BlueRev

Bio-based revitalisation
of local communities

BlueRev
Deliverable 4.2
New business models

Unlocking Sustainable Business Model Innovations in the Blue Bio-based Industry

D4.2

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Deliverable 4.2 New Business Models

Unlocking Sustainable Business Model Innovations in the Blue Bio-based Industry

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1.1	10/02/2025	S. Golesorkhi	Minor revision: Introduction of omega3 business case (example 4 in par. 5.1)

Table of Abbreviations and Acronyms

Abbreviation	Meaning
APRE	Agenzia per la Promozione della Ricerca Europea
BMC	Business Model Canvas
CFP	Common Fisheries Policy
DFBG	Distretto della Pesca e Crescita Blu
DMP	Data Management Plan
EEZ	Exclusive economic zone
EMU	Estonian University of Life Sciences
ESG	Environmental, Social, Governance
FBCD	Food Bio Cluster Denmark
FAIR	Findable Accessible Interoperable Accessible
GDP	Gross domestic product
LCA	Life Cycle Assessment
LNG	Liquefied natural gas
LOBA	GLOBAZ, S.A.
IMTA	Integrated Multi-Trophic Aquaculture
MSC	Marine Stewardship Council
NIBIO	Norsk Institutt for Biookonomi
R&D	Research and Development
RISE	Research Institutes of Sweden AB
SBMC	Sustainable Business Model Canvas
STEM	science, technology, engineering, and mathematics
UiA	Universitetet I Agder
UNIPA	University of Palermo
WP	Work Package

Index of Contents

Index of Figures

1 Executive Summary

The main purpose of this deliverable is to describe the process and outcomes of participatory sessions aimed at co-creating sustainable business models within the blue bioeconomy. These sessions, conducted across pilot regions in Estonia, Italy, Greenland, and Denmark, were designed to build on opportunities identified in earlier stages of the BlueRev project, in WP3. Through co-creation workshops, interviews, and focus groups, a diverse range of stakeholders—including localbusinesses, government representatives, researchers, and civil society—collaborated to tailor business models that leverage local capacities while addressing region-specific challenges and opportunities.

The participatory sessions were structured using the Sustainable Business Model Canvas, underpinned by design thinking methodologies. This approach fostered a dynamic and iterative process, enabling stakeholders to explore innovative solutions and refine their ideas collaboratively. The workshops emphasized empathy and stakeholder inclusivity, ensuring that the co-created models were both practical and aligned with local needs. The process involved systematically defining value propositions, identifying customer segments, and addressing key operational and ecological components such as resource utilization, eco-costs, and eco-benefits. This holistic approach ensured that the proposed business models were not only economically viable but also environmentally and socially sustainable.

The deliverable outlines diverse outcomes across the pilot regions. In Estonia, models focused on macroalgae cultivation and integrated multi-trophic aquaculture, promoting marine spatial efficiency and nutrient management. Italy's initiatives emphasized the valorization of seafood by-products into high-value products like shrimp powder and Omega-3 oils. Greenland and Denmark prioritized advanced freezing techniques, cod side-stream valorization, and nutrient recovery from wastewater. These models highlight the potential of sustainable practices to drive local economic development while contributing to global sustainability goals. The insights gained will serve as a foundation for scaling these practices and developing best-practice guidelines in subsequent project phases as part of WP4.

2 Introduction

This document serves as the deliverable for Work Package 4 (WP4) of the BlueRev project, focusing on the development of sustainable business models for the pilot regions. The purpose is to outline potential business models within the blue bioeconomy, drawing on key findings from pilot studies conducted in Denmark and Greenland, Italy and Estonia—each offering unique socio-economic and environmental context. These regions provide a foundation for identifying business opportunities that encourage environmentally and socially responsible practices in marine and coastal communities.

In addition, this deliverable contributes to the preparation of Deliverable 4.4 (D4.4) under WP4, which will present best practices derived from integration of social innovation (D4.1) and Governance recommendations (D4.3) for these pilot regions in support of Work Package 5 (WP5), which involves demonstration activities in the pilot regions. The deliverable provides a roadmap to potential business models and processes within sustainable blue bioeconomy in the three pilot regions. The objectives of **D.4.2** are as follows:

- To **analyze and propose sustainable new or updated business models**, while simultaneously strengthening local capacities and actively engaging innovation actors. This aims to ensure effective impacts and improved performance across value chains within the pilot regions, building on the foundational analysis of **WP3 and WP4**.
- To **assess the outcomes of co-creation workshops and interviews** conducted in the pilot regions. This involves a critical examination of the effectiveness and feasibility of the sustainable business models developed, ensuring they are both practical and aligned with regional contexts.
- To **identify best practices** that can be replicated or adapted in other regions. These best practices, derived from the pilot regions, will provide actionable insights and will be compiled in **Deliverable D4.4**, contributing to the broader dissemination and scaling of sustainable blue bioeconomy initiatives.

This deliverable presents the findings from extensive stakeholder engagement aimed at co-creating innovative solutions through workshops and interviews. These activities were designed to generate actionable recommendations for a broad spectrum of stakeholders, including local and regional authorities, primary biomass producers, SMEs, and academic institutions in the project's pilot regions. Hosted by regional partners, the workshops and interviews provided participatory spaces where stakeholders could exchange regional insights and collaboratively develop new business models, governance frameworks, social innovations and practical solutions. For the purpose of this deliverable efforts were specifically focused at identifying sustainable business opportunities supporting the sustainable development of the local bio-based sector,

ensuring that the proposed models and strategies align with the unique socio-economic and environmental contexts of each pilot region.

The workshops served a dual purpose: to validate data previously collected under the D3.2 protocol and to address gaps through the collection of additional insights. This iterative process was instrumental in refining sustainable business models tailored to bioeconomy opportunities in the pilot regions—Greenland and Denmark, Estonia, and Italy.

Using the sustainable business model canvas as our guiding framework, we employed a multi-method approach to analyze the outputs from the co-creation workshops and interpret the qualitative data collected during brainstorming sessions, design activities, and participant discussions. These methods included thematic analysis, which involved identifying key themes, patterns, and recurring ideas within the data, such as sticky notes, drawings, and discussion notes. Affinity diagramming was also employed, allowing participants or analysts to organize outputs into clusters of related ideas, providing clearer insights and facilitating the identification of connections between concepts. Additionally, content analysis was conducted, involving the systematic coding of data to categorize different content types and ensure a comprehensive understanding of the qualitative inputs. Furthermore, in-depth interviews were carried out, structured around the categories of the sustainable business model canvas and supported by established protocols from WP3. These interviews were conducted in close collaboration with local project partners to ensure contextual relevance and enhance the robustness of the data collected.

These processes filled gaps from WP3 in the development and implementation of sustainable business models, refining our understanding of regional business dynamics. They also engaged key industry and firm stakeholders essential for collecting data on potential new business opportunities.

This deliverable begins by outlining the methodology and defining the sustainable business model canvas, providing a structured approach to exploring these opportunities. It then delves into the business prospects identified in each pilot region, building on results from D3.6. Additionally, the deliverable highlights key constraints and opportunities, offering a comprehensive view of the challenges and potential pathways for sustainable business growth in the pilot regions.

3 Methodology

The methodology adopted builds on a **participatory approach**, integrating co-creation, stakeholder engagement, and **design thinking principles** within a **triple helix innovation framework**. This multifaceted strategy ensures that the solutions developed are not only context-specific and actionable but also **inclusive and democratic**, addressing the unique challenges of the blue bioeconomy in each pilot region. By prioritizing local contexts and leveraging diverse perspectives, this approach fosters the development of sustainable business models tailored to regional socio-economic and environmental conditions.

The project was further guided by the **triple helix model**, which integrates three key domains: **academia, industry, and government**. This model emphasizes the dynamic interplay between these sectors in fostering innovation and sustainable development. **Academia** contributed cutting-edge research and technological insights, laying the groundwork for evidence-based solutions. **Industry** brought market-oriented perspectives, emphasizing the feasibility and scalability of proposed models. **Government** provided the necessary policy frameworks and regulatory support, ensuring alignment with broader sustainability goals.

This collaborative framework facilitated **knowledge sharing**, enhanced **governance discussions**, and strengthened **capacity building** across the pilot regions. By aligning the efforts of diverse stakeholders, the activities conducted as part of **WP4** have the potential to drive **innovation**, promote **sustainable growth**, and support the development of **resilient** and **inclusive blue bioeconomy ecosystems**. These efforts not only foster regional cooperation but also lay the groundwork for scalable and adaptable solutions that can address broader challenges within the blue economy sector.

3.1 Participatory Approach and Stakeholder Engagement

A core aspect of the methodology involved **active stakeholder engagement** through co-creative workshops held across the pilot regions. These workshops convened a diverse array of actors, including **local and regional authorities, primary biomass producers, SMEs, and academic institutions**, to collaboratively prioritize and refine recommendations. Stakeholders played a pivotal role in **identifying solutions that aligned with regional needs and aspirations**, ensuring that the proposed business models were both relevant and impactful. This participatory approach was designed to foster inclusivity and democratic engagement, ensuring that the perspectives of those most directly affected by the blue bioeconomy were not only heard but actively shaped the decision-making process. By leveraging the collective expertise and insights of varied stakeholders, the process facilitated the co-creation of actionable strategies tailored to the unique socio-economic and environmental contexts of each pilot region.

3.2 Design Thinking and Co-Creation

Design thinking served as the **foundational methodology** for the co-creation sessions, enabling a user-centered, iterative approach to problem-solving. Originating from design practice and later adopted in business and organizational contexts, design thinking is both a philosophy and a set of actionable tools aimed at tackling complex challenges. Its structured yet flexible approach emphasizes **empathy, ideation, and experimentation**, making it particularly suitable for addressing the multifaceted and dynamic issues of the blue bioeconomy. Organizations like IDEO have championed this methodology, demonstrating its value in creating innovative, human-centric solutions that align with real-world needs (Nakata & Hwang, 2020).

At its core, design thinking emphasizes **empathy**, ensuring that solutions are deeply aligned with user experiences and local contexts. This approach was pivotal in the BlueRev project, as it allowed stakeholders to collaboratively explore and address the unique socio-economic and environmental challenges of their regions. Through **discovery**, participants engaged in deep exploration of regional problems, using tools such as interviews and ethnographic research to uncover both explicit and latent needs. This stage provided a holistic understanding of the blue bioeconomy, reframing challenges in ways that encouraged creative problem-solving.

The **ideation phase** harnessed the diverse expertise of stakeholders, enabling the generation of novel ideas and solutions. Visual and interactive tools like mapping and sketching were used to facilitate brainstorming, helping participants push beyond conventional thinking. The final stage, **experimentation**, involved rapid prototyping and iterative testing. By creating and refining low-fidelity prototypes, stakeholders could test the feasibility of their ideas in real-world settings, collecting feedback that ensured their solutions were both practical and impactful.

The participatory nature of design thinking was essential for the BlueRev initiative. The **co-creation workshops** provided inclusive and democratic spaces for stakeholders—ranging from local authorities to SMEs and academic institutions—to collaboratively design business models and governance frameworks. This methodology allowed the project to address **"wicked problems"**, such as balancing environmental sustainability with economic viability across diverse geographical and ecological contexts. Moreover, it fostered a culture of experimentation and resilience, where failure was seen as an opportunity to learn and improve.

Ultimately, the use of design thinking within the BlueRev project not only enhanced stakeholder engagement but also ensured the development of **tailored, actionable, and sustainable business models**. These models align with both local capacities and broader sustainability goals, offering a pathway to innovation in the blue bioeconomy.

3.3 Sustainable Business Model Canvas as a Co-Creation Tool

The sustainable business model canvas was employed as a central framework during the co-creation sessions, offering a **visual and interactive tool** to guide stakeholders through the development of innovative and regionally relevant business models. This approach facilitated structured yet flexible discussions, ensuring that all critical components of a sustainable business model—such as value propositions, customer segments, revenue streams, eco-social costs, and eco-social benefits—were comprehensively explored.

Visual tools like the sustainable business model canvas play a crucial role in fostering **engagement and collaboration** during co-creation sessions. By providing a clear, tangible framework, the canvas helps participants visualize complex concepts and relationships, making abstract ideas more accessible. The **visual representation** of business components serves as a common language, bridging gaps between stakeholders with different backgrounds, from local fishers to policymakers and academic researchers. This shared understanding is vital for addressing the multifaceted challenges of the blue bioeconomy, where diverse expertise and perspectives must converge to create viable solutions. Moreover, the canvas' modular format allows stakeholders to approach each business component systematically, breaking down complex processes into manageable, discussion-friendly segments. This modularity supports a comprehensive exploration of opportunities and constraints without overwhelming participants, thereby encouraging meaningful contributions from all voices around the table.

Each section of the canvas was accompanied by **targeted prompting questions**, designed to spark in-depth discussion and critical thinking. For instance, under the value proposition segment, participants were prompted with: *What unique value does this business offer, and how does it address local environmental and economic challenges?* In exploring customer segments, they considered: *Who are the primary beneficiaries of this business, and how can their specific needs be met effectively?* Similarly, revenue stream discussions were guided by questions like: *What are the potential income sources, and how can they ensure financial sustainability?* For eco-social costs, participants reflected on: *What environmental or social trade-offs might arise, and how can these be mitigated through innovative practices?* Finally, the eco-benefits section invited stakeholders to envision positive impacts by asking: *How will this business contribute to environmental regeneration, community well-being, and carbon footprint reduction?*

These questions served as **conversation catalysts**, encouraging participants to engage deeply with each business model component. They enabled stakeholders to move beyond surface-level considerations, uncovering **hidden opportunities**, identifying **potential risks**, and recognizing **synergistic eco-benefits**. This structured dialogue ensured that every aspect of the business model was thoroughly examined and

customized to fit the unique socio-economic and environmental dynamics of each pilot region. By systematically addressing both potential challenges and benefits, stakeholders were better equipped to design holistic, future-proof business models.

The interactive and participatory nature of the sustainable business model canvas enhanced **stakeholder engagement and ownership** of the process. By actively contributing to each component of the canvas, participants could see how their ideas directly shaped the emerging business models. This collaborative dynamic fostered a sense of **shared responsibility and commitment**, which is crucial for successful implementation and long-term sustainability. Moreover, the iterative use of the tool allowed for real-time refinement, enabling stakeholders to test ideas, gather immediate feedback, and adapt their strategies dynamically. This adaptability is particularly important in the blue bioeconomy, where market conditions and environmental challenges are continuously evolving.

The sustainable business model canvas will be further explained and explored in the next section of this D4.2 report, offering a detailed breakdown of its components and their application in shaping sustainable business models for the blue bioeconomy.

3.4 Benefits of Co-Creation and Multi-Stakeholder Collaboration

By involving a diverse range of stakeholders in the co-creation process, the project was able to harness a wealth of expertise, perspectives, and resources. This inclusive and collaborative approach not only enhanced the legitimacy and feasibility of the proposed solutions but also fostered a sense of ownership and accountability among participants. Such ownership is critical for ensuring the successful implementation and long-term sustainability of the business models developed. Moreover, the iterative nature of the co-creation process allowed for continuous refinement, ensuring that the business models remained flexible and adaptive to emerging challenges and opportunities within the blue bioeconomy.

In summary, the methodology adopted in this project provides a robust framework for tackling complex sustainability challenges. By integrating participatory engagement, design thinking, the sustainable business model framework, and the triple helix model, the project succeeded in developing context-sensitive and scalable solutions. These solutions effectively balance economic growth with environmental stewardship and social inclusivity, offering a holistic and replicable approach to fostering innovation and sustainability in the blue bioeconomy.

4 The sustainable business model canvas

4.1 Defining the tool

The business opportunities in each pilot region were assessed using the Sustainable Business Model Canvas (SBMC) framework. This framework provided a structured approach to examining business ideas, enabling a comprehensive evaluation of their viability and feasibility while clearly outlining their underlying business models. Additionally, the SBMC proved instrumental in identifying both opportunities and gaps across key dimensions, ensuring a holistic understanding of each business model's potential and limitations.

The Business Model Canvas (BMC), developed by Alexander Osterwalder and Yves Pigneur in 2005, has revolutionized how organizations conceptualize, document, and innovate their business models (Osterwalder & Pigneur, 2011). Initially designed to offer a visual, comprehensive framework for understanding the core components of a business model, the BMC has since become a foundational tool for startups, corporates, and entrepreneurs alike, widely used in workshops, presentations, and strategy sessions globally (Blank & Dorf, 2012).

The canvas itself is a structured template that provides a visual map of essential elements, facilitating a clear overview of a company's value proposition, customer interactions, cost and revenue structures, and other critical components. The nine core building blocks include:

1. **Customer Segments**: Defines the target customers for whom the organization is creating value, identifying primary and secondary customers or any niche audiences.
2. **Value Proposition**: Articulates the unique value the business provides, addressing customer needs or solving specific problems through tailored solutions.
3. **Channels**: Outlines the mediums through which value is delivered to the customer, focusing on efficient, cost-effective, and integrated methods for reaching target segments.
4. **Customer Relationships**: Details the nature of the relationships established with each customer segment, considering retention strategies, acquisition costs, and customer engagement methods.
5. **Revenue Streams**: Identifies how and where the business generates revenue, exploring customer payment preferences, pricing strategies, and the contribution of each revenue stream to overall profitability.

6. **Key Resources**: Specifies the essential resources, including physical, intellectual, human, and financial assets, required to deliver the value proposition effectively.
7. **Key Activities**: Highlights the critical activities that must be undertaken to produce, deliver, and sustain the value proposition and ensure seamless customer interactions.
8. **Key Partners**: Identifies essential partners, suppliers, and networks that support core operations, providing access to resources and enhancing efficiency.
9. **Cost Structure**: Breaks down the costs integral to the business model, identifying the most significant expenditures linked to resources and activities.

4.2 Business Model Innovation and the Sustainable Business Model Canvas

The increasing urgency for environmental responsibility and social equity has led to the development of the Sustainable Business Model Canvas (SBMC). This adaptation of the original canvas introduces ecological and social dimensions, encouraging companies to evaluate both the positive and negative impacts of their operations on society and the environment. The SBMC aims to integrate sustainability directly into the business's core, making sustainability not just an add-on but a fundamental aspect of strategic planning.

Key additional components within the SBMC include:

- **Eco-Social Cost**: This component evaluates the ecological and social costs associated with business activities, examining non-renewable resource dependency, environmental impacts, and potential social drawbacks of the business model.
- **Eco-Social Benefit**: This element assesses the ecological and social benefits generated by the business model, identifying specific beneficiaries and examining if these benefits could be leveraged as part of the value proposition.

Through this comprehensive approach, the SBMC emphasizes creating shared value that benefit companies, customers, and society as a whole. By incorporating eco-social costs and benefits, organizations can transition towards sustainable business models that minimize negative impacts while maximizing positive outcomes, fostering a circular economy.

4.3 Implementation and value

Since its inception, the Business Model Canvas (BMC) and its sustainable variant have played a transformative role in driving business model innovation. These frameworks provide structured, visual tools that enable organizations to critically assess their assumptions, uncover growth opportunities, and integrate practices that align with

sustainable development goals. By encouraging a shift from traditional models to forward-thinking solutions, the BMC and its sustainable adaptation empower businesses to generate long-term value that meets societal expectations and addresses pressing environmental challenges.

The BlueRev project builds on this foundation, employing a tailored version of the Sustainable Business Model Canvas (SBMC) presented below.

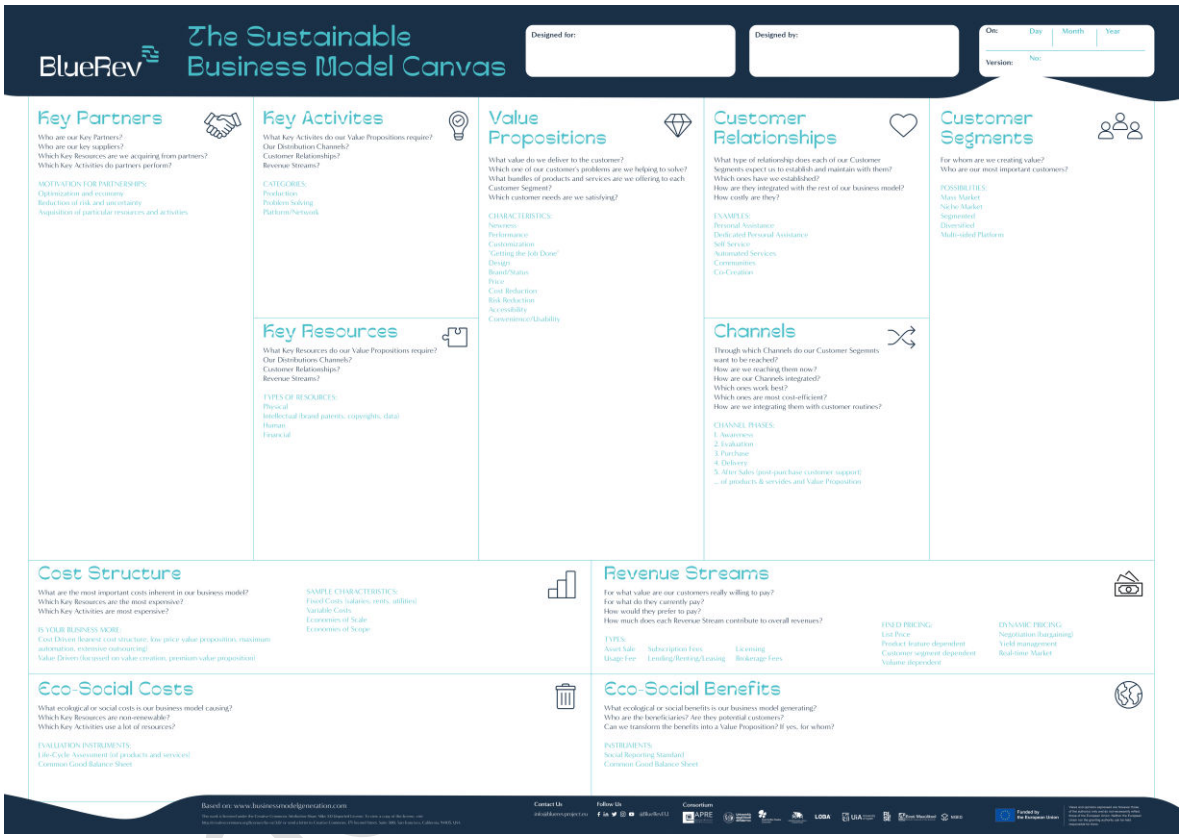

Figure 1: SBMC

4.4 Assessing business opportunities in each pilot region

The methodology applied across the three BlueRev pilot regions—Denmark, Greenland, and Estonia—used a two-step process to comprehensively analyze existing business models and identify opportunities for sustainable innovation. The first step involved document analysis, utilizing resources from key stakeholders and publicly available data to gain insights into the unique business contexts of each region. The second step entailed conducting semi-structured interviews and engaging key informants in co-creation workshops. Guided by a thematic interview protocol aligned with the Sustainable

Business Model Canvas (SBMC), this approach ensured the collection of in-depth, region-specific data on business models. This dual methodology established a robust understanding of each pilot region's current business landscape while highlighting opportunities for sustainable growth and innovation.

The overarching methodology supporting WP4 deliverables adhered to principles established in D4.1 and expanded on findings from D3.6. A detailed analysis of the current business models, framed within the SBMC, allowed for a nuanced understanding of opportunities for sustainable business development. The analysis not only identified the strengths of the existing models but also pinpointed areas needing further development. These gaps were subsequently addressed in co-creation workshops, where industry and firm stakeholders collaboratively explored and refined potential business models. This iterative process enabled the identification of tailored, sustainable solutions designed to meet the diverse needs of each pilot region.

The development of sustainable business models was contextualized within the specific socio-economic and environmental realities of each pilot region, resulting in distinct opportunities:

- **Collaborative Business Models in Greenland and Denmark:**
  These models emphasized leveraging Greenland and Denmark's robust fishing industry, research ecosystem, and seafood processing capabilities to add value to marine resources. Innovations like automated wastewater treatment systems were explored, focusing on minimizing environmental impact while enabling resource recovery.
- **Algae-Based Business Models in Estonia:**
  Estonia's Saaremaa region explored sustainable business opportunities centered around algae processing. Collaborations among researchers, small businesses, and environmental organizations aimed to enhance resource efficiency and expand markets for algae-based products, such as cosmetics and nutraceuticals. This positioned algae as a versatile bioresource within the blue bioeconomy.
- **Marine By-Product Valorization Models in Italy:**
  In Italy, the focus was on transforming marine by-products and fishing waste into value-added products, thereby reducing waste and generating new economic opportunities. By adopting a circular economy approach, this model promoted sustainable fishing practices and fostered regional collaboration.

The co-creation workshops aimed to gather comprehensive data across multiple dimensions of the SBMC, covering aspects such as value propositions, customer segments, revenue streams, cost structures, and eco-social benefits. This inclusive framework enabled stakeholders to holistically explore and develop sustainable business models tailored to their local contexts.

The workshops relied on a structured framework presented in Appendix 1 which included targeted questions designed to guide discussions. These questions were strategically crafted to align with each component of the sustainable business model canvas, serving as a roadmap for data collection and analysis. For instance, participants explored **value propositions** by addressing questions such as: *What unique value does your product offer to the market? How does it address identified industry gaps?* Similarly, under **eco-social benefits**, participants were prompted to consider: *What environmental or social impacts will your business model generate? How will these benefits contribute to local communities and ecosystems?*

The co-creation sessions provided a platform for stakeholders to collaboratively refine and prioritize sustainable business opportunities. By systematically addressing each component of the SBMC, the workshops facilitated actionable insights and strategies tailored to the complex realities of the blue bioeconomy.

5 Findings from Pilot Regions

Building on the analysis of the current business models presented in D3.6, a variety of business opportunities within the blue bio-based industry for each pilot region were also initially identified. These opportunities highlight the potential for innovation and value creation in sectors such as aquaculture, marine by-product valorization, and algae processing, tailored to the unique socio-economic and environmental contexts of each region.

Despite these promising developments, several key questions regarding business models and the discovery of new opportunities remained unresolved. Critical aspects such as long-term feasibility, scalability, and specific market dynamics required further exploration to strengthen the development /upgrading of sustainable business models in the pilot regions. To address these gaps, additional data collection, including further co-creation workshops and interviews, was conducted under WP4. These activities provided the necessary depth to fully explore and validate the identified opportunities while uncovering new areas for business creations and innovation.

5.1 Greenland and Denmark

Greenland and Denmark form a critical part of the Nordic pilot region, with both countries deeply rooted in the blue bio-economy. Greenland, with its resource-rich yet fragile Arctic ecosystem, relies heavily on fishing as its primary economic pillar, whereas Denmark leverages its advanced infrastructure and technological innovation to optimize marine resource utilization. Together, Greenland and Denmark illustrate the potential of leveraging marine resources to drive sustainable economic growth while addressing the challenges posed by climate change, market dynamics, and the need for innovative business models in the blue bio-economy.

Greenland

Greenland, the world's largest island, boasts an extensive exclusive economic zone (EEZ) covering over 2 million square kilometers in the Arctic waters. This unique geographic and ecological positioning makes marine resources a cornerstone of its economy. Fishing is not just the largest economic sector—it is the backbone of Greenland's GDP, contributing over 90% of its export revenue. Key species such as shrimp, halibut, and cod dominate the fishing industry, with shrimp alone accounting for a significant portion of the nation's export income.

Beyond its economic importance, fishing plays a crucial role in Greenland's social and cultural fabric. Coastal communities are heavily dependent on the industry for employment, with fishing activities deeply rooted in their traditions and way of life. However, Greenland faces considerable challenges, including labor shortages, limited

processing infrastructure, and high transportation costs due to its remote location. These factors, coupled with environmental vulnerabilities such as climate change and overfishing risks, underscore the urgent need for sustainable practices and diversification within the fishing sector.

Despite these challenges, Greenland's marine industry holds immense untapped potential, particularly in the utilization of side streams. Every year, approximately a large number of by-products from fish processing, including heads, shells, and viscera, remain unutilised. Properly harnessing these materials could unlock new revenue streams and promote a circular economy, aligning with global sustainability goals.

Initial business opportunities identified in Greenland

i. Selling Cod Side Streams

Currently, companies in Greenland incur disposal costs for side streams generated from cod filleting, including heads, viscera, and bones. However, these by-products present valuable opportunities for other industries, such as fishmeal and fish oil production. By selling these side streams, companies could reduce waste management costs, generate additional revenue, and contribute to a circular economy.

ii. Innovative Fish Freezing Techniques

The introduction of advanced freezing methods could enhance the efficiency of transporting side streams and primary fish products to international markets. Techniques like supercooling or flash freezing can preserve product quality during extended transit, expanding export opportunities and reducing operational costs, thereby improving Greenland's competitive positioning in global seafood markets.

iii. Enhancing Fish Handling for Quality Improvement

Improved fish handling practices, such as immediate throat cutting and effective blood drainage, could significantly elevate product quality. Transitioning to less environmentally harmful fishing methods, like using longlines instead of bottom gillnets, would not only meet higher market standards but also support sustainable fishing practices, potentially opening access to premium markets.

Denmark

Denmark, situated at the crossroads of the North and Baltic Seas, has a long-standing maritime tradition that continues to shape its economy and cultural identity. While the nation has developed a highly diversified economy, the fishing industry remains a key contributor, especially for coastal communities. Danish fisheries primarily target species

such as herring, cod, and mackerel, which are integral to both domestic consumption and export markets.

Denmark's fishing sector is known for its advanced infrastructure and commitment to sustainable practices. The nation actively participates in the European Union's Common Fisheries Policy (CFP), which sets quotas and promotes sustainable fishing to protect marine ecosystems. Danish fisheries often operate under the Marine Stewardship Council (MSC) certification, reflecting their adherence to high sustainability standards.

The Danish seafood processing industry is another vital component, utilizing advanced technology to maximize the value of marine resources. By-products such as fish meal, oil, and collagen are repurposed for use in various industries, including animal feed, cosmetics, and nutraceuticals. This integrated approach exemplifies Denmark's commitment to circular economy principles, ensuring that every part of the catch is used efficiently.

Denmark's strong research and innovation ecosystem further support the fishing industry. Institutions collaborate closely with businesses to develop cutting-edge technologies, such as automated wastewater treatment systems, which not only reduce environmental impact but also create opportunities for resource recovery. Combined with the nation's robust logistical networks, these advancements position Denmark as a leader in sustainable fisheries and marine resource management.

Initial Business opportunities identified in Denmark

i. Recovery and Utilization of Proteins and Phosphorus from Wastewater

Cod processing generates nutrient-rich wastewater, particularly during cleaning and filleting. Advanced treatment systems can recover valuable proteins and phosphorus, reintegrating them into the production process or repurposing them for agricultural use. This approach supports a circular economy by reducing resource waste and enabling water reuse in production.

ii. Valorization of Cod By-Products

By-products from cod, such as carcasses and fins, are rich in collagen and fish oil, which are in high demand in the cosmetics and nutraceutical industries. Currently sold to select buyers, these materials offer significant potential for new market development, allowing companies to diversify revenue streams and reduce environmental waste.

iii. Automated and Eco-Friendly Wastewater Treatment

Advanced wastewater treatment solutions offer a dual benefit: efficient purification for water reuse and the extraction of valuable components like polyphosphates and proteins. These systems not only lower the environmental impact of fish processing but also enable the production of high-value secondary products, supporting Denmark's commitment to sustainable fisheries and boosting the sector's economic potential.

Co-creation data collection

The co-creation workshop in Denmark, held in Aalborg on the 22nd of May 2024, brought together a diverse group of 11 stakeholders, including representatives from enterprises, research institutions, and regulatory bodies. The workshop focused on governance structures, social innovation, and business model development, highlighting the rules and systems necessary to foster sustainable business opportunities in smaller, specialized markets. Participants were guided and grouped to address the following key themes:

- **Understanding the needs**: Identifying barriers and enablers within the blue bioeconomy.
- **Envisioning desirable futures**: Exploring what sustainable growth and innovation could look like in the region.
- **Fostering collaboration and action**: Recognizing the roles and interdependencies of actors within the system to drive collective progress.

Building on these discussions, the workshop introduced the Sustainable Business Model Canvas as a practical tool. Participants engaged in a creative exercise focusing on six core components:

1. Developing a compelling value proposition.
2. Identifying target markets and effective channels.
3. Designing viable revenue streams.
4. Defining cost structures to ensure financial sustainability.
5. Recognizing key partners is essential for scaling operations.
6. Identifying strategic resources, activities, and capabilities to drive innovation and long-term impact.

This structured, participatory approach ensured that the business models developed were tailored to the region's unique needs and opportunities, aligning economic goals with sustainable practices.

The conversations explored:

- Case-specific background on fishery operations
- Social and economic challenges faced by stakeholders
- Community engagement and acceptance of sustainable practices
- The development and effectiveness of new business models

The workshop in Greenland was held in Nuuk, on the 18th of June 2024, gathering a total of 19 regional stakeholders. The workshop methodology adheres with procedures outlined above. The aim was to verify and further develop a selection of the recommended business opportunities.

Summary of New Sustainable Business Models discussed in Greenland and Denmark

Four primary business models emerged from the workshops conducted in Greenland and Denmark, two for Greenland and two for Denmark. These models are detailed below.

1. SELLING COD SIDE STREAMS TO FISH PROCESSING COMPANIES (GREENLAND)

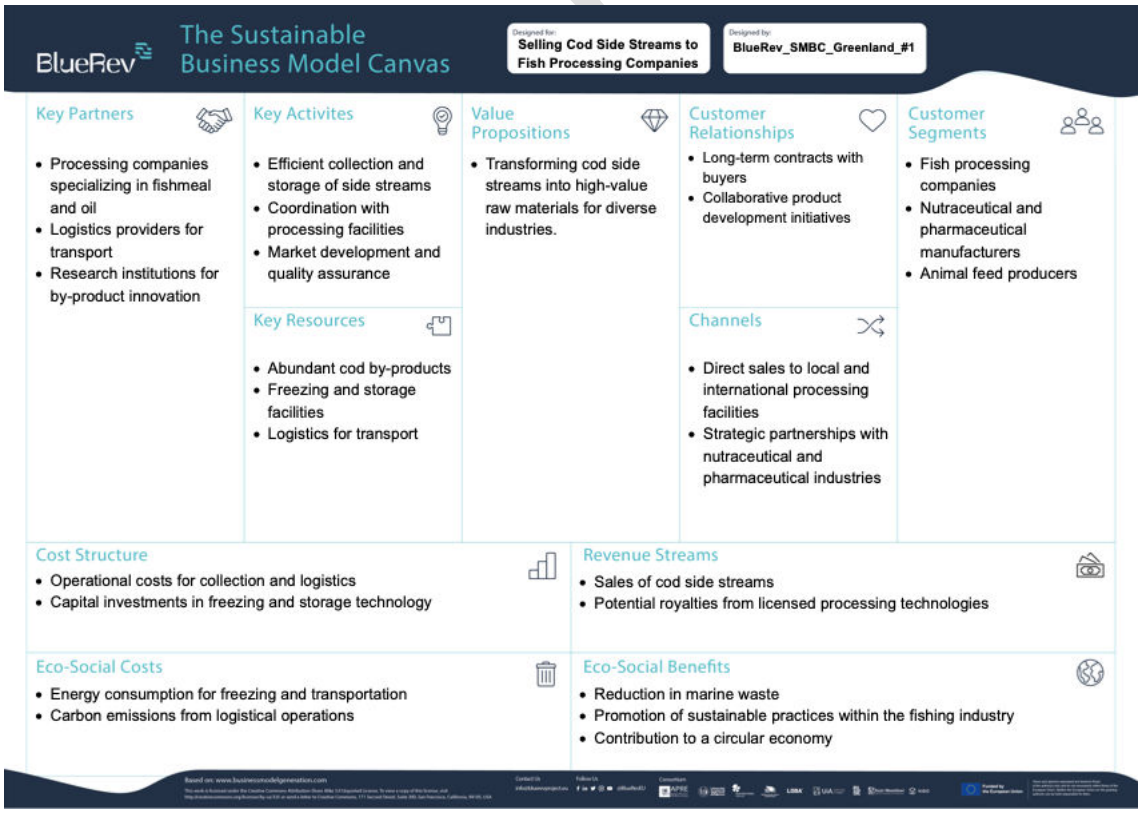

Figure 2: SBMC Greenland, Selling Cod Side Streams to Fish Processing Companies

Background

Greenland's fishing industry generates significant quantities of by-products, including cod heads, viscera, and bones. Traditionally, these side streams were either not utilized or required costly management by producers, resulting in environmental and resource inefficiencies. With growing interest in sustainability and circular economy principles, these by-products present an opportunity to create additional revenue streams while addressing waste management challenges. Currently, fish processing companies in Greenland face rising disposal fees, which cut into their profitability. By monetizing these side streams, they can offset operational costs and invest in more sustainable practices.

The global market for fish-derived products is expanding, particularly in sectors like nutraceuticals, pharmaceuticals, and animal feed. Components such as fishmeal, oils, and hydrolyzed proteins derived from cod side streams are in high demand due to their applications in health supplements, pet food, and agricultural products. Greenland's geographic advantage, with access to pristine Arctic waters, offers a unique selling point—products derived from sustainably sourced and high-quality raw materials. This positioning could attract premium buyers seeking eco-friendly and traceable inputs for their production processes.

Furthermore, leveraging cod side streams aligns with Greenland's broader sustainability goals, reducing marine waste and maximizing resource efficiency. Collaborations with international processing facilities could help Greenland overcome infrastructure limitations by exporting raw side streams to regions with advanced processing capabilities. Such partnerships would not only enhance the value of Greenland's marine resources but also create a resilient, diversified fishing industry that contributes to both local and global markets.

Value Proposition: Transforming cod side streams into high-value raw materials for diverse industries.

Customer Segments

- **Fish Processing Companies**
  Fish processing companies are primary customers as they can further refine cod side streams into fishmeal and fish oil. These products are integral to the production of animal feed, fertilizers, and even cosmetics, ensuring a steady demand for raw materials.
- **Nutraceutical and Pharmaceutical Manufacturers**
  Nutraceutical firms utilize cod by-products to extract bioactive compounds, such as Omega-3 fatty acids and hydrolyzed proteins, for dietary supplements.

Pharmaceutical companies leverage these materials in the development of health products, including capsules and fortified food additives.

- **Animal Feed Producers**
  Animal feed producers benefit from high-protein and nutrient-rich by-products, which can be incorporated into livestock, aquaculture, and pet feeds. These materials enhance feed efficiency and align with sustainable agriculture practices.

Channels

- **Direct Sales to Processing Facilities**
  Raw side streams are sold directly to both local and international facilities that specialize in fishmeal and oil production. This channel ensures the efficient use of by-products and streamlines the supply chain.
- **Strategic Partnerships with Nutraceutical and Pharmaceutical Industries**
  Partnerships facilitate the co-development of high-value products tailored to specific industry needs, ensuring mutual growth and fostering innovation in the bioeconomy sector.

Customer Relationships

- **Long-Term Contracts with Buyers**:
  These contracts provide stability and predictability in revenue streams while fostering trust and collaboration between stakeholders.
- **Collaborative Product Development**:
  Close collaboration with customers helps in creating customized solutions, such as specific blends of fishmeal or tailored formulations for nutraceutical applications, which build loyalty and foster innovation.

Revenue Streams

- **Sales of Cod Side Streams**
  Revenue is primarily generated from the direct sale of raw by-products to various industries, creating a reliable income source for the supplier.
- **Licensing of Processing Technologies**
  Proprietary methods for extracting high-value compounds can be licensed to other firms, providing an additional revenue stream through royalty payments.
- **Value-Added Product Sales**
  Processed derivatives such as fish oils or protein powders, produced either in-house or through partnerships, can be sold directly to consumers or businesses, boosting overall revenue.

Key Resources

- **Abundant Cod By-Products**
  Raw materials, including cod heads, viscera, and bones, serve as the foundation for all value-added processes and products.
- **Freezing and Storage Facilities**
  State-of-the-art freezing and storage infrastructure ensures the preservation of raw materials, maintaining their quality for extended periods and enabling year-round supply.
- **Efficient Logistics Network**
  A robust logistics system ensures the timely and cost-effective transport of by-products to processing facilities, both locally and internationally.

Key Activities

- **Collection and Storage of Side Streams**
  Efficiently collecting, sorting, and storing by-products at optimal conditions is essential to maintain their quality and usability.
- **Coordination with Processing Facilities**
  Liaising with specialized facilities ensures the conversion of raw by-products into market-ready products such as fishmeal, oil, or nutraceutical components.
- **Market Development and Quality Assurance**
  Ongoing efforts in market research and quality control help to meet industry standards and consumer expectations, ensuring product competitiveness.

Key Partners

- **Processing Companies**
  These partners specialize in refining by-products into fishmeal, oils, and other derivatives, enhancing their market value.
- **Logistics Providers for transport**
  Reliable logistics companies manage the transport of by-products, ensuring timely delivery while maintaining quality standards.
- **Research Institutions for by-product innovation**
  Collaboration with universities and research centers drives innovation, enabling the development of new processing techniques and applications for cod side streams.

Cost Structure

- **Operational Costs for collection and logistics**

These include expenses for collecting, sorting, and transporting side streams, as well as wages for labor involved in the process.

- **Capital Investments in freezing and storage technology**
  Significant upfront investments in freezing, storage, and transport technologies are necessary to support efficient operations.
- **Maintenance and Utility Costs**
  Ongoing expenses for maintaining equipment and utilities, including electricity for freezing and transportation fuel, form a substantial part of the operational budget.

Eco-Costs

- **Energy consumption for freezing and transportation**
  Freezing and storage facilities consume significant amounts of energy, contributing to the overall carbon footprint of the operation.
- **Carbon emissions from logistical operations**
  Transporting side streams to processing facilities generates carbon emissions, necessitating strategies for emissions reduction, such as optimizing routes or using greener transportation options.

Eco-Benefits

- **Reduction in Marine Waste**
  By utilizing by-products, the model diverts waste from the marine ecosystem, reducing pollution and its associated ecological impact.
- **Promotion of sustainable and circular practices within the fishing industry**
  This approach maximizes the use of every catch, creating a sustainable value chain that contributes to the circular economy by repurposing waste into high-value products.
- **Resource Efficiency in Fishing**
  Efficient use of by-products enhances overall resource utilization, reducing the environmental impact of fishing activities and contributing to sustainable fisheries management.

2. ADVANCED FISH FREEZING METHODS TO EXPAND EXPORT OPTIONS (GREENLAND)

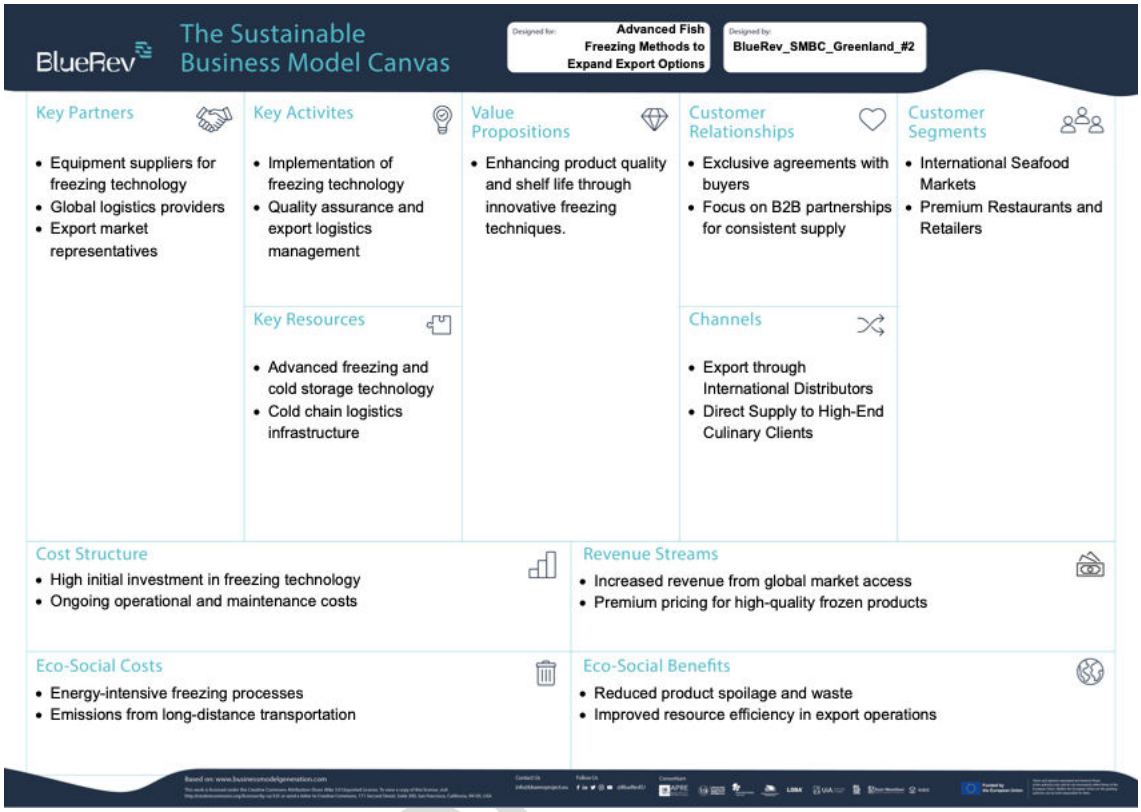

Figure 3: SBMC Greenland, Advanced Fish Freezing Methods to Expand Export Options

Background

Greenland's remote location and challenging climatic conditions pose logistical hurdles for exporting fresh seafood. The reliance on traditional freezing and storage methods limits the ability to maintain product quality during transportation to distant markets. This constraint reduces Greenland's competitiveness in the global seafood market, especially for high-value products that require consistent quality and freshness. Advanced freezing methods, such as supercooling or rapid-freezing technologies, offer a solution by significantly extending the shelf life of seafood while preserving its texture, flavor, and nutritional value.

Innovative freezing technologies could open new export channels for Greenland, allowing its fishing industry to tap into lucrative markets in North America, Europe, and Asia. High-end restaurants, retailers, and specialty food outlets increasingly demand premium-quality frozen seafood, creating a strong market for sustainably sourced

products. Additionally, by maintaining higher product quality, Greenland can command premium prices and establish itself as a reliable supplier in global seafood trade. This shift could lead to increased profitability and a more stable economic outlook for local fishers and processors.

The adoption of advanced freezing techniques also supports Greenland's sustainability objectives. By reducing spoilage and waste, these technologies ensure that more of the catch is utilized, maximizing the economic return from each fishing trip. Moreover, efficient freezing processes can reduce energy consumption and associated emissions, contributing to a greener supply chain. This combination of economic and environmental benefits makes advanced freezing a pivotal strategy for Greenland's fishing industry as it seeks to modernize and expand its global reach.

The co-creation workshop in Greenland, held in June 2024, followed a similar format to the workshop conducted in Denmark. Participants were divided into groups of five to engage in focused discussions, identifying challenges and opportunities associated with new business ventures centered around fish side-stream operations. The groups explored the feasibility of these opportunities, delving into the specific barriers and enablers that could influence their success. The workshop provided a platform for stakeholders to collaboratively address region-specific issues while leveraging insights from diverse perspectives. For example the efforts of a small producer to adopt socially responsible business practices while respecting traditional lifestyles was highlighted. This approach led to the development of unique dog food products that turned marine by-products into high-value products, contributing to the local economy and supporting Greenland's broader circular economy goals.

Value Proposition: Enhancing product quality and shelf life through innovative freezing techniques.

Customer Segments

- **International Seafood Markets**
  The primary target for high-quality frozen seafood includes major seafood markets in North America, Europe, and Asia, where demand for premium, sustainably sourced products is high.
- **Premium Restaurants and Retailers**
  High-end dining establishments and specialty food retailers seek top-quality frozen seafood for their discerning clientele. These segments are willing to pay a premium for consistent quality and sustainable sourcing.

Channels

- **Export through International Distributors**
  Global distributors serve as intermediaries, ensuring that Greenland's frozen seafood reaches international markets efficiently, leveraging their extensive networks to maximize market penetration.
- **Direct Supply to High-End Culinary Clients**
  Direct partnerships with premium restaurants and retailers allow for tailored supply agreements, ensuring the delivery of specific seafood cuts or products that meet unique customer specifications.

Customer Relationships

- **Exclusive Agreements with Buyers**
  Establishing long-term, exclusive supply contracts with key buyers ensures consistent revenue and strengthens trust, positioning Greenland as a reliable partner in the global seafood trade.
- **Focus on B2B Partnerships for Consistent Supply**
  B2B relationships prioritize reliability and quality, with continuous collaboration to meet the evolving needs of business clients, such as adjustments to product specifications or delivery schedules.

Revenue Streams

- **Increased Revenue from Global Market Access**
  Expanding into international markets allows for greater sales volume, leveraging global demand for high-quality frozen seafood.
- **Premium Pricing for High-Quality Frozen Products**
  Superior product quality achieved through advanced freezing methods enables the charging of premium prices, enhancing profitability.

Key Resources

- **Advanced Freezing and Cold Storage Technology**
  Innovative freezing equipment, such as rapid-freezing systems, is essential for preserving product quality and extending shelf life, ensuring competitiveness in global markets.
- **Cold Chain Logistics Infrastructure**
  A robust cold chain network, including refrigerated transport and storage, is critical to maintaining product integrity from Greenland to international markets.

Key Activities

- **Implementation of Freezing Technology**

Installing and maintaining cutting-edge freezing systems is central to ensuring product quality and meeting export standards.
- **Quality Assurance and Export Logistics Management**
  Continuous quality control measures and efficient logistics coordination ensure that products meet international quality standards and are delivered on time.

Key Partners

- **Equipment Suppliers for Freezing Technology**
  Partnerships with technology providers ensure access to the latest freezing innovations and technical support.
- **Global Logistics Providers**
  Collaborating with experienced logistics companies ensures the efficient and reliable transportation of frozen seafood to distant markets.
- **Export Market Representatives**
  Local representatives in target markets facilitate market entry, provide customer support, and enhance brand visibility.

Cost Structure

- **High Initial Investment in Freezing Technology**
  Significant capital is required for purchasing and installing advanced freezing systems, which are essential for maintaining product quality.
- **Ongoing Operational and Maintenance Costs**
  Regular maintenance of freezing equipment and cold storage facilities, as well as energy costs, contribute to operational expenses

Eco-Costs

- **Energy-Intensive Freezing Processes**
  The energy required for advanced freezing and storage systems contributes to the overall environmental footprint, necessitating energy-efficient solutions.
- **Emissions from Long-Distance Transportation**
  Shipping products to international markets involves emissions from refrigerated transport, impacting the carbon footprint of the operation.

Eco-Benefits

- **Reduced Product Spoilage and Waste**
  Advanced freezing methods significantly decrease spoilage rates, ensuring that more of the catch is utilized effectively.
- **Improved Resource Efficiency in Export Operations**

Efficient freezing and logistics systems maximize the value derived from each catch, reducing the environmental impact per unit of seafood exported.

3. AUTOMATED AND ECO-FRIENDLY WASTEWATER TREATMENT IN COD PROCESSING (DENMARK)

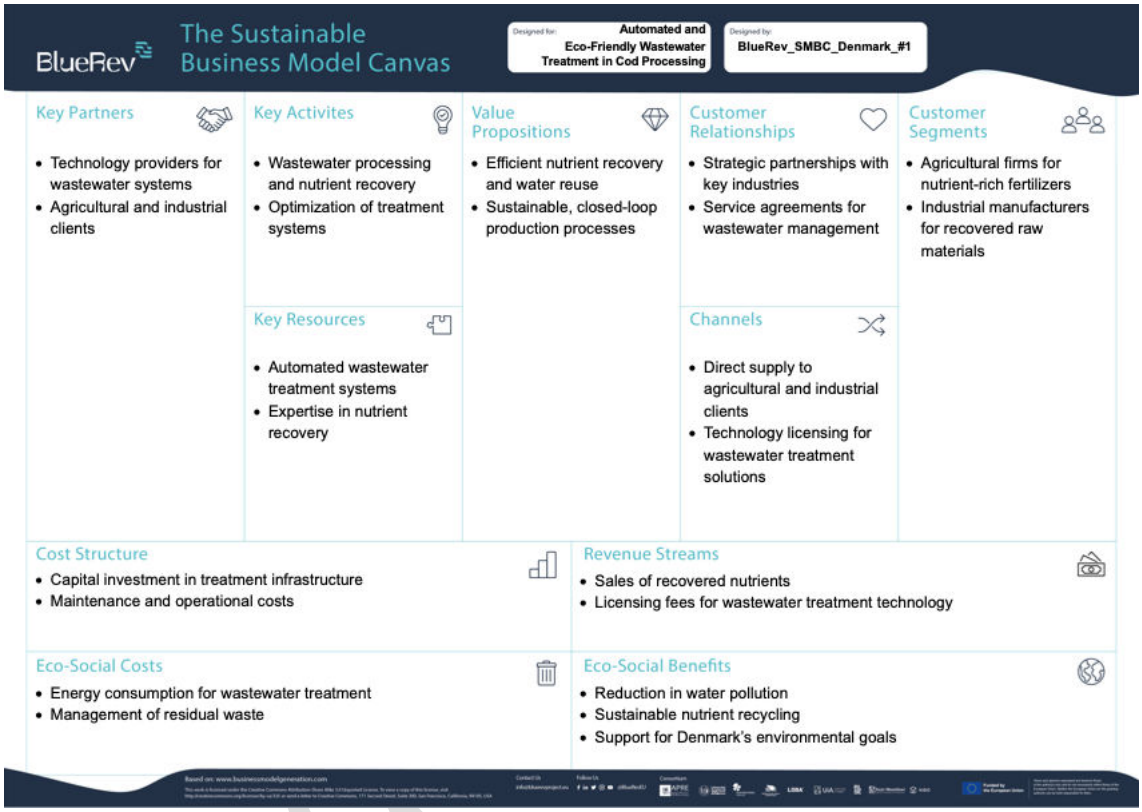

Figure 4: SBMC Denmark, Automated Eco-Friendly Wastewater Treatment in Cod Processing**Background**

Denmark's cod processing industry produces significant amounts of nutrient-rich wastewater, which poses both environmental and operational challenges. Current methods of wastewater disposal often led to nutrient runoff, contributing to water pollution and eutrophication in nearby ecosystems. However, this wastewater contains valuable components, such as proteins, phosphorus, and polyphosphates, which can be extracted and repurposed for various applications. With advancements in wastewater treatment technology, there is now a feasible pathway to turn this waste stream into a profitable resource, aligning with Denmark's commitment to sustainability and circular economy principles.

The use of automated and eco-friendly treatment systems offers a dual advantage: reducing the environmental footprint of the cod processing industry and creating new revenue opportunities. Nutrient recovery processes can generate high-value products like organic fertilizers, which are in demand in the agricultural sector. Additionally, recovered proteins and phosphates can be integrated into feed for aquaculture or livestock, further diversifying the market potential. This closed-loop approach not only minimizes waste but also supports resource efficiency, making industry more resilient and competitive.

Denmark is uniquely positioned to lead in this area, given its access to advanced technologies, robust regulatory framework, and strong market for sustainable products. By implementing these innovative wastewater treatment systems, Danish processors can achieve compliance with environmental regulations while turning a cost center into a profit generator. The adoption of these technologies also enhances Denmark's reputation as a leader in sustainable fisheries management, offering a blueprint for other countries to follow.

Value Proposition: Recovering valuable nutrients and reducing environmental impact through advanced wastewater treatment.

Customer Segments

- **Agricultural Firms for Nutrient-Rich Fertilizers**
  Farms and agribusinesses that rely on organic fertilizers for improving soil health and crop yields are primary beneficiaries of the recovered nutrients.
- **Industrial Manufacturers for Recovered Raw Materials**
  Industries requiring phosphorus, proteins, and other bio-based materials for applications in animal feed, bioplastics, or bioenergy can leverage these sustainable inputs.

Channels

- **Direct Supply to Agricultural and Industrial Clients**
  Nutrients and raw materials recovered from wastewater are directly supplied to buyers, ensuring an efficient and streamlined distribution process.
- **Technology Licensing for Wastewater Treatment Solutions**
  Licensing advanced treatment technologies allows other industries to adopt similar sustainable practices, generating additional revenue.

Customer Relationships

- **Strategic Partnerships with Key Industries**

Long-term collaborations with agriculture and industrial players foster trust and enable tailored nutrient recovery solutions.

- **Service Agreements for Wastewater Management**
  Offering ongoing support and maintenance services strengthens customer loyalty and ensures operational efficiency.

Revenue Streams

- **Sales of Recovered Nutrients**
  Recovered phosphorus and proteins are sold as premium fertilizers and industrial raw materials, contributing to diversified revenue sources.
- **Licensing Fees for Wastewater Treatment Technology**
  Revenue is also generated from licensing the proprietary wastewater treatment systems to other processing facilities or industries.

Key Resources

- **Automated Wastewater Treatment Systems**
  These advanced systems are crucial for extracting valuable components efficiently while minimizing environmental impact.
- **Expertise in Nutrient Recovery**
  Specialized knowledge in nutrient extraction and reuse ensures the effective implementation and optimization of the system.

Key Activities

- **Wastewater Processing and Nutrient Recovery**
  Operational focus lies in transforming wastewater into valuable products while ensuring compliance with environmental standards.

- **Optimization of Treatment Systems**
  Continuous improvement of treatment processes through R&D ensures higher efficiency, reduced costs, and increased nutrient recovery.

Key Partners

- **Technology Providers for Wastewater Systems**
  Collaborations with equipment manufacturers ensure access to cutting-edge technology and technical support.
- **Agricultural and Industrial Clients**
  Partnerships with end-users of recovered products help refine offerings and secure stable demand.

Cost Structure

- **Capital Investment in Treatment Infrastructure**
  Initial setup involves significant expenditure on automated wastewater treatment systems, including installation and customization.
- **Maintenance and Operational Costs**
  Ongoing expenses include system upkeep, energy use, and labor to ensure consistent performance.

Eco-Costs

- **Energy Consumption for Wastewater Treatment**
  Operating advanced treatment systems requires considerable energy, contributing to the facility's overall carbon footprint.
- **Management of Residual Waste**
  Non-recyclable by-products must be handled responsibly, adding to waste management costs.

Eco-Benefits

- **Reduction in Water Pollution**
  Nutrient recovery prevents harmful runoff, mitigating eutrophication in nearby water bodies and promoting healthier ecosystems.
- **Sustainable Nutrient Recycling**
  By recovering and reusing valuable nutrients, the process supports a circular economy, reducing dependence on synthetic fertilizers.
- **Support for Denmark's Environmental Goals**
  Aligning with national sustainability objectives enhances Denmark's reputation as a leader in eco-friendly fisheries management.

4. SUSTAINABLE OMEGA-3 DRINK FOR THE CHINESE MARKET (DENMARK)

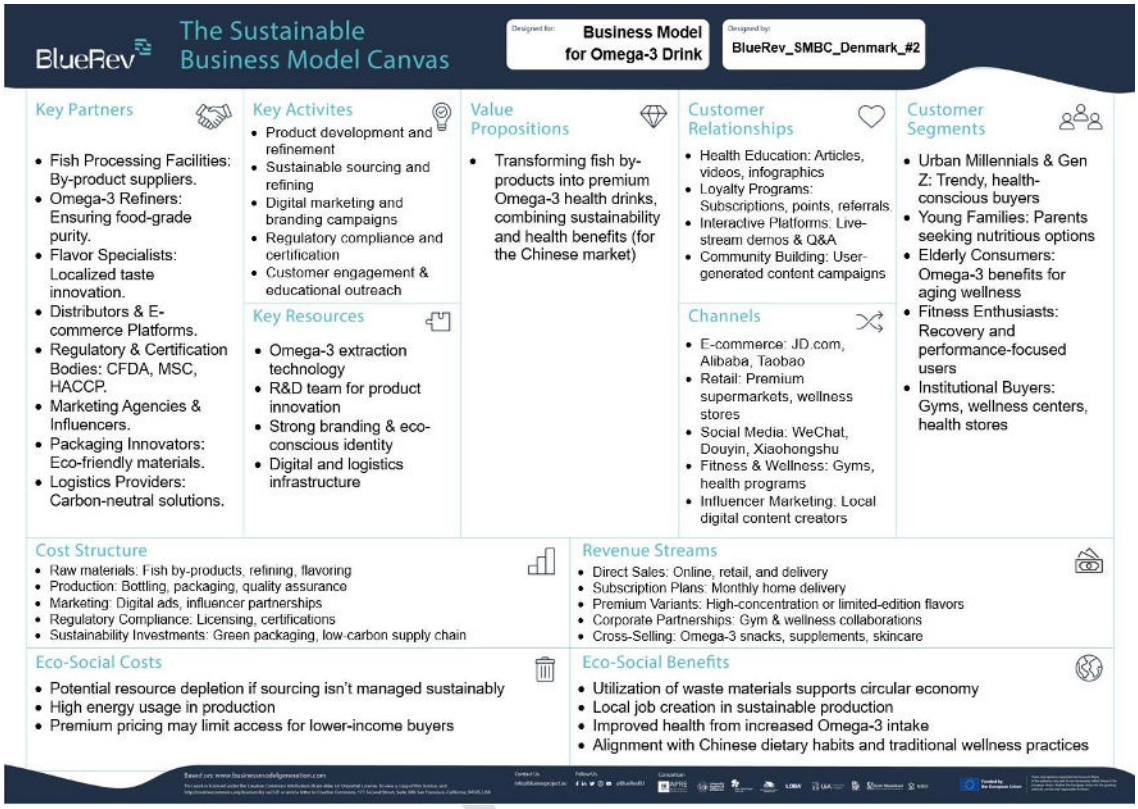

Figure 5: SBMC Denmark, Sustainable Omega-3 Drink for the Chinese market

Background

Denmark's fisheries industry generates substantial amounts of fish by-products, which were traditionally underutilized and considered as waste. However, these by-products contain valuable Omega-3 fatty acids, which have significant health benefits, including supporting heart health, brain function, and reducing inflammation. The global demand for high-quality Omega-3 supplements and functional beverages is growing, particularly in China, where consumers are increasingly prioritizing health and wellness.

The Chinese market presents a unique opportunity for sustainable Omega-3 products due to a rising middle class, an aging population seeking health-boosting supplements, and a strong cultural appreciation for functional foods. However, success in this market requires localization strategies, including tailoring flavors to Chinese preferences, such as goji berry and matcha. leveraging popular e-commerce platforms, and complying with stringent food safety regulations.

By utilizing innovative extraction technologies and eco-friendly processing methods, Denmark can position itself as a global leader in sustainable Omega-3 production. This

approach not only maximizes resource efficiency but also aligns with circular economy principles by repurposing fish by-products into high-value health products. Collaborations with local Chinese partners, including regulatory bodies, distributors, and marketing agencies, will be crucial in ensuring market penetration and consumer trust. Furthermore, the use of eco-friendly packaging and carbon-neutral logistics will reinforce the product's sustainability credentials, appealing to environmentally conscious consumers in China.

By integrating sustainable sourcing, advanced processing, and strategic market positioning, Denmark's Omega-3 industry has the potential to create a profitable and environmentally responsible supply chain, bridging Nordic innovation with Chinese consumer demand.

Value Proposition: Transforming fish by-products into premium Omega-3 health drinks, combining sustainability and health benefits (for the Chinese market).

Customer Segments

- **Urban Millennials and Gen Z:** Health-conscious consumers seeking trendy, convenient, and nutritious beverages.
- **Young Families:** Parents looking for health-boosting products for themselves and their children.
- **Elderly Consumers:** Individuals concerned with heart health, brain function, and aging-related wellness.
- **Fitness Enthusiasts:** Those prioritizing recovery, performance, and balanced diets.
- **Institutional Buyers:** Wellness centers, gyms, and health-focused retail chains.
- **Urban Health-Conscious Consumers:** Middle-to-upper-class individuals in major Chinese cities seeking premium functional beverages.

Channels

- **E-Commerce:** Direct-to-consumer sales through JD.com, Alibaba, Taobao, and company-owned websites.
- **Retail Stores:** Distribution via premium supermarkets (e.g., Ole, Citysuper) and wellness shops.
- **Social Media Platforms:** Engagement via WeChat, Douyin, and Xiaohongshu.
- **Gyms and Wellness Centers:** Offering Omega-3 beverages as part of health-focused services.
- **Influencer Marketing:** Collaboration with fitness and health influencers on Chinese social platforms.

Customer Relationships

- **Health Education:** Articles, videos, and infographics on Omega-3 benefits.
- **Loyalty Programs:** Reward points, discounts for subscriptions, and referral incentives.
- **Interactive Platforms:** Live-streamed product demonstrations and Q&A sessions.
- **Community Building:** User-generated content campaigns to foster engagement.

Key Resources

- **Omega-3 Extraction Technology:** Sustainable and efficient fish by-product processing facilities.
- **R&D Team:** Nutritionists and food scientists specializing in health beverages.
- **Branding Assets:** Strong identity focused on health, quality, and sustainability.
- **Logistics Network:** Efficient distribution channels for online and offline sales.
- **Digital Infrastructure:** E-commerce presence and skilled digital marketing professionals.

Key Activities

- **Product Development:** Formulation of Omega-3 health drinks with appealing flavors.
- **Sourcing and Refining:** Ensuring sustainable fish by-product sourcing and efficient refining processes.
- **Marketing and Branding:** Campaigns emphasizing health benefits and sustainability via WeChat, Xiaohongshu, and Douyin.
- **Regulatory & Compliance:** Securing certifications and maintaining compliance with Chinese food safety regulations.
- **Sustainability Practices:** Reducing carbon footprint, eco-friendly packaging, and ethical sourcing.
- **Customer Engagement:** Educational campaigns and interactive consumer experiences.

Key Partners

- **Fish Processing Facilities:** Providers of fish by-products as raw materials.
- **Omega-3 Oil Refinement Companies:** Experts in refining and encapsulating Omega-3 oil for food-grade use.
- **Flavoring Specialists:** Developers of flavors suited to Chinese preferences (e.g., lychee, green tea, plum).
- **Distribution Channels:** Online platforms such as JD.com, Tmall, and local delivery apps like Meituan.

- **Regulatory Bodies:** Ensuring compliance with Chinese food safety regulations (e.g., CFDA).
- **Certifying Organizations:** Providers of sustainability and health certifications (e.g., MSC, HACCP).
- **Marketing Agencies:** Specialists in targeting health-conscious Chinese consumers.
- **Packaging Innovators:** Suppliers of eco-friendly packaging, including algae-based bioplastics.
- **Logistics and Shipping Companies:** Partners offering carbon-neutral transport solutions.
- **Government and NGOs:** Collaborators in sustainability initiatives such as the "Blue Economy Development Plan."

Revenue Streams

- **Direct Product Sales:** Online platforms, retail outlets, and delivery services.
- **Subscription Plans:** Monthly home deliveries for health-conscious consumers.
- **Premium Variants:** Limited-edition flavors or higher Omega-3 concentrations.
- **Corporate Partnerships:** Collaborations with gyms, wellness programs, and fitness influencers.
- **Cross-Selling:** Additional Omega-3-enriched products, such as supplements and skincare items.

Cost Structure

- **Raw Material Costs:** Fish by-products, refining, and flavoring ingredients.
- **Production Costs:** Bottling, packaging, and quality assurance.
- **Marketing Expenses:** Campaigns, influencer partnerships, and advertisements.
- **Regulatory and Certification Costs:** Compliance with Chinese health and safety standards.
- **Sustainability Investments:** Eco-friendly packaging and supply chain emission reduction.

Eco-Social Costs

- **Environmental Impact:** Potential resource depletion if fish by-product sourcing isn’t managed sustainably.
- **Social Challenges:** Premium pricing may limit access for lower-income populations.

Eco-Social Benefits

- **Environmental Stewardship:** Waste material utilization reduces landfill dependency and supports circular economy principles.
- **Social Welfare:** Local job creation in fish processing and sustainable production.
- **Health Impact:** Improved health outcomes from increased Omega-3 consumption.
- **Cultural Relevance:** Alignment with local dietary habits and traditional medicine for greater consumer acceptance.

Opportunities and Constraints for New Sustainable Business Models in Greenland and Denmark

Opportunities

1. **Market Diversification**

Greenland and Denmark can tap into the global demand for sustainable seafood and bio-based products, particularly in high-growth sectors such as cosmetics and nutraceuticals.

2. **Circular Economy Integration**

By valorizing side streams and implementing resource-efficient processes, both regions align with EU sustainability goals, potentially attracting funding and policy support.

3. **Technological Advancements**

Investments in advanced freezing, processing, and waste valorization technologies can enhance product quality and open new markets. Denmark's established infrastructure provides a solid foundation for such innovations.

4. **Consumer Trends**

The growing consumer preference for sustainable, traceable, and high-quality products presents a strong market opportunity for both countries, particularly for niche and premium products.

Constraints

1. **Regulatory Barriers**

Complex EU regulations for food, pharmaceutical, and cosmetic products pose challenges for new business models. Navigating these regulatory landscapes requires significant time and resources.

2. **High Initial Costs**

The implementation of advanced technologies, such as wastewater recycling and side stream processing, involves substantial upfront investment, which may be a barrier for smaller firms.

3. **Logistical Challenges**

Greenland's remote location and dispersed fishing activities present logistical hurdles, particularly in transporting fresh or frozen products to international markets.

4. **Workforce Instability**

Both regions face labor shortages in the fishing sector. In Greenland, this challenge is exacerbated by the transient nature of the workforce, which impacts operational stability.

5.2 Estonia

The Estonian pilot region, centered on the island of Saaremaa in the Baltic Sea, offers promising prospects within the blue economy. With a rich maritime heritage and abundant coastal resources, Saaremaa has a long history of fishing, maritime technology, coastal tourism, and aquaculture. This pilot project focused primarily on the valorization of macroalgae. Estonia has historically processed red algae (Furcellaria lumbricalis) that has potential applications in food, nutraceuticals, agriculture, and cosmetics.

Since the 1960s, red algae from the shallows near Saaremaa has been used to produce furcellaran, a gelling agent widely utilized in the food industry. Harvesting this resource involves both trawling and beach collection, with current environmental permits allowing up to 2,000 tons of red algae trawling annually, although actual trawling volumes have yet to reach this limit. In addition to furcellaran, red algae are a potential source of microcellulose, highlighting an opportunity to repurpose processing by-products.

There are significant unexplored opportunities with red algae, particularly in utilizing by-products for emerging industries such as food and agriculture, with promising potential in bioplastics and cosmetics. Additionally, expanding the production volume of red seaweed could be achieved by cultivating red seaweed and other macroalgae species. Exploring the use of wind farm foundations for macroalgae farming could help bypass trawling limitations, presenting an innovative solution to increase red seaweed availability and broaden its applications across various industries. In addition, the local aquaculture enterprises are interested in exploring integrated multitrophic farming, including growing mussels and macroalgae in fish farms.

Initial business opportunities identified in Estonia

i. Bioplastic Production from Microcellulose in Algal Biomass

Red algae biomass offers significant potential for producing bioplastics as a sustainable alternative to traditional plastics, with strong demand in the European market. Currently, leftover biomass from algae processing is given to farms for free as fertilizer. However, cellulose extracted from this biomass could serve various applications across industries. Prototypes and tests are ongoing to explore the viability of bioplastic production using red algae by-products.

ii. Furcellaran Powder for the Cosmetic Industry

Furcellaran production has traditionally focused on the food industry, but transforming furcellaran into powder opens new applications within cosmetics. This development is

being explored to create a high-value ingredient, expanding beyond the conventional production of flaky furcellaran.

iii. Red Pigment Extraction for Food and Cosmetics

Red algae contain pigments suitable for natural food coloring and cosmetic applications. While the primary focus has been on the food and cosmetic sectors, these pigments hold potential in other industries, although further exploration is required.

iv. Expanding Macroalgae Production via Seaweed Farming and Co-Location

Given that the current trawling quota may limit future production, technologies for farming red seaweed and other macroalgae are under investigation. This includes exploring the co-location of seaweed farms with offshore wind farms, a solution that could provide scalability while addressing environmental and spatial challenges.

Co-creation data collection

The data collection in the Estonian region focused on the organization and participation in co-creation workshops and seminars, conducted as part of the BlueRev project. These activities included the BANOS Mission Arena workshop held on 25th April 2024 in Riga, Latvia, and the seminar in Saaremaa on 12th August 2024.

The BANOS Mission Arena workshop gathered regional stakeholders to discuss business interaction models supporting the sustainable blue economy. One of the forum's key sessions was a co-creation workshop, which used a world café-style format to facilitate interactive group discussions. Four groups, each guided by a facilitator and supported by a note-taker, explored specific topics aimed at developing a roadmap for scaling Mission Ocean initiatives. The BlueRev Team as part of discussions on *"Business Models for Innovative, Sustainable Macroalgae Applications,"* employed a sustainable business model canvas and presented a sample business model for red seaweed to actively engage stakeholders. This focused discussion included 10 participants: four enterprise representatives, four members from universities or research institutions, and two local government officials. The session yielded valuable insights and data to inform ongoing research activities.

Kõiguste, Saaremaa workshop aimed to advance multi-use models for aquaculture and align them with the Sustainable Development Goals (SDGs). Hosted in Kõiguste, Saaremaa, on 12th August 2024 with 15 participants. The session focused on the existing multi-trophic aquaculture business model, where blue mussels are cultivated alongside rainbow trout farming as an ecological compensation mechanism. The discussions also explored the potential of nutrient removal schemes and nutrient trading as part of broader sustainable aquaculture practices and business potentials.

The covered topics were:

- Aquaculture and multi-use of the sea
- Current model for blue mussels and seaweed cultivation in trout farms in Saaremaa
- SDG assessment and indicators for multi-use projects (OLAMUR project)

Together these workshops provided critical insights into the opportunities and challenges of developing sustainable business models within the Baltic Sea region. Both events highlighted the ecological constraints unique to the Baltic Sea, such as lower salinity, slower growth rates of macroalgae and mussels, and the delicate balance required to maintain biodiversity while scaling production. These factors present significant hurdles compared to regions like the North Sea, where ecological conditions are more conducive to macroalgae farming and related activities.

Key Insights from BANOS Mission Arena

The discussions emphasized:

- **Technical challenges and ecological limitations** in scaling macroalgae production in the Baltic Sea.
- The potential of **multi-use sites** combining offshore wind farms with seaweed cultivation.
- The need for **regulatory and governance frameworks** to incentivize sustainable practices and foster collaboration among stakeholders.

Participants noted that although advancements in the North Sea provide a blueprint, adapting these models to the Baltic requires addressing distinct ecological and technical challenges, as well as creating economic incentives for investment.

Key Insights from Kõiguste, Saaremaa Workshop

Key takeaways included:

- **Nutrient removal and nutrient trading** as potential ecosystem services.
- The limited scalability of current mussel farming models, due to slow growth rates and low nutrient content in Baltic waters.
- The importance of **value chain development** for mussel by-products, such as protein powders or fertilizers.

The workshop underscored the necessity of integrating sustainable aquaculture practices with broader governance and market frameworks.

Broader Implications

These workshops highlighted the **interdependency between ecological sustainability, technical feasibility, and governance innovation** in developing new business models for the Baltic Sea's blue economy. Overcoming these challenges requires a coordinated approach that incorporates stakeholder collaboration, policy support, and investment in research and infrastructure.

These insights will be further explored and expanded upon in deliverable D4.3, which will outline governance strategies and innovative solutions to support the scalability and sustainability of blue bioeconomy initiatives in the region.

Summary of New Sustainable Business Models discussed in Estonia

Two primary business models emerged from interviews conducted co-creation workshops held in Estonia. These models are detailed below.

1. MULTI-USE OF OFFSHORE WIND FARMS FOR MACROALGAE CULTIVATION

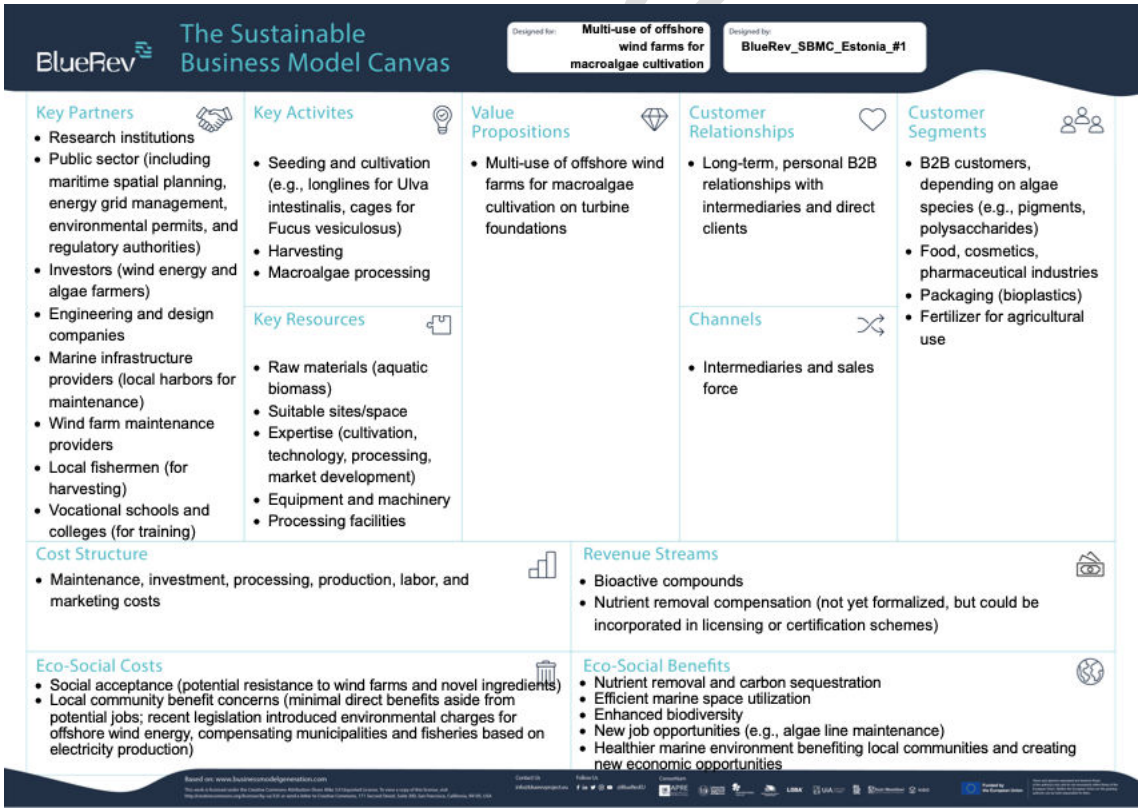

Figure 6: SBMC Estonia, Multi-use of Offshore Wind Farms for Macroalgae Cultivation

Background

Interest in multi-use wind farms for macroalgae cultivation was first highlighted during the 2023 interviews and further explored in the April 2024 BANOS workshop. The Estonian Marine Institute is conducting research on growing various macroalgae species, with ongoing experiments on green algae (*Ulva intestinalis*) and bladderwrack (*Fucus vesiculosus*). However, commercial harvesting of these species has not yet taken place in the Baltic Sea.

While multi-use offshore farms are more advanced in the North Sea, the Baltic region shows interest, particularly in conjunction with the development of a large wind farm west of Saaremaa. The first commercial-scale operation began in the North Sea in summer 2024, led by the consortium North Sea Farmers, which is testing technology for cultivating sugar kelp (*Saccharina latissimi*). This progress suggests potential for similar initiatives in the Baltic Sea, although the ecological conditions differ and will impact species selection.

Estonia currently lacks commercial farms for *Fucus vesiculosus* and *Ulva intestinalis*, as well as the processing infrastructure and value chains necessary for these species. Additionally, significant investments and know-how are required for cultivation technology and market development. The lengthy permit process also increases financial risk, especially given the banking sector's perception of algae farming as high-risk. To foster collaboration, incentives for wind farm developers may be essential.

Value Proposition: Multi-use of offshore wind farms for macroalgae cultivation on turbine foundations

Key Partners

- **Research Institutions**
  Research institutions play a crucial role in advancing cultivation techniques, identifying suitable macroalgae species, and optimizing harvesting methods, ensuring both environmental and economic viability.
- **Public Sector**
  Government bodies and regulatory authorities are essential for navigating maritime spatial planning, issuing environmental permits, and establishing supportive policies for wind farm and macroalgae integration.
- **Investors**
  Both wind energy developers and prospective algae farmers provide the financial backing necessary to implement and scale multi-use projects, reducing risk and fostering innovation.

- **Engineering and Design Companies**

Engineering firms contribute specialized expertise in designing efficient cultivation structures compatible with turbine foundations, ensuring seamless integration of algae farms with wind infrastructure.

- **Marine Infrastructure Providers**
  Local harbors and marine service companies support maintenance activities, facilitating easy access to offshore sites for routine operations and harvesting.
- **Wind Farm Maintenance Providers**
  Existing wind farm maintenance teams assist in ensuring that macroalgae cultivation structures are properly maintained without interfering with energy production.
- **Local Fishermen**
  Incorporating local fishermen into the harvesting process creates employment opportunities and ensures traditional marine skills are utilized in a modern context.
- **Vocational Schools and Colleges**
  Educational institutions offer training programs to equip workers with the skills required for cultivating and processing macroalgae, fostering a specialized workforce.

Key Resources

- **Raw Materials (Aquatic Biomass)**
  Macroalgae such as *Ulva intestinalis* and *Fucus vesiculosus* serve as the primary raw materials, offering versatile applications in food, cosmetics, pharmaceuticals, and bioplastics.
- **Suitable Sites/Space**
  Offshore wind farms provide ideal locations for macroalgae cultivation, utilizing existing marine infrastructure to reduce costs and environmental impact.
- **Expertise in Cultivation and Processing**
  Specialized knowledge in algae farming, from seeding to processing, is critical for optimizing yield and ensuring the economic success of the operation.
- **Equipment and Machinery**
  Advanced cultivation systems, including longlines and cages, are necessary for efficient algae growth and harvesting. Processing facilities for drying, extracting, and packaging biomass are also essential.

Key Activities

- **Seeding and Cultivation**
  Macroalgae are seeded on structures such as longlines or cages, which are then anchored to turbine foundations to optimize growth conditions and maximize yield.

- **Harvesting**
  Harvesting involves collecting mature algae from offshore sites, employing sustainable methods to minimize ecological disturbance.
- **Macroalgae Processing**
  Post-harvest, the algae are transported to processing facilities where they are converted into high-value products like bioactive compounds, bioplastics, and fertilizers.

Customer Segments

- **B2B Customers (Depending on Algae Species)**
  Companies that specialize in extracting bioactive compounds such as pigments and polysaccharides from macroalgae for applications in health supplements, natural colorants, and functional ingredients.
- **Food, Cosmetics, and Pharmaceutical Industries**
  Macroalgae serves as a raw material for producing food additives, skincare products, and pharmaceuticals. These industries value algae for their rich nutrient profile, including vitamins, minerals, and antioxidants.
- **Packaging (Bioplastics)**
  The packaging industry utilizes algae-derived bioplastics as a sustainable alternative to traditional petroleum-based plastics, aligning with growing consumer demand for eco-friendly packaging solutions.
- **Fertilizer for Agricultural Use**
  Macroalgae-derived fertilizers provide essential nutrients for crop growth, enhancing soil health and supporting sustainable farming practices.

Cost Structure

- **Maintenance**
  Routine maintenance of cultivation and processing infrastructure, such as longlines and cages, ensures optimal operation and minimizes downtime.
- **Investment**
  Significant upfront investments are required to establish cultivation systems and processing facilities, as well as to acquire specialized equipment.
- **Processing**
  Post-harvest processing of macroalgae involves cleaning, drying, and extracting bioactive compounds, all of which incur operational costs.
- **Production**
  Costs associated with seeding, harvesting, and producing algae-based products, including raw material procurement and handling.
- **Labor**

Wages for skilled personnel involved in cultivation, maintenance, processing, and marketing activities.

Marketing Costs

Expenses for promoting macroalgae-based products and building market presence, including branding, advertising, and participation in trade shows.

Channels

- **Intermediaries and Sales Force**
  Intermediaries and dedicated sales teams bridge the gap between macroalgae producers and target industries, facilitating product distribution and ensuring market penetration.

Customer Relationships

- **Long-Term Personal B2B Relationships with Intermediaries and Direct Clients**
  Building trust and collaboration through sustained engagement ensures customer loyalty and provides opportunities for co-developing tailored solutions, such as customized algae formulations.

Revenue Streams

- **Bioactive Compounds**
  Revenue is generated from selling bioactive compounds like antioxidants and polysaccharides to various industries, including food, cosmetics, and pharmaceuticals.
- **Nutrient Removal Compensation**
  Potential revenue from environmental services, such as nutrient removal and water purification, which could be formalized through licensing or certification schemes in the future.

Eco-Social Costs

- **Social Acceptance**
  Resistance from local communities or environmental groups regarding the ecological impact of offshore wind farms and algae cultivation may pose challenges.
- **Local Community Benefit Concerns**

Limited direct economic benefits to local communities, apart from job creation, may necessitate strategies to enhance community engagement and equitable distribution of benefits.

Eco-Social Benefits

- **Nutrient Removal and Carbon Sequestration**
  Macroalgae cultivation aids in removing excess nutrients from marine environments, mitigating eutrophication, while also sequestering carbon, contributing to climate change mitigation.
- **Efficient Marine Space Utilization**
  Combining macroalgae farming with offshore wind farms optimizes the use of marine space, enabling dual-purpose functionality and maximizing economic output.
- **Enhanced Biodiversity**
  Algae farms provide habitats for marine organisms, supporting biodiversity and fostering a balanced marine ecosystem.
- **New Job Opportunities**
  The cultivation, maintenance, and processing of macroalgae create employment opportunities, particularly in coastal regions, strengthening local economies.
- **Healthier Marine Environment**
  Improved water quality and ecosystem health directly benefits local communities, enhancing their quality of life and opening avenues for sustainable economic growth.

2. INTEGRATED MULTI-TROPHIC AQUACULTURE WITH MUSSEL CULTIVATION IN TROUT FARMS

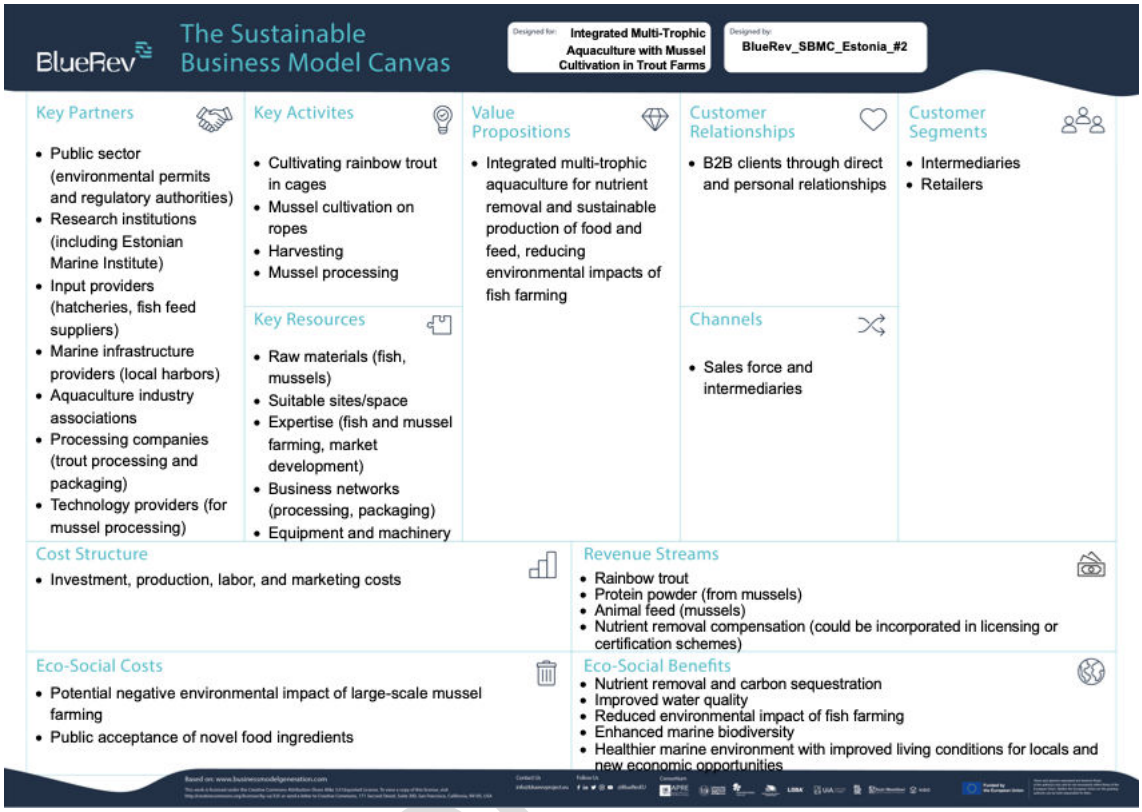

Figure 7: SBMC Estonia, Integrated Multi-Trophic Aquaculture with Mussel Cultivation in Trout Farms

Background

In the northern region of Saaremaa Island, rainbow trout are farmed in sea cages, where blue mussels are also cultivated for water filtration and nutrient removal. Although rainbow trout are produced for human consumption, the mussels currently have no economic value and are used solely for ecological compensation as required by licensing. Due to the low salinity of the Baltic Sea, mussels grow slowly and contain lower nutrient levels, limiting their marketability.

Despite these challenges, there is interest in further exploring the use of mussels for food ingredients, animal feed, or as fertilizer. The Estonian Marine Institute is conducting research on mussel processing technologies and product development, suggesting that mussels could be used to produce protein powder for the food industry. Their assessment indicates that scalable production is possible but would require an expansion of mussel farming operations, as well as the development of processing facilities and related value chains.

Value Proposition: Integrated multi-trophic aquaculture for nutrient removal and sustainable production of food and feed, reducing environmental impacts of fish farming

Key Partners

- **Public Sector (Environmental Permits and Regulatory Authorities)**
  Government bodies ensure compliance with environmental regulations, granting permits and providing oversight to ensure sustainable practices in fish and mussel farming.
- **Research Institutions (Including Estonian Marine Institute)**
  Academic and research organizations contribute expertise in aquaculture technology, mussel processing, and sustainable farming practices, supporting innovation and optimization.
- **Input Providers (Hatcheries and Fish Feed Suppliers)**
  Essential for supplying high-quality rainbow trout fingerlings and nutrient-rich feed to ensure optimal growth and health of aquaculture species.
- **Marine Infrastructure Providers (Local Harbors)**
  Harbors support logistical operations, including the transport of fish, mussels, and aquaculture equipment, enhancing operational efficiency.
- **Aquaculture Industry Associations**
  Associations advocate for industry interests, facilitate networking, and provide platforms for sharing best practices and innovations in integrated aquaculture.
- **Processing Companies (Trout Processing and Packaging)**
  Processing firms ensure that harvested trout meets market standards, handling cleaning, filleting, and packaging for distribution.
- **Technology Providers (For Mussel Processing)**
  Suppliers of specialized machinery for cleaning, sorting, and processing mussels into value-added products such as protein powder or feed additives.

Key Resources

- **Raw Materials (Fish and Mussels)**
  Rainbow trout and mussels serve as the primary biological assets, with trout providing high-value food products and mussels contributing to environmental remediation and by-products.
- **Suitable Sites/Space**
  Access to optimal aquaculture sites in the Baltic Sea with appropriate water quality and depth for trout farming and mussel cultivation.
- **Expertise (Fish and Mussel Farming, Market Development)**
  Technical knowledge in aquaculture operations and market strategies ensures efficient production and competitive product positioning.

- **Business Networks (Processing, Packaging)**
  Strong partnerships across the supply chain, from production to processing and distribution, enhance market reach and operational synergies.
- **Equipment and Machinery**
  Advanced aquaculture systems, including sea cages, mussel ropes, and processing technology, are critical for efficient production and post-harvest handling.

Key Activities

- **Cultivating Rainbow Trout in Cages**
  Sea cages are used to grow rainbow trout, ensuring controlled feeding, monitoring, and optimal growth conditions.
- **Mussel Cultivation on Ropes**
  Mussels are farmed on suspended ropes to filter and improve water quality, leveraging their natural ability to remove excess nutrients.
- **Harvesting**
  Coordinated harvesting schedules for trout and mussels maximize efficiency and ensure the timely delivery of fresh products to markets.
- **Mussel Processing**
  Post-harvest, mussels are processed into protein powder, animal feed, or fertilizers, adding value to what was previously considered a low-value by-product.

Customer Segments

- **Intermediaries**
  Wholesalers and distributors play a key role in connecting aquaculture products to various end markets, including food and agricultural sectors.
- **Retailers**
  Supermarkets and specialty food stores serve as the final touchpoint for consumers, offering fresh trout and mussel-derived products for health-conscious buyers.

Cost Structure

- **Investment**
  Significant upfront costs are associated with acquiring aquaculture systems, mussel processing technology, and infrastructure development.
- **Production**
  Day-to-day expenses for feeding, monitoring, and maintaining fish and mussels throughout their growth cycles.

- **Labor**
  Staff costs for farm operations, including seeding, harvesting, processing, and logistics.
- **Marketing Costs**
  Budget allocated for promoting aquaculture products, building brand awareness, and expanding customer bases.

Channels

- **Sales force and intermediaries**
  Direct interactions through a dedicated sales team and intermediaries help reach diverse markets, from local distributors to international buyers.

Customer Relationships

- **B2B clients through direct and personal relationships**
  Establishing long-term partnerships with businesses ensures reliable demand and fosters collaborative growth, particularly in niche markets such as eco-conscious food and agriculture.

Revenue Streams

- **Rainbow Trout**
  Revenue is generated from the sale of fresh or processed rainbow trout, a high-demand product in the seafood industry.
- **Protein Powder (From Mussels)**
  Mussel-derived protein powder offers a lucrative revenue stream as a valuable ingredient in health supplements and specialized food products.
- **Animal Feed (Mussels)**
  Processed mussels serve as nutrient-rich inputs for animal and aquaculture feed, meeting the sustainability goals of these industries.
- **Nutrient Removal Compensation**
  Potential income could arise from nutrient trading schemes or environmental credits linked to the ecosystem services provided by mussels.

Eco-Social Costs

- **Potential Negative Environmental Impact of Large-Scale Mussel Farming**
  While mussels provide ecological benefits, their large-scale cultivation could disrupt local ecosystems if not carefully managed.
- **Public Acceptance of Novel Food Ingredients**

Mussels and their derivatives may face initial consumer skepticism, necessitating efforts to build trust and educate markets on their benefits.

Eco-Social Benefits

- **Nutrient Removal and Carbon Sequestration**
  Mussels contribute to reducing nutrient pollution and capturing carbon, directly enhancing the health of marine ecosystems.
- **Improved Water Quality**
  By filtering the water, mussels play a vital role in maintaining the ecological balance of the Baltic Sea, benefiting the broader environment.
- **Reduced Environmental Impact of Fish Farming**
  Integrated aquaculture reduces the waste footprint of fish farming, aligning with sustainable seafood practices.
- **Enhanced Marine Biodiversity**
  Mussel farms create habitats for various marine species, promoting biodiversity and fostering a healthier marine ecosystem.
- **Healthier Marine Environment with Improved Living Conditions for Locals and New Economic Opportunities**
  Cleaner waters and thriving marine life support the well-being of coastal communities, providing them with sustainable livelihoods.

Opportunities and constraints for New Sustainable Business Models in Estonia

Opportunities

1. **Innovative Co-Location Models**

The integration of macroalgae farming with offshore wind farms presents a significant opportunity for maximizing the use of marine space. Participants highlighted the potential to leverage existing infrastructure, such as windmill foundations, for seaweed cultivation. This multi-use approach could address ecological constraints while simultaneously providing ecosystem services like nutrient removal and carbon sequestration. Such projects could also stimulate local economies by creating new jobs and fostering collaboration among wind farm operators, seaweed farmers, and local communities.

2. **Growing Market Demand for Bio-Based Products**

The Baltic Sea region can capitalize on increasing global demand for sustainable materials, particularly in industries like food, cosmetics, and bioplastics. European companies, such as major furniture manufacturers and footwear manufacturers, have expressed interest in incorporating macroalgae into their product offerings. This creates

a promising market for locally sourced, high-quality macroalgae, provided that production volumes meet industrial needs.

3. **Nutrient Trading and Ecosystem Services**

Nutrient trading schemes offer a novel opportunity to monetize environmental benefits. By implementing systems that incentivize nutrient removal through macroalgae farming, businesses could generate additional revenue streams while contributing to marine conservation. This aligns with broader EU sustainability goals and could attract financial support and policy incentives.

4. **Support for Startups and Innovation**

The region's focus on fostering innovation through EU-funded projects and collaborative research creates a fertile environment for startups. Participants underscored the potential for EU support to reduce regulatory barriers and provide funding for research and development, enabling the rapid commercialization of innovative macroalgae-based products.

Constraints

1. **Ecological Limitations**

The Baltic Sea's unique ecological conditions, including low salinity and vulnerability to invasive species, pose significant challenges for macroalgae cultivation. The interdependence of marine systems means that scaling up production, such as mussel farming, could have unintended ecological consequences, potentially disrupting local biodiversity and ecosystem balance.

2. **Regulatory Barriers**

Navigating the complex regulatory framework for food-grade macroalgae compounds remains a significant hurdle. Participants noted that the approval process is both time-consuming and expensive, which can deter startups and small businesses from entering the market. Regulatory uncertainty also increases financial risk, making it harder to secure investment.

3. **Operational and Logistical Challenges**

The region's fishing and aquaculture industries face high energy costs and logistical difficulties, particularly in remote areas like Saaremaa. These challenges complicate the transportation, storage, and processing of macroalgae, increasing operational costs and

reducing profitability. Additionally, the dispersed nature of fishing activities makes it difficult to achieve economies of scale.

4. **Market Acceptance and Consumer Perception**

Despite the growing interest in sustainable products, consumer skepticism regarding the use of by-products in food and cosmetics persists. Overcoming these perceptions will require educational campaigns and transparent communication about the safety, quality, and environmental benefits of macroalgae-based products.

5. **Limited Examples of Nutrient Trading**

While nutrient trading offers theoretical potential, practical examples in the Baltic Sea region remain limited. The complexity of implementing such schemes, particularly in agriculture where fertilizer use is subsidized, poses a significant barrier. Establishing a viable market for ecosystem services will require coordinated efforts between policymakers, businesses, and local communities.

5.3 Italy

The Italian pilot region, situated in southern Italy, specifically in Sicily, offers a diverse array of commercial opportunities within the blue economy. The region's long-standing fishing tradition provides a strong foundation for sustainable economic development through product diversification, waste valorization, and the creation of high-value goods. By focusing on enhancing the value of specific fish varieties, such as transforming them into premium offerings like new smoked fish, Sicily can stabilize market prices and meet fluctuating demand during peak fishing seasons (Messina et al., 2021a, b; 2019). This approach not only addresses economic challenges but also contributes to sustainability goals by maximizing the utility of available resources, diversifying production and reducing reliance on traditional fishing methods.

Currently, the valorization of low value local fish species, such as picarel *(Spicara smaris) known as menola in sicilian dialet*, is achieved through salting, drying, and processing them into powder form (Messina et *al., submitted*), which is then marketed for various culinary uses. While this method has proven effective, further opportunities exist to diversify processed fish products beyond the powder format, exploring alternative methods of preservation and value addition. This would allow the region to tap into new markets and expand its product portfolio, providing more options to both domestic and international buyers. Additionally, the setup of a standardized methodology to produce fish broth, such as couscous broth, from fish by-products presents a significant opportunity to add value to a local traditional fish product, by reducing waste while generating new revenue streams. This aligns with the growing demand for sustainable and eco-friendly food products in the global market and with the indication to revitalize the mediterranean diet with reformulated foods and recipes.

Another promising avenue is the utilization of fish waste for the development of pharmaceutical-grade extracts. The pharmaceutical industry has shown particular interest in sourcing specific fish organs, including gills, viscera, liver, intestines, fat, skin, frames, which are often discarded during traditional processing. Collaborating with this sector could lead to the development of innovative products with high market value, such as supplements or medical compounds derived from these by-products (Messina et al., 2022; 2021a; 2021b). This highlights the region's potential to foster cross-industry collaborations and drive innovation, positioning Sicily as a leader in sustainable resource management and blue economy initiatives.

Initial business opportunities identified in Italy

i. Market Expansion and Sale of Tuna By-Products

The region holds significant potential for market expansion by leveraging by-products from tuna processing. These include eyes, stomachs, and hearts, which together constitute approximately 13% of the total weight of each tuna. This translates to around 1 ton of fish waste per day, highlighting a substantial resource for further valorization.

ii. Valorization of Fish Organs for the Pharmaceutical Industry

The pharmaceutical industry has expressed interest in utilizing gills, livers, intestines, and spleens from fish. However, local knowledge on effective methods for valorizing these by-products remains limited, beside the research sector has extensively analyzed both the potential and setup methodology for obtain bioactive compounds (Messina et al 2022), suggesting a need for capacity building and technology transfer to fully capitalize on this opportunity.

iii. Transforming Fish into High-Value Products

Certain fish varieties can be transformed into premium products, such as smoked fish, comparable to smoked salmon. This strategy could help stabilize prices, particularly at the start of the fishing season when demand is high and mitigate price drops during periods of market saturation. This opportunity was tested at high TRL from the research group of UNIPA.

iv. Production of Broth for the Food Industry

By-products from high-value fish can be pasteurized and repurposed into broths, such as couscous broth, which can be marketed to the food industry. This not only reduces waste but also adds a new revenue stream for the sector.

Co-creation data collection

Data collection in the Italian pilot region involved a thorough series of interviews and workshops, engaging diverse stakeholders in Sicily's fishing and processing sectors, totaling ten participants. Stakeholders included representatives from fisheries, processing companies, cooperatives, and local governance bodies. This process spanned multiple stages, beginning with WP3 activities (workshops and interviews conducted April and June 2023) and continuing with WP4 initiatives in 2024.

As part of WP4, the University of Palermo, under the leadership of Professor Concetta Messina, conducted interviews with five enterprises during March 2024. These interviews were guided by the business model canvas and the question framework

outlined in Appendix 1. Follow-up interviews were held on October 23rd 2024, via Teams. Organized by the University of Palermo in collaboration with DFBG and facilitated by APRE, the sessions were supported by Professor Messina's team, who also provided translation assistance.

The interview results were summarized by the University of Palermo team and utilized by UiA to identify innovative business models. These activities significantly advanced the exploration of sustainable business opportunities, focusing on diversification strategies and the valorization of by-products, as framed by the business model canvas.

Key insights from these engagements highlighted the region's strong reliance on traditional fishing and processing practices, which are increasingly challenged by stringent EU regulations and intense global competition. Stakeholders underscored the critical role of regional cooperation and innovation in product development and market expansion. While the sector faces significant hurdles, such as a shortage of skilled labor and high operational costs, there is a clear and growing commitment to sustainability and circular economy principles, positioning the region for a more resilient and competitive future.

Summary of New Sustainable Business Models discussed in Italy

Three primary business models emerged from interviews conducted in Italy. These models are detailed below.

1. SHRIMP POWDER AND "COLATURA DI GAMBERO ROSSO"

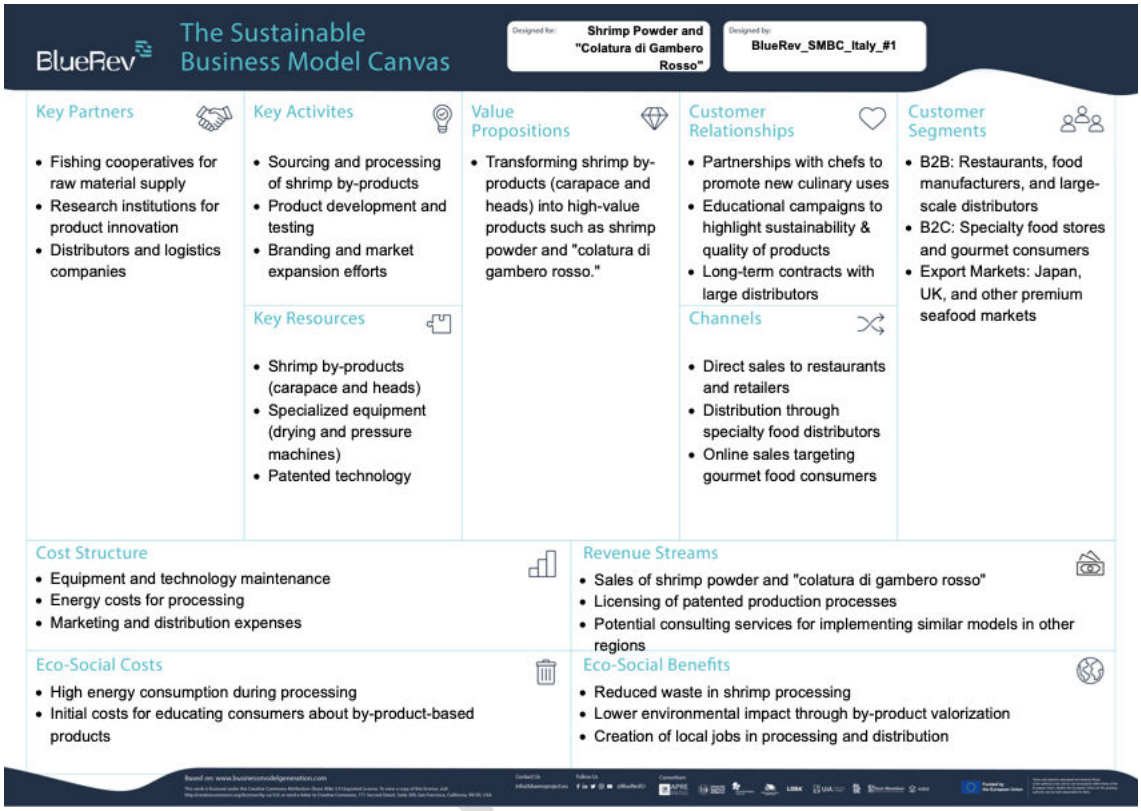

Figure 8: SBMC Italy, Shrimp Powder and "Colatura di Gambero Rosso"

Background

This business model focuses on transforming shrimp by-products, specifically shell and heads, into high-value products such as shrimp powder and "colatura di gambero rosso" (a flavorful liquid extracted under pressure). These products cater to the growing demand for sustainable and gourmet food items. Shrimp powder can be used as a seasoning or ingredient in soups, sauces, and pasta dishes, while "colatura di gambero rosso" serves as a premium condiment, enriching the flavor profile of various dishes in fine dining and home cooking.

The target market spans both B2B and B2C segments, including high-end restaurants, specialty food stores, and gourmet consumers. This model leverages direct sales, partnerships with distributors, and online platforms to expand its reach. The patented process ensures product uniqueness, creating a competitive edge and enabling potential licensing opportunities. The collaboration with chefs to promote innovative culinary uses strengthens the brand's market position.

From an eco-social perspective, this model reduces waste from shrimp processing, promoting a circular economy in the fishing industry. By converting by-products into valuable commodities, it mitigates environmental impact and supports local economies. The model also contributes to consumer education on sustainability, fostering a market for products that align with environmental and social values.

Value Proposition: Transforming shrimp by-products (shell and heads) into high-value products such as shrimp powder and "colatura di gambero rosso."

Customer Segments

- **B2B: Restaurants, Food Manufacturers, and Large-Scale Distributors**
  High-end restaurants and food manufacturers benefit from shrimp powder and "colatura di gambero rosso" as versatile ingredients for sauces, soups, and gourmet dishes. Distributors, in turn, provide these products to niche markets seeking premium and sustainable seafood solutions.
- **B2C: Specialty Food Stores and Gourmet Consumers**
  These consumers prioritize artisanal and eco-friendly products, purchasing shrimp powder and "colatura" for use in home cooking or as gifts for food enthusiasts.
- **Export Markets: Japan, UK, and Other Premium Seafood Markets**
  Global markets with a high appreciation for unique and sustainable seafood products offer significant opportunities, particularly in regions with established culinary traditions that favor innovative ingredients.

Channels

- **Direct Sales to Restaurants and Retailers**
  This channel ensures a direct connection with end users, providing immediate feedback and fostering strong relationships with chefs and specialty stores.
- **Distribution Through Specialty Food Distributors**
  Partnering with distributors expands market access, ensuring products reach a wider audience while leveraging the distributor's expertise in niche food markets.
- **Online Sales Targeting Gourmet Consumers**
  E-commerce platforms enable the direct sale of products to consumers, capitalizing on the growing demand for unique and sustainable food items in global market

Customer Relationships

- **Partnerships with Chefs to Promote New Culinary Uses**
  Collaborating with chefs enhances product visibility and adoption, as they experiment with and showcase innovative uses in their dishes, influencing consumer preferences.

- **Educational Campaigns to Highlight Sustainability and Quality**
  These campaigns focus on the eco-friendly nature of the products, educating both industry players and consumers about the environmental and culinary benefits of utilizing shrimp by-products.
- **Long-Term Contracts with Large Distributors**
  Securing stable supply agreements with distributors ensures consistent revenue streams and strengthens market presence.

Revenue Streams

- **Sales of Shrimp Powder and "Colatura di Gambero Rosso"**
  Revenue is primarily driven by the direct sale of these high-value products to B2B and B2C customers.
- **Licensing of Patented Production Processes**
  Licensing proprietary methods provides an additional revenue stream, allowing other producers to replicate the process under a royalty agreement.
- **Consulting Services for Implementing Similar Models in Other Regions**
  Offering expertise in by-product valorization to other regions diversifies income and establishes the company as a leader in sustainable seafood solutions.

Key Resources

- **Shrimp By-Products (Shell and Heads)**
  These are the essential raw materials, sourced consistently from local fisheries to maintain operations and ensure sustainability.
- **Specialized Equipment (Drying and Pressure Machines)**
  Advanced machinery ensures efficient processing and high-quality product output, supporting both small-scale and large-scale production.
- **Patented Technology**
  The proprietary extraction and processing technology offers a competitive advantage, safeguarding product uniqueness and enhancing market positioning.

Key Activities

- **Sourcing and Processing of Shrimp By-Products**
  Efficiently sourcing and transforming shrimp waste into valuable products is at the core of the operation, reducing environmental impact and enhancing profitability.
- **Product Development and Testing**
  Ongoing innovation ensures the products meet evolving market demands and maintain high standards of quality and taste.

- **Branding and Market Expansion Efforts**
  Building a strong brand identity and expanding into new markets are key to sustaining growth and reaching a global audience.

Key Partners

- **Fishing Cooperatives for Raw Material Supply**
  These cooperatives ensure a reliable and sustainable supply of shrimp by-products, supporting local economies and promoting responsible fishing practices.
- **Research Institutions for Product Innovation**
  Collaborations with research entities drive innovation, improving extraction processes and developing new applications for shrimp by-products.
- **Distributors and Logistics Companies**
  Key to expanding market reach and ensuring efficient delivery of products to both domestic and international customers.

Cost Structure

- **Equipment and Technology Maintenance**
  Ongoing costs associated with maintaining specialized machinery are crucial for ensuring operational efficiency and product consistency.
- **Energy Costs for Processing**
  Energy consumption, particularly during drying and pressure extraction, represents a significant operational expense.
- **Marketing and Distribution Expenses**
  Investments in branding, customer outreach, and logistical operations ensure sustained market presence and growth.

Eco-Social Costs

- **High Energy Consumption During Processing**
  The energy-intensive nature of the drying and extraction processes contributes to the overall environmental footprint, requiring efficiency improvements to reduce emissions.
- **Initial Costs for Educating Consumers About By-Product-Based Products**
  Significant investment is needed to shift consumer perceptions and build trust in products derived from seafood waste.

Eco-Social Benefits

- **Reduced Waste in Shrimp Processing**
  Repurposing shrimp by-products minimizes waste and contributes to more sustainable seafood industry practices.
- **Lower Environmental Impact Through By-Product Valorization**
  The model supports a circular economy, reducing the environmental footprint and promoting resource efficiency.
- **Creation of Local Jobs in Processing and Distribution**
  By establishing processing facilities and distribution networks, the model generates employment opportunities, boosting the local economy.

2. FISH BROTH AND SOUPS

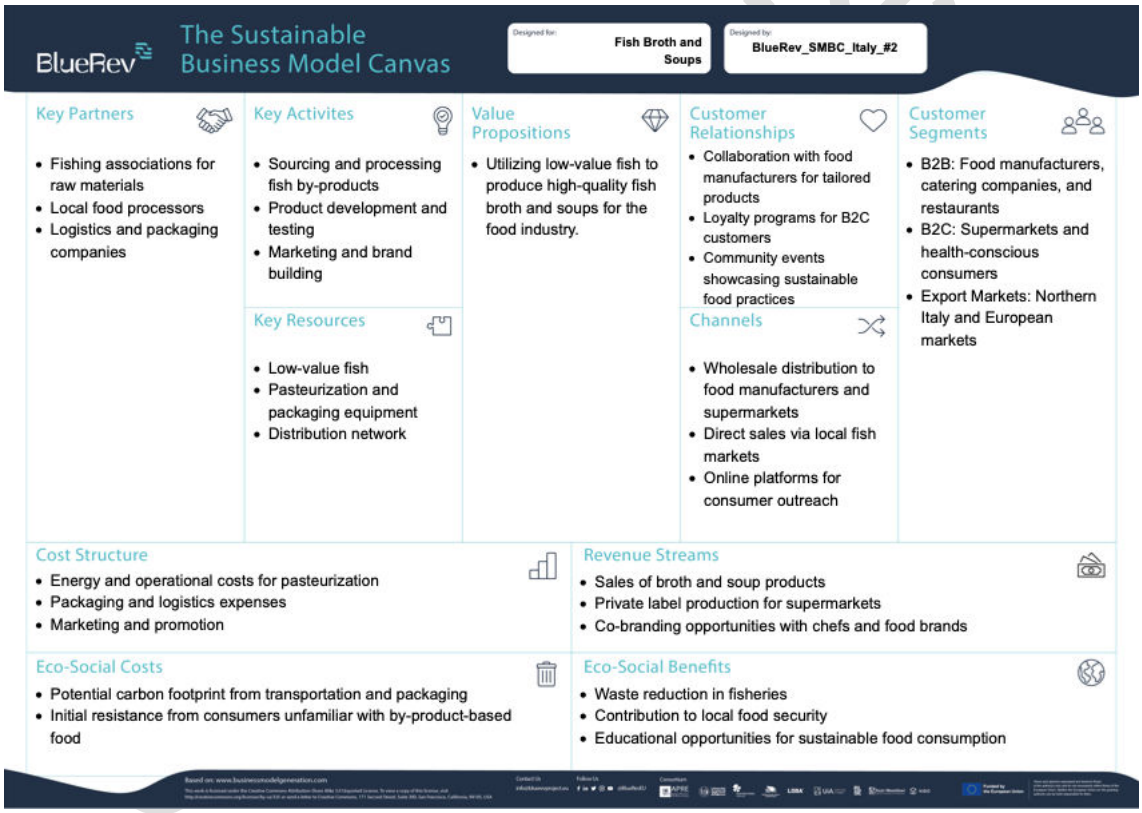

Figure 9: SBMC Italy, Fish Broth and Soups

Background

This model emphasizes utilizing low-value fish and by-products to create high-quality fish broth and soups, targeting both the food industry and health-conscious consumers. By

transforming these underutilized resources, the model not only addresses food waste but also provides a nutritious and sustainable product line. These products can be sold directly to restaurants, catering businesses, and retail supermarkets.

The value proposition revolves around delivering healthy, ready-to-use fish-based products with a low environmental footprint. Channels include wholesale distribution, local fish markets, and online sales, reaching a broad consumer base. Collaborations with chefs and food influencers help introduce innovative uses, enhancing product appeal. The inclusion of private label production for retailers diversifies revenue streams and strengthens market presence.

Eco-socially, the model contributes to reducing food waste and supporting local fisheries, thereby fostering economic resilience in coastal communities. It also educates consumers on the importance of sustainable seafood practices, promoting a shift toward environmentally conscious consumption. However, challenges include initial consumer resistance to by-product-based foods and the carbon footprint associated with packaging and distribution.

Value Proposition: Utilizing low-value fish to produce high-quality fish broth and soups for the food industry.

Customer Segments

- **B2B: Food Manufacturers, Catering Companies, and Restaurants**
  These businesses benefit from ready-to-use fish broths and soups, which simplify meal preparation while offering consistent quality and flavor. Caterers and restaurants incorporate these products into their menus to provide nutritious and sustainable dishes.
- **B2C: Supermarkets and Health-Conscious Consumers**
  Health-conscious consumers, including families and individuals seeking convenience, value the nutritional benefits and low environmental footprint of fish-based products. Supermarkets act as intermediaries, making these products widely accessible.
- **Export Markets: Northern Italy and European Markets**
  The model targets export markets with a strong appetite for gourmet and sustainable food products. European countries known for their focus on health and environmental sustainability provide significant growth opportunities.

Channels

- **Wholesale Distribution to Food Manufacturers and Supermarkets**

This channel leverages existing distribution networks to reach a broad range of commercial and retail clients efficiently, ensuring widespread product availability.

- **Direct Sales via Local Fish Markets**
  Selling directly at fish markets fosters local engagement and provides immediate feedback from end consumers, while emphasizing the community-oriented aspect of the model.
- **Online Platforms for Consumer Outreach**
  E-commerce allows direct interaction with consumers, capitalizing on the growing demand for sustainable food products and expanding market reach beyond physical locations.

Customer Relationships

- **Collaboration with Food Manufacturers for Tailored Products**
  Working closely with manufacturers ensures the development of customized broths and soups, meeting specific market demands and strengthening partnerships.
- **Loyalty Programs for B2C Customers**
  Incentives like discounts and exclusive products help build brand loyalty among health-conscious consumers, fostering repeat purchases.
- **Community Events Showcasing Sustainable Food Practices**
  Organizing events such as cooking demonstrations or workshops educates consumers on sustainable seafood practices and highlights the versatility of fish broths and soups.

Revenue Streams

- **Sales of Broth and Soup Products**
  Revenue primarily comes from selling these ready-to-use products to both businesses and consumers.
- **Private Label Production for Supermarkets**
  Creating custom products under supermarket brands diversifies income and strengthens relationships with major retail players.
- **Co-Branding Opportunities with Chefs and Food Brands**
  Collaborating with renowned chefs or food brands enhances product credibility and appeal, while generating additional revenue through shared marketing efforts.

Key Resources

- **Low-Value Fish**

Raw materials sourced from local fisheries form the foundation of the product line, ensuring cost-effective and sustainable production.

- **Pasteurization and Packaging Equipment**
  Advanced equipment ensures product safety, extends shelf life, and maintains quality during storage and transport.
- **Distribution Network**
  A robust logistics system facilitates the timely delivery of products to local and international markets, supporting scalability and growth.

Key Activities

- **Sourcing and Processing Fish By-Products**
  Efficiently transforming low-value fish into high-quality broths and soups is central to operations, maximizing resource utilization and minimizing waste.
- **Product Development and Testing**
  Continuous innovation and quality testing ensure that products meet evolving consumer preferences and regulatory standards.
- **Marketing and Brand Building**
  Strategic marketing campaigns and brand development efforts position the company as a leader in sustainable food production.

Key Partners

- **Fishing Associations for Raw Materials**
  Collaborating with local fisheries ensures a reliable supply of fish by-products, supporting sustainable practices and contributing to community livelihoods.
- **Local Food Processors**
  Partnerships with processors enhance production efficiency and product consistency, leveraging local expertise and infrastructure.
- **Logistics and Packaging Companies**
  These partners facilitate the efficient transportation and packaging of products, ensuring they reach markets in optimal condition.

Cost Structure

- **Energy and Operational Costs for Pasteurization**
  Pasteurization processes consume significant energy, contributing to operational expenses but ensuring product safety and quality.

- **Packaging and Logistics Expenses**

Costs associated with sustainable packaging solutions and efficient distribution networks are critical for maintaining product integrity and market competitiveness.

- **Marketing and Promotion**
  Investment in marketing initiatives, including consumer education and brand awareness campaigns, supports long-term growth and market penetration.

Eco-Social Costs

- **Potential Carbon Footprint from Transportation and Packaging**
  The reliance on packaging and transport introduces environmental costs, necessitating strategies for minimizing emissions and waste.
- **Initial Resistance from Consumers Unfamiliar with By-Product-Based Food**
  Educating the market about the safety and quality of these products requires time and resources, as consumers may initially hesitate to adopt by-product-based foods.

Eco-Social Benefits

- **Waste Reduction in Fisheries**
  By repurposing low-value fish, the model significantly reduces waste, promoting more sustainable fishing practices.
- **Contribution to Local Food Security**
  The production of affordable and nutritious fish-based products enhances food availability and supports healthier diets within local communities.
- **Educational Opportunities for Sustainable Food Consumption**
  Through outreach and engagement, the model raises awareness of sustainable food practices, encouraging consumers to make environmentally conscious choices.

3. BUSINESS MODEL FOR OMEGA-3 OIL AND COSMETIC EXTRACTS

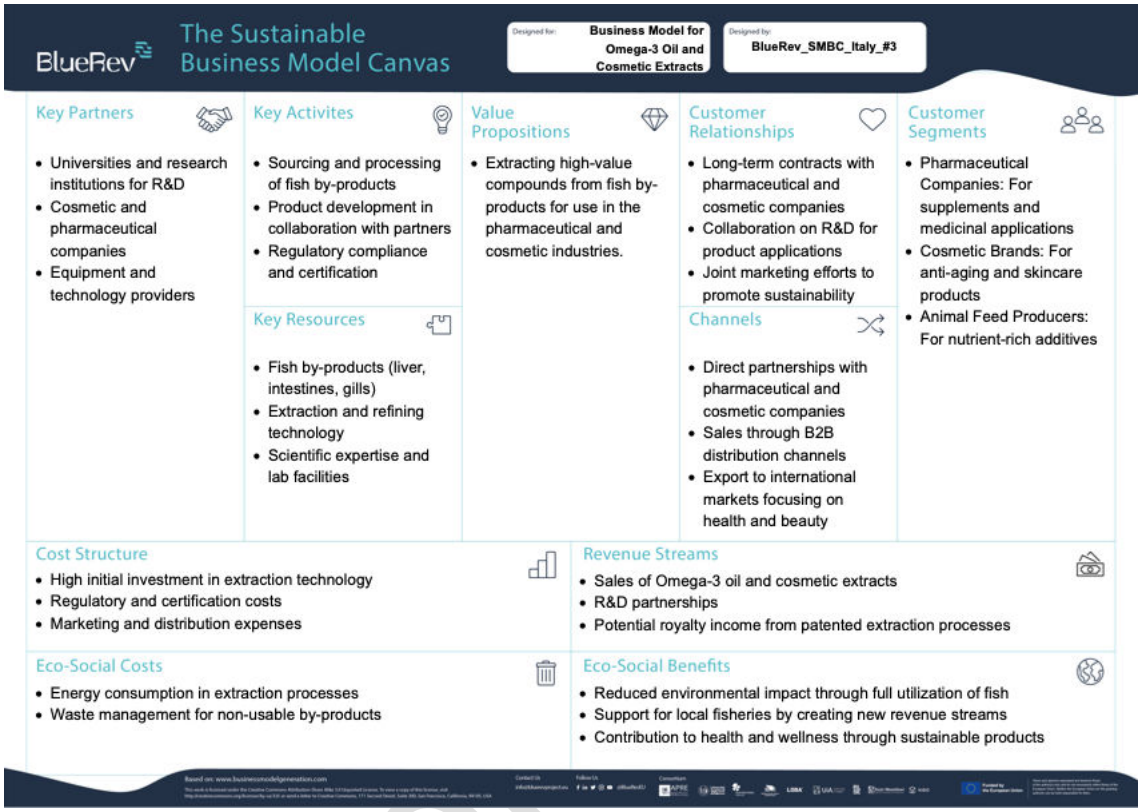

Figure 10: SBMC Italy, Business Model for Omega-3 Oil and Cosmetic Extracts

Background

This business model focuses on extracting high-value compounds, such as Omega-3 oil and other bioactive substances, from fish by-products like liver, intestines, and gills. These extracts cater to the pharmaceutical and cosmetic industries, offering applications in dietary supplements, skincare products, and anti-aging treatments. The model capitalizes on growing global demand for health and wellness products.

Target customers include pharmaceutical companies, cosmetic brands, and animal feed producers. Sales channels consist of direct partnerships, B2B distribution networks, and potential export to international markets. This model emphasizes collaboration with research institutions to optimize extraction techniques and ensure compliance with regulatory standards. Revenue streams come from product sales, R&D partnerships, and licensing of patented extraction processes.

From an eco-social standpoint, this model maximizes resource utilization in the fishing industry, reducing waste and its environmental impact. It supports local economies by creating jobs in advanced processing and contributing to global health and wellness trends. However, initial investments in technology and navigating complex regulatory frameworks are key challenges to overcome.

Value Proposition: Extracting high-value compounds from fish by-products for use in the pharmaceutical and cosmetic industries.

Customer Segments

- **Pharmaceutical Companies**
  Pharmaceutical companies utilize Omega-3 oils and bioactive compounds in developing dietary supplements and medicinal products. These ingredients enhance cardiovascular health, reduce inflammation, and support brain function, meeting the demand for preventive health solutions.
- **Cosmetic Brands**
  Cosmetic companies incorporate fish-derived extracts into skincare products, including anti-aging creams and moisturizers. These bioactive compounds, rich in antioxidants and essential fatty acids, improve skin elasticity and hydration.
- **Animal Feed Producers**
  Fish by-products can also serve as a nutrient-rich additive for animal feed, offering high protein content and essential nutrients for livestock, aquaculture, and pets.

Channels

- **Direct Partnerships with Pharmaceutical and Cosmetic Companies**
  Building direct partnerships enables streamlined supply of raw materials and promotes joint product development, ensuring customized solutions for high-value applications.
- **Sales through B2B Distribution Networks**
  B2B distribution channels expand market reach, connecting with a broad range of industry players and facilitating bulk sales of refined extracts.
- **Export to International Markets Focusing on Health and Beauty**
  Targeting international markets with a focus on health and beauty allows the business to tap into regions with high consumer demand, such as North America, Europe, and Asia.

Customer Relationships

- **Long-Term Contracts with Pharmaceutical and Cosmetic Companies**

Establishing long-term contracts ensures consistent demand and fosters trust, enabling collaborative innovation in product development.

- **Collaboration on R&D for Product Applications**
  Joint research efforts help tailor extracts to specific applications, enhancing product effectiveness and meeting evolving market needs.
- **Joint Marketing Efforts to Promote Sustainability**
  Collaborative marketing campaigns emphasize the sustainable sourcing and environmental benefits of these products, building brand equity and consumer trust.

Revenue Streams

- **Sales of Omega-3 Oil and Cosmetic Extracts**
  Revenue is generated from the direct sale of refined products, catering to the pharmaceutical and cosmetic sectors.
- **R&D Partnerships**
  Collaborations with research institutions and industry players contribute to revenue through joint innovation projects and shared intellectual property.
- **Potential Royalty Income from Patented Extraction Processes**
  Licensing proprietary extraction techniques offers an additional income stream, leveraging intellectual property to expand the business's market influence.

Key Resources

- **Fish By-Products (Liver, Intestines, Gills)**
  These raw materials provide the foundation for extracting high-value compounds, ensuring a sustainable and cost-effective supply chain.
- **Extraction and Refining Technology**
  Advanced equipment and technology are essential for efficiently extracting and refining bioactive compounds to meet industry standards.
- **Scientific Expertise and Lab Facilities**
  Specialized knowledge and facilities enable the continuous improvement of extraction processes and product quality.

Key Activities

- **Sourcing and Processing of Fish By-Products**
  Efficient sourcing and processing maximize resource utilization, transforming waste into valuable inputs for health and beauty products.
- **Product Development in Collaboration with Partners**
  Collaborative product development ensures that extracts meet specific industry requirements and consumer preferences.

- **Regulatory Compliance and Certification**
  Adhering to regulatory standards and obtaining necessary certifications guarantee product safety and market access.

Key Partners

- **Universities and Research Institutions for R&D**
  Collaborating with academic institutions drives innovation, advancing extraction techniques and exploring new applications for bioactive compounds.
- **Cosmetic and Pharmaceutical Companies**
  Partnerships with industry leaders facilitate market entry, product development, and knowledge sharing.
- **Equipment and Technology Providers**
  Suppliers of advanced extraction and refining equipment are critical for maintaining efficient and high-quality production processes.

Cost Structure

- **High Initial Investment in Extraction Technology**
  Substantial capital is required to acquire and install advanced extraction and refining equipment.
- **Regulatory and Certification Costs**
  Expenses related to meeting regulatory requirements and obtaining certifications for product safety and efficacy are significant.
- **Marketing and Distribution Expenses**
  Investments in marketing campaigns and distribution networks ensure market penetration and brand visibility.

Eco-Social Costs

- **Energy Consumption in Extraction Processes**
  The energy-intensive nature of extraction processes contributes to the business's overall carbon footprint, necessitating efforts to improve energy efficiency.
- **Waste Management for Non-Usable By-Products**
  Managing and disposing of any residual waste from the extraction process adds operational complexity and environmental responsibility.

Eco-Social Benefits

- **Reduced Environmental Impact through Full Utilization of Fish**
  By transforming fish by-products into valuable extracts, the model significantly reduces waste, contributing to sustainable fisheries management.
- **Support for Local Fisheries by Creating New Revenue Streams**

The demand for by-products provides additional income for local fisheries, enhancing economic resilience and supporting community livelihoods.

- **Contribution to Health and Wellness through Sustainable Products**
  The production of Omega-3 oils and bioactive extracts aligns with global health and wellness trends, offering consumers sustainable choices in health and beauty.

Opportunities and Constraints for New Sustainable Business Models in Italy

Opportunities

1. **Market Diversification**

There is a growing global demand for sustainable, health-focused products such as Omega-3 oil, bioactive cosmetic extracts, and gourmet seafood ingredients like shrimp powder and fish broths. These products can cater to multiple sectors, including food, cosmetics, pharmaceuticals, and animal feed, offering diverse revenue streams. The expansion into international markets, such as Japan and Northern Europe, further broadens the customer base, enhancing profitability and market resilience.

2. **Technological Innovation**

Patented processes for extracting bioactive compounds and transforming by-products into high-value goods can create a significant competitive advantage. These innovations not only provide market differentiation but also offer opportunities for licensing technology to other enterprises. Collaboration with research institutions to acquire these processes, that are yet to be set up, further strengthens the technological edge, enabling cost efficiency and product quality improvements.

3. **Circular Economy Integration**

The valorization of by-products aligns with the EU's circular economy and sustainability goals, positioning businesses to benefit from policy incentives, grants, and funding opportunities. Utilizing fish waste for new products like biofertilizers, animal feed, or bioplastics reduces environmental impact and promotes resource efficiency, thereby enhancing corporate reputation and compliance with environmental regulations.

4. **Consumer Awareness and Preferences**

Growing consumer interest in sustainable and locally sourced products creates a favorable market environment. Educational campaigns and certification (e.g., organic, sustainable) can further boost consumer trust and willingness to pay a premium for these products. Partnerships with chefs, food influencers, and wellness brands can enhance

product visibility and acceptance, particularly in gourmet and health-conscious segments.

Constraints

1. **Regulatory Barriers**

Navigating the complex EU regulatory framework for food, pharmaceutical, and cosmetic products poses a significant challenge. The approval process for new bio-based products, particularly those derived from fish by-products, can be lengthy and costly, involving stringent quality and safety standards. Compliance requires substantial investment in documentation, testing, and certification.

2. **High Initial Costs**

Establishing sustainable business models often requires significant upfront investment in advanced processing technologies, R&D, and infrastructure. For small and medium-sized enterprises (SMEs), securing the necessary capital can be difficult, particularly without guaranteed returns. Energy-intensive processes such as freezing and drying add to operational expenses, further straining budgets.

3. **Market Acceptance**

Despite the benefits, consumer skepticism regarding products made from by-products remains a hurdle. There is a need to shift public perception and communicate the health, safety, and sustainability benefits of these products. This challenge is especially pronounced in sectors like cosmetics and food, where consumer trust is paramount.

4. **Operational Challenges**

Sicily's dispersed fishing industry faces logistical hurdles, including high transportation and storage costs. The small scale of many fishing operations complicates the consistent supply of raw materials, impacting production efficiency and scalability. Additionally, the region's high energy costs exacerbate operational expenses, making it harder for businesses to maintain profitability.

6 Conclusions

The findings from the pilot regions of Estonia, Italy, Greenland, and Denmark offer a comprehensive overview of sustainable business models tailored to their unique local contexts. The purpose of this deliverable, D4.2, was to explore business models that not only enhance sustainability but also strengthen local capacities, particularly in marine-based industries. The results underscore the importance of leveraging co-creation workshops, interviews, and focus groups to ensure that these models are both feasible and aligned with stakeholder expectations.

In Greenland and Denmark, the focus was on transforming cod side streams, improving freezing methods, and implementing automated wastewater treatment systems. Greenland's models emphasized optimizing resource utilization in its remote Arctic setting by turning cod by-products into valuable products such as pet food and enhancing export capabilities through advanced freezing. Denmark, leveraging its established infrastructure, explored nutrient recovery from wastewater, showcasing its leadership in sustainable fisheries management while also exploring the potential to develop nutritious health drinks from fish by-products for international markets. These models align with the EU's circular economy goals, offering pathways to reduce waste, improve resource efficiency, and generate new revenue streams. However, logistical challenges in Greenland and high technology costs in Denmark pose significant constraints.

In Estonia, two promising models emerged: the multi-use of offshore wind farms for macroalgae cultivation and integrated multi-trophic aquaculture (IMTA) combining trout and mussel farming. These models reflect Estonia's commitment to marine spatial efficiency and nutrient management. The macroalgae initiative builds on the potential of existing wind farm infrastructure to produce high-value products for food, cosmetics, and bioplastics, while the IMTA model focuses on nutrient removal and sustainable fish farming. Both models highlight the critical role of research institutions and regulatory frameworks in driving innovation. However, ecological challenges, including the Baltic Sea's low salinity, and regulatory complexities, such as lengthy permit processes, remain significant barriers.

Italy's focus was on valorizing seafood by-products, with three business models: shrimp powder and "colatura di gambero rosso," fish broth and soups, and Omega-3 oil and cosmetic extracts. These models address food waste and environmental sustainability while catering to growing markets for gourmet and health-conscious products. Each model leverages Italy's rich culinary heritage and advanced processing technologies to create high-value products. However, challenges such as high initial investment, consumer scepticism, and regulatory hurdles in the EU were identified. These constraints underline the need for strategic collaborations with research institutions and targeted consumer education campaigns.

The co-creation workshops and interviews were central to this process, employing the Sustainable Business Model Canvas as a tool to guide discussions and collect structured data. This framework enabled participants to comprehensively evaluate each business model across key dimensions such as value propositions, cost structures, and eco-social impacts. By adopting a participatory approach, the project engaged a diverse range of stakeholders, ensuring the relevance and practicality of the proposed solutions. These sessions not only validated prior findings but also uncovered new opportunities for innovation and collaboration.

Moreover, the project utilized a design thinking methodology, fostering creative problem-solving and iterative development of business models. This approach emphasized empathy and user-centricity, allowing stakeholders to co-develop solutions that address local challenges while aligning with broader sustainability objectives. The combination of participatory engagement and structured tools like the Sustainable Business Model Canvas proved instrumental in bridging gaps between theory and practice, enabling the translation of sustainability principles into actionable business strategies.

Across all pilots, common themes emerged, including the necessity of technological innovation, market diversification, and circular economy integration. The pilots also underscored the importance of engaging a wide range of stakeholders—from local fishers and processors to research institutions and regulatory bodies. This multi-stakeholder approach ensures that the business models not only address environmental concerns but also create socio-economic benefits, such as job creation and improved local livelihoods.

The eco-benefits of these models are clear. They reduce marine waste and contribute to nutrient removal, improving water quality and sequestering carbon. In Estonia, for instance, macroalgae farming integrated with offshore wind farms offers a dual solution: supporting renewable energy while enhancing marine biodiversity. Italy's valorization of shrimp by-products not only reduces waste but also produces gourmet products, meeting the growing demand for sustainable and high-quality food items. Denmark's innovative wastewater treatment system exemplifies how nutrient recovery can transform environmental challenges into economic opportunities by producing fertilizers and animal feed, while reducing water pollution.

However, these initiatives are not without challenges and present significant eco-costs, such as high energy consumption, particularly in Greenland's advanced freezing methods, and emissions from long-distance transportation. Scaling up operations, such as macroalgae farming in the Baltic Sea, may risk unintended ecological consequences like habitat disruption. Additionally, managing residual waste that cannot be valorized remains a persistent issue across all regions. Addressing these challenges will require continuous technological innovation and a commitment to minimizing environmental footprints through renewable energy integration and improved waste management systems.

Opportunities for growth and innovation are robust. Increasing global demand for sustainable products offers regions the chance to diversify their economies and tap into high-growth markets. Collaboration between public and private sectors, along with research institutions, has been pivotal in fostering innovation and ensuring the feasibility of these models. Moreover, the alignment of these initiatives with EU sustainability goals provides access to funding and policy support, enhancing the financial viability of these ventures.

Nonetheless, significant constraints persist. Regulatory and permitting challenges, particularly in aquaculture and macroalgae farming, delay implementation and increase financial risks. High initial capital requirements for technologies like automated wastewater treatment systems and advanced freezing infrastructure limit accessibility for smaller enterprises. Additionally, logistical challenges, such as those faced by Greenland's remote fishing industry, hinder market expansion and competitiveness.

Finally, market acceptance remains a critical hurdle. Despite growing consumer awareness of sustainability, scepticism about products derived from by-products or novel sources could slow adoption. Overcoming these perceptions will require targeted educational campaigns and transparent communication to build trust and highlight the quality and safety of these products. Overall, while the path to widespread adoption of these sustainable business models involves navigating complex challenges, the long-term benefits for local economies and the environment make these efforts both necessary and promising.

To conclude, the deliverable demonstrates how localized sustainable business models can contribute to global sustainability goals. The insights gained will inform the next phase, D4.4, focusing on best practices and scaling strategies, ensuring that these models can be adapted and implemented in other regions facing similar challenges.

7 Next steps

Building on the findings and insights gathered in this deliverable, the next phase of the BlueRev project will focus on refining and scaling the sustainable business models developed for the pilot regions. This section outlines the key activities and objectives planned will ensure that the progress made thus far translates into actionable outcomes.

1. Further Data Collection and Stakeholder Engagement

While significant insights have been gathered, additional data collection will be crucial to deepen our understanding of regional dynamics and validate the business models proposed. Future co-creation workshops, semi-structured interviews, and focus groups will be evaluated as they could be beneficial to address remaining gaps and refine the proposed models. These sessions will also aim to engage a broader spectrum of stakeholders, including local communities, industry partners, and policymakers, to ensure inclusivity and build consensus around the implementation strategies.

2. Development of Best Practices (Deliverable D4.4)

The project will synthesize insights from the pilot regions to develop a set of best practices for sustainable business model implementation. These best practices (Deliverable 4.4) will provide a roadmap for other regions willing to adopt similar strategies. By sharing these practices, the project aims to promote knowledge transfer and inspire broader adoption of sustainable practices within the blue bioeconomy.

3. Monitoring and Evaluation

It is beneficial for the long-term success of the proposed business models, to establish a robust framework for monitoring and evaluation. This will involve defining key performance indicators (KPIs) that align with environmental, social, and economic objectives. Regular assessments will provide feedback on the models' effectiveness, allowing for continuous improvement and adaptation to changing circumstances.

4. Policy Recommendations and Knowledge Dissemination

An integral part of the project's next steps includes the development of policy recommendations based on the outcomes of the demonstration activities and stakeholder feedback. These recommendations will aim to support regulatory frameworks that foster sustainable practices in the blue bioeconomy. Additionally, knowledge dissemination activities, including workshops, publications, and international conferences, will be prioritized to share the project's findings with a wider audience.

By following these next steps, the BlueRev project will continue to build momentum, driving innovation and fostering sustainable growth in marine and coastal regions.

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9 Appendix

9.1 Appendix 1: Questions underpinning the co-creation of sustainable business models

Task	Description	Supporting questions
1. What kind of products can be produced from side operation and bio-based industry? (this provides data for Q9)	Start by defining the problem you´re trying to solve.	What could be the potential market for a new bio-product? What is the market demand for blue bio-based products? What are the challenges and opportunities in the industry? What are the gaps in the current value chain?
2. Define the value proposition. (this leads to Q7)	Once you have a clear understanding of the problem, define your value proposition.	What is the unique value you´re offering to the market? How does your solution address the identified gaps and challenges in the industry?
3. Identify the target market. (potential for internationalization)	Continue by identifying the target market.	Who are the customers you´re targeting? What are their needs and preferences? What are their pain points and what benefits can your solution offer? are there international markets/customers?
4. Develop revenue streams	Once you have identified your target market and unique value proposition, develop revenue streams.	How will you monetize your solution? Will you charge for products or services, or both? Will you use a subscription model or a pay-per-use model?
5. Define the cost structure	It is important to understand the costs associated with developing and delivering your solution.	What are the fixed and variable costs? How much will it cost to develop and produce your product or service?

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6. Identify key partners (business /institution) (Provides some data for Q9&Q10)	No business can operate in a vacuum. Identify the key partners and resources you need to develop and deliver your solution.	Who are your suppliers, distributors, and strategic partners? What kind of infrastructure, equipment, and technology do you need?
7. Develop a sustainable business model	Ensure that your business model is sustainable.	How will you ensure long-term profitability and growth? What are your plans for scalability and expansion? What kind of social and environmental impact will your solution have?
8. Develop a competitive strategy.	The business model needs to be competitive.	How would you compete? What is your position vis a vis your competitors?
9. Develop a strategic fit. Complementarity of activities	A business model must ensure internal resources are matched with external factors. Mapping core activities.	What are key strategic activities? (alignment with core strategy)
10.Define sector attractiveness.	A sector's attributes and forces shaping it need defining to determine the attractiveness of a sector/industry.	What is the bargaining power of suppliers and buyers, in this sector (reduces price)? Is there any substitute (direct and/or indirect) for the product (service) of this sector? Are there barriers to entry?
11. Identify (develop) internal resources and capabilities required.	A business (requires resources (tangible/ intangible) to operate	Identify your key resources and capabilities?

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