

Policy Recommendations for Innovation and Market Access Barriers in the Recirculating Aquaculture System Sector within the Baltic Sea Region



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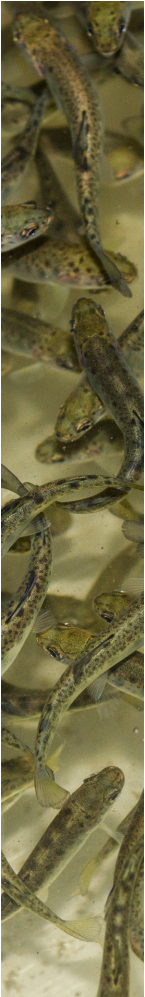
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Context

Context for the current policy recommendations for innovation and market access barriers in the RAS sector within the Baltic Sea Region



In 2021 the European Commission announced strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030.^{*1} These guidelines aim to help building an EU aquaculture sector that: (i) is competitive and resilient; (ii) ensures the supply of nutritious and healthy food; (iii) reduces the EU's dependency on seafood imports; (iv) creates economic opportunities and jobs; and (v) becomes a global reference for sustainability.

Between 2000 and 2018, the global aquaculture production grew at an average annual rate of 5.3%, making it the fastest-growing food production sector globally. The European Union's aquaculture sector has experienced limited growth compared to global trends. Between 2000 and 2020, the EU's fish aquaculture grew at an average annual rate of 1.1%, while mollusc aquaculture saw a 2.8% annual increase. In EU, more than 50 % of the fish and shellfish we consume are imported from outside EU, and the aim of the targeted growth is to partly close the gap between internal consumption and production.

Recirculating aquaculture systems (RAS) offer a more sustainable method for producing healthy and nutritious food closer to markets. Enabling local production creates economic opportunities and jobs with the potential to reduce the reliance on imports. The integration of circular principles makes RAS resilient and strives to become economically competitive with other production methods. With a majority of RAS production occurring in a few EU countries (Denmark, the Netherlands, France, Germany, Poland, and Spain) and considering the fragile condition of the Baltic Sea and its biodiversity, the development of RAS is potentially of great importance to this region.

To drive progress in this region, there is a need for governance reforms that enhance transparency, access to information and clear regulatory demands, foster the development of a skilled workforce, and offer targeted incentives and funding opportunities for aquaculture advancements, particularly in RAS. These changes are also reflected in the Aquaculture Assistance Mechanisms Commission Staff Working Document on Implementing the Strategic Guidelines for EU aquaculture Regulatory and administrative framework for aquaculture in which the 3 main bottlenecks are described as 1) legislation and institutional framework; 2) licensing process; and 3) social licence.^{*2}

^{*1} [Strategic Guidelines for a more Sustainable and Competitive EU Aquaculture](#)

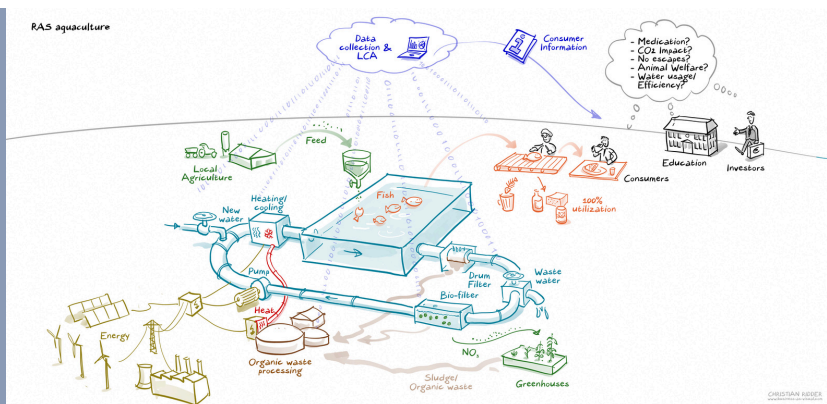
^{*2} [Aquaculture Assistance Mechanisms Commission Staff Working Document](#)

The TETRAS Project

TETRAS (Technology Transfer for Thriving Recirculating Aquaculture Systems in the Baltic Sea Region) is a three year project funded by Interreg Baltic Sea Region. The project addresses a common challenge across the Baltic Sea Region: how to harmonise economic development with social and environmental goals.

On their own, RAS can be energy-intensive and expensive production systems. However, when placed strategically or coupled with other industries and processes, RAS have the potential to increase resource use efficiency and improve economic and environmental performance.

TETRAS aims to demonstrate new concepts of industrial symbiosis, where one process's waste or residual becomes another process's resource. The project revolves around four pilots working on different water solutions, each tackling unique challenges of RAS and complementing each other: treatment of RAS discharged water to be used as technical water for other industries, use of geothermal resources in RAS, best use of land and resources for a fully circular agro-industrial park, and a small-scale RAS for aquaculture awareness.



Contributors and Endorsments to the Current Policy Recommendations

Contributors: Interreg TETRAS BSR Project; Thorsten Vammen - FREA Solutions ApS; Marcin Juchniewicz - K-2 Fish Farm; Adrian Bischoff-Lang - University of Rostock; Brian Thomsen - Danish Aquaculture Producers Association; Carolin Ackermann - SEAWATER Cubes GmbH. We also acknowledge the valuable input from various other stakeholders who have helped shape these recommendations.

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Objectives of the recommendation

- Foster cohesion both within and across countries (and municipalities/states) to enhance awareness of RAS and streamline governance through standardized classification.
- Establish a unified definition or framework for recirculating aquaculture that can guide strategies, planning, and future recommendations, with clear targets for permitting and reporting processes.

Recommendation 1

Define Recirculating Aquaculture Systems

Context and challenges linked to the definition of recirculating aquaculture systems

- RAS are closed-loop systems that treat and reuse water, reducing intake and discharge. Their design, operation, and environmental impact vary based on water recirculation rates, species farmed, and technologies used.
 - This variation affects the volume of discharged water and nutrient levels in the effluent.
- The absence of standardized definitions and regulations across Europe and at national level leads to fragmented governance, complicating permitting, monitoring, and reporting processes due to regional differences.
- In countries such as Germany and Denmark RAS can fall under several sectors such as agriculture, industry, and aquaculture (traditional model pond farm aquaculture in the case of Denmark), leading to regulatory overlap and confusion. This fragmentation increases the complexity of navigating the licensing process.
- The limited understanding of RAS among authorities in many countries exacerbates these challenges. Insufficient expertise results in delays, inconsistencies, and increased difficulty to secure the necessary permits and meet regulatory requirements.
- Consumers often have limited awareness of RAS, which can negatively affect the market value and sales of products produced through these systems.



Recommendations

1. Agree on a common definition of recirculating aquaculture systems

To ensure consistent governance, innovation, and market growth in the aquaculture sector, there is a need to establish a common definition of recirculating aquaculture. Such a definition would provide clarity on the scope and specific characteristics of RAS, streamlining regulatory processes and enabling investment.

A common definition for RAS, whether at European or at national level, should focus on:

- **Water Recirculation Rates:** Clearly define thresholds for low, medium, high and zero-discharge recirculation rates in aquaculture systems. These thresholds can guide regulatory standards, particularly concerning nutrient discharge and water reuse efficiency
- **Waste Management:** Incorporate principles of circularity, focusing on the capture and reuse of waste and nutrient byproducts from aquaculture processes, thereby aligning with broader EU goals of sustainability and circular economy.

- **Cross-Sector Alignment:** Harmonise the definition and understanding of RAS across different sectors, such as agriculture, industry, and aquaculture, to eliminate fragmentation in regulatory practices and improve licensing and permitting procedures.

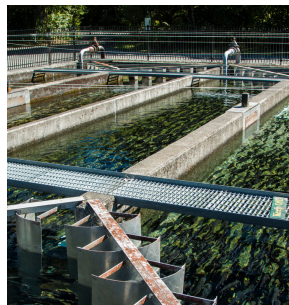
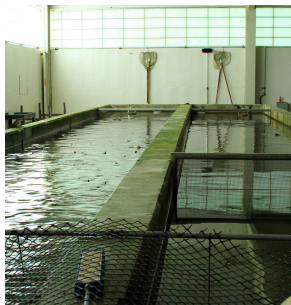
2. Clarify the role of RAS in the green transition

By clarifying RAS's role as a fully controllable, resource-efficient and environmentally friendly food production system and promoting its integration into broader circular economy strategies, policymakers can accelerate the sector's contribution to the green transition.

3. Leverage the definition of RAS by establishing measurable indicators to align with the UN Agenda 2030 Sustainable Development Goals (SDG).

RAS directly contributes to UN SDGs 2, 3, 6, and 12 and indirectly contributes to UN SDGs 8, 9, 14, 15.^{*3}

^{*3} [UN Sustainable Development Goals](#)



Good Practice Example

Denmark

- Until 2021, Denmark defined the concept of "Model Fish Farms", categorizing them into four types based on their water recirculation levels and water treatment processes (Table 1).^{*4}
- Since 2021, the following terms are now used:^{*5}
 - Plants with low recirculation: Plants located on land that have a water intake of between 5,000 and 25,000 litres per kg of feed.
 - Plants with medium recirculation: Plants located on land that have a water intake of between 1,000 and 5,000 litres per kg of feed.
 - Plants with high recirculation: Plants located on land that have a water intake of less than 1,000 litres per kg feed.

^{*4} [Prospective Analysis of the Aquaculture Sector in the EU. PART 2: Characterisation of Emerging Aquaculture Systems](#)

^{*5} [Order on the reporting of information on Danish aquaculture](#)

Table 1. The different types of Danish model fish farms (until 2021).^{*4}

Type of Farm	Model I	Model Ia	Model II & Ia	Model III & IIIa
Pond Type	Earth or Concrete	Earth or Concrete	Earth or Concrete	Concrete
Recirculation level (%)	70	85	85	95
Mechanical Filtration	Yes	Yes	Yes	Yes
Biofilter	No	No	Yes	Yes
Plant Lagoon	Yes	Yes	No	Yes

Recommendation 2

Support the Development and Upkeep of a Skilled Workforce



Context and challenges linked to supporting the development and upkeep of a skilled workforce

- Across the Baltic Sea Region, the shortage of skilled labour is widely seen as a key barrier to the advancement of the RAS industry. This is especially true in countries like Denmark, Germany, Sweden and Finland where RAS developments are expanding rapidly.
- Operating a recirculating aquaculture system requires not only highly educated professionals, such as biologists, but also workers with specialized technical skills. Many countries face a gap in the educational system, where the workforce lacks the practical experience and technical knowledge needed to efficiently operate a RAS.
- There is currently no comprehensive overview of the challenges in attracting young people to the aquaculture sector. Key contributing factors include perception issues stemming from low awareness and a generally negative image, concerns about the work environment and career progression, educational barriers, and broader cultural trends such as increasing urbanization. Mapping these factors is essential to address the problem effectively.
- Similarly to conditions for agriculture farmers, employment at a RAS facility often requires long shifts, including weekends, nights, and holidays, and is frequently based in remote areas. Few countries and companies currently offer incentives for these demands, which can deter young, highly trained professionals from moving away from city centres.
- By improving conditions i.e. through RAS technology advances, workers need regular training to keep up with innovations in areas like automation, AI-based monitoring, and alternative feed systems.
- Due to the technical nature of RAS and the specific knowledge required, training new employees can be resource intensive. Companies often need to invest heavily in onboarding and ongoing training, which can be challenging, especially for smaller companies without dedicated training budgets.
- Insufficient education and awareness of recirculating aquaculture within related sectors, particularly among licensing and permitting authorities.

Recommendations



Objectives of the recommendation

- Facilitate the development of a skilled and diverse workforce that can support the growing RAS sector.
- Ensure ongoing workforce development and retention to meet sector demands.



Support the Development of a Skilled Workforce

1. Assess the skills required by the industry.
2. Establish national apprenticeship programs aligned with industry needs, comparable to those available for land-based agriculture.
3. Explore farm-driven workforce development programs to foster essential skills to develop the aquaculture sector.
4. Develop recirculating aquaculture system training and education modules for the advancement of knowledge for husbandry staff, regulators, and RAS engineers.

Supporting the development of regulators and public authorities will promote consistent standards, improve the regulatory and permitting process and enhance decision-making in aquaculture practices.

5. Ensure that funding and incentives for training programs for trade skills such as internships, apprenticeships and vocational education be elevated.

6. Support training programs in topics that are essential to recirculating aquaculture system operation at all education levels.

RAS systems are complex requiring diverse skills to operate. Therefore, skills that may be beneficial include, but are not limited to' engineering, water treatment technology, biology, digital monitoring etc.

7. Establish or support "Train the Trainer" programs in areas of the country without existing programs and with significant need.

To develop a new workforce, teachers and trainers need to be educated in the subject. Providing "train the trainer" programmes facilitate upskilling of both teachers and students.



8. Develop targeted outreach initiatives for younger generations, neurodivergent individuals, and former farmers to engage them in meaningful careers in RAS.

The younger generation seeks meaningful, impactful careers.*⁶ Neurodivergent individuals and ex-farmers may excel in RAS roles due to their unique skills and dedication. Modernized apprenticeships offering hands-on training can connect these groups with RAS opportunities effectively.

8. Develop a publicly available inventory of RAS training opportunities.

9. Promote and support the coordination of local and regional programs that aim to support and connect qualified applicants to employment opportunities throughout the aquaculture industry.

Support the Upkeep of a Skilled Workforce

1. Improve Workforce Retention and Attract Skilled Workers to Rural and Remote Locations

To address workforce shortages in rural or remote areas where RAS facilities are often

*⁶ 2024 Gen Z and Millennial Survey

located, explore cost-effective strategies to attract and retain skilled workers. These could include partnerships with local governments to facilitate housing options, flexible work arrangements to improve work-life balance, and industry-led initiatives such as training programmes or career development incentives. Additionally, reviewing compensation structures for demanding work schedules (e.g., weekends, holidays) may help improve retention without significantly impacting overall operational costs.

2. Streamline work permit processes for skilled foreign workers

Simplifying and expediting work permit processes for foreign professionals with RAS expertise can help fill critical skill gaps quickly. By reducing bureaucratic delays, the industry can ensure timely hiring of necessary talent, enhancing productivity and operational continuity.

3. Offer training incentives to support continuous skill development

Encourage ongoing professional development through training subsidies for RAS employers who invest in upskilling their workforce. This approach ensures that employees remain current with technological advancements and best practices, contributing to a highly competent and adaptive workforce.



Good Practice Examples



Sweden



In 2024, the Swedish government enacted a regulation to strengthen support for national vocational training. In response, the Swedish National Agency for Higher Vocational Education (MYH) launched a 2-year pilot project for new training courses, with a government grant of almost €20 million. Although aquaculture is not included in the current program, it features a course in Industry and Marine Technology, and other relevant skills needed for RAS facilities. If successful, future iterations will expand to encompass additional subjects.^{*7 & 8}

Denmark



Denmark is home to the Technical University of Denmark (DTU), where DTU Aqua offers BSc and MSc programmes in Fisheries and Aquaculture, including specialized courses on RAS with practical training. Hansenberg, the only college in Denmark that integrates aquaculture with agriculture and farming, provides vocational programmes that give students hands-on experience in fish farming, preparing them for careers in the aquaculture sector. These educational opportunities help build a skilled workforce to support the country's growing aquaculture industry.

Norway



Norway offers vocational education schools specializing in aquaculture, with county authorities overseeing vocational education and training provision, funding, and apprenticeship placements. These schools utilize various infrastructures to prepare students for careers in aquaculture, offering apprenticeships that lead to diplomas or training as aquaculture technicians. Additionally, students can take courses to prepare for further studies at college or university.

^{*7} [Ordinance \(2024:107\) on support for national vocational training](#)

^{*8} [Sweden: VET reform tackles skill shortages](#)

Good Practice Examples



Poland

The University of Gdansk offers a BSc in Aquaculture: Business and Technology, designed to prepare students for careers in aquaculture companies, research labs, and administration. The program combines practical and theoretical training, covering biology, breeding physiology (fish, invertebrates, algae), food processing, legal aspects, and business management. Students gain hands-on experience through two 7-week internships in aquaculture-related companies. The course is available in Polish or English.



Online

The AquaVIP project offers six online self-learning courses in key areas of aquaculture: recirculating systems, larviculture, fish diseases, algae culture, aquafeeds, and business development. Designed to enhance skills and update knowledge, the platform connects professionals, and shares job and internship opportunities. It also highlights the South Baltic Aquaculture Competence Center, a collaboration of universities in Rostock, Gdansk, and Klaipėda, showcasing their projects and resources to foster innovation in modern aquaculture.



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Photo Credit: A.Kundrotas

Strengthen Co-Governance and Licensing Efficiency

Context and challenges linked to strengthening co-governance and licencing efficiency

- Aquaculture governance is confusing in most Baltic Sea Region countries. A more streamline system for delegating licences and permits is needed in order to further develop both traditional and recirculating aquaculture.
- Greater integration between agriculture and aquaculture offers substantial benefits, especially regarding circularity and sustainability. Agriculture and aquaculture have much to gain from each other by sharing resources and innovations, creating more resilient and sustainable food systems.
- Digitalisation of processes or development of a centralised platform for document management may enable better communication between different authorities.
- The RAS regulatory process is fragmented, resulting in lengthy turnaround times and confusion for applicants, which limits growth potential across countries.
 - In Denmark, RAS is regulated as an industrial activity rather than agriculture or aquaculture, which complicates and restricts the development of aquaculture on agricultural land. Developers must also engage a variety of authorities to obtain the required permits.
 - In Germany, certain aspects of RAS licensing are governed by industrial regulations while husbandry falls under agriculture. Additionally, regulations prohibit the establishment of RAS on agricultural land, hindering potential industrial symbiosis between the two sectors.



- In some countries, RAS regulations vary significantly between municipalities and states, leading to inconsistent licensing procedures. Often, there is no standardized framework detailing how the licensing process should be conducted or specifying required elements.
- As RAS projects offer geographical flexibility, new projects are often situated in locations with no previous knowledge of aquaculture and especially RAS. This lack of knowledge among authorities results in slower licensing process and administrative burden for new projects

Recommendations

Objectives of the recommendation

- Simplify and accelerate RAS licencing to make it easier for operators to navigate complex regulatory frameworks and ultimately facilitate sector growth.
- Encourage cross-sector collaboration to support the integrated adoption of circular principles within the aquaculture sector and beyond.

1. Review national aquaculture legislation to support recirculating aquaculture

Simplify and streamline the application process for setting up recirculating aquaculture operations and consolidate all aquaculture administration within a single sector.

2. Develop clear guidelines for the RAS permitting process

These guidelines should describe the different phases and requirements of the licensing process. This would enable more effective procedures, reducing licensing time by avoiding delays from incomplete applications and increasing processed applications and licenses issued.

The document could include:

- Information on the authorities involved during each phase
- Time frames of the process
- Costs
- Checklist of requirements including environmental protection, water usage, discharge and any additional authorities that need to be involved i.e., for zoning and building permits
- Guidance documents published by the European Commission
- Tools and support operators (impact assessments, monitoring, site selection etc.)
- Application form template
- List of documents to be submitted

3. Establish national (or regional) "one-stop shops" for RAS permits and licensing.

As mentioned in the Strategic Guidelines and highlighted in the AAM Staff Working Document, "setting up a 'one-stop shop' system for aquaculture licenses which facilitates both transparency on the licensing process and interaction between^{*1} the applicant^{*2} and the decision-making authorities" will standardize and streamline the procedure, allowing operators to submit all required documents in one place. A digital platform can support in making this process easier. A one-stop shop also enables knowledge of RAS operations to be concentrated in a single location, rather than being scattered across various authorities and regions.

4. Integrate agriculture and aquaculture sector licences to encourage symbiosis.

Fostering collaboration between the aquaculture and agriculture sectors promotes nutrient synergies and can reduce overall emissions. By integrating these sectors, waste from one can be utilized as a resource in the other, enhancing sustainability and minimizing reliance on chemical fertilizers. Enabling the shift of nutrient emissions between primary activities allows a higher production of animal protein with the same or fewer emission of nutrients.



5. Harmonize discharge standards across regions and countries.

This will ensure a level playing field and avoid cross-border relocation of aquaculture facilities due to unequal environmental regulations. It will also encourage technology development and innovation.



Good Practice Examples



Guidelines



The German Federal State of Schleswig-Holstein offers specific permit guidelines for aquaculture activities. However, these guidelines are not available or applicable for other states.^{*9}

The Lithuanian Ministry of Agriculture has published a guide^{*10} outlining the administrative procedures and requirements for individuals looking to establish a business in the aquaculture sector. This document aims to clarify the relevant legislation by detailing the necessary steps for getting started in the industry.



One-Stop Shop



In Norway, the 2006 Aquaculture Act^{*11} appointed the County Council as the central authority for processing aquaculture licenses, creating a one-stop system that streamlines all licensing requirements, from environmental standards to enforcement.

Sweden's Board of Agriculture established a central aquaculture website to facilitate connections between producers and authorities, while Government Services for Businesses offers a digital checklist to guide new aquaculture ventures through licensing.^{*12}



Cross-Sector Collaboration



Finnforel, in partnership with Stora Enso paper mill in Finland, has created a symbiotic system for sustainable aquaculture. By utilizing the paper mill's water treatment facilities, Finnforel's fish farm efficiently reuses treated water while also sourcing energy from the mill.^{*13}

The Danish Planning Act provides guidelines for allocating space for various activities. The Danish Aquaculture Association has called for equal treatment of agriculture and aquaculture under this framework and easier access to land for land-based aquaculture facilities. This request is currently under discussion in Parliament, addressing space allocation challenges in the sector.

^{*9} [Development and promotion of one sustainable aquaculture in Schleswig-Holstein \(coastal waters of the Baltic Sea\)](#)

^{*10} [Memo on administrative procedures for the Lithuanian aquaculture sector](#)

^{*11} [Aquaculture Act 2006](#)

^{*12} [Checklist for starting aquaculture](#)

^{*13} [The fish of the future grows ecologically indoors](#)

Recommendation 4

Increase Financial Incentives and Access to Capital

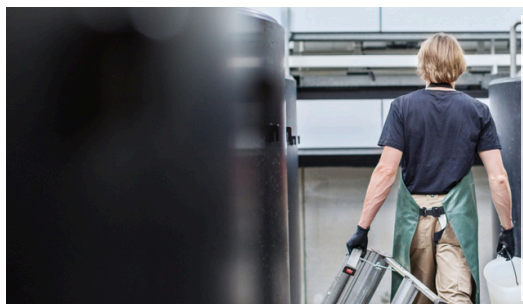


Context and challenges linked to increasing financial incentives and access to capital

- The licensing process is costly and does not guarantee approval.
- Currently, funding schemes for aquaculture are broad in scope. There is a need to refine and focus these resources on specific, high-impact areas, addressing both present conditions and anticipated challenges.
- In some countries, regional funding is primarily directed toward traditional aquaculture methods, such as earthen ponds and flow-through systems, with values and objectives that don't align well with the specific needs of RAS facilities.
- In Germany, access to certain funding mechanisms depends on the state's aquaculture development strategy and their priorities. As RAS allows geographical flexibility, to foster RAS development across countries, access to subsidies and funds should be equal across the country.
- In countries such as Estonia, some funding mechanisms are not available for new RAS developments. It is possible to obtain support for renovations of older systems but not new projects. In other countries, such as Denmark, funding mechanisms have reduced their support of RAS projects as initial costs are too high.
- RAS systems have high initial capital and operational costs, particularly related to technology, energy, and feed. Many projects are dependent on public subsidies or private investment, but banks and investors are often reluctant to fund RAS due to perceived risks.
- RAS technology for producing fish for consumption is still relatively new, with limited historical data on performance and feasibility. A small number of failed projects tend to dominate the perceived risk profile, while successful, well-operated RAS facilities that achieve profitability receive less attention.
- High initial investment costs are required for RAS, with little to no incentives for environmentally friendly practices.



Recommendations



Objectives of the recommendation

- Increase financial support and access to capital to help reduce barriers and drive sustainable growth for the RAS sector.
- Develop recommendations for RAS projects with a low risk, and a high feasibility, that are attractive for investors.

1. Ensure equal access to subsidies, incentives, and funding across all regions or states within a country.

Regional aquaculture development strategies should account for the geographic flexibility of RAS, rather than limiting funding to traditional or marine-based aquaculture models. To maximize this potential, funding models should be inclusive of RAS, ensuring that subsidies and financial incentives are accessible regardless of location or proximity to marine environments.

2. Incentivise the adoption of environmentally sustainable technologies and practices.

Introduce incentives, such as license fee reductions or tax credits, for RAS systems and other facilities that incorporate circular and sustainable principles. These financial incentives can lower operational costs and support the transition toward more sustainable models, promoting resource-efficient, low-impact practices.

3. Re-design research calls for aquaculture projects, to specifically address unique issues facing the RAS sector.

Prioritize projects that drive innovation in sustainable practices and have clear commercial applications.

This targeted approach will accelerate advancements in the sector and support the broader adoption of RAS technologies.

4. Expand Public-Private Partnerships

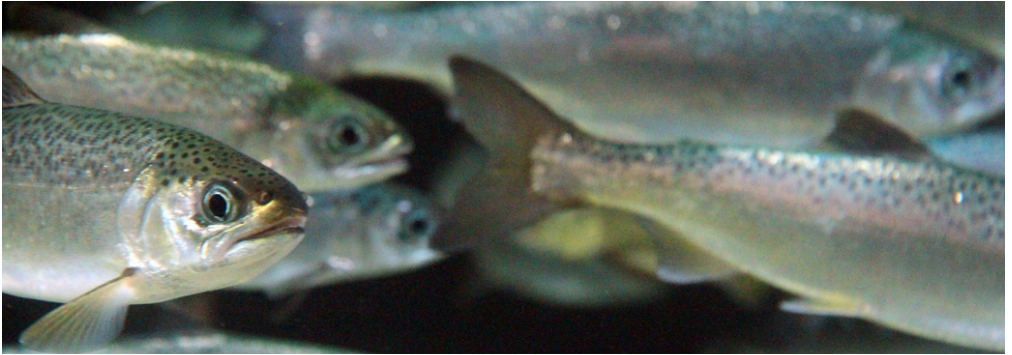
Foster collaborations between government, private investors, and industry stakeholders to create co-financing opportunities for RAS projects. This can reduce risk for private investors and stimulate investment in sustainable aquaculture.



5. Provide Low-Interest Loans for RAS Startups

Set up low-interest loan programs for RAS ventures, especially for small and medium enterprises (SMEs) that may struggle to access traditional financing. These loans can be tied to sustainability metrics, encouraging eco-friendly practices.

Good Practice Examples



Norway

- Norway offers free licenses for recirculating aquaculture systems. This provides significant benefits by removing cost barriers and accelerating the adoption of these systems. This incentivizes investment, especially from smaller startups, fostering industry diversity and competitiveness. By freeing up capital, it encourages technological innovation and supports advancements that enhance resource efficiency and environmental sustainability.



Photo Credit: Guldborgsund Kommune

Sweden

- Sweden provides grants to aquaculture startups focusing on sustainable solutions. The Swedish Environmental Protection Agency (EPA) and Vinnova (the Swedish Innovation Agency) offer funding for companies working on RAS and other green technologies. These grants help cover research, development, and the integration of innovative systems like RAS, which minimize environmental impact.





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