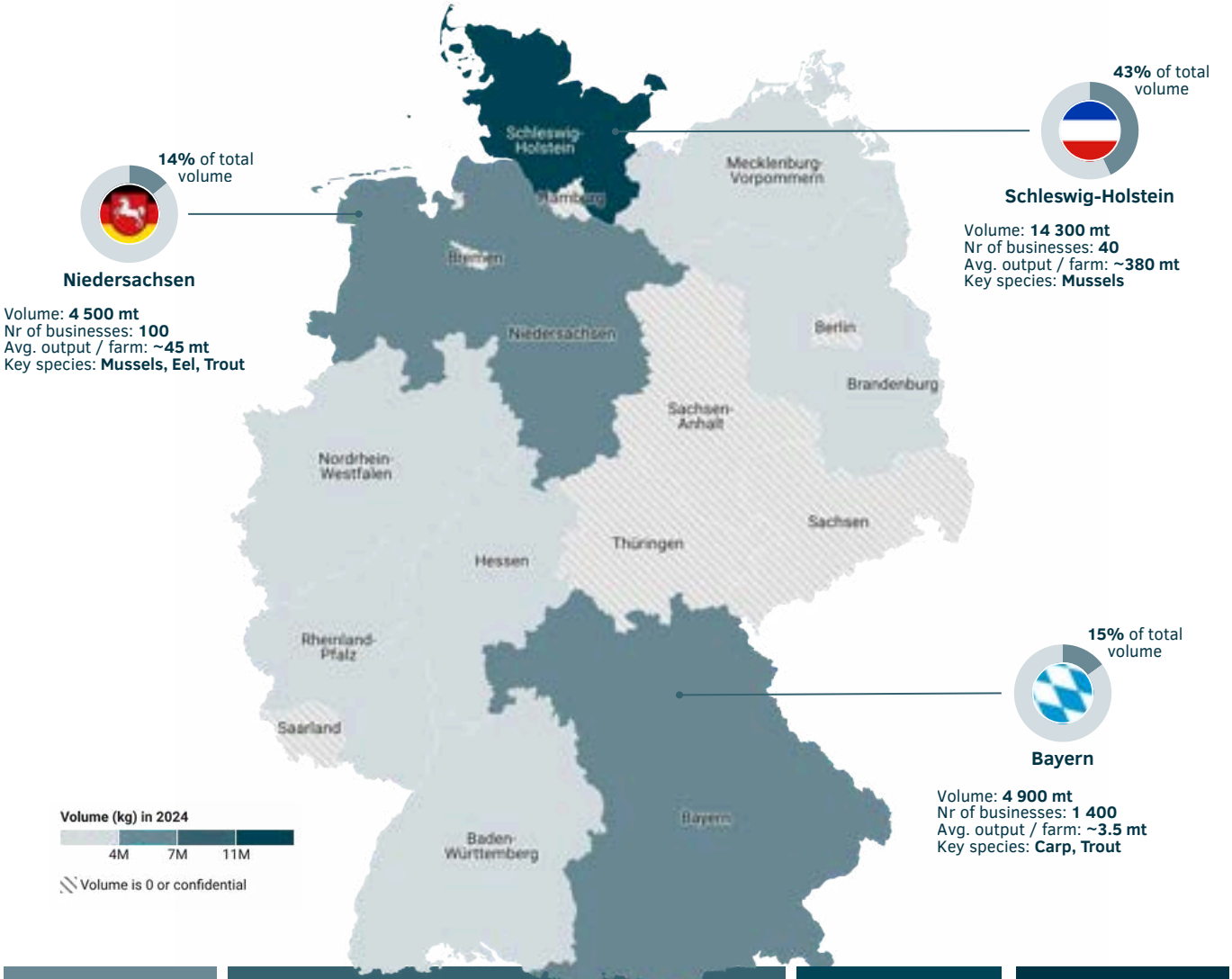
While Germany is an important European seafood hub, its influence comes from processing and moving fish rather than growing or catching them. The market is defined by a high structural reliance on imports (90%) and a consumer base that prioritizes convenience (frozen/canned), with gradually growing demand for fresh, local products.

# 2.1. Current Industry Profile

Germany's aquaculture sector remains modest in scale and has shown minor overall growth in recent years. The industry is characterized by a large number of small operations, particularly concentrated in the south. Production is geographically focused, with northern and southern states forming the core regions of activity and contributing the majority of national output (Figure 11).

Salmonids, led by rainbow trout, are the most significant finfish, followed by common carp, while other species such as eel, kingfish, and pikeperch are increasingly farmed in specialized systems. Marine aquaculture is dominated by blue mussels. This segment accounts for nearly 45% of total German aquaculture production by volume. Producers are also shifting from traditional pond-based carp farming to more intensive, efficient flow-through systems for trout and salmonids.

**Figure 11: Map of German regional (state level) aquaculture landscape and key industry figures**
Source: Multiple sources from DESTATIS German Federal Statistical Office (accessed 2025) and calculated metrics




# 2.2. Consolidation in German Aquaculture Since 2015

Long-term trends in German aquaculture, as reflected in both production volumes and business counts, indicate sector consolidation rather than random fluctuation.

According to Thünen Institute statistics, the total number of aquaculture businesses fell from about 3,285 in 2015 to only 1,978 in 2024, a reduction of around 40% across freshwater and marine segments (Figure 12).

Size-class data reveal a highly skewed distribution of production. While small farms dominate in number (52% produce 1 tonne per year or less), they contribute only around 2% of output, while, 21% of farms producing over 5 tonnes account for about 91% of total production (Figure 13), demonstrating that output is increasingly concentrated in a few larger operations.

**Figure 12: Number of aquaculture producer businesses by species group**
Source: DESTATIS German Federal Statistical Office (accessed 2025)

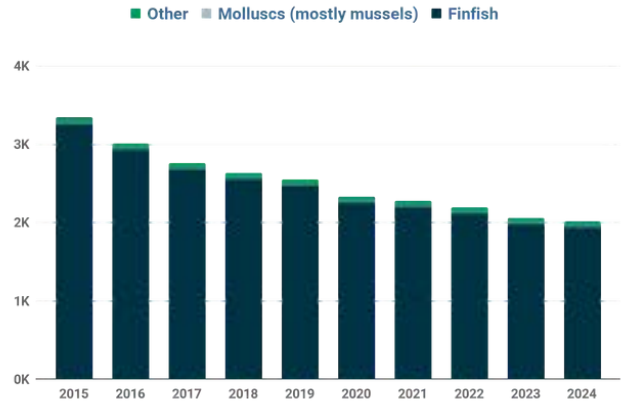
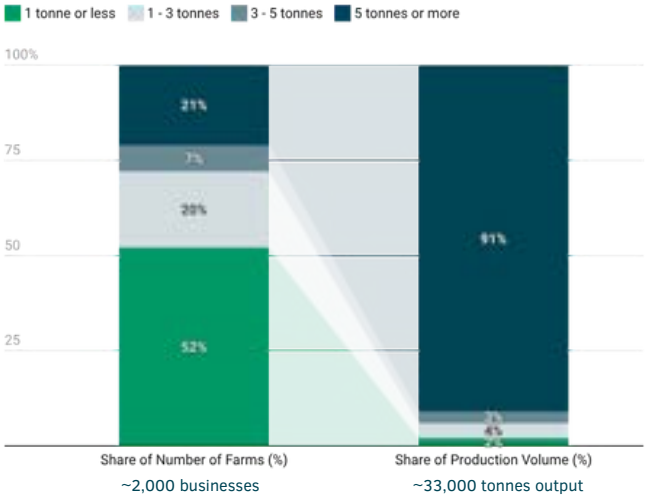


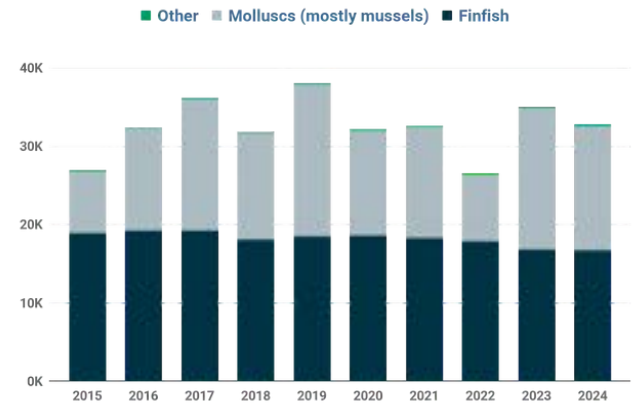

**Figure 13: Germany's aquaculture landscape: farm size v.s. output (2024)**
Note: Categories are based on annual farm output ranges
Source: Thünen Institute, German aquaculture report (2025)




These dynamics explain why production volumes remained stable despite a sharp decline in businesses after 2015 (Figure 14). The departure of many small, low-output farms was offset by continued output from larger, more productive operations. Destatis (German Federal Statistical Office) data also record how fish and mussel production volumes reflect this trend of fewer but larger contributors.

The 2015 inflection point in the business count likely reflects this consolidation process rather than a sudden production collapse. Small farms facing economic, regulatory, and environmental challenges have exited or consolidated with larger operations, while remaining producers maintain aggregate output.

**Figure 14: Aquaculture production volume (tonnes) by species group**
Source: DESTATIS German Federal Statistical Office (accessed 2025)




This level of business consolidation is also vastly different across regions and species based on state and country level aggregated data. Carp farms in Bavaria for example, are numerous but small, averaging only around 3 - 4 tonnes per farm per year.
On the other hand, mussel production is much less fragmented. In Schleswig-Holstein, statistics show that only 30 - 40 companies operate. This reflects the high costs, specialized vessels and farming equipment required for blue mussel farming.

# 2.3. Germany's Aquaculture Market Dynamics and Trade Flow Assessment

## Market overview and European context

The German seafood market is a paradox of high consumer demand and low domestic self-sufficiency. It is a large consumption market that relies heavily on imports to meet approximately 90% of its domestic demand. The market size for aquaculture products is expected to grow. However, domestic production remains modest, with signs of contraction in traditional farming. Within Europe, Germany acts as a pivotal processing and logistical hub rather than a primary producer. It is the largest importer of Alaska pollock, a cod-like species, accounting for 51% of the total imports for this species, primarily for the processing industry. The market is driven by strong environmental regulations and rising consumer demand for certified sustainable seafood.

## Import dynamics and market deficits

Germany's trade balance reveals major market deficits in key fish species, necessitating robust import pathways to satisfy a self-sufficiency rate of only about 10% for the total fish market.

**Salmonids (Trout and Salmon):** Germany has a self-sufficiency rate of only 26% for salmonids, relying on imports to cover 86% of its domestic supply. While domestic trout production is significant, it is insufficient to meet demand. Key suppliers include Poland (primarily for smoked products), Denmark, and Turkey. Atlantic salmon is almost entirely imported, as local production is currently limited to smaller land-based systems that are not yet operational products further for aquafeed.

**Carp:** Despite being the fourth-largest producer in Europe, Germany imports approximately 39% of its carp supply to meet domestic demand, primarily from the Czech Republic and Poland

**Alaska pollock:** Germany is the primary European destination for frozen Alaska pollock fillets, sourced primarily from China (54% of frozen fillet imports) and the United States

**Fishmeal:** Germany serves as a logistics hub for non-food aquaculture inputs. It is the second-largest importer of fishmeal, after Spain, and often distributes these products further for aquafeed.

## Trade flow assessment and export pathways

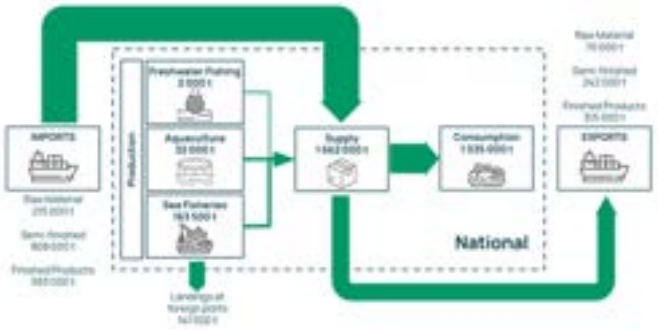
Germany's export flows focus on specific processing roles and unique cross-border logistics rather than on domestically farmed finfish.

**The "Dutch Connection" for mussels:** More than 90% of German blue mussels are exported to Yerseke in the Netherlands, home to Europe's only mussel auction. There, they are processed and distributed further. This creates an export surplus for Germany.

**Fleet landings as exports:** Most of the German fishing fleet, 86%, lands its catch in foreign ports (Figure 15). These are recorded as exports, distorting the perceived volume of outbound trade.

Re-export: Germany is a major re-exporter of processed goods, especially fishmeal, ranking second after Denmark.

**Figure 15: Overview of material flows of fisheries and aquaculture products in Germany in 2023**
Source: Adjusted from Thünen Institute, German aquaculture at a glance (2026)



## Consumption patterns and product forms

In 2023, Germany's per capita consumption stood at 12.5 kg, well below the global average of 20.7 kg. Consumption is heavily skewed toward marine species (6.8 kg) versus freshwater species (3.8 kg).

**Product form preference:**
German consumers strongly prefer convenience and shelf-stable products.

- Canned/Marinades: 27% market share,
- Frozen: 23% market share,
- Fresh: Only 13% market share,
- Smoked: 9% market share.

**Processed products:**
Germany is the largest consumer of shelf-stable seafood (e.g., canned tuna, herring), accounting for 31% of total sales volume in this category. It is also the leading market for frozen seafood products, consuming over 200,000 tonnes annually.

# 2.4. The Structural Shift - From SMEs to Industrial Innovation

## Production trends

The German aquaculture sector is at a critical crossroads. Despite long-standing technical expertise, strong research and development (R&D), and a large consumer market, local production remains modest. The number of carp and salmonid businesses fell nearly 39% and 46%, respectively, between 2015 and 2023, as small, family-owned farms struggle with profitability.

The local production landscape is dominated by SMEs and micro-enterprises. While historically viewed as less competitive, this structure proved resilient during COVID-19 through direct marketing and local supply chains. While RAS technology is growing and a major focus of innovation in Germany, it remains secondary to traditional pond farming for carp and flow-through systems for trout. Some traditional farms are already making the transition to more RAS based concept, combined with their existing systems.

Although only 12% of freshwater production currently uses RAS, adoption is accelerating. This is driven by:

- Environmental control: Closed-loop systems enable consistent water quality, better disease control, and reduced environmental footprints.
- Decentralization: Modular "plug-and-play" systems (e.g., shipping container units) support production near urban centers, reducing transport emissions.
- Regulatory pressure: Stringent rules for open water and pond licenses make land-based, indoor facilities a more viable investment option.

Small to medium-scale operations currently use RAS for African catfish and eel, and increasingly for high-value species such as Atlantic salmon, shrimp, yellowtail kingfish, and giant grouper.

## Case Study - Heidefisch

**Turning a traditional farm into a high-tech aquaculture leader**

Heidefisch GmbH, a family-run farm in Wietzendorf, transitioned from agriculture to rainbow trout and trout caviar production using RAS in the late 1990s. Today, it produces around 900 tonnes annually using partially recirculating aquaculture systems (PRAS) with less than 5% water exchange. It exports over 90% of its products across Europe and to high-fish-consumption markets further east, while also selling through its factory outlet and online shop. The farm uses RAS to reduce water extraction, combined with computer-controlled feeding and biofilter-based water treatment.

Energy is the farm's second-largest cost after feed, prompting investment in photovoltaic systems and plans for around two megawatts of rooftop solar capacity, supported by a new transformer station. This on-site generation enables immediate use of electricity, including for water cooling, with cooled water stored for extended periods. Continuous monitoring of water parameters, such as $CO_2$, is performed via data loggers, while about 20% of production capacity is estimated to remain optimizable. Together, these efforts demonstrate a commitment to technological innovation, and highlight how industries can evolve through the adoption of cutting-edge solutions.

**Case study - SEAWATER Cubes**
**Modular RAS for local food production**

SEAWATER Cubes develops fully automated, container-based RAS designed for decentralized fish production. The systems enable the farming of marine species such as sea bass and sea bream directly in urban or rural environments, close to the end consumer. Each system is based on four recycled shipping containers and requires only 150 m² of installation space, with a production capacity of up to 7.8 tonnes per year. Using a patented biofiltration process, the systems achieve water recycling rates of up to 99% and operate without antibiotics. The modular design enables flexible deployment in industrial areas, on farms, or in urban settings, making production independent of coastal access.

A key differentiator is the high level of automation. The systems are designed to run with minimal manual intervention, enabling a wide range of operators, including farmers, entrepreneurs, and businesses without prior aquaculture expertise, to enter fish production. This lowers operational complexity and opens up new, locally anchored business models. By producing fish directly where they are consumed, SEAWATER Cubes significantly reduce transport distances. This increases product freshness, as fish no longer needs to be frozen, and strengthens the connection between consumers and food production. The proximity to the end customer also contributes to greater awareness of how food is produced and where value is created.

The approach highlights the potential of locally developed technology to enable distributed aquaculture models and small to mid-scale production units across different regions.

*"We are installing approx. 2 megawatts of PV electricity on our roof surfaces, and estimate that we can meet about 30% of our energy needs through solar power."*
***Production manager, land-based fish farm***

## Potential and opportunities

The true opportunity for German aquaculture lies in leveraging the country's engineering proficiency, strong R&D, and potential for decentralized, local production, particularly through RAS and integration of aquaculture with existing agricultural systems.

**Diversification for agricultural farmers:**
Traditional German farmers can expand into aquaculture using existing land, skills, supply chains, and marketing channels, while leveraging waste heat from local or their own biogas plants to significantly lower RAS operational costs.

**"Energy farming" synergy:**
Integrating photovoltaics (PV) and biogas heat presents a viable approach for economic resilience within the sector.

**Decentralized urban production:**
Innovative systems, such as modular container-based farms, bring fresh, sustainably produced seafood to urban and rural areas, reducing transportation and carbon footprints. These farms can be very small in scale, yet still face similar overhead costs to larger operations. However, they also create opportunities for innovations that improve production efficiency.

**High-value species:**
Farming exotic species such as yellowtail kingfish and giant grouper enables local producers to compete on quality rather than just price.

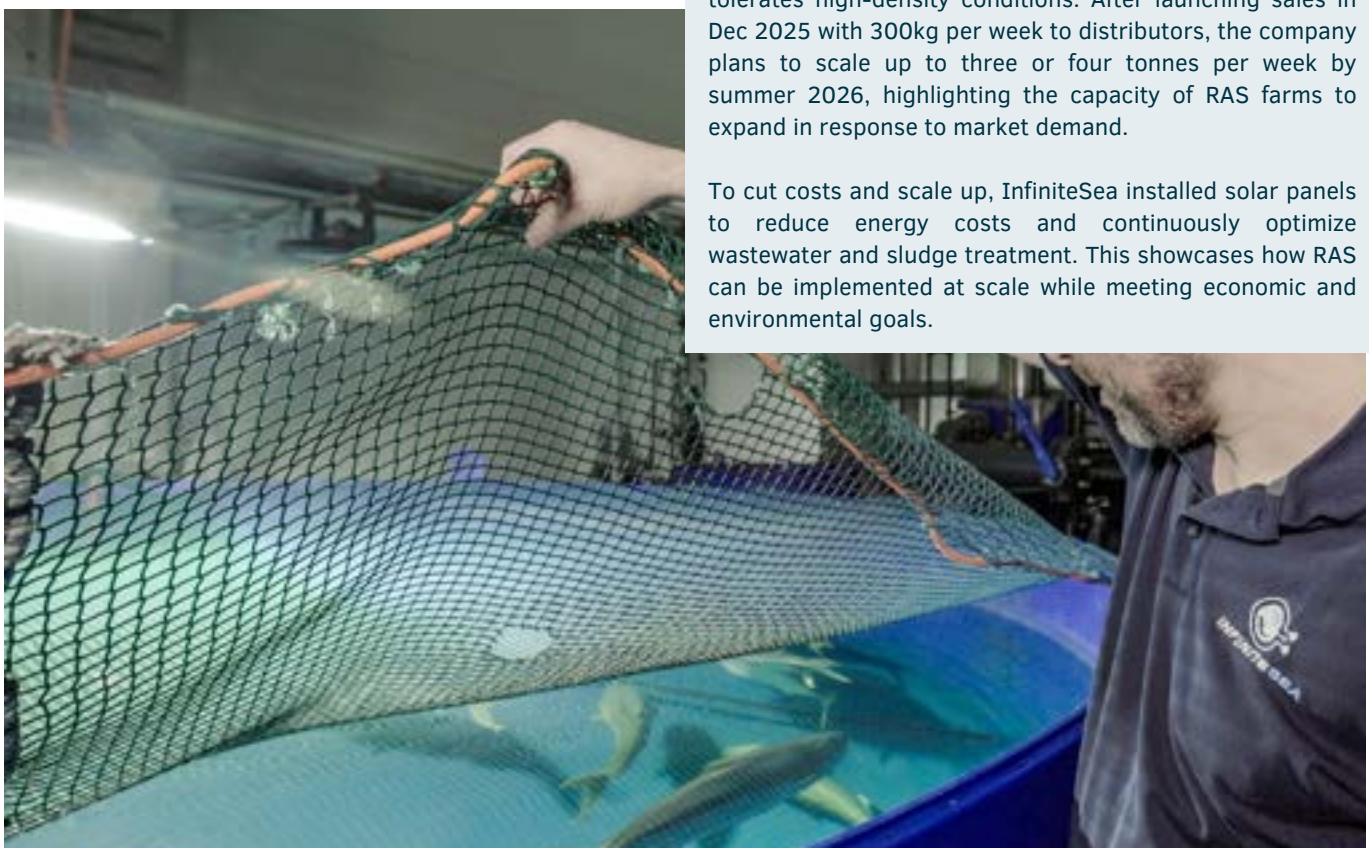

## Case study - Die Geflossenschaft

**Building local connections through innovative sea bass farming**

Die Geflossenschaft (The Fin Cooperative), located in Münsterland, is an initiative founded by a partnership between SeawaterCubes and Louise and Carl Niehues, focusing on land-based sea bass farming. Using SeawaterCubes RAS technology, the farm produces sea bass and sells them directly to consumers.

The Niehues began farming sea bass to meet local demand for locally produced food, complementing their other agricultural products, as well as a showcase farm. They focus on direct marketing, selling fresh fish to consumers and local restaurants. This approach is centered on building direct connections with customers, creating interest through marketing and consumer interactions.

Fingerlings are sourced from a hatchery in France and raised from 1-2 grams to 400 grams. Currently, around 15,000 fish are raised in converted shipping containers, with plans to scale to seven tonnes a year. The farm operates with high levels of automation, reducing labor requirements. For marketing, a vending machine offers high-quality sea bass and local products, providing customers with a convenient shopping option. This small-scale local approach emphasizes the potential for innovation even within niche local markets and highlights the potential of small-scale, local aquaculture operations that prioritize sustainability and community engagement.

## Case study - InfiniteSea

**Scalable, sustainable land-based aquaculture with high-value species**

InfiniteSea, based in Völklingen, Saarland, is a land-based RAS farm that produces yellowtail kingfish, a saltwater species. With its own broodstock and hatchery, it ensures year-round production, independent of seasonal cycles.

Using a closed-loop system, the farm demonstrates the efficiency and sustainability of larger-scale land-based farming. The system filters, biologically treats, and reuses over 95% of water, enabling lower water and energy needs and allowing production in strategic locations, including urban industrial areas and near major cities. InfiniteSea chose yellowtail kingfish for its high market price, nearly double that of salmon or sea bream, and lower competition. The species is well-suited to RAS, grows quickly, and tolerates high-density conditions. After launching sales in Dec 2025 with 300kg per week to distributors, the company plans to scale up to three or four tonnes per week by summer 2026, highlighting the capacity of RAS farms to expand in response to market demand.

To cut costs and scale up, InfiniteSea installed solar panels to reduce energy costs and continuously optimize wastewater and sludge treatment. This showcases how RAS can be implemented at scale while meeting economic and environmental goals.

# 03

# Technological Innovation in Advanced Land-Based Systems

## Key Insights

Global aquaculture is gradually shifting from open, low-cost systems to environmentally controlled, technologically advanced models, especially land-based and hybrid RAS. This transition is driven by the need to mitigate risks, making innovation and precision management essential for long-term viability.

Fully closed RAS offers high control and sustainability. However, its complexity, high capital and energy costs, and technical risks have slowed expansion. This has pushed the industry toward hybrid systems that balance water recirculation with operational simplicity. These are supported by expanding investment, species diversification, and a maturing supplier network.

Advances in automation, advanced monitoring, and AI-based solutions are improving RAS reliability and efficiency, enhancing feeding accuracy, biomass estimation, and operational control. These are key to reducing costs, minimizing losses, and improving financial viability.

Europe leads global RAS development with strong capacity and investor interest, but high energy costs, regulatory complexity, and past financial losses underscore the need for regular project timelines and financially resilient operations.

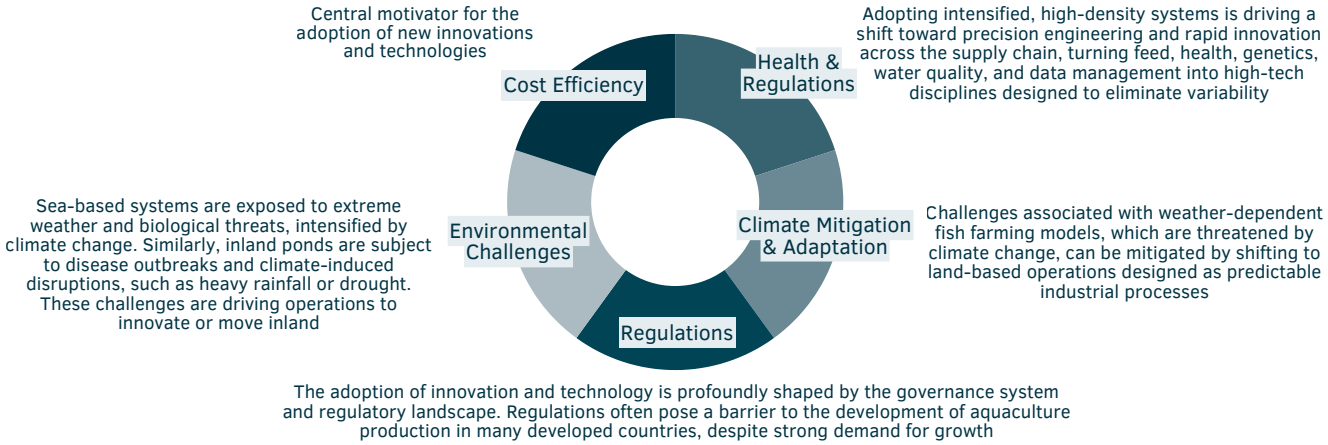
The RAS sector is evolving from large-scale pure RAS toward modular, hybrid systems that emphasize financial stability, predictable performance, and investor confidence.

Germany's RAS sector is a global hub for aquaculture technology and engineering, with strong investment in equipment, system integration, and efficiency. This positions it as a key supplier of RAS solutions.

# 3.1. The Drivers Behind Aquaculture Innovation

The global aquaculture industry is shifting from natural resource-dependent systems to more controlled, independent models. Climate change, environmental risks, diseases, and pollution (Figure 16) drive this change. The transition, both technological and existential, comes with a trade-off: operators exchange the lower capital costs of open systems for high complexity in biologically stable, offshore, closed-continent, or land-based infrastructure.

**Figure 16: Key drivers for innovation in aquaculture**
Source: Hatch Blue Analysis

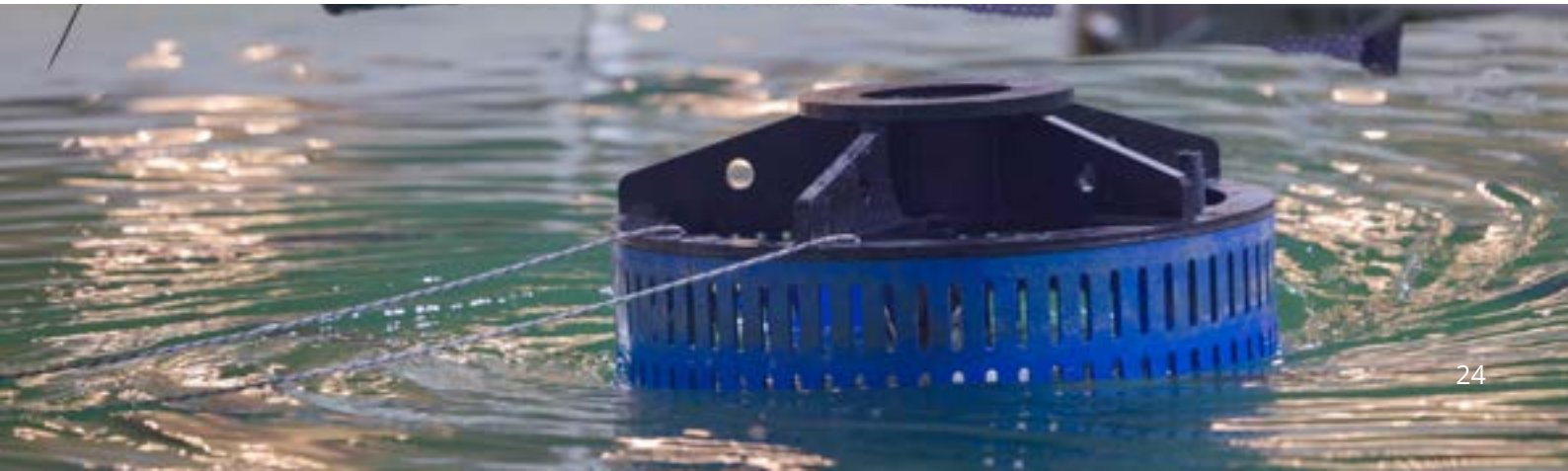



In the past, aquaculture relied on extensive and semi-intensive systems. These included open-net pens and cages for marine species and earthen ponds for freshwater species and shrimp. Although these offer low entry costs, they are highly vulnerable to external threats. This has led to unpredictable mortality and unstable harvests. In Norway, for example, the government's "traffic light" system limits production growth where sea lice pressure is high, capping supply based on the environmental impact of biological performance.

Consequently, the shift to land-based farming aims to decouple production from uncontrollable, external factors. However, the industry is learning that "stability" does not require moving the entire lifecycle indoors immediately. A hybrid model has become dominant, particularly in the salmon sector. It focuses on post-smolt production by raising juveniles to larger sizes (up to 1kg) in land-based RAS facilities before sea transfer. This cuts the time in open water from 16 months to under a year. Exposure to sea lice and disease is significantly reduced.

This drive to mitigate environmental and biological risks has become the main catalyst for technological innovation across production systems. This is especially true in land-based RAS, where a single system failure can result in total stock loss. Innovation is no longer just a strategic advantage; it's a necessity for long-term viability. This shift is driven by internal economic pressures and external societal expectations, pushing the industry to adopt transformative technologies that align technical and biological needs.

Ultimately, the move to controlled environments is turning aquaculture into a process industry. The priority is no longer just growing fish, but managing complex biological data through advanced equipment, automation, and precision inputs to better control and reduce farming risks.

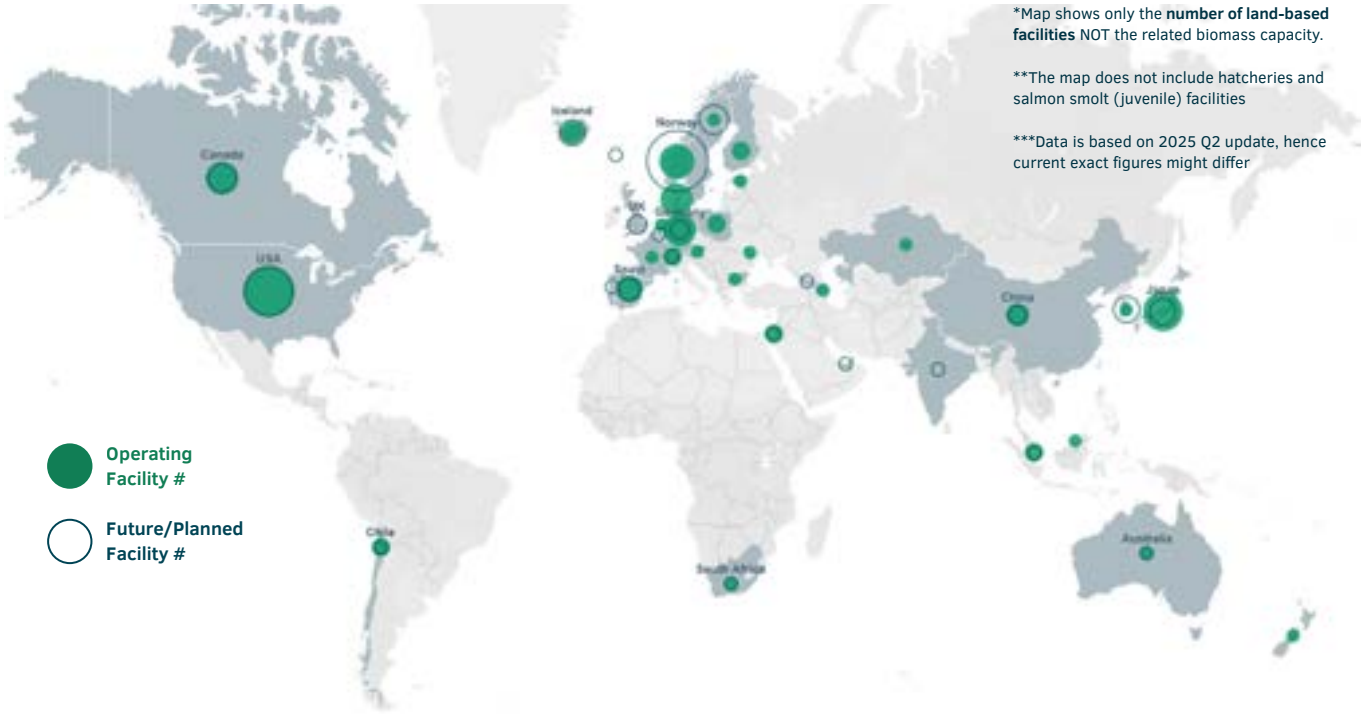


# 3.2. The Global RAS Sector

The transition toward controlled production systems was also largely driven by significant improvements in water-recirculating systems, which began around the 1970s. Compared to sea-based systems, RAS technology enables precise control over environmental conditions, improving efficiency and long-term sustainability. Moving production on land also addresses risks, such as parasites, algae, and jellyfish blooms; temperature fluctuations; spatial constraints; pollution from fish farms; and negative public perception, which have previously limited growth at sea.

The map below (Figure 17) shows notable geographic clustering of land-based facilities in economically developed regions, particularly North America, Europe, and East Asia. The U.S. and Canada dominate North America, while Europe forms a major hub with concentrations in Norway, Iceland, Spain, and Germany. In contrast, South America, Africa, and Oceania have only isolated facilities, indicating more limited industry development associated with high upfront capital requirements. Germany's concentration of both operational and planned sites suggests rapid market expansion, reinforcing Europe's importance within the land-based sector.

**Figure 17: Map of land-based RAS grow-out facilities**
Source: Spheric Research, Land-Based Aquaculture Report (2025)




## The rise of hybrid systems

While RAS offers high biosecurity and flexible site selection, the industry is increasingly embracing Hybrid Flow-Through (HFT) systems that combine partial recirculation with continuous water exchange to balance environmental control and operational simplicity. Over the past decade, several pure RAS projects have faced challenges, including mass mortality due to technical failures, hydrogen sulfide (H2S) accumulation, early maturation, off-flavor issues, and high CapEX and energy demands. While RAS offers predictable yields and independence from coastal locations, its complexity and risk profile have slowed expansion, making HFT an attractive alternative. Current forecasts predict that by 2030, traditional flow-through systems (TFT) and HFT systems will represent around 59% of land-based salmon production, surpassing pure RAS volumes.

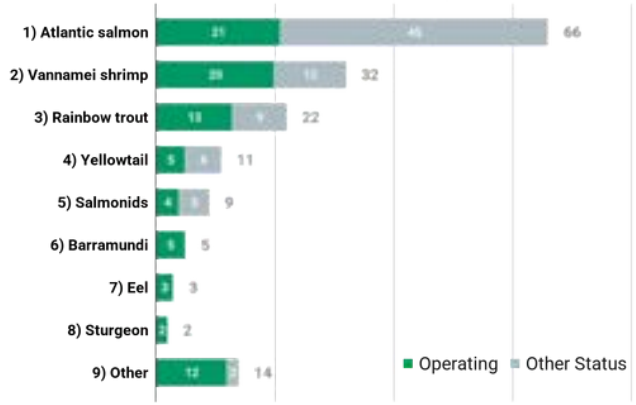
## Species diversification

While Atlantic salmon dominates in RAS, other species are emerging (Figure 18) based on specific economic advantages.

**Figure 18: Number of land-based growout projects by species and status (global scope, data excludes salmon smolt)**

Note: Data is based on 2025 Q2 update, hence current exact figures might differ

Source: Spheric Research, Land-Based Aquaculture Report (2025)




**Trout and char:**
Land-based trout production is increasing, with volumes forecast to reach 26,000 tonnes by 2030, alongside growing investment in Arctic Char.

**Sturgeon:**
Largely driven by high-value caviar production, with around 14 operational and planned projects globally. Key players are expanding operations in Moldova and Azerbaijan to increase their RAS footprint to up to 10 tonnes of caviar annually

**Sole and turbot:**
Though still in small volumes, continued RAS investment by Stolt Sea Farm signals a positive outlook for flatfish RAS.

**Yellowtail kingfish:**
Often considered the "non-salmonid leader," this species benefits from premium pricing and suitability for RAS, supported by successful scale-ups by companies such as The Kingfish Company and Nordic Aquafarms.

**Shrimp:**
Despite higher indoor operating costs, major Chinese feed companies are investing heavily in mega-RAS shrimp farms to address water pollution. Meanwhile, in Ecuador, pond farmers are adopting "RASification," partial recirculation techniques to improve sustainability without full indoor costs.

<u>Notable mentions</u>:

**Eel:**
Significant infrastructure development is underway, primarily in China, alongside operations such as ALBE Fischfarm in Germany and American Unagi in the U.S. However, a high reliance on wild-sourced glass eels for stocking remains a constraint.

**African Catfish and Tilapia:**
These hardy species perform well in RAS, and are easier to handle than delicate salmonids. Europe hosts several successful African catfish farms. However, the species's lower market value can limit institutional investment, as returns may not always justify the high CapEx required for RAS.

**Barramundi:**
Seen as a high-potential marine species for RAS, alongside grouper and snapper, with a handful of active projects globally.

## Investment and market growth

The sector is experiencing a mix of trends, with capital inflows alongside the struggle of existing projects to meet production plans. In the first half of 2025 alone, debt and equity fundraising reached over $1.3 billion. This surge is driven largely by institutional investors, including banks and pension funds, particularly in Iceland and Japan. On the other hand, events such as technology providers going out of business, RAS facilities being put up for sale, equipment failure-related mass mortality events, or poor financial results reflect the challenging reality for some operating companies in this space.

## Supply chain maturation

The ecosystem supporting these farms is maturing rapidly. The number of specialized suppliers grew by 51% in the last year, with a notable influx of "multi-industry" players from water treatment and industrial automation entering aquaculture. This signals a move toward industrial standardization, moving away from the custom, experimental designs that characterized early ventures.

# 3.3. Next-Generation Operational Trends

**Figure 19: The enabling technologies toolbox**
Source:Hatch Blue Analysis


In traditional systems, the main concern is looking after the animals, while in RAS, farmers also need to look after the water (pumping, filtering, treating, monitoring), as well as the bacterial populations that inhabit the biological filter, which is the heart of any RAS facility. These systems rely on mechanical and biological filtration, disinfection (UV and ozone), degassing, heating, cooling, and oxygenation to maintain water quality and support high-density biomass. The equipment also increases the system's dependency on its energy sources and the need for backup systems and contingency plans.

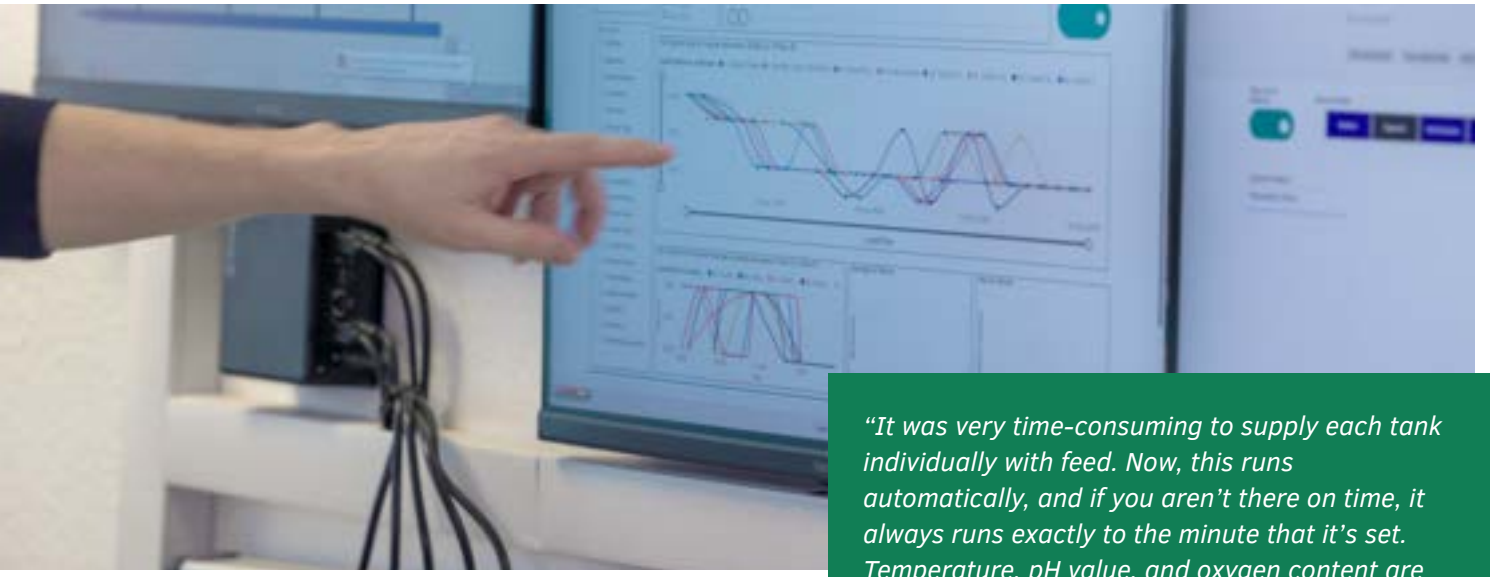
Over the past two decades, global investment in RAS has stimulated breakthroughs in supporting technologies and high-performance operational techniques (Figure 19). These developments allow more farmers to adopt land-based production, making it more reliable and accessible.

RAS systems are increasingly driven by automation, data integration, and animal health monitoring. Artificial intelligence (AI) tools and computer vision enable accurate biomass estimation and early stress detection. These support predictive systems that link animal behavior with water quality parameters such as oxygen, carbon dioxide, and nitrate. This can improve feeding accuracy, which is critical since manual stock estimation errors of ~20% often lead to over- or underfeeding, impacting profitability.

AI-powered cameras and algorithms provide real-time data on fish growth. This improves operational efficiency and resource planning. Other systems aggregate health and welfare data for early disease detection. Underwater AI drones monitor water quality, perform maintenance, and remove dead fish.

Although most AI startups are in the early stages, major industry players such as producers, feed companies, and tech providers are partnering to develop practical solutions that improve growth rates, feed conversion, reduce waste, and lower costs and environmental impact.

Given the complexity of RAS as a full-scale life support system, technological improvements are essential to increase efficiency, reduce costs, ensure stable, year-round production, enhance resilience, support scalability, and improve sustainability.



*"It was very time-consuming to supply each tank individually with feed. Now, this runs automatically, and if you aren't there on time, it always runs exactly to the minute that it's set. Temperature, pH value, and oxygen content are the main units that are important to us. Now we can view these from anywhere. That's the advantage."*
***Owner and manager, land-based fish farm***

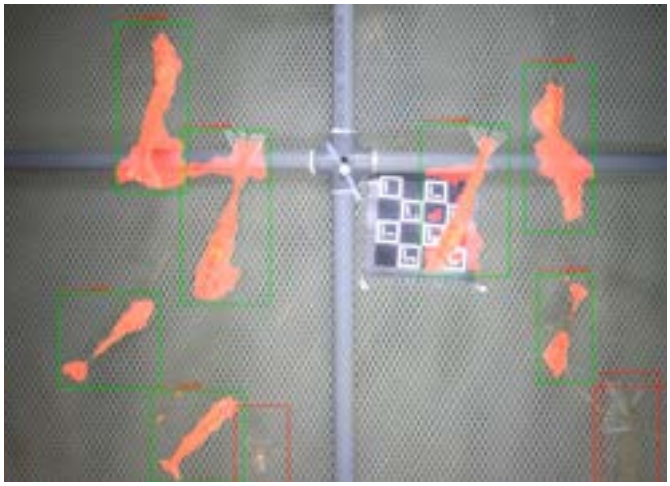
## Case study - Oceanloop and the Alfred Wegener Institute (AWI)

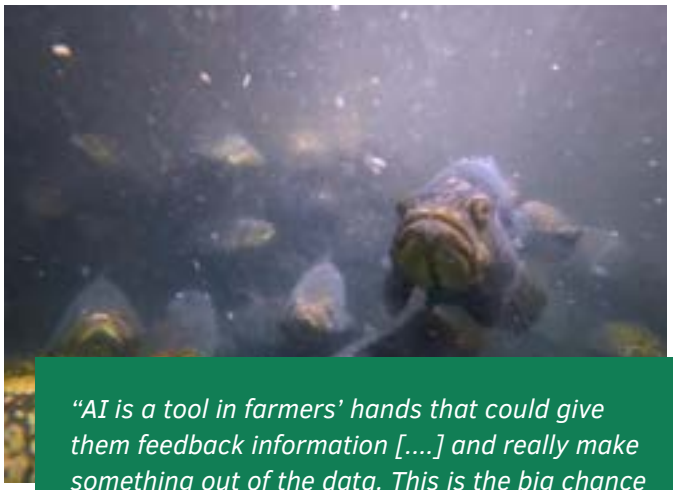
**Advancing sustainable shrimp farming through AI-driven innovation**

In Germany, digitalization and AI in aquaculture are advancing through collaborations between startups and research institutes. The ShrimpWiz project, led by AWI and Oceanloop, shows how such partnerships can improve technology and operational efficiency. The project aims to enhance shrimp farming conditions and lower costs.

Shrimp farming requires frequent handling for weighing and inspection, which can cause stress. Combined with turbid water, this makes it hard to identify unhealthy individuals. To address these challenges, AWI and Oceanloop have developed an AI-based computer vision system that counts shrimp and monitors welfare throughout production. Specifically, a smartphone positioned above the tanks captures images every minute, sending them to a local server, where algorithms count shrimp, measure length, and detect visual signs of stress such as red tails. Oceanloop's clearwater RAS system makes this monitoring highly accurate, ultimately demonstrating the benefits of combining innovative research with advanced farm technology.

Funded by the Federal Ministry of Food and Agriculture (BMEL) through the Federal Office for Agriculture and Food (BLE), the project illustrates how funding, research expertise, and startup innovation can work together to advance digitalization and AI in aquaculture.





*"AI is a tool in farmers' hands that could give them feedback information [....] and really make something out of the data. This is the big chance that we have now with AI, to prevent "fires" and production failures before they happen."*
***Project coordinator, research institute***

# 3.4. The European RAS Sector

The European RAS sector has developed rapidly and is widely regarded as a global leader in land-based aquaculture innovation. Europe holds a significant share of global RAS capacity, with 41% of land-based salmon facilities in Norway, Denmark, and Iceland. Norway alone produced 20,000 tonnes of land-based salmon in 2023. Several other facilities are now reaching commercial scale. Hima Seafood in Norway has started harvesting fish at its 8,000 tonnes-per-year trout farm, while Danish Salmon in Denmark and Nordic Aqua Partners in Norway are operating near full capacity. Growing investment has also attracted suppliers from related industries. Norway, for example, has invested heavily in land-based smolt production. It has also developed a cluster of RAS-focused integrators, engineering firms, and equipment providers. As Figure 20 highlights, these developments further reinforce Europe's global leadership.

Within Europe, Norway dominates the RAS project pipeline. Emerging clusters exist in Germany, Spain, Iceland, and Denmark (Figure 21). Another notable example is The Kingfish Company's Kingfish Zeeland facility in the Netherlands, which produces yellowtail kingfish using RAS. The farm has expanded in recent years, reaching a production capacity of 4,000 tonnes annually by 2024. This demonstrates the commercial viability of land-based systems for high-value marine species. The company also raised €32 million in financing in 2023 to support further expansion, illustrating continued investor interest in the sector.

**Figure 20: Number of land-based growout projects by status**

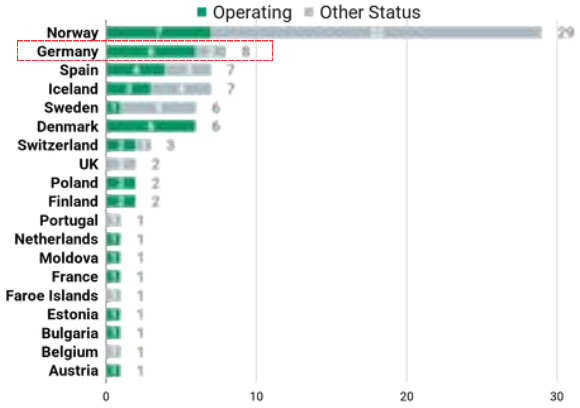
Scope of chart is GLOBAL, data excludes salmons molt (juvenile) facilities

Source: Spheric Research, Land-Based Aquaculture Report (2025)


**Figure 21: Number of land-based growout projects by status in Europe**

Scope of chart is EUROPE, data excludes samlon smolt (juvenile) facilities

Source: Spheric Research, Land-Based Aquaculture Report (2025)




Despite these advances, the European RAS sector has faced challenges. Some companies have experienced heavy losses or closures, such as the bankruptcy of Gaia Salmon in Norway in 2024. In addition, high energy and material costs, price fluctuations, and complex regulatory requirements continue to create barriers to RAS development. Furthermore, some projects have stalled primarily due to regulatory hurdles and difficulties obtaining permits for land development and water use. As a result, the sector is entering a more cautious phase, with investors focusing on more realistic project timelines and financially resilient operations.

# 3.5. The German RAS Sector

While Nordic countries lead in Atlantic salmon production, Germany has built a distinct and influential role in land-based aquaculture. Drawing on engineering expertise, the country has become a hub for indoor farming technology. Germany's RAS sector is characterized by a "technology-first" approach, using advanced engineering to optimize traditional species production and manage non-native species efficiently. Investment in land-based facilities and tech supplier networks has positioned Germany as an influential player.

Although Germany's domestic production remains modest, the country has become a key hub for RAS technologies, components, and engineering, some of which extend beyond the aquaculture industry. As a result, Germany is currently the fourth-largest global supplier of RAS technology, behind Norway, the U.S, and Denmark.

This technical leadership is evident in the German ecosystem, which includes specialized engineering firms and multi-industry suppliers adapting technology for aquaculture:

- Water quality management: Companies such as Sander supply essential components, including protein skimmers and ozone generators, for high-density systems. Sander's designs are competitive in terms of price, power consumption, and volume, helping to reduce operational costs.
- System integration: Spranger delivers custom RAS facility design, including shrimp farms for clients such as SwissShrimp and CrustaNova.
- Design and construction: Water Proved and FutureFish Aquaculture offer design and construction services, while Seawater Cubes develops modular RAS systems in shipping containers, showcasing Germany's engineering expertise.
- Biological support: Firms like Christian Stöhr supply biological carriers for moving bed bioreactors (MBBR), a standard best practice for nitrification in RAS.

The traditional pond farming of carp and trout remains culturally and environmentally important. These ponds serve as biodiversity hotspots, provide essential ecosystem services such as water retention, flood protection, and groundwater recharge, and represent a nature-integrated form of food production. At the same time, modern technological advancements, including RAS, precision feeding, and digital monitoring, have the potential to significantly improve production efficiency and support the sustainable intensification of German aquaculture.

*"With RAS, you have a high level of control over inputs, outputs and product quality, so I see that as the future. [....] It ultimately depends on energy supply and demand. But with sustainable energy sources [....] this could become the future of aquaculture in Europe, including Germany."*
***Senior scientist, research institute***

**Case study - ALBE-Fischfarm**
**Enhancing competitiveness by farming a unique species**

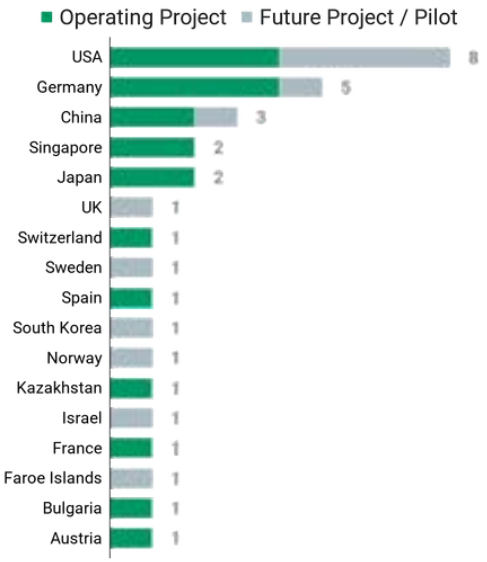
Founded in 1989, ALBE-Fischfarm is a market leader in eel farming, producing 320 tonnes a year in Haren-Rütenbrock, and marketing around 600 tonnes across Europe. The farm manages the full value chain from production and processing to imports and sales, using RAS and automation for its production efficiency. Water quality is maintained through biological treatment, biofilter towers, and oxygen enrichment. Operations have significantly improved through fully automated feeding, real-time alerts, and remote monitoring of temperature, pH, and oxygen.

Germany is the main market, followed by the Netherlands, Denmark, Poland, and Spain. German smokehouses, the farm's largest customers, prefer farmed eel for its consistent quality and predictable availability. In contrast, wild eel varies in taste and supply, and is seasonally restricted (winter fishing is banned to allow migration, limiting availability to April through September). The farm also supports eel conservation through stocking, research, and the release of mature females into open waters.

ALBE-Fischfarm's comprehensive approach to eel farming, processing, and sales positions it as a pioneering example of vertically integrated RAS-based aquaculture.

Since shrimp, a warm-water non-native species, cannot be farmed using traditional methods in Europe, producers are exploring land-based, intensive tank systems that use RAS systems. These indoor systems are generally clear water (RAS-based) or hybrid biofloc systems. RAS relies on mechanical and biological filtration, while biofloc systems use microbial aggregates (bacteria, algae, protozoa, and organic matter) to convert nitrogenous waste (ammonia and nitrite) into microbial protein. This maintains water quality while providing supplemental nutrition. Biofloc systems also lower CAPEX by eliminating biofilters and lower OPEX by reducing pumping requirements and feed demand, as biofloc provides part of the shrimp's feed. In Germany, farms predominantly use clear-water systems for higher water quality and greater control, and the country is becoming an active location for land-based shrimp farming, with several pilot and planned projects (Figure 22).

**Figure 22: Land-based shrimp projects by country**
Note: chart includes global vannamei shrimp projects as of 2025 Q2
Source: Spheric Research, Land-Based Aquaculture Report (2025)




Both systems are less price-competitive than imported shrimp but can provide higher-quality products. However, as technology matures, scaling up is expected; mid-term project capacities are projected to reach 1,000 to 2,000 tonnes, with long-term goals of 5,000-tonne facilities. Achieving such scale will require regional supply chain progress in post-larvae availability, specialized feed, and processing, as well as market acceptance, with more customers willing to pay premium prices for locally produced shrimps.

### Case study - HanseGarnelen

**Energy-conscious shrimp farming in a high-cost environment**

A land-based whiteleg shrimp farm in Glückstadt, was founded in 2019. Acquired in 2020 and rebuilt as a proof-of-concept for a larger facility, the farm has a nominal capacity of 100 tonnes per year. It sells shrimp year-round across Germany to online private customers, retailers, wholesalers, and high-end catering and restaurant clients.

The farm creates seawater by blending drinking water, natural sea salt, and marine minerals, while biofilters and oxygen-rich inlets maintain circulation and rem, which is then converted to nitrate; next, denitrifying bacteria convert nitrate to nitrogen gas for removal. The purified, oxygenated water is then recirculated back into the system. A circulating current and sinking feed promote swimming and efficient feeding.

The rearing system is efficient and environmentally friendly, with around 99% of its water reused. Additionally, the farm is heated with waste heat from a neighboring paper mill and supported by rooftop solar panels, helping minimize its carbon footprint.

# 3.6. The German RAS Sector - Financial Feasibility Analysis

## Capital Expenses

One major challenge of RAS is its high upfront investment, primarily driven by specialized infrastructure such as tanks, water treatment systems, drum filters, ozone generators, backup power, and pumping systems, as well as land development and construction. Compared with open-ocean and other land-based systems, this initial capital creates an entry barrier and can lead to long payback periods, increasing exposure to early-stage risks. As a result, financial feasibility depends on scale, system design, access to long-term financing, and effective management of biological and technical risks.

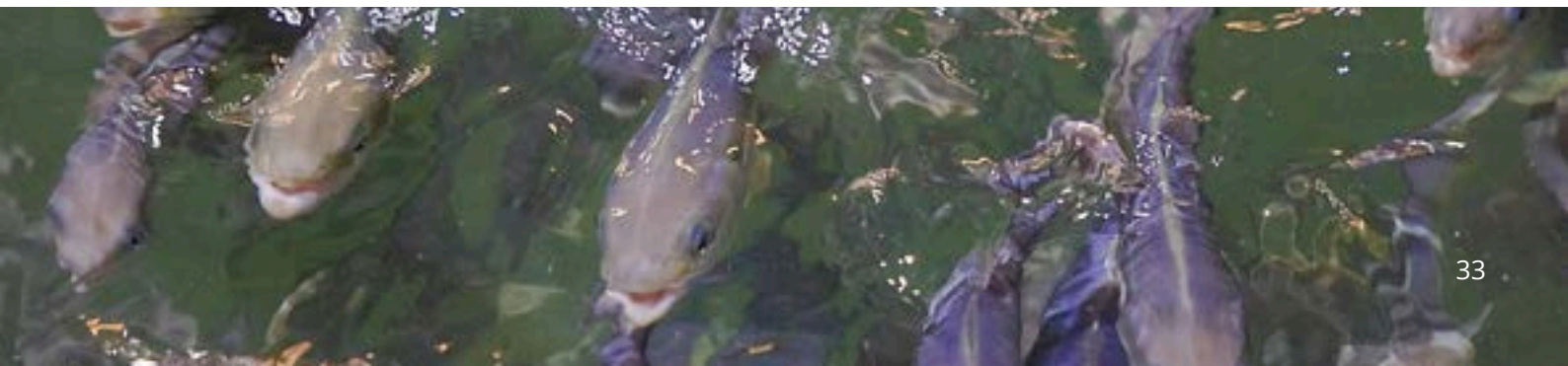
**HanseGarnelen**
German shrimp RAS facilities face similarly high capital intensity. For example, HanseGarnelen required an initial investment of approximately €15 million to cover land acquisition, construction, and technical infrastructure, including tanks, filtration, mechanical equipment, monitoring systems, and water treatment. Of this total, €6–7 million was spent on construction, around €4 million on technology and water treatment, approximately €0.5 million on land, €1 million on the energy system, and about €2 million on planning and development. These figures highlight the capital-intensive nature of RAS projects, underscoring the need for careful planning, system design, OPEX-reducing solutions, and financing to ensure long-term viability.

## Operating Expenses

Operating expenditure is a key driver of financial feasibility. Energy typically accounts for 20–40% of costs, with Germany's high electricity prices and grid charges adding further expense. Feed represents another major cost, often accounting for over 84–85% of variable expenses, especially for carnivorous species that require high-protein diets. RAS operations also depend on skilled labor for complex biological and technical processes, increasing personnel costs. Additional costs arise from regulatory compliance, monitoring, and administration.

**The Kingfish Company**
The Kingfish Company, a yellowtail RAS producer in the Netherlands, provides a useful benchmark due to its publicly available financial data. In 2024 (with ~2,000 tonnes of sales), raw materials, mainly feed and biological inputs, cost €16.763 million; employee costs €10.529 million; and depreciation, amortization, and impairment €14.323 million. This demonstrates RAS's capital and labor intensity. Other operating expenses, including maintenance, utilities, and administration, totaled €7.489 million, while transport and logistics added €0.897 million. These costs resulted in an operating loss of €22.352 million. This example highlights feed, labor, and depreciation as primary cost drivers and underscores the importance of operational efficiency for profitability.

**HanseGarnelen**
Annual operating costs are mainly driven by feed and post larvae (about 28%), and labor (about 28%). Energy represents a smaller share (around 8%), followed by packaging and dispatch, sales and marketing (around 15%). Together, these account for roughly 80% of total costs, resulting in an estimated EBITDA margin of about 19.5–20%. This highlights the margin sensitivity of RAS operations, where profitability depends on tight cost control, operational efficiency, and biological performance.



## Revenue & Pricing

Revenue in RAS facilities depends on achieving premium pricing, especially in Germany's high-end seafood markets. While energy and labor subsidies may support early profitability, long-term viability depends on operational efficiency, cost reduction, and effective marketing to maintain premium prices and offset high production costs.

**The Kingfish Company**

The Kingfish Company serves as a notable example. In 2024, it sold 1,992 tonnes of yellowtail, generating €27.7 million in revenue, up 26% from 2023, despite a lower average price of €13.9/kg. Operational losses narrowed, with EBITDA per kg improving from –€2.7/kg in 2023 to –€1.7/kg in 2024, reflecting higher volumes and better cost control. While payback period and IRR are undisclosed, progress toward full 4,000-tonne capacity shows how scaling RAS operations spreads fixed costs, improves unit economics, and moves facilities closer to profitability, despite high capital and operating expenses.

**HanseGarnelen**

With retail and wholesale prices of €40–50/kg, HanseGarnelen's annual shrimp production is estimated to generate approximately €4 million in revenue, reflecting the premium for locally produced, sustainable shrimp. At full capacity, in mid- to late-2027, an EBITDA margin of 19.5–20% is projected. These estimates indicate that revenue is driven by premium pricing, while profitability depends on successfully scaling production and maintaining both price premiums and cost discipline.

## Possible Risks

Assessing RAS financial feasibility requires careful attention to risk. System failures, power outages, oxygen loss, operational accidents, and more can have critical consequences, while lengthy permitting procedures may delay market entry and increase pre-operational costs. Price volatility is the main driver of profit variability, while the likelihood of system failure largely determines expected profit. Financial viability thus depends on robust price management to handle market volatility (as well as cold storage capacity in the event of marketing delays) and on reliable technology to minimize operational risks.

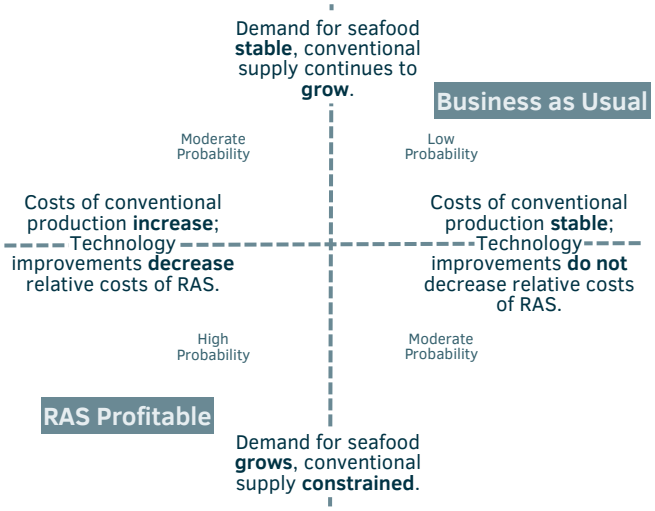
> *"I think the big players [....] are interested in the future to source their own fish and produce their own fish. I think there will be an industry of those that will invest in RAS plants. My primary advice for future projects is to think big."*
> ***CEO, land-based shrimp producer***

## Conclusion

While RAS offers significant potential for German aquaculture, its commercial viability depends on overcoming high capital intensity and operational complexity. Achieving profitability requires the right scale for the business model and marketing approach, optimizing resource efficiency, and coordinated government support, such as subsidies or grants, to mitigate financial risk. Despite delayed returns, the sector presents an attractive opportunity for private investors to tap into the premium seafood market. Continued innovation in energy efficiency, alternative feeds, and automation, alongside strategic partnerships, can lower operating costs.

**Figure 23: Scenarios influencing RAS profitability**

Source: Adapted from O'Shea et al. (2019)



# 3.7. Regulatory Bottlenecks in Germany

German aquaculture development is constrained by its regulatory framework. Stakeholders, including officials, researchers, startups, and commercial operators, cite complexity, unpredictability, and fragmentation as major barriers to growth. Other assessments, such as the National Strategic Plan Aquaculture 2021–2030, also highlight stringent legal requirements and complicated licensing procedures.

## Challenges

**Administrative knowledge gaps and rigid legal interpretation:**
Authorities often lack basic knowledge of aquaculture, leading to risk aversion and decision anxiety. Permits are frequently denied, or require costly expert opinions. Decisions are often justified by rigid legal interpretations; for example, the strict application of the EU Water Framework Directive's non-deterioration principle may block permits based on theoretical impacts, even when those impacts are negligible in practice.

**Decentralized authority:**
While the EU and federal levels set overarching strategies (e.g., "Farm to Fork"), the actual regulatory power lies in the district level (Landkreise). As a result, with ~400 local districts, there are significant inconsistencies in enforcement across states and districts.

**Water rights insecurity:**
Water rights, once permanent, are now often limited to 5–10 years, creating massive investment risk for capital-intensive projects if the core license expires.

**Inconsistent sector classification:**
Aquaculture is often not classified as agriculture for planning/building purposes, i.e., land-use requiring industrial land. Stakeholders have highlighted that they often remain ineligible for industrial support programs, such as reduced electricity rates.

**Zoning distinction:**
Farmers can build in rural "outer zones", but face pressure to reuse unsuitable old agricultural buildings. Commercial operators, by contrast, are effectively banned from the outer zone and forced to operate in commercial areas.

**Length and uncertainty of permitting:**
Permitting is a major barrier, often taking 1.5–2 years or more,due to unclear timelines and limited guidance from authorities, making investment planning difficult. Approvals for inland aquaculture require compliance with water, nature, conservation, and animal welfare laws from multiple authorities. Critical permits include the building permit (Baugenehmigung) and the water permit (Wasserrechtliche Erlaubnis).

**Other - prohibitive economics:**
High operational costs, particularly labor and electricity (over 20 cents/kWh), make production in Germany more expensive than in neighboring countries such as the Czech Republic and Poland. This makes it extremely challenging to compete with global commodity prices.

Regional economic conditions, environmental or infrastructural suitability, and varying administrative and regulatory conditions may influence the expansion of closed aquaculture systems in Germany (Figure 23). For example, a complex and time-consuming permitting process may partly explain the uneven regional distribution and concentration of facilities.

*"The first major obstacle for RAS farms is administrative. The initial thing is you need a water permit, and that's the main hurdle at first. That can take up to two years."*
***CEO, land-based shrimp producer***

*"One obstacle is a fragmented regulatory system where different regions have different rules. There are people in offices in the middle of nowhere, having the chance to block this or that, applications of building a fish farm etc, and they are not educated."*
***Project manager, agricultural society***

**Figure 24: State map of closed aquaculture systems in Germany (2024/25)**
Source: DESTATIS German Federal Statistical Office (accessed 2025)


# 3.8. Turbulence of Trends and Future Outlook

The RAS sector is highly volatile, with record-breaking capital inflows alongside major operational failures. In the global landscape, despite successful harvests and institutional support, many producers are closing, farms are up for sale, and technology providers are downsizing or filing for bankruptcy.

Amid this, financing for land-based aquaculture remains promising, reflected by market maturity and a shift from venture capital to mainstream debt financing. Examples include Pure Salmon's $211 million loan from Japanese banks and Andfjord Salmon's entry into the Nordic bond market, supported by operational successes that are advancing the industry beyond the conceptual stages.

This momentum is further illustrated by companies like Salmon Evolution. In 2024, it achieved record harvests of 4,900 metric tonnes, with a 96% "superior grade." This outperformed many net-pen competitors. Likewise, The Kingfish Company has successfully scaled yellowtail operations in Europe and the U.S. The supply chain is also expanding, with specialized suppliers growing by 51% over the last year. This trend reflects a move toward industrial standardization and away from the experimental, custom engineering of early projects.

However, the sector is also undergoing a painful trimming process, with technical complexity and liquidity challenges causing significant contractions. Atlantic Sapphire has faced major technical malfunctions and mass mortalities. AquaBounty, a long-standing U.S. salmon producer, had to close or sell farms and equipment, scaling back its expansion plans.

Technology providers are also affected. In 2024, Billund Aquaculture went bankrupt due to operational and capital challenges, reshaping the competitive landscape for systems integrators.

These challenges have rippled through the sector, halting pipeline projects. For instance, West Coast Salmon, a Norwegian company that planned a large land-based salmon farm in Nevada, filed for bankruptcy after nearly $10 million in losses, joining other large-scale, land-based projects in the U.S. that have struggled with high capital expenditure, rising interest rates, and execution risks.

This turbulence is driving a shift away from large "pure RAS" projects toward stable, modular, and hybrid technologies. The focus is shifting from "bigger is better" to "stable is profitable." Consistent biological performance is now prioritized over sheer scale. The industry seeks more manageable designs that provide a more reliable path to consistency and predictability.

In Germany, while still modest, the RAS sector is poised for a technology and research-led expansion, offering a range of opportunities from small-scale, locally oriented facilities to industrialized, scalable operations. A key driver is the modernization of traditional farms, which are increasingly successfully implementing RAS upgrades to move beyond seasonal pond constraints. Germany's role is further evolving into that of a global "Solution Provider"; the nation's world-class engineering is becoming the gold standard for high-efficiency inland farming. We are seeing a strategic shift toward high-value species such as Atlantic salmon, Yellowtail kingfish, Grouper, and shrimp, driven by a 90% reliance on imports and a consumer base demanding local sustainability.

Ultimately, as with any emerging high-tech industry, the future trajectory will be determined by the results of current operations. The sector is currently in a "demonstration phase," where the performance of existing facilities serves as the primary signal to the market: consistent operational successes and proven profitability will act as a catalyst, drawing in new players and institutional capital. Conversely, high-profile failures due to technical or financial mismanagement could deter potential entrants. For investors and policymakers, the upcoming years will be a period of "de-risking," where the combination of precision biotech, smarter federal permitting, and the proven reliability of early adopters will determine whether German land-based aquaculture becomes a cornerstone of a resilient, domestic food system.

> *"I call for a standardization of legal project implementations across Germany's 16 federal states to ensure the same success in all states. The main obstacle in Germany is the fragmented regulatory system, where you have 16 different regulations and rules."*
> ***Project manager, agricultural society***

# 04

# Upstream Industries
## The Engine of Growth

## Key Insights

Germany's aquaculture strength lies in a globally competitive R&D, engineering, and upstream innovation ecosystem. Unlocking private capital and simplifying regulation are key to translating this into a stronger domestic aquaculture blue-biotech sector.

Germany's aquafeed market is small, fragmented, and export-oriented, yet supported by a strong innovation ecosystem of advanced feed producers, additive specialists, and industry-academic collaboration.

Germany has strong research in aquaculture health and genetics, but with limited commercialization. While the majority of innovation is focused abroad, alternative seafood is growing rapidly, leveraging biotech and microalgae expertise.

The microalgae sector is driven by solid R&D, technical expertise, and high-value production, but high costs, restrictive regulations, and fragmentation limit domestic scale. Tools like offtake guarantees are needed to de-risk investment and unlock growth.

Startups face a shortage of private capital and complex regulatory and permitting processes. Potential solutions include one-stop digital portals, regulatory support tools, simplified applications, and a dedicated aquaculture strategy.

# 4.1. Introduction

Germany can redefine its domestic aquaculture by leveraging technical expertise, engineering infrastructure, and R&D. Close collaboration between industry and institutions, such as Fraunhofer IMTE, the International Research Association of Feed Technology, the German Institute of Food Technologies (DIL), the Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), the Max Planck Institute for Molecular Cell Biology and Genetics (MPI-CBG), and The Alfred Wegener Institute (AWI), drives innovation in upstream industries: aquaculture feed, nutrition, animal health, genetics, and welfare. These institutions offer scientific expertise, policy guidance, and industry-focused solutions to support the sector (Figure 25).

**Figure 25: German R&D institutes and their research focus areas**
Source: HATCH BLUE primary research and interviews

| Research Areas | Thünen- Institute | Fraunhofer IMTE | The Alfred Wegener Institute |
|---|---|---|---|
| **Infrastructure & Engineering** (e.g. RAS, farming technology) | D | B | A |
| **Digitalization & Monitoring** (e.g. AI, sensors, automation) | B | C | A |
| **Animal Health & Welfare** (e.g. diagnostics, welfare monitoring) | A | B | A |
| **Feed & Nutrition** (e.g. novel feeds, ingredients) | B | A | A |
| **Sustainable Production** (e.g. restorative, low trophic aquaculture) | A | C | A |
| **Product & Species Development** (e.g. new aquaculture species) | D | C | A |
| **Economic Efficiency** (e.g. profitability, market analysis) | A | D | C |

**A**
**Core focus:** strategic priority, many projects

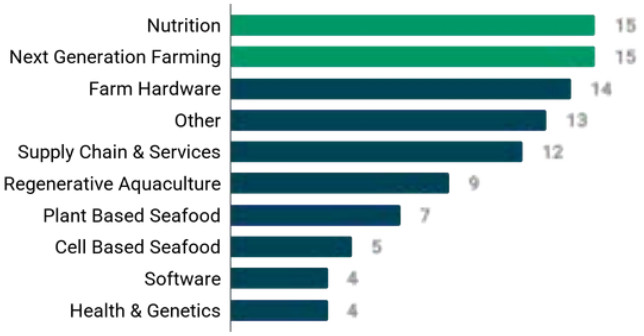
**B**
**Active focus:** regular projects & research

**C**
**Secondary focus:** addressed occasionally

**D**
**Not a research focus at the institute**

There is also a clear concentration of German startups in Nutrition, Next Generation Farming, and Farm Hardware (Figure 26). Startup innovations in Nutrition include novel animal feed ingredients and alternative protein production that support sustainability and cost-efficiency. In Next Generation Farming, startups use advanced technologies, such as RAS, submersible cages, and offshore systems to modernize aquaculture production. Farm Hardware startups develop engineering-driven solutions using AI and digitalization to enable high-efficiency, data-driven aquaculture operations.

**Figure 26: Germany's aquaculture related startups by main segment (# of companies)**
Source: HATCH BLUE startup database




Despite these strengths, Germany's upstream industries face challenges. Addressing private capital and regulatory hurdles through milestone-based funding, shared pilot infrastructure, and streamlined regulation will enable innovations to modernize and scale domestic aquaculture, driving sustainable growth and job creation.

*"Our relationship with the Fraunhofer Institute has made sustained development possible. We have been constantly working on R&D and optimizing the processes to cultivate microalgae."*
***Sales and marketing coordinator, production systems manufacturer***

# 4.2. Feed and Nutrition

German aquafeed production is small in global industry terms. In 2024/25, 260 feed mills produced 22.2 million tonnes of compound feed, mostly in northern regions. The majority of this output is for swine (8.4m tonnes), cattle (6.6m tonnes), and poultry (6.5m tonnes); aquafeed is included within the remaining 0.7m tonnes classified as "other" feeds.

Domestic aquafeed demand is also low, with most production exported across the EU and global markets. In 2023, Germany produced 31,353 tonnes of aquaculture output: 55% freshwater and 45% marine (mainly mussels). Freshwater production was 60% salmonids and 25% carp, a species that does not require compound feed. Based on this, a rough estimate of aquafeed demand is around 16,800 tonnes: (calculated as 31,353 tonnes x 55% x 75% excluding carp x 1.3, assuming a feed conversion ratio of 1.3).

This low demand is influenced by the fragmented structure of Germany's aquaculture sector. 53% of farms produce 1 tonne or less, accounting for 2% of total production, while 21% produce over 5 tonnes a year, representing 91% of total production volume. The prevalence of small-scale operations, combined with low aquafeed demand, makes Germany a challenging market for aquafeed.

Despite this, major players maintain research and production facilities in Germany for talent and engineering expertise. For example, Alltech Coppens' Nettetal facility produces 70,000 tonnes of feed annually across 400 products, while Aller Aqua Group, a specialist in high-performance aquafeed, has a production site in Golßen and a research facility in Busum.

*"I think we have many great entrepreneurs that are willing to [....] use the engineering sources and talent that we have in Europe and specifically also in Germany. There's also a lot of collaboration, and a lot of universities have huge amounts of knowledge and talent that can be shared. That's a really cool advantage of Germany."*
***Venture capitalist and investor, insect production facility***

Germany also has strong expertise in additives, animal by-products, specialist ingredients, and compound feed. Producers include Spezialfuttermittelwerk Beeskow GmbH, or Aquafeed Germany, which produces 18,000 tonnes annually for species such as sturgeon, carp, trout, and catfish. BEWITAL Agri GmbH incorporates active ingredients into oil matrices in fish feed, while Symrise Aqua Feed supplies palatability enhancers and functional hydrolysates. Poultry by-product meal producers help reduce reliance on marine inputs and lower the carbon footprint of aquafeed.

University-industry collaboration drives innovation. Aller Aqua has partnered with universities in Kiel and Hamburg to develop specialized feed. Technische Universität Berlin has produced DHA (an omega-3 fatty acid) for aquafeed by feeding barn straw hydrolyzed to heterotrophic microalgae.

Academic research has also led to the launch of novel feed-ingredient startups: Max Planck Institute research serves as the scientific foundation for b.fab, a single-cell protein company. Similarly, decades of research into black soldier fly larvae led to Illucens, an insect-based protein producer.


## Case study - Dr. Eckel Animal Nutrition

**Innovation in animal nutrition through digitalization and global market expansion**

Founded in 1994 in Niederzissen, Dr. Eckel Animal Nutrition showcases how a German business can use research-driven innovation to improve animal welfare and support sectors such as aquaculture and livestock. Its products enhance animal health, minimize environmental impact, and streamline efficiency for feed manufacturers and large aquaculture producers.

The company mainly targets major international aquaculture markets, particularly in southeast Asia. This is because Germany's small, fragmented aquaculture sector generates limited demand for high-tech feed additives, while regulatory and veterinary requirements for feeding trials add further complexity, reinforcing the importance of Dr. Eckel's international growth strategy.

More recently, the company has invested around €2 million in digitization and production automation to improve safety, ensure consistent product quality, and enable better data collection for product improvement. This transition provides a clear example of how German innovation can be applied to improve operational efficiency.

## Single-cell proteins, insect-based meal and others

The modern aquaculture industry is navigating a transition as production expansion outpaces the availability of traditional fishmeal, which is now facing challenges such as limited supply, environmental scrutiny of feed ingredients, climate change, and volatile pricing. With feed accounting for 40–60% of total production costs, there is a need for a more resilient supply chain that moves beyond reactive health strategies, which often rely on the precise yet difficult timing of expensive functional additives. Instead, the industry is shifting toward "elevated standard feeds" that incorporate functional alternative proteins directly into daily diets. These ingredients not only bridge the nutritional supply gap but also provide essential bioactive compounds that naturally enhance fish immunity and stress tolerance. This evolution from simple caloric replacement to bioactive health support is best exemplified by the emergence of specialized categories such as single-cell proteins, insect-based meals, and other novel ingredients currently shaping the aquafeed landscape.

Single-cell proteins are made from microorganisms such as bacteria, yeast, fungi, or microalgae that are grown via fermentation or cultivation and harvested as protein-rich biomass; they are efficient to produce, require little land, and can use waste or low-carbon feedstocks.

Insect meal, most commonly black soldier fly larvae or yellow mealworms, is fed organic by-products and processed into protein-rich feed that closely matches the natural diet of many fish, offering a circular, resource-efficient alternative to fishmeal and soy.

A number of German companies and start-ups are leading this shift.

**Figure 27: Alternative protein companies in Germany**

**Single Cell Protein**

**350PPM** produces protein by using a fast-growing bacterium that feeds solely on $CO_2$ and $H_2$.

**b.fab** creates single-cell protein from carbon dioxide and hydrogen, with formate as a mediator. It was founded in 2018 as a Max Planck Institute spinoff.

**MicroHarvest** produces protein from bacteria using various feedstocks, targeting the aquaculture and pet food industries.

**Insect Protein**

**Illucens** produces insect protein and offers turnkey automated factories for large-scale insect farmers.

**FarmInsect** provides farmers with automated, modular systems to breed insect larvae (like Black Soldier Flies) on-site from regional organic waste.

**Additive**

**Koralo** produces a white-fish alternative from microalgae and fungal co-fermentation, as well as a feed additive for aquaculture using fermentation broth.

**Marketplace**

**Bygora** operates a specialized B2B digital marketplace for trading novel proteins (such as insect, algae, and single-cell proteins) to make the food, feed, and biofuel industries more sustainable by reducing reliance on traditional protein sources and minimizing environmental impact.

# 4.3. Health and Genetics

Germany has a strong academic and research base in aquaculture health, disease diagnostics, prevention, and genetics. Leading institutions, such as the Friedrich Loeffler Institute (FLI) and Fish Genetics Research Groups at the University of Rostock, conduct cutting-edge research in disease detection, vaccine development, selective breeding, and genome mapping of key aquaculture species.

Despite Germany's strengths in fundamental research, there is a noticeable gap in translating these advances into domestic startups. Most German aquaculture startups instead target high-value species for international markets, such as salmon in Norway or shrimp in Asia, rather than addressing the needs of local farmers.

Within this context, the strengths of German aquaculture's health and genetics sector include:

**Integrated approaches**
Combining molecular genetics, genomics, and aquaculture physiology to support selective breeding and disease resistance research.

**Biotechnological expertise**
Strong capabilities in microalgae, single-cell protein, and bioactive compounds drive innovation in aquaculture health and nutrition.

**Gene editing capabilities**
Advanced expertise that enables the modification of organisms to produce specific bioactive compounds for aquaculture.

Innovations in health and genetics have directly contributed to the emergence of several startups:

**PhytoX** uses microalgae as delivery systems for oral vaccines for tilapia.

**SenseUp** applies research in double-stranded DNA to parasite prevention, expanding expertise from crops into aquaculture.

**NextTuna** and **TunaTech** conduct genetics research to complete the tuna life cycle and design optimal farming systems.

**Case study - PhytoX**
**Turning microalgae research into a practical fish health solution**

PhytoX emerged from a decade of microalgae research at the Max Planck Institute. Launched in 2024, the company is developing a microalgae-encapsulated oral vaccine platform for fish. It uses genetically modified microalgae to express high levels of antigen and leverages a simple production process that avoids complex downstream processing, making the approach potentially scalable and cost-efficient. Strong scientific support and non-dilutive funding allowed PhytoX to progress from concept to operational startup.

Building a biotech company in Germany is challenging due to high laboratory costs in Europe and slower research processes. To address this, PhytoX collaborates with partners outside Germany, leveraging more cost-effective resources while maintaining Germany as its innovation hub.

# 4.4. Alternative Seafood

Germany is rapidly establishing itself in the alternative seafood sector, leveraging plant- and algae-based innovation to drive growth. This expansion is fueled by a growing cohort of startups and Germany's strong biotech, foodtech, and innovation ecosystem, especially research on microalgae and microalgae-fungi consortia. Germany's plant-based fish sector is expected to grow steadily, with a CAGR of 8.8% through 2035, supported by advanced market infrastructure, strong environmental awareness, and established distribution networks. The alternative seafood sector encompasses plant-based, microalgae-based, and fermentation-derived products, reflecting Germany's diverse approach to creating sustainable protein solutions.

**Case study - BettaF!sh, Quazy Foods, and Koralo**
**Germany's growing leadership in alternative seafood technologies**

BettaF!sh in Berlin develops plant-based tuna and salmon analogues using seaweed and legumes. The company leverages programs like EIT Food's RisingFoodStars to connect with European research partners, investors, and retail channels. Also based in Berlin, Quazy Foods uses microalgae cultivation and fermentation to produce functional ingredients with broad food applications. The company has received pre-seed funding from investors such as ProVeg International, Antler, Sprout & About Ventures, and various local and EU innovation grants. Koralo, founded in Munich, combines microalgae and mycelium in a patented co-fermentation process to produce vegan "NewF!sh." The company is building pilot production and testing B2B channels domestically and abroad, including in South Korea.

These examples highlight Germany's alternative seafood ecosystem, which integrates R&D, biotech, and commercial innovation. The sector shows strong scalability, export potential, and alignment with European sustainability priorities.


Credit: BettF!sh

Credit: BettF!sh


Credit: Koralo

# 4.5. Upstream Gaps and Opportunities

## Gap 1: Financing and scale-up

Germany lacks private capital to move from research to startups and from early-stage startups to scale. This creates a "chicken-and-egg" problem: investors often require trial data before committing funding, but generating such data is costly and depends on access to financing.

**Potential solutions**

To address this challenge, a full funding stack is recommended, from early-stage grants to growth-stage loans, including revenue-based financing, infrastructure financing for CAPEX-intensive startups, and R&D tax credits to lower risk and attract investors. Milestone-based public-private funds could release capital in tranches tied to specific technical or commercial milestones, with public or philanthropic capital absorbing early losses.

Independent testing, standardized benchmarks, and shared pilot and demonstration infrastructure are also recommended to provide credible commercialization metrics for investors and startups and to reduce pre-scale CAPEX requirements. In addition, commercial experts in academic labs can steer research toward scalable economic pathways. Investor support groups can assist with business plans and financial models. To further ease commercialization, deferred or success-based licensing fees can reduce upfront spinout costs, while energy subsidies can reduce operational expenses for protein producers.

*"We have a really good education system, good applied science, a good funding base and even good scale-up centers. There is a lot of research but I feel that it's not being converted, because private money is missing to finance these technologies."*
***CEO and co-founder, single-cell protein producer***

## Gap 2: Administrative and regulatory burdens

Startups and companies face significant administrative challenges, including reporting requirements for government grants and innovation funding, as well as complex permitting and regulatory processes to establish operations and protein production facilities.

**Potential solutions**

A one-stop regulatory portal should centralize permits, licenses, and reporting requirements, allowing startups to track applications, deadlines, and compliance. This could be supported by regulatory advisors, consultants, or government-funded advisors. Workshops by regulators and funding agencies can also clarify reporting requirements, permitting procedures, and common pitfalls.

Regulatory sandboxes could enable testing of new products, ingredients, or production methods under relaxed oversight with real-time feedback, accelerating learning and commercialization. An online grant application portal could clarify funding options and eligibility criteria for startups.

Simplified, standardized grant application processes and faster reviews for pilot-stage technologies would improve access to funding. Additionally, a dedicated aquaculture strategy with targeted funding mechanisms and a regulatory office would provide consistent oversight and support.

*"Aquaculture needs a more adaptable approach, a scheme that can address the sector's needs in a more flexible way. What you would need might be something that you can get from a lab study into the market, then establish a post-approval commitment while it makes money, a system where products could be approved more quickly."*
***CEO, biotechnology company***

# 4.6. Microalgae and Seaweed

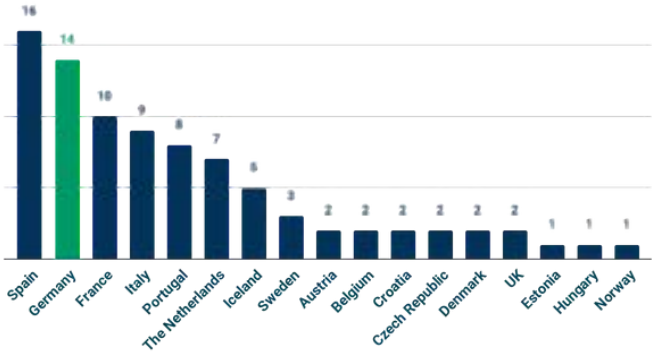
## Microalgae

Germany has a diverse microalgae sector, ranging from system and technology providers such as Subitec and GICON, to companies serving food, aquaculture, biofuel, pharmaceuticals, and environmental services, supported by strong R&D and engineering expertise.

According to the Submariner report and Figure 28, Germany ranks second in Europe for microalgae companies, with the most production facilities in 2022. Cultivation methods include photobioreactors and open and semi-open constructed systems. Most companies (Algenfarm Klötze GmbH & Co., Algenland, Algova, Astaxa, BlueBioTech, Alga Pangea) produce Chlorella spp, while other species, such as Nannochloropsis spp., Phaeodactylum tricornutum, Dunaliella salina, and Spirulina are also commonly cultivated.

**Figure 28: Number of microalgae-producing enterprises in Europe**

Source: EU Commission, An overview of the algae industry in Europe (2022)




The examples below show how microalgae species are delivering a range of solutions.

Application 1
**Food supplements**

Species such as Haematococcus and Chlorella provide high-value compounds, including astaxanthin, beta-carotene, omega-3 polyunsaturated fatty acids (PUFAs), proteins, and vitamins, used in dietary supplements and functional foods. Notable companies active in this segment include Roquette Klötze, Viride, Sea & Sun Organic, and Algaecytes.

Application 2
**Aquaculture live feed and fish oil alternatives**

Microalgae are used as starter cultures, live feed for larvae (rotifers, artemia), and additives for fish (turbot, seabass) and shellfish, with BlueBioTech as a key player. They also provide an alternative to fish oil; for example, Evonik Industries partnered with Veramis in 2018 to produce omega-3 fatty acids (EPA and DHA) for animal nutrition, combining algae cultivation with large-scale fermentation.

Application 3
**Cosmetics and pharmaceuticals**

Microalgae extracts provide natural pigments, antioxidants, and active ingredients for skincare and anti-aging products, as well as potential applications for antiviral or anticancer treatments. Alganex is a key company in this segment and also operates as a B2B platform for microalgae products.

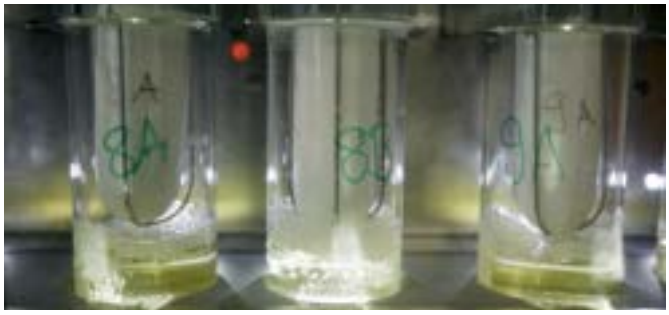
Application 4
**Energy generation**

Microalgae can be used for biofuel production, as demonstrated by a 2010 flight powered solely by algae-based kerosene. Germany actively explores this sector to support sustainable energy and reduce carbon emissions. A notable contributor is the Audi Environmental Foundation, which cultivates Chlorella vulgaris for biofuel applications.

Application 5
**Agricultural biostimulants**

Microalgae and seaweed-based biostimulants are emerging as efficient alternatives to synthetic fertilizers. Various identified species contain bioactive compounds, amino acids, and polysaccharides that enhance plant growth, improve nutrient uptake, and increase resistance to abiotic stresses such as drought and salinity. This application promotes a circular economy by growing the algae using waste streams and CO2 to produce high-value resources that convert pollutants into valuable agricultural resources.

Germany's microalgae industry is characterized by a few specialized commercial farms producing high-value products, but growth remains constrained. Initial startup investment has slowed, and talent has increasingly shifted to other areas. European products benefit from superior quality control but face high energy and labor costs, making them 5-10 times more expensive than products from low-cost countries like China. Restrictive regulations and a constrained market limit growth, as small customers purchase only limited quantities, and larger customers are unwilling to fund production. Offtake guarantees could help de-risk investments, but are only viable if European microalgae can compete globally.



**Case study - Subitec**

**Bridging research and industry: scaling microalgae production with photobioreactor technology**

Out of the Fraunhofer Institute in 2000, Subitec GmbH builds on 26 years of R&D to optimize microalgae cultivation. Renowned for its patented Flat Panel Airlift photobioreactor, the company offers scalable solutions for pre-culture, laboratory, and industrial needs. Serving a global clientele in the pharmaceutical, food, and biofuel sectors, all manufacturing and assembly takes place in Linden.

The Flat Panel Airlift photobioreactor uses rising microbubbles to minimize biofilm formation and reduce shear stress on microalgae, while providing precise control over carbon dioxide, light, pH, and temperature. Integrated cooling systems counteract heat generated by LEDs, enabling continuous 24/7 indoor cultivation. In addition, its modular design accommodates multiple microalgae species and delivers up to 40 times the productivity of open-pond cultivation and 4 times that of indoor tubular systems, all within a compact 16 m² footprint.

## Seaweed

The demand for seaweed is expected to increase in Europe, driven by consumer interest in health-focused products. Seaweed hydrocolloids are widely used in the food sector for their thickening and stabilizing properties. Germany is a net importer of seaweed hydrocolloids, with approximately 16,275 tonnes imported valued at €153 million and 6,751 tonnes exported in 2022. The country also has one of the highest numbers of products containing seaweed hydrocolloids and a strong processing infrastructure for such products. However, domestic seaweed farming is limited, with most production carried out on a small, local scale, and imports are primarily used for processing purposes. However, several German startups are targeting emerging applications in higher-value markets, such as cosmetics and personal care.

**Case study - Vyld**

**Unlocking value through emerging applications for seaweed biomass**

Founded in 2021, Vyld, a Berlin-based start-up, brings innovation to feminine care with biodegradable tampons made from seaweed biomass. Their flagship product, Kelpon, harnesses a biopolymer derived from seaweed to transform ocean-grown fibers into tampons.

Vyld is relevant to aquaculture because its model depends on seaweed cultivation. By creating new consumer markets for seaweed-derived products, the company supports eco-friendly innovation, stimulates demand for large-scale seaweed cultivation, and contributes to the growth of Europe's blue bioeconomy. Vyld highlights how Germany's aquaculture ecosystem is evolving beyond primary production into high-value product innovation.

# 05

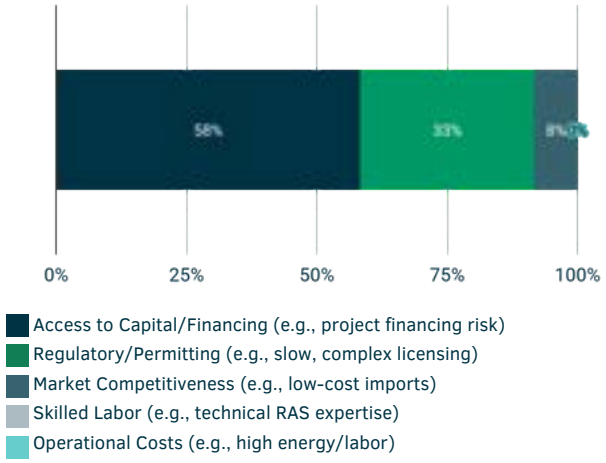
# Voice of the Industry

The Voice of the Industry assessment employed a focus group survey targeting experts from the German aquaculture industry, including producers, startups, government officials, researchers, and investors. The survey comprised two main parts. The first component consisted of multiple-choice questions addressing sector challenges, competitive positioning, and R&D priorities. The second component involved a scoring exercise in which respondents evaluated seven innovation opportunities. Each opportunity was rated on a scale from 1 (lowest) to 5 (highest) across five criteria: Technical Readiness, Scalability, Fit to Germany, Time to Market, and Return on Investment (ROI).

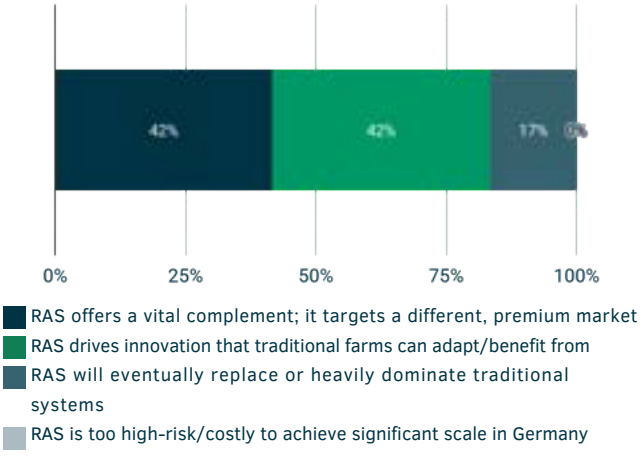
## Part 1 Results

Source: HATCH BLUE primary survey

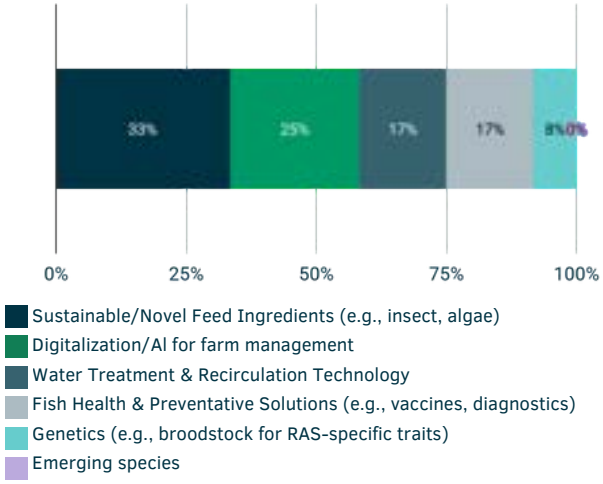
**What is the single most significant challenge limiting investment and expansion across the entire German aquaculture sector today?**



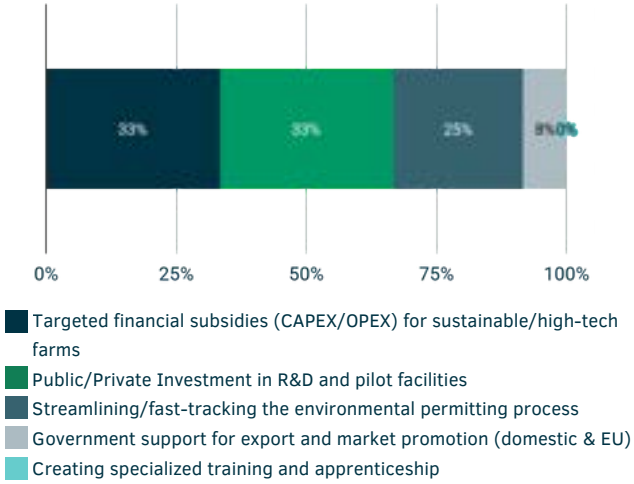

**What is your view on the emerging RAS developments and how they will affect the established traditional German aquaculture (e.g., pond/flow-through) business?**



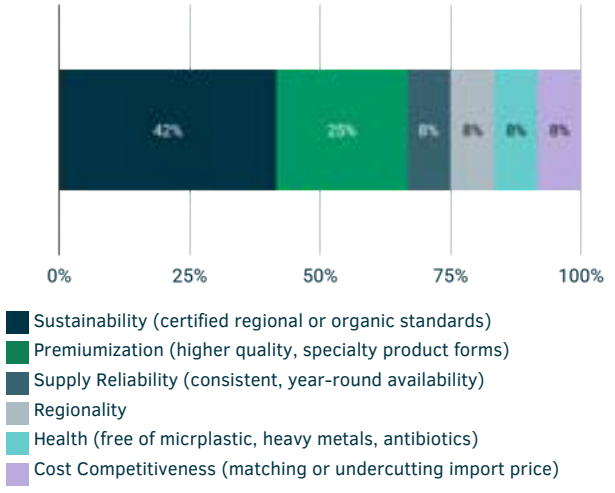
**Which upstream sector should German R&D efforts be prioritized in to support the sector's growth and innovation?**




**In your view, what single policy change or investment could most effectively help the German aquaculture sector reach its next level of growth?**




**The majority of high-volume seafood imports create a market gap that German producers could best fill by focusing on...?**




## Key Insights

**The capital-regulatory financing bottleneck**

Survey respondents identified Access to Capital (58%) and Regulatory/Permitting (33%) as the primary barriers to sector growth. Financial analysis in the report supports these findings, indicating that land-based facilities require substantial initial investments, particularly for technical infrastructure and water treatment. Investors typically demand validated trial data before committing funds; however, generating such data is costly. Consequently, the sector experiences a funding gap that necessitates a combination of early-stage grants and milestone-based public-private funding to mitigate early technical risks.

**Technological integration and modernization**

The industry sees the growth of RAS as a valuable addition (42%) and a source of innovation (42%), rather than a threat to traditional farming. This view shows there is real potential in upgrading local production systems. For example, Heidefisch demonstrates how traditional trout farms can move to high-tech production by adding partially recirculating systems, which reduce water exchange rates to less than 5%.

**R&D and policy priorities**

To unlock the next level of growth, the industry advocates for prioritizing R&D in Sustainable/Novel Feed Ingredients (33%) and Digitalization/AI (25%). Policy experts suggest that the most effective interventions would be Targeted Financial Subsidies (33%) and Public/Private Investment in R&D and pilot facilities (33%). A critical administrative need is the creation of federal aquaculture guidelines to standardize permitting rules across Germany's 16 federal states, replacing the current fragmented system that often results in multi-year delays.

**Market positioning**

Faced with high-volume, low-cost imports that satisfy nearly 90% of domestic demand, responders find the German market's greatest competitive advantage in Sustainability (42%) and Premium positioning (33%). By focusing on certified standards and high-quality specialty products, local producers can justify the higher price points necessary to cover Germany's significant electricity and labor costs. This strategy is exemplified by InfiniteSea, which selected yellowtail kingfish for its premium market price, nearly double that of salmon, and its RAS suitability.

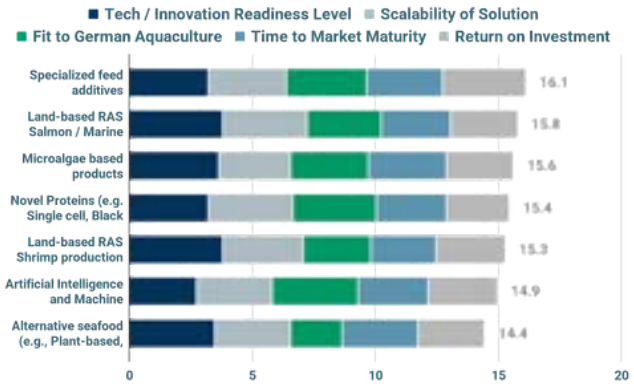
# Part 2 Results

Source: HATCH BLUE primary survey

The second section of the survey provides a quantitative evaluation of specific technologies, pinpointing where Germany's engineering and biotech strengths offer the highest potential for both domestic application and global tech export.

**Average Total Score of Assessed Innovation Opportunities**

Criteria were assessed on a scale 1 (low) to 5 (high) with respondent replies averaged




## Key Insights

**Commercial Viability of Land-Based RAS for Premium Species**

Land-based RAS for salmon and marine species scored 15.8, and shrimp production scored 15.3, both ranking high for technical readiness and scalability. These technologies are important for meeting Germany's rising demand for local seafood. With controlled environments, producers can offer high-quality, antibiotic-free products that attract consumers willing to pay more for local options.

**Digitalization, AI, and Operational Reliability**

While artificial intelligence and machine learning (14.9) scored slightly lower on immediate market maturity, they are regarded as the "brain" behind the next generation of aquaculture. AI-driven tools are being developed to de-risk the industry by providing real-time data on biomass estimation, early stress detection, and feeding accuracy. Collaborative R&D-industry projects like ShrimpWiz demonstrate the business opportunity for commercialization research and developing tech products for the global industry.

**Land-based RAS Salmon / Marine Species production**


**Artificial Intelligence and Machine Learning**


**Land-based RAS Shrimp production**

**Novel Proteins (e.g. Single cell, Black Soldier Fly, etc.)**


**Alternative seafood (e.g., Plant-based, fermentation, cell-cultivated)**


**Microalgae based products**


**Specialized feed additives**


**Dominance of Specialized Feed Additives and Novel Proteins**

Ranking as the top innovation opportunity with a total score of 16.1, specialized feed additives represent a sector where Germany already maintains a global competitive edge. Despite relatively small domestic aquafeed demand, German expertise in feed, additives, and functional ingredients is highly scalable, as demonstrated by companies such as Aller Aqua and Dr. Eckel Animal Nutrition, which have successfully entered large-scale global markets. Closely following are novel proteins (15.4), such as insect-based meals and single-cell proteins. Startups like b.fab, FarmInsect, and MicroHarvest leverage Germany's world-class research in microbiology and automation to address the global fishmeal supply gap.

**Microalgae and the Blue Biotech Frontier**

Microalgae-based products (15.6) represent a robust segment of Germany's innovation ecosystem, currently ranking second in Europe for the number of microalgae enterprises. Backed by decades of research from institutes such as the Alfred Wegener Institute (AWI), the sector is expanding beyond food supplements into higher-value markets, such as cosmetics and biostimulants. While high energy costs remain a constraint, the survey reflects a belief that German engineering, such as the patented photobioreactor systems developed by Subitec, can lower operational barriers and position Germany as a leading provider of high-efficiency cultivation technology

# 06

# Strategic Support Mechanisms for German Aquaculture

## Key Takeaways

**Integrated financial ecosystem**
To address high CAPEX barriers, the sector would benefit from a range of financial enablers, such as reduced interest rates, government-backed guarantees, and milestone-based funds in which public capital absorbs the "first loss" to protect private investors. Public-private partnerships, like 50/50 side-investment models, are also essential tools for signaling project viability and building private investor confidence in early-stage ventures.

**Engineering and know-how as a competitive edge**
Germany's strategic value lies in becoming a global innovation and knowledge hub by leveraging its engineering expertise to develop and export advanced technologies, equipment, production, and processing systems.

**Administrative streamlining**
A shift to a federal, standardized permitting system and a "One-Stop-Shop" support center is recommended to replace the current complex, fragmented local regulations and reduce lengthy bureaucratic delays.

**Resilience and sovereignty**
Supply chain disruptions, as seen during COVID, along with geopolitical instability and rising oil prices, show why domestic seafood production is important for national food security by providing local, climate-resilient, antibiotic-free, and traceable seafood to consumers who value quality and sustainability.

# 6.1. Financing Opportunities in Aquaculture

Below is a range of approaches that could support the development of Germany's aquaculture sector. They are organized into four categories: finance, operational, administrative, and policy.

## Finance

**Reduced interest rates:**
Rates that enable young entrepreneurs and farmers to enter the sector without unmanageable debt.

**Side-investment leveraging:**
50/50 side-investment models where a development agency provides backing that leverages private investor confidence. For example, a governmental organization commits 50% of the investment, signalling viability and encouraging private investors to contribute the remaining share.

**Working capital and development support:**
Financing that goes beyond physical assets to cover operational expenses such as labor and development costs, which are typically difficult to finance through local banks.

**Infrastructure financing:**
Dedicated financing for CAPEX-heavy setups to decrease technical risk during commercialization.

**Milestone-based public-private funds:**
Investment structures that release capital in tranches linked to technical or commercial milestones. Public or philanthropic capital can absorb the first loss, protecting private investors and attracting capital that would otherwise avoid early-stage technical risk.

**Government-backed guarantees:**
State-backed guarantees that help startups lacking sufficient collateral, reducing risk for lenders in high-CAPEX projects.

**Grace periods and extended repayment terms:**
Terms that allow farms to reach harvest volume and generate revenue before debt servicing begins.

**Revenue-based financing:**
Repayments tied to future revenues rather than fixed monthly payments, providing flexibility during volatile ramp-up periods.

**Deferred licensing fees:**
Reduced upfront costs for university spin-outs by deferring licensing fees until commercial success is achieved.

**R&D tax credits:**
Financial incentives that lower the burn rate for companies that are heavily invested in R&D.

*"Young people … need financing. If loans carry exorbitant interest rates … there are no financing options available to people … they need interest-free or low-interest loans."*
***Consultant, consulting organization***

*"Investors are much more willing if this is backed up partially by a governmental organization… if they can say, 'I will put in 50% and you're putting in 50%,' then we can leverage it."*
***CEO, RAS marine fish farm***

# 6.2. Operational, Administrative, and Policy Measures

## Operational

**Subsidizing photovoltaic (PV) integration:**
Promotion of, and financial support for, installing solar panels on aquaculture facility roofs. This can create a secondary revenue stream and lower energy costs.

**Biogas integration:**
Targeted investments for farmers who can utilize waste heat from existing biogas plants. This approach helps offset the high energy demands of RAS operations.

> *"Electricity is expensive. I always say: 'Cover your roofs with PV modules – this investment [a photovoltaic system] will pay off in any case.' If there is an opportunity to obtain financial support through the EMFAF, you should make every effort to take advantage of it."*
> ***Consultant, consulting organization***

## Administrative

**Federal standardization:**
Implementation of a federal, standardized permitting system for aquaculture to replace the wide range of local administration requirements. A "model guideline" (Musterleitfaden) would clarify permitting rules across water, nature conservation, and animal welfare laws, replacing the current "jungle" of local regulations. This would shorten timelines and reduce multi-year delays that can threaten startup liquidity.

**Administrative guidance:**
Introduction of specialized guidelines to help local authorities better understand and expedite permitting for closed aquaculture systems. Projects should be allowed to proceed under strict monitoring and improvement targets, rather than being blocked at an early stage by rigid legal text.

> *"We need a guideline that the authorities... have a better understanding what they have to decide about... to make these permits just faster."*
> ***Founder and CEO, land-based farming technology leader***

**"One-Stop-Shop" support:**
Creation of a central knowledge hub to guide farmers through complex administrative processes and reduce bureaucratic barriers. A Federal Aquaculture Competence Center, currently being explored by the Thünen Institute, would consolidate expertise, analyze fragmented state-level regulations, and help streamline processes. It would help local authorities make faster, more informed decisions and prevent the "paralysis" caused by the complexity of modern aquaculture applications. Mediation and coordinated advocacy would further address misconceptions and strengthen authority–industry cooperation.

## Policy

**Market-driven innovation:**
Targeted R&D funding that is aligned with market demand and focused on high-value industry challenges like disease resistance or feed efficiency.

**Venture building programs:**
Initiatives that provide network access and legislative guidance to research spin-offs in their early years, helping prevent failure during the startup phase.

> *"The true opportunity lies in leveraging Germany's engineering process... but commercialization often needs to occur globally rather than in the local market."*
> ***Fisheries biologist and manager, fisheries association***

# 6.3. Future Outlook - Germany as a Global Innovation and Knowledge Hub

## The German competitive advantage

Germany's strength in aquaculture lies not in mass-market production, but in its role as a global innovation and knowledge hub. This advantage is built on three pillars that demonstrate how Germany leverages technical expertise, research strength, and rigorous testing to maintain a distinct edge in the aquaculture sector.

**Engineering and hardware excellence:**
Germany's long-standing expertise in mechanical engineering and the automotive industry provides a strong talent base of highly skilled hardware engineers capable of developing next-generation RAS technology.

**Leading R&D and education:**
With world-class research institutions and a robust dual-vocational training system, Germany produces internationally renowned personnel and cutting-edge solutions in areas such as sustainable feed additives, genetics, and sensor technology.

**Strategic "Proof of Concept" platform:**
Germany is an ideal environment for developing and testing new technologies. Solutions that have proven effective in a strict, high-cost regulatory environment are well-positioned to compete successfully in global markets.

*"The German aquaculture space serves best as a 'proof of concept' due to its high R&D capacity and technological expertise. Germany is a showcase to export technology, and has the innovation necessary to lead in the field."*
***CEO, land-based shrimp producer***

*"Germany... [is] a very good platform with a strong R&D, strong technical expertise and developing solutions... but commercialize it globally rather than in the local market."*
***Founder and CEO, land-based farming technology leader***

*"I do see Germany as an innovative and also research-oriented country, and that always offers the promise of developing technologies and also selling them somewhere else."*
***Managing director, feed manufacturer***

## Future Drivers

The future growth of German aquaculture will be driven by rising demand for sustainable, local food and the need for climate-resilient production. These trends create opportunities that align with both market demand and strategic priorities.

**Local market potential:**
Germany represents a large consumer market, with per capita fish consumption of 13kg per year. A growing niche of consumers is willing to pay a premium for locally produced, antibiotic-free, and traceable seafood.

**Resilience and food security:**
As global supply chains become more volatile, domestic aquaculture production is increasingly seen as a means to strengthen national resilience and food security.

*"I strongly believe that the next hockey stick [in consumption] will be coming from an aquaculture-farmed origin... because fisheries is at its end."*
***Fisheries biologist and manager, fisheries association***

*"I hope to see German aquaculture built around many small, local systems like ours [.....], producing fish close to where it is consumed. This would allow farmers to keep more of the value while consumers know where their food comes from [....]."*
***Founder, fish cooperative***

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