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TITLE: Green Bonds: a strategy for improving salmon aquaculture sustainability

AUTHORS		SUPERVISOR
Candidate number:	Name:	Ragnar Tveterås
9050	Shristina Dhaugoda	
9078	S M Nayem Abdullah	

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This thesis is written as a final study in the Master of Science in Business Administration, specializing in Business Development and Innovation, at the University of Stavanger. The thesis addresses the green bond role in advancing sustainability in Norwegian salmon industry. The topic is relatively new, and the study process has therefore been very educational.

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Shristina Dhaugoda

S M Nayem Abdullah

Summary

Green bond is sustainable finance that enables companies to involve in environmentally friendly initiatives and promote long-term sustainable development. To date there have only been a few academic studies on green bond in seafood industry. Our analysis is the first empirical studies designed to address the question of how does green bond advances sustainability in Norwegian salmon industry with the aim of addressing sub questions of what sustainability initiatives are the four companies funding through their green bonds, how effective are each of these initiatives towards sustainability, what is the economic rationale of the companies to acquire green bonds and is there any greenwashing present in the practices of companies.

To answer the questions, the data were collected primarily from green bond impact reports and additionally from annual reports, government websites, and different scientific literature. The research design is based on three-dimensional approach where the practices were identified and further evaluated for the effectiveness by linking it to the UN SDGs and the objective of EU Taxonomy.

The findings indicates that all four companies have done a wide range of sustainability activities funded through the green bonds. The prioritization of proceeds is seen in the environmental dimension of sustainability. However, it is essential to understand that obtaining the best overall sustainability outcomes requires a balancing of all three dimensions: environmental, social, and economic. Likewise, the effectiveness of each initiative aligns with several the UN SDGs and the EU Taxonomy objectives. The finding also shows that certain initiatives like RAS investments reduce freshwater demand but increase energy use and some companies are addressing these issues as well. To assess long-term sustainability benefits and address any drawbacks and trade-offs, more research and monitoring are needed in this case. Furthermore, SRI, CSR, and green bond motivators support economic rationale, according to the study. Along with the positive result, the finding also reveals a few instances where their claims and actions contradict each other that reflects greenwashing. This paper provides an insight to industry stakeholders to identify the most effective initiative that has successfully achieved sustainability outcomes and functioned as industry best practices while taking greenwashing into account

List of Abbreviations

ASC — Aquaculture Stewardship Councils

BAP — Best Aquaculture Practices

CBI — Climate Bond Initiatives

CBS — Climate Bonds Standard

COP — Climate Change Conference

CSR — Corporate Social Responsibility

DPSIR — Driver-Pressure-State-Impact-Response

EIB — European Investment Bank

EIB — European Investment Bank

ESG — Environmental, social and governance

EU — European Union

EU — European Union

EuGBR — European Green bond regulation

FAO — Food and Agriculture Organization

GB — Green Bond

GBP — Green Bond Principles

GHG — Greenhouse gases

GSSI — Global Sustainable Seafood Initiative

ICMA — International Capital Market Association

ICMA — International Capital Market Association

PSR — Pressure-State-Response

RAS — Recirculating aquaculture systems

SDG	Sustainable Development Goals
SRI	Socially Responsible Investment
TBL	Triple Bottom Line
UN	United Nations
UNDP	United Nations Development Program

List of Symbols

√	The proceeds of the green bond are allocated to the specified indicator.
x	The proceeds of the green bond are not allocated to the specified indicator

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Chapter 1

1. Introduction

1.1 Background of the study

Sustainability can be defined as the development that satisfies current requirements without impairing the capacity of future generations to meet their own needs (Brundtland, 1987). Rapid industrialization and human-caused climate change pose a severe threat to sustainable development by putting people's lives and livelihoods in danger and reducing the planet's essential resources. In order to support a growing global population, carbon emissions must increase which accelerates global warming. Net-zero emissions and a complete switch to renewable energy sources and environmentally beneficial behaviors are necessary to stabilize world temperatures (IPCC, 2022). As a result, academics and professionals are interested in the subject of sustainable development with an emphasis on environmental issues in order to fulfil the Sustainable Development Goals (SDG) under the United Nations Development Program (UNDP). Through the Paris Agreement, which was accepted by 196 parties in December 2015 to fully decarbonised the entire world's economy by the end of the 21st century, the United Nations (UN) recommends that business organizations incorporate Environmental, Social, and Governance (ESG) initiatives into their future strategic planning to ensure the preservation of the present temperature (ICMA, 2021). In this process, the businesses are required to change their business practices and shift themselves to more climate-friendly projects.

The primary challenge that countries face is how to finance these climate-friendly projects. Increased investments, especially in infrastructure, will significantly aid the transition to a low-carbon economy. Additionally, global financial institutions like The World Bank must increase their financial resources (Stern, 2015). The challenge, at least for developing nations, is too large for government resources to handle alone (Reichelt, 2010). Hence, there is a option of Green Bonds. Green bonds are a type of fixed income security that share similarities with conventional bonds, but are distinguished by the fact that the proceeds are allocated solely towards the funding or refinancing of environmentally sustainable projects (ICMA, 2021). The proceeds from green bonds enables companies to finance environmentally friendly initiatives and promote long-term sustainable development.

Getting the SDG targets accomplished is a huge task. Enhancing funding for sustainable projects is one of the SDG mechanism's key components. The overall objectives of the SDGs directly depend on access to funds. For example, capital availability facilitates countries to eliminate extreme poverty (Bhutta et al., 2022). Additionally, the availability of capital flow encourages the development of innovative products that make effective use of cutting-edge technology and has a good impact on the SDGs. CBI (2018b) defines green bonds as a bridge to the environment-related SDGs of the UN. In relation to this, another essential standard to be noted is The EU Taxonomy, that aligns with EU policy commitments, including the Paris Agreement and the UN Sustainable Developments Goals (SDGs) (EU, 2020a). This consist of six objectives that helps in environment sustainability.

1.2 Research Problem

Numerous organizations have clearly confirmed that green bonds are a crucial component of green finance for environmental preservation. However, there are conflicting views and an overall lack of research in specific areas to know the effectiveness of green bonds in improving the sustainability in highly dynamic environments for example Norwegian Salmon Industry. This research aims to identify and evaluate sustainability initiatives and strategies that top salmon industry in Norway are practicing under their issuance of green bond. This section will start by providing an introduction to the study, beginning with a discussion of the background and context, followed by the research problem, the research aims, objectives and questions, the significance and finally limitations.

The European Investment Bank (EIB) issued the first "Climate Awareness Bond" in the middle of 2007 in order to attract capital for green initiatives (EIB, 2023). Gradually, with the implementation of the Paris Agreement, governments from around the world began to pay attention to the growth of the green bond markets, and more interaction between global market participants resulted in greater standardization. (OECD, 2017). The Green Bond Principles, a collection of recommended guidelines for the issuance of green bonds, were introduced by the International Capital Market Association (ICMA) in 2014. These principles are voluntary in nature and are intended to promote best practices in the field. Following that, the Climate Bonds Initiative and other global organizations released their respective taxonomies, benchmarks, and certifications (Ehlers & Packer, 2017). Green bonds is an essential cog in the wheel of sustainable finance, business models and sustainable development to fund this green transition (Kedia & Joshipura, 2022).

The studies that are now available on green finance are either a simple bibliography of previous research on green bonds (Dayong et al., 2019) or they focus on brief elements of green bonds (Jones et al., 2020). Further, the researchers studied the impact of green bonds on the cost of capital (Flammer, 2021), stock market reaction to climate-friendly financing (Wang et al., 2020), the impact on shareholders of this structural change in the capital structure (Tang & Zhang, 2020), issuance of green bond impact on firm performance (Dongyang Zhang & Du, 2020) and other related topics are studied (Dörry & Schulz, 2018). These studies cover a wide range of topics and are more broadly oriented toward the green bond market. As a result, the present research is insufficient for certain industries, such as the seafood industry, where the sustainability indicators are to be analyzed to determine how well the green bond process advances sustainability.

1.3 Research Question, Aims and Objectives

Given the lack of research regarding green bond in the seafood industry, this study aim to identify and evaluate sustainability initiatives and strategies that four leading salmon companies are practicing under their issuance of green bond in Norway. This study aims to fill this gap by addressing the following research questions.

RQ 1. How does green bond advances sustainability in Norwegian salmon industry?

- What sustainability initiatives are the 4 companies funding through their green bonds?
- How effective are each of these initiatives towards sustainability?
- What is the economic rationale of the companies to acquire green bonds?
- Is there any greenwashing present in the practices of companies?

The research objectives are to identify the practices that four leading salmon companies in Norway, namely Mowi, SalMar, Grieg and Lerøy, are doing with the allocated green bond proceeds under three-dimensional approach i.e. Environment, Social and Economic. The study also seeks to evaluate the effectiveness of these practices towards sustainability by linking it to the international standards such as UN SDGs and the objectives of EU taxonomy. The study also aims to know the economic rationale that companies gain from green bond, which may be obtained by understanding more about CSR and SRI. Similarly, the research will look into any activities that lead to a greenwashing strategy.

1.4 Research Significance

To the best of our knowledge, this analysis of the leading salmon companies in Norway is one of the first to update readers about sustainable practices under green bond. This will contribute to addressing the current research gap in this area and offer academics and businesses operating in the seafood industry practical benefits.

1.5 Study limitation

While this study provided valuable insights into the given topic, it is important to acknowledge it’s limitation. The study was carried out in a particular geographic area, namely Norway, which may limit the applicability of the findings in other contexts. In addition, the data were collected from limited reports of only four salmon companies that may limit the observation to achieve significance in the study. Most of the information found that includes green bond and EU taxonomy in relation to salmon aquaculture are reports and government websites. Aside from that, there were no research articles available in the salmon sector worldwide that explored green bonds, EU taxonomy, and SDGs on a single framework. Likewise, the research was conducted within a limited time frame, which impacted the depth of the analysis. As a result, certain aspects under investigation may not have been fully explored.

1.6 Structure of the thesis

The subsequent sections of this study are structured in the following manner. In Chapter one, the foundation of the study has been introduced. The research objectives and questions have been identified, and the significance of conducting such research has been proposed. The study's limitations have been duly acknowledged and discussed. In Chapter two, the background information about green bonds and salmon industry will be discussed. In Chapter three, theoretical framework will be covered. In Chapter four, the existing literature and relevant literature will be reviewed to identify the initiatives under green bond to boost sustainability, especially seafood industry. In Chapter five, research methodology will be shown to demonstrate research designs and data collection. In Chapter six, analysis of four salmon companies on green bond will be examined. In Chapter seven, the discussion of the findings will be highlighted along with the limitations and recommendations for further research. Finally, Chapter eight concludes the insight of the entire study.

Chapter 2

2. Background

In this chapter, we outline the overall salmon industry along with the environmental issues in this field and sustainable practices to solve those issues and then narrowed it down to the salmon industry in Norway. Some definitions and standards of green bonds by linking with The UN SDGs and EU Taxonomy are further discussed.

2.1 Salmon Industry

As a direct consequence of the expansion of the human population across the globe, there will be a concomitant rise in the total quantity of food that must be provided. According to UN (2023), the global population has quadrupled since the middle of the 20th century. The global population surpassed 8 billion at mid-November 2022, up from 2.5 billion in 1950. In 30 years, the world's population will increase from 8 billion to 9.7 billion in 2050 and 10.4 billion in the mid-2080s. Reforms to offshore aquaculture and fisheries might lessen the effects of climate change on the marine industry and increase the amount of food that can be harvested from the ocean (Free et al., 2022).

While salmon consumption does account for a small fraction of the world's total protein intake, pork, poultry, and beef make up most of the animal protein in our diets. The statistics from Shahbandeh (2022) illustrates, the Food and Agriculture Organization (FAO) predicted that 133 million tons of chicken, 113 million tons of pork, and 70 million tons of beef and veal would be consumed worldwide in 2021. In contrast, about 2 million metric tons (GWT) of farmed Atlantic salmon were consumed.

According to the findings of the study conducted by Sintef, the emission rates range from 4.8 to 28 kg CO2e per kg of edible fish now available for purchase (Ace, 2023; Johansen et al., 2022). The production of one kilogram of beef results in the release of seventy kilograms of emission (Milman, 2021). Carbon and greenhouse gas emissions from salmon are lower compared to those from pork, poultry, and cattle (Ritchie, 2020). Therefore, salmon is a more eco-friendly and long-lasting protein option than chicken, cattle, goat, or pork. Farmed salmon is considered to be an eco-efficient source of animal protein due to its low carbon footprint, low feed conversion ratio, low land and freshwater consumption, and high edible yield (Greig, 2023).Table 1 provided by Grieg from GSI, presents the carbon footprint, feed conversion ratio, and edible yield of farmed salmon, chicken, pork, and cattle.

	Farmed Salmon	Chicken	Pork	Cattle
Carbon footprint	0.60	0.88	1.30	5.92
Edible yield	68%	46%	52%	38%
Feed conversion ratio	1.2-1.5	1.2-2	2.7-5	6-10

Table 1: Comparison of salmon with other protein option
Source: (Grieg, 2023)

As the number of people living in the world and their appetite for seafood continue to rise, a greater proportion of our fish will come from aquaculture. As an oily fish, farmed Atlantic salmon is an international trade item and a rich source of nutritionally advertised long-chain omega-3 fatty acids, eicosapentaenoic (EPA) and docosahexaenoic (DHA) acid and these fatty acids are found in abundance in farmed Atlantic salmon (Sprague et al., 2016).

2.1.1 Environmental issues under salmon aquaculture

The recent surge in popularity of aquaculture, which seeks to increase global fish production for the sake of human nutrition and food security, has been referred to as a "blue revolution." This term is used to describe the recent popularity surge of aquaculture. The use of blue water in aquaculture has resulted in a significant increase in global fish production; however, it has also resulted in a number of environmental issues, such as the devastation of habitat, the contamination of water supplies, and the spread of disease (Ahmed & Thompson, 2019). Pacific salmon from British Columbia in Canada are important for the economy, culture, and the environment all at once. Climate change, habitat loss, overfishing, and population growth are only a few of the causes of the Pacific salmon's precipitous decline (Flores et al., 2021). Johnson et al. (2018) also argued that overfishing, water diversion projects, habitat loss, diminished connectivity, the introduction of hatchery-born fish, and the construction of hydropower facilities all contributed to a decline in Columbia River salmon populations. Again, Tveterås et al. (2020) addressed that salmon aquaculture can have negative externalities on its maritime environment, including pollutants, parasites, and illnesses, and on global ecosystems if feed resource utilization is not appropriately regulated. However, negative externalities may vary according to the method of fish farming and the quantity of fish produced.

Water pollution is a serious problem, and salmon farms are a major source. Salmon farm waste can cause oxygen depletion in water, which can result in fish deaths and ecological deterioration due to the growth of algae. Antibiotic-resistant bacteria are dangerous to both people and animals, and the broad use of antibiotics and other chemicals in fish farming has helped spread them. A recent study published in Environmental Science & Technology indicated that antibiotics, metal compounds, pesticides, other agrochemicals, and even animal and human wastes are all frequent in aquaculture operations in Asia, where the majority of farmed fish is currently produced. In addition they highlighted that salmon farms are a major cause of water contamination and degradation in the surrounding area (Sapkota et al., 2008).

Despite the widespread growth of coastal aquaculture, environmental worries still linger. The public's understanding of the dangers of releasing fish waste, nutrients, and medicines into the environment is expanding at the same time as the amount of trash being discharged into the environment increases. Using wild fish as a source of fish meal for aqua feeds has been rumoured to have unfavourable effects on coastal marine ecosystems. Discharges of fish waste, fertilizers, and medicinal substances have raised public concern about the sector. The accumulation of discarded food and fish waste under fish cages causes changes to the sediment and the formation of nitrogenous and phosphorous chemicals (Mente et al., 2006).

There is a significant possibility that salmon farms have an effect on the waters that are in close proximity to them, in particular, if the farms are placed in an unfavourable area or are poorly maintained. There is a lot of worry about the chance that chemical inputs will change the variety of local plants and animals, which are sometimes called "non-target organisms." Another worry is that bacteria might become resistant to antibiotics through the process of natural selection (Burridge et al., 2010).

In recent years, gill illness in Atlantic salmon (Salmo salar) farmed in the maritime environment has become a major issue for the salmon aquaculture business. Gill disease in marine salmon has been linked to a wide variety of pathogens, including amoebic gill disease (AGD), parasitic gill disease, viral gill disease, bacterial gill disease, zooplankton (cnidarian nematocyst)-associated gill disease, harmful algal gill disease, and chemical/toxin gill disease

(Boerlage et al., 2020). Amoebic gill disease (AGD) has had a negative impact on the salmon industry in Tasmania, Australia, and has also been recorded in the majority of countries that produce salmon (Valdenegro-Vega et al., 2015).

The salmon louse, Lepeophtheirus salmonis, is responsible for annual commercial losses totaling multiple millions of dollars in countries where salmon is farmed (Hamre et al., 2013). The aquaculture-derived salmon louse, Lepeophtheirus salmonis, can have a deleterious effect on wild salmonids like the sea trout, Salmo trutta (Shephard & Gargan, 2021). Norway's fastest-growing industry is salmon aquaculture. Utilizing natural resources efficiently, the industry promotes social, economic, and environmental sustainability. This industry faces idle capacity, pollution, illnesses, parasites, and fish escapes. The extended production cycle creates these issues (Alam, 2018).

There is a vast range of environmental damage caused by the aquaculture industry. Housing that many fish in such a small space inevitably leads to issues with waste and uneaten food. The area under and surrounding the aquaculture plant may be covered with a thick layer of muck. An additional form of contamination is caused by sea lice. Over the years, a variety of chemical treatments have helped keep the population of sea lice in aquaculture facilities to a minimum. Chemical control tactics may work initially; however, it can pose a threat to wild crustaceans (Olaussen, 2018). A considerable rise in output may increase the hazards associated with other environmental problems, even though escaped farmed fish and salmon lice have since been identified as the most serious dangers to the ecosystem (Bailey & Eggereide, 2020).

The practice of disclosing scope 1, 2, and 3 emissions can serve as a means for companies to showcase their dedication to sustainability and assume responsibility for their ecological footprint (Hertwich & Wood, 2018). The study represented about Scope 1 emissions pertain to the direct discharge of greenhouse gases from sources that are either owned or managed by the entity responsible for reporting. Scope 2 emissions pertain to the greenhouse gas emissions that are indirectly generated by the reporting entity through the consumption of purchased electricity, heat, or steam. Scope 3 emissions encompass all non-direct greenhouse gas emissions that arise in a corporation's value chain. This includes both upstream and downstream operations, such as the acquisition and manufacturing of procured materials and fuels, conveyance of goods and services, utilization of sold products, and the management of waste.

Atalah & Sanchez-Jerez (2020) stated that the industry is confronted with the significant challenge of environmental sustainability, with fish escapes being a prominent issue that poses a considerable threat to marine ecosystems. The findings of the analysis suggest that a considerable proportion, specifically one-third, of the global marine ecoregions are susceptible to the potential consequences of farmed fish escapes. The research conducted an identification of risk hotspots for three prevalent stressors that are linked to escapes of farmed fish. These stressors include the ecological impact of introducing non-native species, the impact of genetic introgression of farmed fish into wild populations, and the spread of pathogens and parasites.

2.1.2 Sustainability practices under salmon aquaculture

In recent years, the salmon industry has been subjected to a growing quantity of scrutiny due to rising concerns about its impact on the environment and wild salmon populations. In response to these issues, several businesses within the sector have implemented sustainability practices with the objectives of minimizing their impact on the surrounding environment and maximizing the long-term profitability of their operations.

In a report, Tveterås et al. (2020) pointed out that new information and innovations have the potential to reduce the number of negative externalities per tonne of salmon produced. Aquaculture's track record shows that innovations in this sector have considerably mitigated environmental impacts and disease impacts. The potential for more technologies to lessen environmental and biological consequences is likely substantial. It is crucial to incentivize the business sector to make investments in innovations and select production practices that reduce negative externalities. The structure of the government's regulatory framework is crucial here. Less water use, better biosecurity, and more output are some of the main advantages that Recirculating aquaculture systems (RAS) offers. Through the implementation of RAS technology, salmon, Asian seabass, and flatfish are all successfully raised in aquaculture (Yue & Shen, 2022).

RAS is considered a green method in the fish production method because it uses less water than flow-through systems, requires no or minimal vaccines or antibiotics, and prevents disease transmission and genetic contamination of wild stocks (Badiola et al., 2018). Fish health and growth require disinfected rearing water. When fish populations are crowded, the fish are stressed, and there is a lot of food in the water, RAS diseases grow. To combat the spread of exotic diseases, RAS follows established practices for treating source water to lower the pathogen load, disinfecting effluent waters prior to release, and quarantining any new fish before they enter production tanks (Badiola et al., 2018).

Sustainable seafood is becoming increasingly popular among consumers, but there is little indication that sustainability certification will be eliminated very soon. In today's world, it is no secret that the globe is becoming more and more environmentally conscious. The fish industry in many nations is not yet ready to embrace green ecolabelling and certification initiatives. FAO supports the Global Sustainable Seafood Initiative (GSSI) Measuring and Accelerating Performance Program, which has the potential to get more seafood producers involved in the improvement and certification process by offering financial incentives for showing improved sustainability performance (FAO, 2020).

Aquaculture feed costs a lot. Fishmeal and fish oil are common protein and fat sources in aquaculture feed. Aquafeed fishmeal and oil are scarce. The decreased catch from capture fisheries drives up fishmeal and fish oil prices. Fishmeal and fish oil costs have risen to $1600 and $900–1800 per Mt, respectively. Use non-traditional protein and fat sources to increase aquaculture output. This will improve aquaculture by replacing fishmeal and fish oil. Animal and plant protein and fat sources are widely available. It can replace fishmeal and fish oil without slowing development and is readily available at a reduced cost (Hodar et al., 2020)

A study by Han et al. (2019) suggests that the negative environmental impact of aquaculture can be mitigated by incorporating microalgae, which are efficient at fixing carbon dioxide and cleaning effluent. This can help reduce the environmental impact of aquaculture. In addition, the use of microalgae as feed for aquatic animals can improve animal health and reduce the need for antibiotics and other medications, thereby assisting in the control of the developing problem of antibiotic resistance in aquaculture. Furthermore, microalgae-assisted aquaculture can have beneficial effects on environmental safety and sustainability, thereby contributing to global sustainability.

One of the most prevalent insect pests on industrial poultry farms is the lesser mealworm (Alphitobius diaperinus), which lives in the litter and feeds from poultry excrement, spilled feed, and other organic debris. However, recent regulations in the European Union (EU) have listed this as a potential nutrient source for aquafeed, changing the perspective of this insect from a pest to a protein provider (Rumbos et al., 2019). The demand for fish and other natural resources could be alleviated if we could use insects as a protein source for fish food.

The difficulty, however, comes from finding reliable and renewable sources of high-protein components for feed. Protein meals derived from soy concentrate protein (SCP) have the potential to mitigate the shortage of fishmeal in aquaculture diets by making up for the shortfalls of plant-based meals. Now available for commercial production, SCP meals have been proved to be effective in feeding trials with key aquaculture species like salmon, trout, and shrimp. Finding new strains, inventing new procedures, and successfully testing on fish species are all very hopeful developments for SCP products, despite the fact that there are still obstacles to overcome (Jones et al., 2020).

In addition to these practices, certification programs such as the Aquaculture Stewardship Council's (ASC) Best Aquaculture Practices (BAP) program and the Global Aquaculture Alliance's Best Aquaculture Practices (BAP) program have been formed to enable independent verification of sustainable practices within the salmon sector. These certification programs make it simpler for consumers to locate products that were produced in a socially and environmentally responsible manner (ASC, 2023; BAP, 2023).

The Salmon Group has its own proprietary fish feed formula that places a premium on fish quality, animal welfare, and environmental effect, and it is always being refined through the use of benchmarking and the investigation of new sustainable materials. The companies work together through interdisciplinary committees to ensure group expertise is utilized in making decisions about fish health and biology (Salmon Group, 2023).

According to Badiola et al. (2018), Recirculating Aquaculture Systems (RAS) are a closed-loop aquaculture system that facilitates the rapid and large-scale growth of fish and other aquatic animals. A Recirculating Aquaculture System (RAS) involves the continuous pumping of water throughout the system while subjecting it to various treatment methods to maintain water quality and eliminate waste. In contrast to conventional open-water aquaculture techniques, this approach has the potential to optimize resource utilization and minimize environmental impact. In another study by Ahmed & Turchini (2021), supports the view that

Recirculating aquaculture systems (RAS) have been devised as a means to cultivate fish in regions where there are insufficient biophysical conditions, limited water resources, compromised water quality, and unfavourable environmental circumstances. They offer an alternative means of production in situations where cost-effective alternatives are hindered by factors such as environmental regulations, disease, land availability, salinity, temperature, and water supply.

According to the review of Martins et al. (2010), the implementation of RAS technology in fish production has been shown to contribute to sustainable practices through the reduction of water usage, as well as the improvement of waste management and nutrient recycling. The aforementioned systems are engineered to facilitate the recirculation of water via a treatment procedure that effectively eliminates waste materials and sustains the quality of water. Use of RAS results in a reduction of water usage for pisciculture, which holds particular significance in regions where water resources are limited or come at a high cost. Furthermore, the implementation of Recirculating Aquaculture Systems (RAS) facilitates the manufacturing of aquatic food items in nearby areas, thereby mitigating the carbon footprint linked with food transportation and unfavourable trade imbalances attributed to the importation of seafood. In general, the utilization of RAS technology facilitates the cultivation of fish in a highly concentrated manner, while concurrently mitigating negative ecological consequences and advancing principles of sustainability.

These systems have the advantages of multilevel conservation (e.g. land and water resources), wide adaptability (e.g. climate, geography and seasonal) and convenient management (e.g. infrastructure and daily operation). Therefore, these systems can meet the requirements of sustainable development and are regarded as an inevitable trend in the future development of aquaculture (Zhao et al., 2022). Hence, the Food and Agriculture Organisation has promoted efficient intensive aquaculture, represented by RASs, in both core and frontier areas (Nie & Hallerman, 2021). Badiola et al. (2018) argues that RAS high energy need is a disadvantage increasing both operational costs and potential consequences of using fossil fuels.

Another study states that the indoor functioning of RAS implies that their susceptibility to climatic factors such as variations in rainfall, floods, droughts, global warming, cyclones, fluctuations in salinity, ocean acidification, and sea level rise is relatively low. The primary limitations faced by the RAS technology are related to energy consumption and greenhouse gas emissions. The potential and promise of RAS notwithstanding, their extensive use is limited, particularly in developing countries, due to the sophisticated and costly nature of their system designs (Ahmed & Turchini, 2021).

2.1.3 Salmon industry in Norway

Norway benefits from its extensive coastline and abundant marine resources. Norwegians have traditionally relied on fishing, hunting, and sealing as means of livelihood. Atlantic salmon fishing holds significant social, cultural, and economic value for Norwegians. The Norwegian salmon industry comprises three sectors: wild salmon fishing in rivers and oceans, salmon aquaculture, and salmon processing. The three domains provide distinct societal, economic, and cultural advantages, yet they encounter numerous issues and obstacles. They exhibit distinct objectives, methodologies, customs, and target demographics. They are subject to distinct regulations, management structures, and officials. The farming sector has received significant political backing in recent years (Liu et al., 2011).

The Norwegian fish farming industry has undergone rapid technological changes, resulting in the emergence and disappearance of various companies, and altering its operational dynamics. Companies with a 3–5-year tenure exhibit greater efficiency compared to those with longer tenure (Nilsen, 2010). The study indicates that new companies exhibit slightly higher technical efficiency compared to established ones. New firms may have an advantage over existing firms due to their use of superior technology, despite the time required for the technology to become fully effective. The technological changes need to be profitable and should be sustainable as it involved time and cost. This concept is supported by Moe Føre et al. (2022), the study described that new technological designs are expected to significantly advance marine aquaculture in the future. Aquaculture units will be enhanced to ensure greater resilience and adaptability to diverse environments. This innovation will facilitate ocean farming in unexplored regions and the propagation of novel species. Technological advancements in production are fuelling these changes. The profitability and regulatory frameworks in various regions will determine the viability of these innovations.

According to Sandvold & Tveterås (2014), technological advancements in breeding, fish feed, equipment, fish health, and water management have significantly impacted the production of juvenile salmon in the Norwegian salmon industry. The enhanced productivity in juvenile production results in reduced costs, which are subsequently transferred to the grow-out farms through decreased prices. Norwegian salmon aquaculture products become more competitive with other food producers. Enhancing productivity across all stages of the salmon aquaculture value chain, including juvenile production, is crucial. The study indicates that the juvenile stage of salmon has exhibited a reduced capacity to contribute to productivity growth compared to previous periods. In recent years, the suppliers have experienced stable or increased costs for producing juvenile salmon, resulting in unchanged or elevated smolt prices.

Bergesen & Tveterås (2019) asserted that advancements in input quality and process improvement are the primary drivers of growth in aquaculture. The seafood industry in Norway has established a system for innovation that includes public universities and research centers, as well as private businesses that are part of value chains. The study examined innovation patterns within Norway's seafood industry. The study revealed that the presence of internal R&D staff in a company has a noteworthy impact on the likelihood of collaboration, both in general and specifically with academic institutions. R&D employees have a positive impact on collaboration with research institutions due to their skills, which enhance firms' productivity in such collaborations.

The implementation of feed quotas and transfer of ownership facilitated the emergence of a substitution road, leading to the development of salmon farming as a significant national economic undertaking. As production rebounded, overfishing for feed emerged as a concern (Hansen, 2019). Using vegetarian feed for salmon has led to unexpected outcomes, including environmental and social concerns related to soy cultivation. The study indicates that prioritizing economic sustainability over environmental health in the transition to soy-based salmon feed lacks long-term sustainability. However, in Norway Salmon aquaculture firms are maintain the SDG commitment through sustainability practice, A study by Abualtaher et al. (2021) revealed that the largest companies' annual sustainability reports contained evidence of the SDGs after the Norwegian government expressed its commitment to them. This demonstrates the efficacy of the top-down approach. Academic institutions are compiling a database of information on the significance of the SDGs for utilization by the corporate sector.

2.2 Green Bonds

The European Investment Bank (EIB) issued the first "Climate Awareness Bond" in the middle of 2007 in order to attract capital for green initiatives (EIB, 2023). In close collaboration with Skandinaviska Enskilda Banken (SEB), The World Bank established a framework for bonds in

2008 whose proceeds support green activities and these bonds are referred to as "green bonds" (World Bank, 2021).

Green Bonds refer to a category of bond instruments that are specifically designated to finance or refinance new and/or existing eligible Green Projects. These projects must be in accordance with the four main elements of the Green Bond Principles (GBP), and the proceeds from the bonds must be specifically applied towards this purpose (ICMA, 2017, p. 2).

Another important agreement to be acknowledged is the Paris Agreement, which represents the end of the era of fossil fuels and the beginning of a new clean energy future (Mountford, 2015). In December 2015, The Paris Agreement on climate change, which was accepted by 196 parties at 21st Conference of Parties representing the United Nations Framework Convention on Climate Change (UNFCCC) and the UN Climate Change Conference (COP21), set a goal of having the entire world's economy fully decarbonized by the end of the 21st century (Bultheel et al., 2015). This was a very clear indication from world leaders about the climate action plan. Increased investments, especially in infrastructure, will significantly aid the transition to a low-carbon economy. Additionally, global financial institutions like The World Bank must increase their financial resources (Stern, 2015). The challenge, at least for developing nations, is too large for government resources to handle alone (Reichelt, 2010). Hence, there is an option of Green Bonds.

The creation of green bonds, a financial innovation designed to make sustainable investment simpler for institutional investors such as pension funds, insurance companies, mutual funds, and sovereign wealth funds, represents a significant advancement (Maltais & Nykvist, 2020, p.3). For instance, green bonds are commonly mentioned as a technological advancement that can motivate institutional investors to increase their investments in environmentally friendly infrastructure by enhancing the liquidity of infrastructure assets (Yermo & Croce, 2013). Figure 1 illustrates the interest in green bonds that exists throughout the world.

2.2.1 Green Bond Principle

The term "green bond" indicates an agreement to solely use the funds raised to finance or re-finance "green" projects, assets, or company activities that comply with the four Green Bond Principles, setting it apart from a regular bond (ICMA, 2015). The Green Bond Principles (GBP) initiative aims to emphasizes on the transparency, accuracy, and integrity of the activities that issuers would disclose and report to stakeholders through fundamental elements and important recommendation (ICMA, 2021). The International Capital Market Association (ICMA) oversees the GBP initiative, which brings together green bond issuers, investors, and market intermediaries in addition to observers (ICMA, 2021). This initial worldwide standard served as a major market growth driver and the foundation for many of the current green labels (Ehlers & Packer, 2017).

The issuer must consider four core factors that correspond with GBP in order to issue the green bond namely Use of Proceeds, Process for Project Evaluation and Selection, Management of Proceeds and Reporting along with the recommended Green Bond Frameworks and External Reviews (ICMA, 2021) as shown in the figure 1.

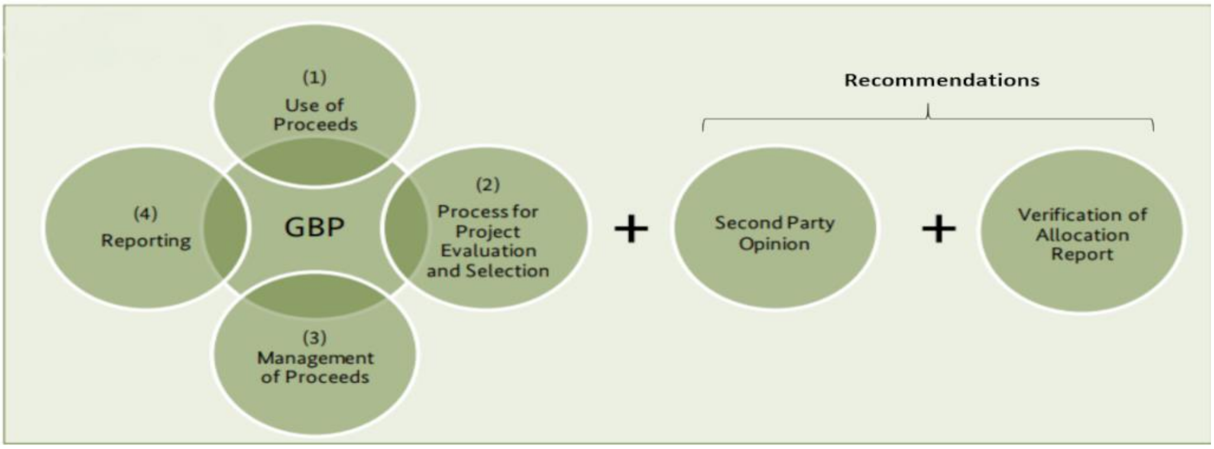


Figure 1: ICMA Green Bond principles and recommendation

Source: (Banque De France, 2022)

Firstly, Use of proceeds could be for financing or re-financing, and this should be specified in the legal documents. Secondly, the process of evaluating and selecting projects is very important for issuers of green bonds, because they need to make sure that possible investors understand the environmental goals of eligible green projects. Thirdly, management of proceeds is required to track the allocated net proceeds and the temporary use of funds. Finally, reporting of up-to-date information on the use of proceeds is another essential part. The annual report must comprise a list of projects that have received Green Bond proceeds, accompanied by a brief overview of the projects, the allocated amounts, and the anticipated impact of the initiatives (ICMA, 2021). The GPB emphasizes the importance of high levels of transparency under each of these components and, as a result, strongly suggests an external assessment of the project evaluation and selection process. For instance, CICERO, VIGIO, and other consulting firms are among the few that carry out these kinds of external reviews (ICMA, 2021). The overview of the process of issuing a green bond is given in Appendix 1. Every provider has a different evaluation process, and each has slightly different requirements of the green bond issuer.

The purpose of the projects that will be funded with the proceeds is the most important factor of green bonds. These categories include a wide range of environmental factors, and carrying out projects in any of these categories can result in sustainability to some degree. The project categories listed below are eligible for green bond issuance, but are not limited to (ICMA, 2021).

- Renewable energy
- Energy efficiency
- Pollution prevention and control
- Environmentally sustainable management of living natural resources and land use
- Terrestrial and aquatic biodiversity conservation
- Clean transportation
- Sustainable water and wastewater management
- Climate change adaptation
- Circular economy adapted products, production technologies and processes
- Certified eco-efficient products
- Green buildings

For a green bond to be listed on the Climate Bonds Initiatives (CBI) green bonds list, it must also go through an external evaluation. The Climate Bonds Initiative is a worldwide entity that encourages for the utilization of debt capital markets to tackle climate change (Clark, 2015). They do this through working to build the Climate Bonds Standard (CBS) and Certification Scheme, engage in policymaking, and gather market intelligence and CBS, which explain the conditions for a bond to be certified as a Climate Bond and are completely linked with the GBP (Cortellini & Panetta, 2021).

Further guidelines have been developed to promote common definitions for the global market and these guidelines are called Climate Bond Taxonomy (CBI, 2018a). CBI’s green bond list includes all labelled green bonds complying with the Climate Bonds Taxonomy (CBI, 2018a). Despite the fact that the GBP created a widely recognized standard, other regional green bond regulations have emerged. A number of regional standards are based on the general methodology of the GBP, but each has its own requirements for qualified green projects and third-party validation (Cortellini & Panetta, 2021).

Climate Bond Taxonomy was first released in 2013. The tool serves as a means for issuers, investors, governments, and municipalities to figure out the primary investments that will facilitate the realization of a low carbon economy and provides GHG emissions screening criteria that align with the 1.5 degree Celsius global warming threshold established by the COP 21 Paris Agreement (Climate Bond, 2015). The Climate Bonds Initiative screens bonds using a taxonomy to assess projects underlying an investment are eligible for green or climate finance and these taxonomy are regularly updated (Climate Bond, 2015).

2.2.2 The Green Bond Market

The green bond market has experienced significant growth in recent years, as investors increasingly prioritize investments that support environmentally sustainable projects. The majority of green bonds are issued in developed countries, with the China (USD 85.4bn) , United States (USD 64.4bn), and Germany (USD 61.2bn) being among the largest markets (CBI, 2022). Likewise, top 3 issuers are European Union, European Investment Bank and Federal Republic of Germany (CBI, 2022). Figure 2 shows the top countries in Green Bond Issuance 2022 with China being at the top.

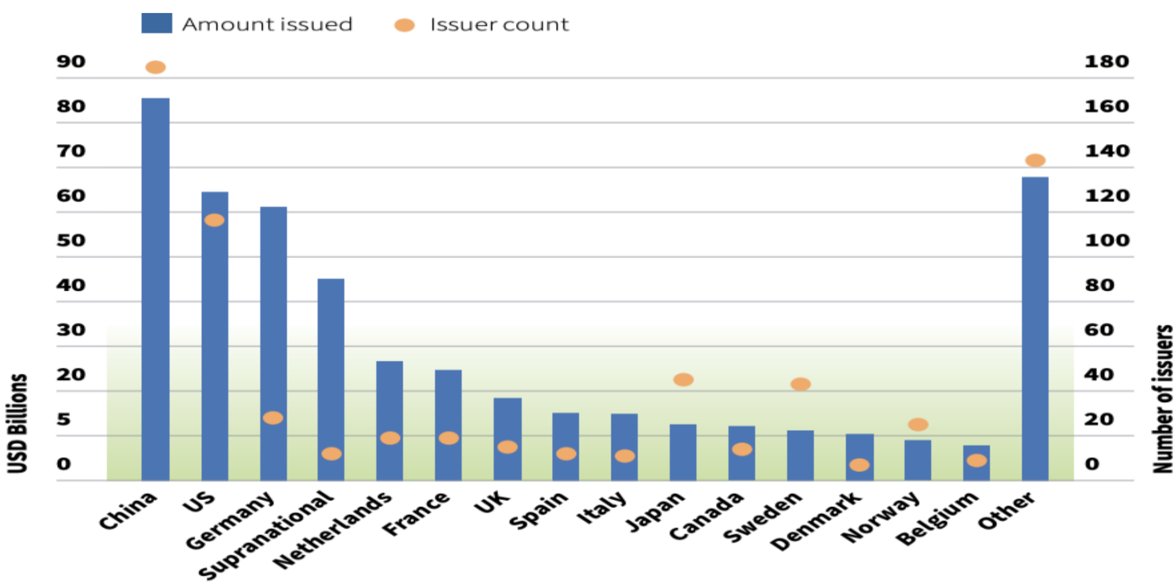


Figure 2: Green Bond Issuance 2022

Source: (CBI, 2022)

In Nordic countries, Sweden, Norway, Denmark, and Finland have been pioneers in environmental legislation, regulation, public awareness, and behavioral changes associated with a sustainable economy for decades, starting in the 1970s (McCormick, Richter, & Pantzar, 2015). The Nordic nations were also early adopters of using green bonds to raise finance for environmental objectives. Among the leading issuers of green bonds, Norway is also the one (Nassiry, 2018).

The Norwegian Stock Exchange has made positive efforts to handle the green bond market (NOU, 2018). It demonstrates how this market will eventually have a greater impact on financing or more environmentally friendly options. In January 2015, Oslo Brs joined the UN's Sustainable Stock Exchange Initiative, becoming the first stock exchange in the world with a dedicated list for green bonds and one must provide a fair assessment of the project in order to be listed on the Oslo Børs green list (OBX, 2019). Similarly, KBN is one of the most active Norwegian bond issuers and has the longest history of green bond listings with eight outstanding bonds totaling NOK 25.8 billion in green funding are available as of 2021 and are issued in five different currencies (KBN, 2021). Green bond issuance is increasing in Norway, and a majority of the issuers are in the energy industry (OBX, 2019).

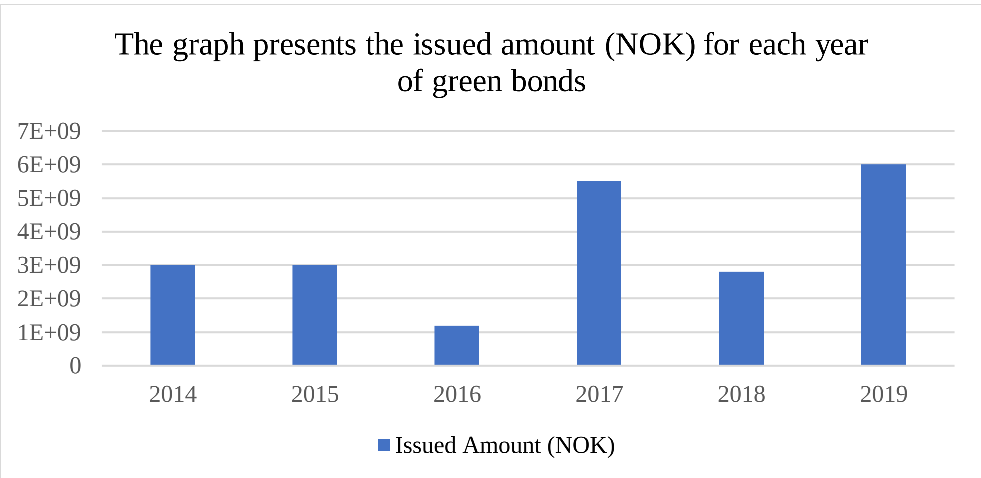


Figure 3: Number of green bond issued amount

Source: (Stamdata, 2019)

2.3 Interlinkage between Green bond and Sustainability Development

CBI (2018b) defines green bonds as a bridge to the environment-related sustainable development goals (SDGs) of the UN (United Nations). The SDGs and green bonds both aim to advance sustainability. Achieving multiple SDGs with the help of green bonds ultimately helps the sustainability. Green bonds have the highest impact on six out of the 17 SDGs i.e. Clean water and sanitation (SDG6), Clean energy (SDG7), Sustainable industry, innovation and infrastructure (SDG9), Sustainable cities and communities (SDG11), Climate action (SDG13) and Life on land (SDG15) CBI (2018b). There will be more progress on SDGs when there are more green bonds.

11% of green bonds have been issued so far in the category of clean water and sanitation (SDG 6) (CBI, 2018b). Cape Town's Certified green bond, which financed clean water and sanitation assets (SDG6) that are both low carbon and climate resilient, is a recent example of green bond investment in this area. (Ngwenya & Simatele, 2020).The market for green bonds continues to be dominated (by 40%) by clean energy (SDG7) (CBI, 2018b). For instance, the majority of the revenues from Nigeria's sovereign green bond were used to expand renewable energy sources (SDG7) (Doronzo, Siracusa, & Antonelli, 2021). Low carbon transportation accounts for 15% of the market for green bonds, with low carbon buildings making for 24% of it (CBI, 2018b). Jain, Gangopadhyay, & Mukhopadhyay (2022) illustrates a good instance of a green bond from the transportation industry that used the revenues to fund electrified rail, a low-emission transportation option, is provided by India Railways Finance Corporation.

City locations make up a large portion of the assets financed by green bonds and they focus on the goal of sustainable cities and communities (SDG11). Cape Town's green bond for water shows how one asset may support several SDGs simultaneously by supporting both climate action (SDG13) and sustainable cities (SDG11) (CBI, 2018b).

The majority of proceeds from green bond to date have been used to fund climate mitigation, adaptation, and resilience, with only a small portion going to other green assets. The SDGs acknowledge that environmental protection is crucial for attaining sustainable development in domains such as wellness, schooling, and financial stability, highlighting their interdependence (Bhutta et al., 2022). Sustainable forestry and agriculture are also financed by a lower percentage of green bonds (3%) and contribute to life on land (CBI, 2018b). A sustainable forestry or land use component can be found in about half of the green bonds issued in Brazil, a major exporter of agricultural products. Launch of the first green bond program in the world to support ethical soy production was in Brazil (Tolliver, Keeley, & Managi, 2019).

The United Nations has established 17 Sustainable Development Goals (SDGs) aimed at promoting global sustainability across various sectors. However, these objectives cannot be met unless funds are raised to finance global efforts to adapt to and mitigate climate change (R. Ahmed et al., 2022). According to Hanif et al. (2019) per capita growth and carbon emissions have an inverted U-shaped relationship, making the move to greener energy sources necessary for emerging countries and helped by the rise of green bond markets. Glomsrød & Wei (2018) found that financing with green bonds and fossil fuel elimination can effectively reduce worldwide coal use and emissions by 2030, in comparison to the business as usual (BAU) scenario. Tolliver et al. (2019) document that improved impact reporting and climate measures are crucial for international expansion, even though green bond disbursements are going to priority sectors like renewable energy and green transportation.

The table below illustrates the SDGs' relevance to several GDP project categories. Thus, by funding initiatives that advance these SDGs, green bonds may speed up the transition to a future that is more sustainable. Out of 17, 12 SDGs have been linked to the GBP principles. The reason why all goals are not included is because green bonds projects promote environmental sustainability and generate financial returns, the SDGs aim to address a broader range of social, economic, and environmental challenges and guide global efforts to achieve sustainable development (ICMA, 2020).

SDGs	GBP Project Categories
1 NO POVERTY	• Climate Change Adaptation
2 ZERO HUNGER	• Climate Change Adaptation • Environmentally Sustainable Management of Living Natural Resources and Land Use
3 GOOD HEALTH AND WELL-BEING	• Pollution Prevention and Control • Renewable Energy
6 CLEAN WATER AND SANITATION	• Sustainable Water and Waste Water Management • Terrestrial and Aquatic Biodiversity Conservation
7 AFFORDABLE AND CLEAN ENERGY	• Energy Efficiency • Renewable Energy
8 DECENT WORK AND ECONOMIC GROWTH	• Eco-efficient and/or Circular Economy Adapted Products, Production Technologies and Processes • Energy Efficiency • Renewable Energy
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	• Energy Efficiency • Renewable Energy
11 SUSTAINABLE CITIES AND COMMUNITIES	• Clean Transportation • Eco-efficient and/or Circular Economy Adapted Products, Production Technologies and Processes • Environmentally Sustainable Management of Living Natural Resources and Land Use • Green Buildings • Pollution Prevention and Control • Renewable Energy • Sustainable Water and Waste Water Management

	• Eco-efficient and/or Circular Economy Adapted Products, Production Technologies and Processes • Environmentally Sustainable Management of Living Natural Resources and Land Use • Pollution Prevention and Control • Renewable Energy • Sustainable Water and Waste Water Management
	• Climate Change Adaptation • Climate Change Mitigation
	• Environmentally Sustainable Management of Living Natural Resources and Land Use • Terrestrial and Aquatic Biodiversity Conservation
	• Environmentally Sustainable Management of Living Natural Resources and Land Use • Terrestrial and Aquatic Biodiversity Conservation

Table 2: Mapping SDGs and GBP project categories
Source: (ICMA, 2020)

2.4 European Union (EU) Taxonomy

The European Union Taxonomy intends to support increasing investments in projects required to fulfill the goals of the European Green Deal which was proposed by the European Commission (Dan & Tiron-Tudor, 2021). The objective is for the EU to have a climate-neutral economy by 2050, with a reduction of 55% already implemented in 2030 (EU, 2021). The EU Taxonomy aligns with EU policy commitments, including the Paris Agreement and the UN Sustainable Developments Goals (SDGs) (EU, 2020a). In addition, based on Climate Bond (2015), a major contributor to the development of the EU Sustainable Finance Taxonomy is climate bond.

A framework for categorizing "green" or "sustainable" economic activities carried out in the EU is described in the EU taxonomy regulations (EU, 2020a). The aim to recognize and advance environmentally friendly business methods and technological advancements. The focus lays on the following six environmental objectives (EU, 2020b):

1. Climate change mitigation
2. Climate change adaptation
3. Sustainable use and protection of water and marine resources
4. Transition to a circular economy
5. Pollution prevention and control
6. Protection and restoration of biodiversity and ecosystems

Different economic activities for these objectives are defined by Technical Expert Group (TEG) which undergo through technical screening criteria. For instance, Fawzy et al. (2020) explains the different strategies that are carried out for climate change mitigation such as renewable energy, fuel switching, efficiency gains, nuclear power, and carbon capture storage and utilization, bioenergy carbon capture and storage as well as afforestation and reforestation, ocean fertilization and so on.

According to the EU taxonomy regulations, a company must not only support at least one environmental goal but also avoid violating the other goals in order to be categorized as a sustainable economic activity. In addition, there are four criteria which company needs to align, which base on the previously mentioned environmental objectives (EU, 2020b):

1. Making a substantial contribution to at least one environmental objective.
2. Doing no significant harm to any of the other five environmental objectives.
3. Complying with minimum safeguards; and,
4. Complying with the technical screening criteria set out in the Taxonomy delegated acts.

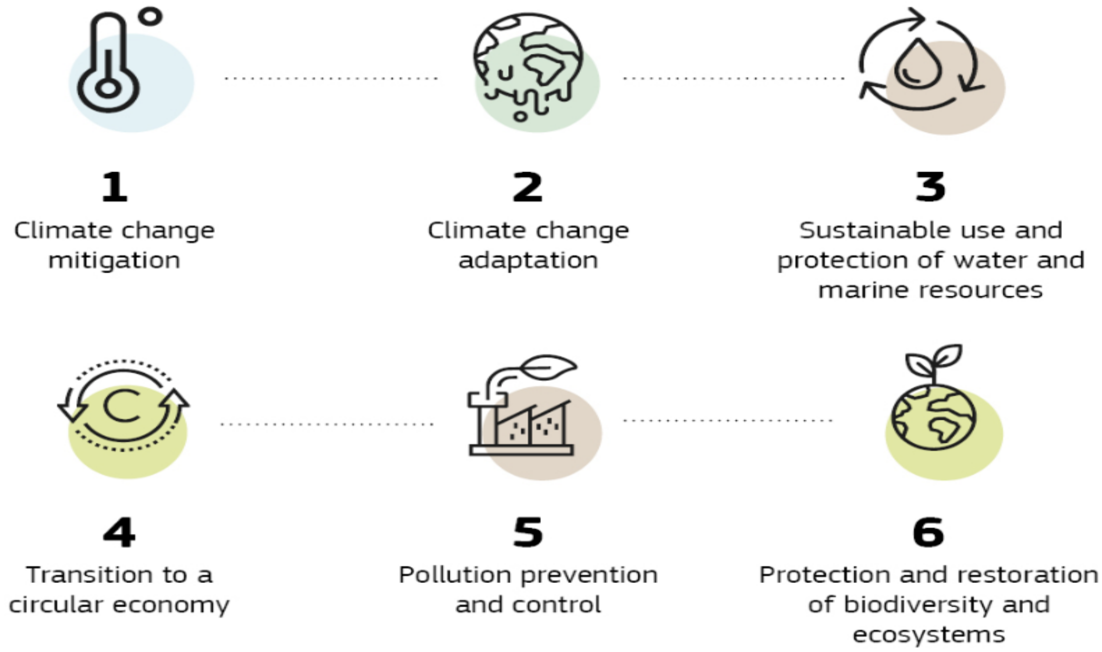


Figure 4: Objectives of EU Taxonomy

Source: (European Commission, 2023)

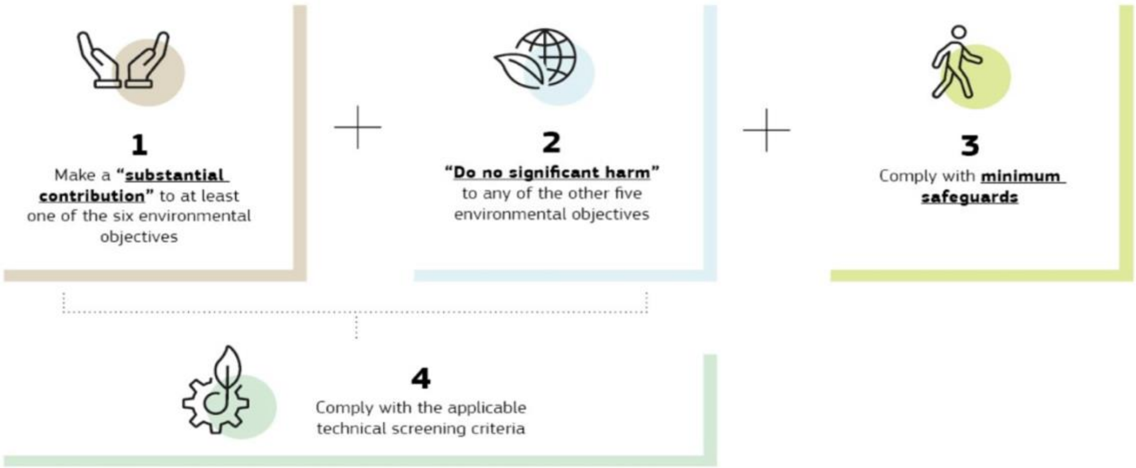


Figure 5: Conditions of EU Taxonomy

Source: (European Commission, 2023)

2.4.1 Green bond contributes toward EU Taxonomy

S.N.	EU Taxonomy	Green Bond
1	Climate change mitigation	Renewable energy Energy efficiency Clean transportation
2	Climate change adaptation	Climate change adaptation Green buildings
3	Sustainable use and protection of water and marine resources	Sustainable water and wastewater management
4	Transition to a circular economy	Circular economy adapted products, production technologies and processes Certified eco-efficient products
5	Pollution prevention and control	Pollution prevention and control
6	Protection and restoration of biodiversity and ecosystems	Terrestrial and aquatic biodiversity conservation Environmentally sustainable management of living natural resources and land use

Table 3: Mapping the objectives of EU Taxonomy and Green bond project categories

Source: (Authors)

The EU Taxonomy's goals, which encourage sustainable economic growth and the shift to a low-carbon economy, can be significantly enhanced by green bonds. Table 1 shows the alignment of green project categories described by ICMA (2021) for the eligibility of green bond with the objective of EU Taxonomy. This shows that the contribution of green bond towards EU Taxonomy objectives.

According to (Maragopoulos, 2021), there is no standard benchmark like GBP under EU Green Bond (EuGB). However, in July 2021, the European Commission adopted a legislative proposal for the adoption of a European Green Bond Standard in an effort to advance sustainable finance that will boost investor confidence and lessen the effects of greenwashing, resulting in an effective market. The standard includes a uniform framework, disclosure requirements and the performance of external reviews (Maragopoulos, 2021).

In addition, the drivers for engagement with sustainability practices under green bond are direct financial benefits, business case benefits and legitimacy and institutional-oriented drivers (Maltais & Nykvist, 2020a). The benefits of these bonds motivates number of companies and helps in the increment of more green projects leading to the achievement of EU taxonomy.

Since there are strict regulation that is to be followed by the companies who are involved in the green bond, it ensures that the activities carried out are contributing towards the sustainability. For instance, The EuGB is anchored to the EU Taxonomy in line with Aricle 4 of Taxonomy Regulation, which states that the Union should use the EU Taxonomy criteria when establishing any requirements for corporate bonds that are environmentally friendly (EU, 2020b). As per Article 6 of the European Green Bond Regulation (EuGBR), the entire proceeds of a EuGB must be utilized to fund Taxonomy-aligned environmentally sustainable economic activities or activities that aid in transforming them into environmentally sustainable ones within a specified timeframe, as stated in a taxonomy-alignment plan (EU, 2020b).

Chapter 3

3. Theoretical Framework

3.1 Three-dimensional approach of sustainability

The word sustainability first appeared in the 1650s when it was translated from the German word Nachhaltigkeit and research at the time focused on keeping soils that may ensure the sustainability of wood sources and the author emphasized the necessity of planting as many trees as were cut down to safeguard future supplies (Carlowitz, 1713). Brundtland World Commission Report (1987) defined sustainability as the development that satisfies current requirements without impairing the capacity of future generations to meet their own needs.

Sustainability is mostly defined in terms of three dimensions: social, economic and environmental (Robert, Parris, & Leiserowitz, 2005). In relation to sustainability, the phrase Triple Bottom Line (TBL) stands for People, Planet, and Profit, has also gained popularity throughout the world and used often with the three dimension interchangeably (Elkington, 1997). Based on three crucial aspects of sustainable development shown in the figure 1: the interactions among environmental quality, social equality, and economic benefits helps establishing the fundamental elements of long-term strategies for businesses making the switch to sustainability (Elkington, 1998).

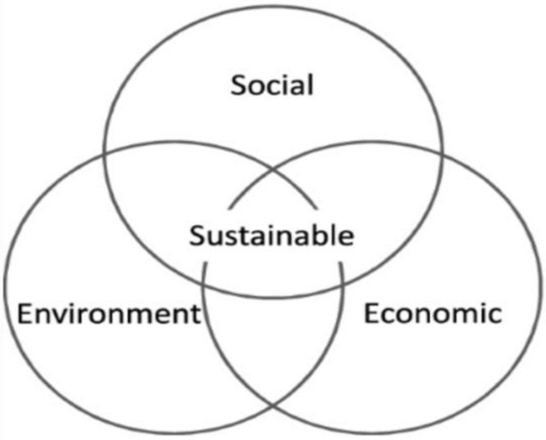


Figure 6: Three dimensional approach of sustainability

Source: (Purvis, Mao, & Robinson, 2019)

Environment

The concept of environmental sustainability is founded on the idea of ecosystem services, which include both renewable and non-renewable resources as well as the ability to absorb waste and benefit humans and so raise their standard of living. According to the previously mentioned World Conservation Strategy, the very broadly defined concept of sustainability was historically thought to be primarily environmental sustainability (IUCN, UNEP, WWF, 1980). Scientists at the World Bank are likely the ones who first invented the phrase. The term "environmentally responsible development" was initially employed as per the World Bank (1992). Serageldin & Streeter (1993) introduced the term "environmentally sustainable development" thereafter. Goodland (1995) is credited with formulating the concept of environmental sustainability. According to (Munasinghe & Shearer, 1995), environmental sustainability is characterized by the preservation or improvement of the Earth's life-sustaining systems, with a focus on its bio-geophysical constituents. According to Sutton (2004), environmental sustainability pertains to the capacity to uphold the preferred characteristics of the natural surroundings.

Environmental sustainability has been significantly impacted by the OECD Environmental Strategy for the First Decade of the 21st Century (OECD, 2001) by defining four specific criteria:

1. Regeneration: Renewable resources must be utilized efficiently and their consumption should not surpass their natural regeneration rates in the long run.
2. Substitutability: Efficient utilization and limited consumption of non-renewable resources should be practiced, and their usage should be restricted to levels that can be compensated by replacement with renewable resources or alternative kinds of capital.
3. Assimilation: The discharge of unsafe or polluting compounds into the environment should not surpass its capacity to absorb and process them.
4. Avoiding irreversibility: It is essential to prevent unchangeable harm to ecosystems and biogeochemical and hydrological cycles caused by human actions.

The Pressure-State-Response (PSR) model and environmental issues that have a major impact are used for the indicators of environmental sustainability by the OECD Core Set of Environmental Indicators (CEI). The framework may be seen in the Appendix 2 (OECD, 2003).

Additionally, the reliable study conducted by Dong & Hauschild (2017) using the Driver-Pressure-State-Impact-Response (DPSIR) framework with LCA (Life cycle assessment), PB (Planetary boundaries), and Sustainable Development Goals (SDGs) developed under United Nations are also important in terms of the indicators of environmental sustainability. The overview can be viewed in Appendix 3.

The concept of a safe operating space for humanity is defined by PB, taking into account the intrinsic biophysical processes that govern the stability of the earth system. On the other hand, LCA evaluates every relevant emissions and resources utilized, as well as the associated health, ecological, and degradation of resources issues that arise from the production of goods or services (Dong & Hauschild, 2017). The United Nations has released 17 Sustainable Development Goals (SDGs) that acknowledge the interdependence of various areas of action and the need for growth to prioritize social, economic, and environmental sustainability. Appendix 4 provides an overview of these SDGs (UNDP, 2022).

To make the most of all the dimensions, balance is crucial. Positive correlations between a company's environmental practices and its economic and environmental performance have been discovered by empirical researchers (Russo & FOUTS, 1997). Environmental sustainability strategies and high-quality performance have synergy, according to (Kleindorfer et al., 2005).

Social

The concept of social sustainability covers a broad range of definitions. Martin (2001) notes that the social dimension of sustainable development lacks a precise definition. Black (2004) defined social sustainability as the ability of social values, identities, relationships, and institutions to persist over time. Torjman (2000) defines social sustainability as the interdependence of a healthy environment and a vibrant economy for the sustenance of human well-being. Furthermore, Eight sub-indicators make up the social sustainability index used by Husgafvel et al. (2015), which are location, supply chain, social innovations, labour practices, training and education, reporting, health and safety, and legal–social aspects in his study for process industry.

Numerous social indicators are currently used by international organizations to evaluate social sustainability (McGuinn, 2020). The UN (the Global indicator framework for the Sustainable Development Goals) has created and accepted the most complete indicator system for assessing sustainable development, including its social elements (General Assembly, 2017). Since the EU and its Member States have committed to implementing the SDGs into practice, the UN indicator system has been used to track EU progression toward sustainability starting in 2016 (McGuinn, 2020).

Economic

It should be noted that over the past five decades, growth has been considered to be the most crucial policy objective worldwide. Finding a balance between sustainability and national economic growth has proven to be challenging for this reason (Moldan et al., 2012). Top political figures are now increasingly acknowledging the significance of economic sustainability.

Regulations to establish reporting frameworks are growing on a global, regional, and national level in an effort to encourage organizations to enhance their environmental, social, and governance (ESG) performance. According to Băndoi et al.(2021), increased transparency, for instance, to the extent that it is achieved through mandatory legislation, could help and direct organizations, inspiring them to perform more effectively in meeting the three pillars of sustainable performance.

Amundsen & Osmundsen (2018) discuss variables including labor and employment, wealth and distribution, financial performance, production costs, indirect effects on economic activity, investments in technology and innovation, and license and permit conditions under the heading of economics. As a key tool for attaining sustainable development, technological innovation has attracted the attention of academics, professionals, and politicians and several scholars have already demonstrated the importance of technological innovation. Omri (2020), technical innovation in high-income nations promotes environmentally friendly production by motivating investors to adopt innovative technologies for a friendlier environment. The relationship between governance and technical innovation positively contributes to Malaysia's sustainable growth, according to Bekhet & Latif (2018) analysis of the effects of institutional quality and technological innovation on achieving sustainable growth. A company is more likely to invest in green innovation if it emphasizes economic, institutional, and social sustainability (Saunila, Ukko, & Rantala, 2017).

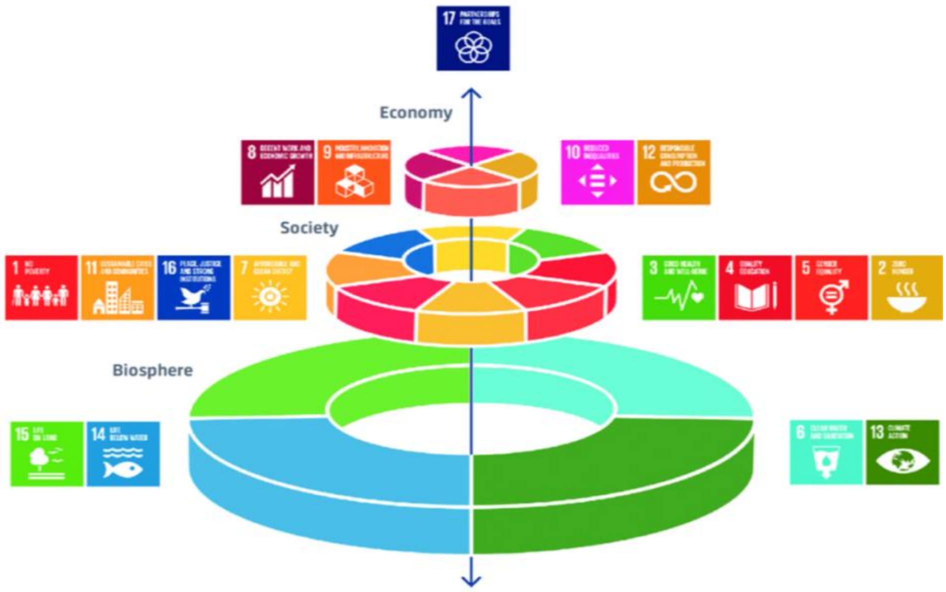


Figure 7: Restructured model for the UN SDGs

Source: (Rockstrom and Sukhdev, 2016)

Chapter 4

4. Relevant literature

4.1 Optimal Capital Structure

According to Jagtap (2013), the capital structure of a company is simply the total of the debt and equity used to finance its long-term operations and growth; bonds and loans often fall under the category of debt, whereas common stock and preferred shares fall under the category of equity. Following an assumption of the ideal capital market and the irrelevance mode of capital structure, four significant theories regarding capital structure have arisen over the years. (Abeywardhana, 2017). First, according to trade-off theory, firms should balance the advantages and disadvantages of debt and equity financing to achieve their best debt-to-equity ratio. Second, Pecking order theory presupposes companies hold to a finance hierarchy to reduce the issue of information asymmetry (Myers & Majluf, 1984). Third, Market timing theory, which explains previous attempts to time the equity market have resulted in the current capital structure as a whole (Baker & Wurgler, 2002). Fourth, the signaling theory predicts that managers would choose their companies' leverage levels to show that they are capable of taking on large amounts of debt and making profitable investments (Kontuš et al., 2022).

It is crucial to understand the cost of capital, which plays a crucial role in investment decisions since it is used to assess the merit of investment proposals, before discussing the ideal capital structure. In simple term, “it is the required rate of return that a firm must achieve in order to cover the cost of generating funds in the marketplace” (Jagtap, 2013). The terms "cost of capital" and "discount rate," "opportunity costs of an alternative project," "investor-required rate of return," and "Weighted Average Cost of Capital (WACC) " can all be used interchangeably and the WACC is widely used to calculate the total cost of capital (Breitschopf & Alexander-Haw, 2022). The use of cost of capital are investment decisions, economic regulation and performance measurement which can be based on several determinants of cost of capital such as Real risk-free rates, Nominal risk-free rates, Investment horizon and term structure, risk premiums and taxes and transaction costs (Patterson, 1995).

There exists a vast body of literature regarding the identification of the most favorable capital structure. Since decisions about finance affect performance, viability, and future survival, capital structure optimization is a crucial yet complex area of company financial management. “An optimal capital structure is the best mix of debt and equity financing that maximizes a company's market value while minimizing its cost of capital” (Kontuš et al., 2022). According to the traditional view, debt is less expensive, therefore combining equity with manageable amounts of debt lowers the firm's overall cost of capital. When a lower cost of capital is applied to the company's cash flow stream, the value of the company increases (Kontuš et al., 2022). Thus, under the traditionalists’ argument, finding a combination of securities that results in a minimal total cost of capital and optimizes corporate value is the aim of corporate management. (Kontuš et al., 2022).

4.1.1 Green bond and Optimal Capital Structure

When it comes to the relation between green bonds and capital structure, there are a several key points to consider. For instance, companies can use green bonds as a method to diversify their funding sources and raise money to finance environmentally friendly projects (Hadaś-Dyduch et al., 2022). By doing this, businesses can rely less on traditional loans from banks and other types of finance, which might not be as accessible or economical.

Likewise, the issuance of green bonds can impact a company's capital structure. Green bond issuance could result in a company's overall debt levels rising and the debt's composition changing. According to empirical studies, companies with higher CSR (Corporate Social

Responsibility) scores have reduced capital costs (El Ghoul et al., 2011) and obtain a better credit risk assessment, measured by credit ratings (Oikonomou et al., 2014) and zero-volatility spreads (z-spreads) (Stellner et al., 2015). Other research indicate that a company's environmental strengths influence its bond spread, bond, and issuer grade (Cubas-Díaz & Martínez Sedano, 2018), and reduce the cost of equity and debt (Chava, 2014).

According to Ning et al., (2022) investors exhibit a willingness to pay a higher price for GBs, resulting in a corresponding decrease in yield. The findings hold significance for the stakeholders involved in the issuance process and the growth of the GB industry. Additionally, government entities could derive advantages from engaging with the GB market for financing low-carbon initiatives at a reduced expense, particularly for bonds that have been verified by third parties. Furthermore, Wurgler & Baker (2018) provide evidence that green bonds experience lower yields ("greenium") than conventional bonds, thus lower the issuer's cost of debt capital. A good track record of subsequent green bond issuances decreases the cost of equity and the WACC by attracting more investors with stronger green preferences and by decreasing the systematic and litigation risk of the firm. This evidence also corresponds to the findings that a firm's ESG/CSR performance can lower the equity cost of capital (El Ghoul et al., 2011) and the debt cost of capital (Chava, 2014). Overall, acquiring green bonds allows companies to acquire capital at possibly lower rates, position themselves in the market, mitigate risks, meet stakeholder expectations, and align with sustainable investment practices.

4.2 Greenwashing

According to Dahl (2010), the phenomenon of greenwashing, which involves the dissemination of misleading or overstated assertions regarding the eco-friendliness or sustainability of products or services, has been observed to have gained traction since the 1980s. The prevalence of this phenomenon has increased in recent times owing to the escalating consumer inclination towards environmentally sustainable commodities and amenities. According to TerraChoice Environmental Marketing, a consulting firm specializing in advertising, there has been a noteworthy surge in the quantity of products that make environmentally friendly assertions. However, the report suggests that 98% of these products are engaging in greenwashing (Dahl, 2010).

Kolcava (2023) argued that the environmental governance community is concerned about greenwashing because of the damage it can do by misleading customers and undermining sustainable development initiatives. The impetus on businesses to implement true sustainability initiatives is diminished if consumers have a false sense of confidence that they are making ecologically responsible decisions when they are not. In the long run, this can have unfavourable effects on the environment and slow down efforts to achieve sustainability targets.

According to Ioannou et al. (2022), any environmental promises have been broken. Greenwashing was found on a large scale in Europe, where 42% of green claims were exaggerated, wrong, or meant to trick people. Greenwashing hurts the happiness of customers. They looked at statistics from the American Customer Satisfaction Index (ACSI), Thomson Reuters' ASSET4 ESG database on social responsibility, and WorldScope's accounting and financial data. As there is a gap between what ACSI says its goals are and what it actually does, customer happiness with ACSI goes down. This difference leads to company hypocrisy, which hurts the product experience for customers. Businesses lose an average of 1.34 points on their ACSI customer happiness score because of greenwashing.

Stopping greenwashing won't guarantee environmentally friendly products. Although greenwashing is illegal, companies may still not implement sustainable practices if the cost is too high or if corporate social responsibility (CSR) is not a top priority (Lee et al., 2018).

When a company doesn't have any other options owing to a lack of resources, it will resort to greenwashing. According to Zhang (2023), It is vitally essential to have access to sufficient financial resources in order to achieve success that is both long-term and sustainable. But if there aren't any subsidies, there's a chance of bankruptcy and "greenwashing." In order to assess the connection between "subsidy shock" and "greenwashing," the author examines data pertaining to publicly traded Chinese companies from 2011 to 2021. Greenwashing is encouraged by subsidy shocks. Subsidy shocks boost greenwashing. When their money runs out, many companies fake their environmental practices. When companies confront financial risks, they are less willing to invest in green innovation and efficiency.

The study by Kolcava (2023) provides suggestions for combating greenwashing. Government regulation of businesses is one option. Voluntary business sustainability pledges are often merely greenwashing, according to those who want top-down government control. More transparency and accountability are other options. So, it may be necessary to combine transparency with other measures, like incentives or fines, to get companies to really help the environment. Also, consumers can help stop greenwashing by learning more about how the goods and services they buy affect the earth and by supporting companies that are really committed to sustainability.

4.3 Sustainability Corporate strategy

CSR is a set of business practices and ideas that every companies practice for the societal good with selected policies and to meet customer expectations. Every business, including the salmon industry, is prepared with corporate strategies to survive in its competitive market. The strategy can be divided into two approaches: Inside-out and Outside-in.

4.3.1 Outside in Approach and Inside out Approach

In this approach, the business takes its environment and customers as its first priorities and designs its business practices accordingly. These include the regulations imposed by the governing institutions about environmental and social issues, which every business must respect; the environmental concerns about pollution, greenhouse gas emission, climate change, and global warming are some external concerns to be considered by the business, shareholder awareness on the ethically sound investments, the pressure from the media and the labor unions in certain decisions of the business (Saeed et al., 2015). This approach is driven by organizational competence with the desire of having the financial capability by lowering the prices of their products and services, strategic capability which provides unique product features to its customers, and technological capability by providing innovative products or services to its customers. All these capabilities help an organization to get optimum competitive advantages over its competitors with its brand, and distinction from competitors within the marketplace (Saeed et al., 2015). To get the best result, Herzig & Schaltegger (2011) suggests embedding sustainability reporting in a double-path approach that combines the strategic inside-out approach of performance measurement and management with the outside-in approach of adapting to the external requirements that benefits with the sustainability communication.

4.4 Corporate Social Responsibility and Socially Responsible Investment

If we analyse the purpose of green bonds, we can find that the organizations are trying to develop better environment, and sustainable economy. According to UNPRI (2023), Fixed income investors can combat climate change and reap dividends by purchasing green bonds. By investing in initiatives related to environmental and climate preservation, they have committed to assisting the transition to a low carbon economy. Also, investors are becoming more conscious of the need to adopt greener practices and work to meet the rising demand for green investment solutions (Maltais & Nykvist, 2020).

So, the behaviour of green bonds is related to the CSR & SRI theory. Maltais & Nykvist (2020) mentioned that with regard to understanding the bottom-up development of the green bond market, the CSR and SRI literature provides us with a significant body of theoretical and empirical work that investigates why businesses engage in sustainability and social responsibility practices beyond what is legally required and regulated. It's crucial to understand that Maltais & Nykvist (2020) do not see involvement in the green bond market as being comparable to SRI, much less as a type of CSR but occurrences might be connected.

The GRI Sustainability Reporting Guidelines are consistently updated to offer the best advice for successful sustainability reporting. Regardless of an organization's size, industry, or location, the Guidelines include Reporting Principles, Standard Disclosures, and an Implementation Manual for the creation of sustainability reports. All persons interested in the disclosure of governance practices as well as the environmental, social, and economic performance and impacts of organizations can use the Guidelines as a global resource. There are two elements to the G4 Sustainability Reporting Guidelines: (i) the Implementation Manual; and (ii) the Reporting Principles and Standard Disclosures (GRI, 2013). However, the need for sustainability in the context of environmental perspective is vital, firms need to change their strategy, mission, and vision as well to ensure the goals of sustainability.

CSR

The fulfilment of a company's financial, statutory, moral, and philanthropic obligations is the entirety of its corporate social responsibility. The CSR corporation should endeavor to make a profit, follow the law, be moral, and be a good corporate citizen, to use more managerial and pragmatic language (Carroll, 1991).

According to Andronie et al. (2019), corporate social responsibility is a way for businesses to consciously include social and environmental responsibility in their business plans and interactions with key stakeholders in society. According to a broad definition, corporate social responsibility refers to actions taken by businesses to maximize profits while also benefiting society (Blowfield & Frynas, 2005). Additionally, they view the CSR as a substitute for the government. The voluntary nature of the strategies firms undertakes in the name of CSR, in contrast to the formal regulatory processes traditionally used to manage business, is seen by many supporters and detractors as a fundamental differentiating factor of the concept (Blowfield & Frynas, 2005). Blowfield & Frynas (2005)_explained that the term "voluntary CSR" can also refer to a broader reexamination of the role of government, with a growing emphasis on enabling laws that promote particular behaviors rather than merely seeking to codify every aspect of conformity.

Depending on how the organization views sustainability ideals and how much it has embraced them, strategies can be classified as passive, reactive, or proactive. By gaining advantages for the business (improving the reputation and image of the organization, boosting operational effectiveness, boosting customer loyalty, creating a competitive advantage, providing incentives for shareholders, and increasing profitability), employee advantages (improving motivation, fostering teamwork, minimizing internal conflicts, and eliminating discrimination), and shareholder advantages like paying benefits to shareholders, boosting financial performance (Andronie et al., 2019). According to Maltais & Nykvist (2020), the external success like direct financial benefits, business case benefits, and legitimacy and institutionally oriented incentives is a form of motivation to both issuers and investors for acquiring green bond.

CSR is crucial for promoting green finance. Chueca et al. (2021) highlighted that CSR and ESG factors are emerging issues resulting from growing customer concerns for sustainability and environmental respect. Corporate Social Responsibility (CSR) entails companies acknowledging their societal and environmental impact and adopting sustainable policies and practices. Companies can exhibit their dedication to sustainability and appeal to investors who prioritize ESG factors by taking this approach. Consequently, this may result in a surge in the allocation of funds towards green finance, denoting financial instruments and amenities that facilitate ecologically feasible projects and initiatives.

SRI

Tennberg et al. (2019) argued that socially responsible investments (SRIs) have the potential to serve as a financial instrument for raising capital to support both the reductions of emissions and adaptation measures in response to climate change. SRIs tend to take into account both financial profits and the good of society. For an investment to qualify as an SRI, it must demonstrate a commitment to achieving a positive social or environmental impact. According to Chueca et al. (2021), the concerns of environment and sustainability have a significant influence on both consumers and investors. Contemporary investors have incorporated non-financial factors such as environmental, social, and governance (ESG) standards into their investment decision-making process. The investment strategy of socially responsible investment (SRI) extends beyond the pursuit of monetary profit. Investors who prioritize non-financial benefits are attracted to companies that are in alignment with their social values. Lewis (2001, p. 333) stated that a solid majority of moral green investors are ready to face losses in order to put their cash where their principles are.

Investors initially requested information from the "bottom-up" regarding the projects supported by labelled bonds, but as global regulators and standards bodies make it more transparent through the implementation of global sustainability standards, this information need is also driving "top-down" strategies. Investors may be capable of routing funds to the most preferable areas depending on both return and risk with the aid of these additional disclosures. In light of policies like carbon pricing, which has made progress but still has a ways to go, calculating external costs and benefits, and determining the economic value of nature, such comprehensive approaches to transparency will allow for better comparisons and allow investors to take into account an investment's full social and environmental impact (Reichelt & Cantor, 2023).

As of 2021, there were no explicit criteria or procedures from the Securities and Exchange Commission (SEC) for SRI investors in the United States, particularly for registered investment companies. Nonetheless, the SEC has been taking constant action in relation to ESG-related investing, such as issuing risk alerts on suspected misconducts of registered investment companies and other fund managers over ESG-related (environmental, social, and governance) product claims (SEC, 2021).

The anticipated return a company must provide as payment for the risks involved in owning its stock is known as the cost of equity capital (Wang et al., 2023). It is a crucial component of corporate valuation and greatly affects choices regarding operations and finance (Dhaliwal et al., 2011). Wang et al. (2023) noted that investors will demand a greater projected rate of return from a company if they associate a project with high risk as contrasted to a project with low risk. The benchmark for evaluating the relative risks connected with business projects is the firm cost of equity capital. When the cost of equity capital is lower, a company can more easily take on new ventures due to the lower projected return it must pay investors.

Chapter 5

5. Research Methodology

This section on the research methodology seeks to describe the systematic approach and framework used to evaluate companies' green bond impact reports using the three-dimensional sustainability approach (Eadie et al., 2011). To understand how this approach relates to the UN SDGs and EU Taxonomy, it takes into account three factors: the environment, the social, and the economic (EU, 2020a). The following sections provide an overview of the research design, data collection, analysis techniques, and theoretical framework applied in this study.

5.1 Research Design

This study is built upon a qualitative research design based on green bond impact reports, annual report, sustainability reports, companies' websites, different scientific literature and governmental websites related to either aquaculture, green bond or sustainability to answer the research question. The nature of the method is interpretivism, hence making the research inductive. The major goal is to broaden the understanding of how green bonds enhance the sustainability of the Norwegian salmon business by assessing the environmental and social effect of green bond projects, as well as their alignment with the SDGs and EU Taxonomy.

For developing the framework, we used the The Three-dimensional Approach of sustainability. Therefore, information found in the documents and reports that was relevant was organized based on whether it related to the environment, the social, or the economic. This design seeks to investigate and analyze the green bond impact reports of four salmon companies namely, Mowi, SalMar, Grieg and Lerøy with a focus on evaluating their strategic initiatives related to sustainability practices. The study also uses a cross-sectional approach to look at annual reports and sustainable reports from companies over the past five years to examine the sustainability initiatives they have implemented so far in addition to their participation in green bonds. It is further classified into two different corporate strategies: Inside-out and Outside-in (Saeed et al., 2015). In order to see the impact in the sustainability areas, linking between the UN SDGs, EU Taxonomy, and Green Bond has been prioritized. This research design offers an extensive understanding of the green bond's sustainability features, as well as its contribution to the SDGs and EU Taxonomy compliance.

5.2 Data Collection

The primary data source for this research is the green bond impact reports of selected companies. Following the first green bond issuance, these reports offer a lot of information about a company's sustainability efforts. According to specific requirements, such as Norway's top salmon companies that have issued the green bond, companies are chosen. The green bond impact reports are accessed through company websites, online databases, and other relevant sources. In total 8 green bond impact reports were analyzed for the selected four companies. In brief, Mowi has 3, SalMar has 2, Grieg has 2 and Lerøy has 1. In addition, the five-year period of annual report was analyzed from 2018 to 2022. Likewise, sustainability reports, companies' websites, different scientific literature, and governmental websites related to either aquaculture, green bond or sustainability were accessed.

Since we have been very careful when selecting the documents, only those documents that will clarify the study question have been chosen. The selection of the documents was guided by two requirements: First to identify how green bond links with improving sustainability both on a global and national (Norway) basis in general. Second, we needed documents that could be used to identify how green bond advances sustainability in Norwegian Salmon industry.

5.3 Data Analysis

The three-dimensional sustainability approach is used in the data analysis process to systematically examine the collected green bond impact reports. To gain insights into environmental, social, and economic aspects, each dimension is examined independently. Each of the three dimensions has its own indicators, which are listed in Table (Amundsen & Osmundsen, 2018; Husgafvel et al., 2015; OECD, 2003).
All the practices carried out by the four salmon companies will be segregated in these indicators to see how well they align with the SDGs and EU taxonomy goals and, ultimately, improve the sustainability of the Norwegian salmon industry. The evaluation will be done by looking at the tables showing linkage between Green Bond and SDGs (ICMA, 2020) and Green bond and EU Taxonomy (Authors). The analysis and results in the next chapter will mainly consist of information from green bond impact reports under these given indicators.

Environment Indicator	**Social Indicator**	**Economic Indicator**
Carbon Emission	Safe workplace	Labor & employment
Freshwater use	Diversity & Equality	Value Chain
Sustainable feed	Community Engagement	Investment in technology &Innovation
Waste management	Human safety	
Certification and ratings		
Fish health and welfare		

Table 4: Selected indicators under three dimensional approach

Source: (Authors)

5.4 Limitation

It is important to be aware of any possible limitations this research methodology may have. These might include the potential limitations of indicators, subjectivity in analysis: dependency on publicly available reports and documents, time constraints, and possible data limitations in green bond impact reports. Understanding these limitations contributes to a more thorough comprehension of the results and their implications.

5.5 Ethical considerations

This study abides by ethical standards and principles, such as confidentiality, privacy, and accurate source citation. The study acknowledges the companies' efforts to disclose information while respecting the intellectual property rights of the green bond and other related reports. Without appropriate consent and anonymization, no personal or sensitive information is collected or disclosed.

This research methodology describes the systematic approach used to evaluate the environmental, social, and economic aspects of companies' green bond impact reports. A thorough framework for evaluating companies' strategies toward sustainability practices is provided by the research design, data collection techniques, data analysis strategies, and theoretical framework. The limitations and ethical considerations ensure that the research is carried out carefully and honestly.

Chapter 6

6. Analysis

Under this analysis section, we have analyzed the green bond impact reports of four salmon companies i.e. Mowi, SalMar, Grieg and Lerøy in Norway using theoretical framework three-dimensional approach i.e. environment, social and economic. This approach by Tanzil (2006) was used to assess how green bonds are advancing sustainability in the salmon aquaculture sector. We organized our findings by identifying the key sustainability indicators that these companies focus under green bonds. Furthermore, we examined the annual reports of all companies from 2018 to 2022 to determine how committed they are to sustainable practices that demonstrate their commitment to green bond projects.

6.1 Environment Indicator

In this section, we discussed the practices of four salmon companies in relation to six environmental measures namely carbon emission, freshwater, sustainable feed, waste management, certification and ratings, and fish health and welfare.

6.1.1 Carbon emission

Carbon emission is one of the major challenges to maintain the sustainability. Carbon emissions contribute to the greenhouse effect, which disrupts the Earth's climate system leading to global warming and climate change. The different strategies followed by the stated salmon companies to reduce the carbon emission are analyzed below.

Mowi

Mowi (2020, p. 8) has demonstrated its commitment to lowering carbon footprints by improving logistical efficiency. For instance, the Kyleakin feed factory's coastline position combined with its own deepwater pier enables effective bulk shipping of feed products and raw materials. According to Mowi (2020), Mowi was able to prevent more than 8,000 individual truck trips, saving 2 million miles of travel time. It is noteworthy that the plant is predicted to reduce CO2 emissions by about 3,000 tonnes annually. This shows Mowi has practiced the control over the impact of scope 1 in terms of clean transportation aligning with sustainable goal of climate action. The green bond proceed for this category supports the objective of EU taxanomy i.e. Climate change mitigation (EU, 2020a).

Mowi also favors the deforestation free consumption. Therefore, Kyleakin consumed 23,116 tonnes of soy protein concentrate (SPC) that was 100% segregated and deforestation-free according to certifications from ProTerra (22,900 tonnes) or Naturland (216 tonnes), which prevented about 95,400 tonnes of CO2e emissions over the course of the year compared to using uncertified soy that was sourced from deforested land (Mowi, 2020, p. 8).

As part of a "outside-in" approach, the Green Bond Committee approves each green project, and the Green Register keeps track of all expenses that are currently eligible for financing with green bond proceeds, minus any sums for the acquisition and installation of fossil fuel-consuming equipment. For instance, while a normal RAS facility has backup diesel generators, Kyleakin features an LNG power plant (Mowi, 2020, p. 11). The act of using equipment that avoids fossil fuel also shows the effort in fulfilling the climate change adaption of EU taxonomy and supports SDGs 1,2 and 13 (ICMA, 2020). By using segregated deforestation-free soy at Kyleakin, Mowi prevented 95,354 tonnes in 2020, 84,276 tonnes in 2021, and 64,572 tonnes in 2022 each year, aligning the SDGs 13 climate action goal.

SalMar

In 2021, SalMar's local processing kept 52,000 tonnes of CO2-equivalent pollution from going into the atmosphere (Ronæss, 2022, p. 7). Taking into account the InnovaNor plant's ability to process materials locally, these emission saves are expected to grow by 26,000 tonnes CO2e per year. In 2022, SalMar's local processing prevented 86,000 tonnes of CO2-equivalent emissions from entering the atmosphere (Ronæss, 2023, p. 7). Thus, they achieve a 34,000-ton decrease in carbon emissions between 2021 and 2022. They are taking positive climate action by reducing their carbon output, which is in line with Sustainable Development Goal 13 and EU Taxonomy Objective 1: Climate Change Mitigation. As a result, they have a beneficial effect on the surrounding ecosystem and increase its longevity.

At Tjuin, the smolt facility will be adjacent to the energy company, Nippon Gases, allowing for a possible symbiotic collaboration in which Nippon Gases could receive waste substances from filtered wastewater from the smolt facilities and SalMar could receive excess heat from their production or other necessities for smolt production from Nippon Gases, all locally sourced (Ronæss, 2023, p. 8).

Grieg

Grieg is primarily focused on the RAS project, which is a crucial part of the post-smolt strategy that lowers organics emissions and the danger of escape and supports the reduction of scope 1 and 2 emissions, in accordance with the SDGs to reduce emissions (Grieg, 2020, p. 11). The period spent in seawater can be greatly reduced by using the post-smolt technique, since the smolt is held longer in a protected environment before being placed into conventional sea cages because the seawater is the most lice and disease prone environment in the production cycle (Asche and Bjørndal, 2011). Reducing the amount of treatments for sea lice helps cut down on carbon emissions (Liu & Bjelland, 2014). In 2021, 40% of the fish harvesting pens received no sea lice treatment, maintaining the annual economic losses and Grieg has reduced the requirement for well boats for sea lice treatments (Grieg, 2021, p. 11) (Hamre et al., 2013).

Furthermore, there are different projects that Grieg has invested on that has good impact on carbon emission. The Gold River Expansion Project was initiated in 2019 and consisted of the construction of a new recirculating aquaculture building (RAS 34) also plays a role in reduction of emission. Another plant, Adamselv, is an important part of our post-smolt strategy enabling Grieg Seafood to sustainably produce fish under the best circumstances (Grieg, 2020, p. 15). At the Teistholmen sea farm in 2020, reduced the number of sea lice treatments applied to the post-smolt fish by 50%. As mentioned by Boerlage et al. (2020), Pancreas Disease (PD) indications show that a shorter time at sea has reduced the risk of PD. PD often occurs at the end of the salmon's production cycle, just before harvest. In 2017, Grieg had PD at more than half of their farms in Rogaland, while in 2020 they had only one outbreak (Grieg, 2020, p. 13).

Grieg is also trying to reduce the emission by boosting the logistical efficiency. For instance, by investing in new plants as a part of their green bond in Newfoundland, that facilitates to supply fresh salmon to the fast-growing North American market without airfreight which is one of the biggest sources of emissions (Feldhoff & Metzner, 2021). Newfoundland RAS design focus on low energy consumption supporting the scope 2 (Grieg, 2020, p. 5).

Proceeds include investments in battery packs and electrification through grid connection to make production sites independent from fossil fuel/ diesel consumption (Grieg, 2021, p. 12). Overall effort shows they have control over the scope 1 and 2 from their green bond reports. For instance, the report shows that the emission avoided in the category environmentally sustainable aquaculture i.e., increased fish survival has decreased in 2021 by 5000tCO_2/year. Scope 3 is the hardest one and the green bond impact report of Grieg doesn't show any effort in this side supporting the innovation in seafood value chains (Bergesen & Tveterås, 2019).

Lerøy

Lerøy cut their GHG output by 8 percent between 2020 and 2021. Using 2019 as a starting point, Lerøy aims to cut carbon emissions in half by 2030. The Science Based Targets effort has shown that this goal is consistent with the "below 1.5 degrees" scenario outlined in the Paris Agreement (Johansen, 2022).

The automated facility of Lerøy makes lots of fresh fillets. With maximum production of fillets, the transport requirement, and thus the emissions of CO_2, will be reduced by about 45%. This demonstrates Lerøy's control over the impact of scope 1, specifically with regards to clean mobility that is in line with a long-term goal of climate action. EU Taxanomy's goal of climate change mitigation is enhanced by the proceeds from these green bonds. This achievement is also supported by SDG goal 13 Climate Action as it reduced the Co_2 emission.

6.1.3 Freshwater use

Excessive or maximum freshwater extraction can have a number of negative environmental consequences. As a result, it is critical to have sustainable freshwater management. This can include practices that promote water conservation, efficiency, and responsible use, water recycling and reuse, rainwater harvesting, efficient irrigation techniques, water-saving technologies, and so on. The different strategies followed by the stated salmon companies to reduce and recycle the freshwater use are analyzed below.

Mowi

Mowi follows the circular economy concept to minimize the freshwater usage. Hence, following the inside out approach, Mowi's freshwater plant Fjæra is actively engaged in recycling and recirculating freshwater. RAS can be seen as a practical application of the circular economy concept in the aquaculture industry (Ahmad et al., 2021). Following this approach, Fjæra produces smolt of up to 350 grams compared to the normal size range of 100–150 grams from a conventional flow-through facility (Mowi, 2020, p. 11). Freshwater use and efficiency is governed through their sustainability strategy, Leading the Blue Revolution Plan. Mowi's freshwater use is audited by a third-party and reported according the GRI 303-3 (Freshwater Policy, 2022).

They have constants freshwater savings record of 121 million m3 per year from 2020 to 2022 meeting SDG 6 clean water and sanitation (Hoekstra, Chapagain, & Van Oel, 2017) . Meeting SDG 14 Life below water, they have continued expansion of smolt facilities using Recirculating Aquaculture Systems (RAS) technology has the potential to allow for reduction of time in sea by up to six months for larger postsmolt (Rud et al., 2017). Proceeds allocated to the water-use efficiency category in Mowi has reduced production time in sea, thereby reducing the number of sea-lice treatments, and exposure to other external risks. The usage of technology like RAS shows that Mowi supports the objectives of EU Taxonomy i.e. Transition to a circular economy, pollution prevention and control, and sustainable use and protection of water and marine resources.

SalMar

New smolt facilities in InnovaNor with state-of-the-art Recirculating Aquaculture System (RAS) technology will improve operational control of the water environment and in 2022 it saved 865 million m3 of external freshwater compared to conventional flow-through systems. Over the past few years, SalMar's proportion of smolt delivered by RAS facilities has grown, resulting in a corresponding reduction in freshwater withdrawal. New estimates put 2022 RAS smolt delivery at 97%, with 45.1 million m3 of freshwater withdrawal (Ronæss, 2023, p. 11), and 2021 RAS smolt delivery at 89%, with 36.7 million m3 of freshwater withdrawal (Ronæss, 2022, p. 11).

Withdrawing 441.5 million m3 of water annually from a system that circulates 840 m3/min. At Tjuin and Senja flow-through system would remove this much water. With 98% recirculation, the system will reduce 8.8 million m3 water withdrawal annually. RAS investments at SalMar's new smolt facilities will reduce yearly water extraction by 432.7 million m3 in each facility, or 865 million m3 for both facilities, compared to flow-through systems (Ronæss, 2023, p.11).

Grieg

The majority of the green bond proceeds are allocated to their RAS facilities, which reduce fresh water consumption by almost 100% when compared to standard non-recirculating aquaculture systems (Fredricks, 2015). Grieg recirculates the majority of the freshwater using RAS technology to increase water efficiency following the inside out approach. In addition, wastewater management is an essential component that Grieg focuses, with the goal of reducing discharges to the sea and environment (Venier, 2018).

In 2020, proceeds were invested in water and wastewater management infrastructure at their broodstock Finnmark plant in Rogaland, thereby increasing resource efficiency and lowering wastewater discharges (Grieg, 2020, p. 12). However, in 2021, they did not allocate proceeds directly to this category (Grieg, 2021, p. 12). Grieg's RAS plant in Newfoundland is fitted with cutting-edge effluent treatment equipment that enables for the reuse of nearly 100% of RAS effluent water in the production line. Furthermore, all solid waste is collected, resulting in a facility with zero effluent discharge and complete control over waste products such as sludge (Grieg, 2021, p. 15).

For instance, all of the discharge water at Adamselv is collected at a dedicated building through a piping system and goes through different process for water treatment. The Gold River Expansion Project was initiated in 2019 and consisted of the construction of a new recirculating aquaculture building (RAS 34) (Grieg, 2020, p. 15). Despite the fact that the project was delayed due to Covid-19, the first fish were transported to the RAS 34 facility in April 2022 and are doing well. All of these activities contribute to the achievement of SDGs 6, 7, 8, 9, 11, and 14 (ICMA, 2020). Grieg's usage of RAS demonstrates its support for EU Taxonomy objectives i.e., Transition to a circular economy, pollution prevention and control, and sustainable use and protection of water and marine resources.

Lerøy

Sustainable fish processing plant at Jøsnøya uses 50% less freshwater than the old one. One of the goals of EU Taxonomy is to ensure that water and marine resources are used and protected in a sustainable manner. The plant is helping to achieve one of the goals of the EU Taxonomy by reducing the amount of water it consumes (Johansen, 2022).

The new plant at Kjaerelva recycles 98.9% of its water and uses only 600 liters of new water per kilogram of feed. In 2021, 3,505 tons were made at Kjrelva. If the feed factor is 0.85, it is expected that 1.8 million m3/year of water will be used in 2021. Water is not recycled in a standard flow-through system. Based on a recirculation rate of 98.9%, a typical flow-through system uses an estimated 119.2 million m3 of water per year (Johansen, 2022). So, the new system saved around 117.4 million m3 of water annually.

6.1.3 Certification and Ratings

Certification and Ratings are one of the measures that evaluate three dimensions of sustainability of any companies based on specific standards. These certifications and ratings offer third-party verification and recognition, enabling stakeholders to make more informed decisions that promote sustainable practices. ASC is one of the most widely used in the salmon industry. The different certification linked with the stated salmon companies are analyzed below.

Mowi

Mowi operates under different third party certifications i.e. Global Seafood Sustainability Initiative, Global Food Safety Initiative, The Aquaculture Stewardship Council, GLOBAL G.A.P. and GSA BAP (Mowi, 2022a).

Mowi has a track record of being a market leader in ASC certification, with a total of 133 farming sites certified globally by the end of 2021 (Mowi, 2021, 2022a). This represents 50% of their farming sites and accounts for 33% of all the ASC certified Atlantic salmon sites worldwide. All the green projects of Mowi follow the global standards such as the Global Reporting Initiatives (GRI) which is crucial in maintaining sustainability (Milne & Gray, 2013). The continuity in securing good score from different rating agencies is also a highlight in the report (Mowi, 2022b). They focus on the criteria set by these external parties to improve the sustainability and is outside in strategy.

SalMar

The new production licenses must be applied for at fish farms that have received certification from the ASC or are in the process of doing so. ASC rules are currently the most significant in the sector and apply severe restrictions on all elements of fish farming operations.

The Board of Directors and Group Chief Financial Officer (management) are in charge of establishing the criteria and presenting the subject matter in a manner that is, in all material ways, consistent with those criteria. In order to prepare the Subject Matter without serious misstatement, whether as a result of fraud or error, this task entails creating and maintaining internal controls, keeping proper records, and generating estimates that are pertinent to the preparation of the Subject Matter. The value of farms with ASC or Debio (organic) certifications increased to 79% in 2021 (Ronæss, 2022, p. 9). The percentage of ASC or Debio (organic) certified farms has dropped to 62% as SalMar has expanded into new facilities (Ronæss, 2023, p. 9).

Grieg

Most of the active sites of Grieg are certified by ASC mainly in Rogaland, Finnmark and British Columbia with a total of 29 of 40 eligible sites (Grieg, 2022, p. 7). In 2021, Grieg managed to certify all active farms in Finnmark, and aim to certify all their active farms by 2023 (Grieg, 2021, p. 10). Along with ASC, BAP (Best Aquaculture Practices) or GLOBALG.A.P (Global Good Agriculture Practices) certifies the farming operation in Rogaland, Finnmark and BC which is recognized by Global Food Safety Initiative (GFSI) allowing Grieg to access the corner of global market. GFSI is considered to be a mark of highest standards in food safety (Overbosch & Blanchard, 2023). All these certifications are the outside in strategy that Grieg follows to support the dimension of sustainability.

Lerøy

The Green Finance Framework considers Chain of Custody (CoC)-certified ASC product processing facilities Green Projects. The Jøsnøya plant has been independently assessed and certified as environmentally and socially responsible by the Aquaculture Stewardship Council (ASC) for farmed seafood. Lerøy's commitment to sustainability and commitment to upholding responsible standards are attested to by their possession of Global GAP and ASC accreditation. One hundred percent(100%) of Lerøy's facilities have either a GLOBAL GAP or an ASC certificate on their sites (Johansen, 2022).

6.1.4 Sustainable Feed

Sustainable feed refers to the production and use of feed ingredients in animal agriculture that minimize negative environmental impacts, promote animal welfare, and support long-term ecological balance. The different strategies followed by the stated salmon companies in the process of producing sustainable feed are analyzed below.

Mowi

The majority of the proceeds from Mowi's green bond are invested in sustainable feed. 100% of their marine raw materials were either Marine Trust Standard certified (MSC) or part of fisheries improvement projects intended at reaching MSC (Mowi, 2022b, p. 76). In addition, in 2022, they included algal oils in their feed formulation, which is an useful sustainable alternative (Bélanger-Lamonde et al., 2018).

Mowi has been collaborating closely with their soy suppliers to including work through Proterra certification and continuing to support MRV (Monitoring, Reporting and Verification) audits of their Brazilian soy protein concentrate suppliers. A study was also initiated on the carbon footprint of Brazilian soy from ProTerra-certified sources (Mowi, 2020, p. 8). However, based on the green bond impact reports, in 2020, 23116 tones deforestation-free SPC was consumed, in 2021, 17745 tones and in 2022 11731 tones. This shows the decrement in the consumption of SPC.

This practice of using sustainable raw materials to produce sustainable feed shows the effort in fulfilling SDGs 12 and 15 along with the EU taxonomy objective of Protection and restoration of biodiversity and ecosystems.

SalMar

SalMar has reduced economic feed conversion ratio from 1.19 in 2021 to 1.18 to 2022 in their coastal fish farming. To reduce the use of wild fish as a feed ingredient and to preserve full traceability for both wild fish and soy back to a responsibly managed source, fish farms must adhere to stringent rules (Ronæss, 2022, 2023).

Grieg

Grieg buys feed in which all of the marine ingredients meet the standards for sustainability set by MSC, or the International Fishmeal and Fish Oil Organization's Global Standard for Responsible Supply (IFFO RS) and this is where 100% of the soy products are certified according to the sustainability standards set by Proterra or the Round Table on Responsible Soy (Grieg, 2021, p. 11). This is done using the segregation model to make sure that certified and non-certified soy are kept separate (Salzeet al., 2010).

The feed Grieg use also complies with ASC standard on fish meal and fish oil and also supports the traceability within supply chain (Grieg, 2022, p. 46). For instance, feed from Cargill Aqua Nutrition has not been included in the use of proceed to ensure to meet the standard of green bond. Grieg also supports the Zero deforestation by involving with Brazilian soy protein concentrate vendors (Grieg, 2022, p. 47).

Grieg (2020) shows that the feed included in their use of proceeds, is part of a fish health and welfare project with the feed supplier Skretting. This sort of effort shows the inside out approach towards sustainability. The aim is to investigate the effect of feed for prevention of diseases and nutritional support for infected fish. This will contribute to a lower carbon footprint by reducing the amount of feed needed to produce salmon (diseased fish do not utilize feed optimally, in particular in the event of mortality) (Stentiford et al., 2012). Another effort towards this category shows that a share of their feed volume used in 2021 has been part of research and development projects where the focus has been to optimize nutrition in relation to different fish health and welfare challenges (Grieg, 2021, p. 11). However, in the transparent report, Grieg hasn't shared any consumption calculation of the SPC.

Lerøy

There is a 98.9 percent water recycling rate at the new Kjaerelva facility, and only 600 liters of fresh water are required for every kilogram of feed processed (Johansen, 2022). In 2021, Kjrelva's output amounted to 3,505 tons. Water consumption in 2021 is predicted to be 1.8 million m3/year, based on a feed factor of 0.85 (reducing water consumption and saving the water while produce feed).

6.1.5 Waste management

Sustainable waste management aims to reduce waste's adverse effects on the environment, preserve resources, and promote the concepts of the circular economy. The different strategies followed by the stated salmon companies in the process of managing waste are analyzed below.

Mowi

There is no information regarding the waste management in the green bond impact report of Mowi.

SalMar

The smolt facility will be situated in Tjuin, not far from the Nippon Gases power plant. Because of their close proximity to one another, Nippon Gases and SalMar may be able to work together to mutually benefit both businesses. For example, Nippon Gases may be able to use filtered wastewater from the smolt facilities to generate electricity, while SalMar may be able to use excess heat from Nippon Gases' production to power its own operations (Ronæss, 2023, p.8).

Grieg

Grieg follows the circular economy to ensure sustainable food production. For instance, in Adamselv, they make a circular usage of the nitrogen and phosphorous rich fish sludge which are transported to a factory where it is used as a high quality fertilizer component and further used for agriculture (Grieg, 2020, p. 12). This shows the effort towards the objective of EU Taxonamy i.e., Transition to a circular economy.

Likewise, in Newfoundland, A by-product of the RAS which is also a sludge are efficiently collected so that it can be processed at a local municipal waste management facility. Through the use of a sophisticated enclosed vacuum-pump system, Grieg also efficiently collect mortalities from our RAS facility and biosecurely produce silage. This essentially recycles the waste into a value added stream, where it produces energy and a high value agricultural product.

It is estimated that in Norway, around 27000 tons of nitrogen and 9000 tons of phosphorus are discharged to the sea each year as fish sludge emissions from fish farming (Hamilton et al., 2016). This circular economy effort of Grieg has positive impact as in 2020 proceeds include investments in infrastructure for handling biological waste, contributing to increased resource efficiency and reduction in waste to landfill and incineration (Grieg, 2020, p. 12). Proceeds in 2021 included investments in infrastructure for handling biological waste in Finnmark and British Columbia (Grieg, 2021, p. 12).

Lerøy

The water in all of the different areas of the plant in Kjaerelva is cooled and heated using a heat pump that is fuelled by glycol, which is part of the contemporary energy system that the facility uses. The facility is able to extract energy from the wastewater through its processes. Before the wastewater is released into the environment, the energy that was previously utilized to heat the water is recycled. The facility contains heat pumps that transfer heat from the outside air to the interior air, which results in significant energy savings. The manufacturing facility in Jøsnøya produces no emissions other than highly filtered process water, and it separates all of its waste (Johansen, 2022).

6.1.6 Fish health and welfare

Fish health and welfare are critical aspects of aquaculture sustainability. Sustainable fish health and welfare practices reduces fish diseases and promote responsible and ethical fishing and farming practices. The different strategies followed by the stated salmon companies in the process of enhancing fish health and welfare are analyzed below.

Mowi

In green bond impact report, there is no proceeds allocated to this category by Mowi.

SalMar

SalMar exercises strategic decision-making regarding the growth environment and ultimate size of the smolt, as it oversees the complete life cycle of the salmon. SalMar has the potential to produce the required quantity of smolt at any given time, provided that optimal biological conditions are maintained to ensure the maximum welfare of the fish. The novel infrastructure of

SalMar will embody their offshore strategy, characterized by the utilization of tanks that are specifically engineered to accommodate larger smolt compared to those typically employed in coastal operations. The optimal weight range for smolts in the marine environment, characterized by low mortality rates and high welfare standards, has been identified as falling within the range of 500 to 700 grams. These young fish exhibit greater resilience in coping with adverse weather conditions (Ronæss, 2023, p. 8).

Grieg

In this indicator, Grieg have embraced the reduction in the use of chemical treatments that saves the deliveries and pickups (Grieg, 2020, p. 11). But it might be their Greenwashing strategy to save their operating cost on chemicals, which was the same scenario when the concept of Green Washing was initiated (Chen, Bernard, & Rahman, 2019). This could be noted because they haven’t been precise about the chemical treatments in any of their transparent reports.

Grieg monitor, control and analyze the seawater environment, as well as preparations to become certified by the ASC. For instance, post-smolt strategy in Rogaland is an example. In 2021, 40% of the pens with fish harvested did not receive any sea lice treatment. Also, all the active farms in Finnmark in 2021 was certified by ASC. This supports SDGs 14 i.e., life below water and EU taxonomy of protection and restoration of biodiversity and ecosystems.

Lerøy

Lerøy Seafood Group has made investments in "post-smolt" in recent years. Smolts spend less time at sea if they are kept on shore for longer. Because nearly all of the water is reused, this should improve fish wellbeing without significantly increasing water withdrawal. It's useful for stopping someone from getting away. The Kjaerelva smolt facility is one of our most environmentally friendly because it was developed with an eye toward the future. In order to maintain the ideal environment for the fish during the smoltification process, a smolt facility requires a substantial amount of water circulation. Fish do better in clean, fresh water (Johansen, 2022). Jøsnøya plant receives fish directly from well boats, eliminating the need for additional pumping required at the prior factory. This is good for the fish (Johansen, 2022).

6.2 Social Indicators

Social indicators are the measure for assessing social impact that includes performance of organizations, communities, and individuals by addressing various social aspects, such as community engagement, child labour, safe workplace and so on. The different strategies followed by the stated salmon companies in promoting positive social outcomes are analyzed below.

Mowi

In the annual report of Mowi, they have mentioned about the social perspectives. However, in green bond impact report, the information related to social dimension is not shared.

SalMar

SalMar has increased its operational scope and workforce to enhance its potential for cultivating specialized professionals and acquiring significant expertise in critical areas such as human safety (Ronæss, 2023, p. 7).

SalMar promotes Diversity & Equality allowing safe and fairer workplaces where workers are paid fairly and have set working hours. Likewise, enhancing safe workplace, child labor and any other forms of forced labor is prohibited in SalMar. Promoting community engagement, they also engage with local communities, educate them about health hazards, and give them access to necessary resources. SalMar improves its potential for producing subject-matter experts and gaining useful expertise in crucial social norms like human safety by expanding operations and hiring more people.

Grieg

In the annual report of Grieg, they have mentioned about the social perspectives. However, in green bond impact report, the information related to social dimension is not shared.

Lerøy

The primary objective behind the construction of the Jøsnøya facility was to establish a state-of-the-art and extensively automated salmon processing plant. The aim is to achieve a processing method for fish that eliminates the need for manual handling by human operators within the facility. Whilst the facility may not be entirely automated, the automated components of the building serve to minimize human contact, thereby enhancing human safety (Johansen, 2022).

6.2 Economic Indicators

Economic indicators are the metrics that are used to examine the overall performance of the economy that includes various economic aspects such as employment, innovation and so on. The different strategies followed by the stated salmon companies in promoting economic growth are analyzed below.

Mowi

The proceeds have been invested in RAS supporting Technology & Innovation. In addition to its environmental benefits, RAS technology has the potential to provide economic benefits through increased efficiency and productivity (Mowi, 2022a, p. 5). This effort aligns with SDG 9 for industry innovation and infrastructure. Another sustainability excellence is innovation on net pens that includes real time surveillance, autonomous cleaning of nets, underwater camera and sensing systems (Mowi, 2022b, p. 147).

SalMar

The focus shows towards investment in Technology & Innovation. SalMar seeks to maximize output while maintaining salmon-friendly conditions for the oceans. This involves making a contribution to the creation of new technology, such as cutting-edge processing facilities and recirculating aquaculture systems for the sustainable production of smolts (Ronæss, 2022).

Likewise, under Labor & Employment, local processing has a positive social impact. More work being done in Norway results in more jobs being created in the coastal areas, where InnovaNor already employs over 200 people (Ronæss, 2022, p. 7). More jobs in the areas encourage people to come there, where they may make a livelihood and spend their money locally, maintaining the economic wheels rolling also in these nearby villages. Also, in value chain, by keeping the processing local, the value chain can be regionally shortened, which also helps the government execute its policies more skilfully. This makes internal and external auditing more transparent and enables SalMar to keep complete control over a broader portion of its value chain.

Grieg

The proceeds have been invested highly in RAS meaning it is invested in Technology & Innovation. Grieg has invested immensely in the research and development that aligns with SDG 9 for industry innovation and infrastructure.

RAS facility in Newfoundland is equipped with the latest state of the art effluent treatment technology (Grieg, 2021, p. 15). The Gold River Expansion Project was initiated in 2019 and consisted of the construction of a new recirculating aquaculture building (RAS 34) and upgrades to the chemical and hydro power services for both RAS 34 and the rest of the hatchery, as well as installation of state-of-the-art IT and systems for the whole site (Grieg, 2020, p. 14).

Grieg has also invested in building new plants. High-end freshwater and saltwater RAS facility in Marystown's marine industrial park, close to Placentia Bay is another example (Grieg, 2021, p. 15). The RAS facility currently under construction includes a hatchery, a nursery and a smolt unit. This shows an inside out strategy to maintain the efficiency within the firm.

These type of R&D projects leads to cost savings, which can be passed on to customers in the form of lower prices, making the products more competitive in the market. Finally, as sales increase, companies can reinvest their profits in sustainability initiatives, further promoting sustainability and creating a virtuous cycle of sustainability and sales growth (Seebode, Jeanrenaud, & Bessant, 2012).

Lerøy

The primary goal of Lerøy is to establish a seafood value chain that is sustainable, highly efficient, and unparalleled in its global reach. The effective incorporation of Lerøy's value chain, which encompasses the entire process from raw material production to end-user consumption, plays a crucial role in creating value and advancing sustainability efforts. Lerøy's competitive advantage is attributed to the efficiency, affordability, and reliability of its operations. In addition, the approach enables the generation of novel products, guarantees the ability to track the origin and journey of food items, and maintains the standards of quality control. Lerøy's complete control over all stages of the process provides them with a unique advantage in understanding, measuring, and improving the value chain, ultimately reducing its impact on the environment (Johansen, 2022).

Environment Indicator	Mowi	SalMar	Lerøy	Grieg
Carbon Emission	√	√	√	√
Freshwater use	√	√	√	√
Sustainable feed	√	√	√	√
Waste management	x	√	√	√
Certification and ratings	√	√	√	√
Fish health and welfare	x	√	√	√

Table 5: Overview of Environment Indicator based on Green bond impact report of 4 salmon[1]

[1] √ The proceeds of the green bond are allocated to the specified indicator.
x The proceeds of the green bond are not allocated to the specified indicator.

Social Indicator	Mowi	SalMar	Lerøy	Grieg
Safe workplace	x	√	√	x
Diversity & Equality	x	√	x	x
Community Engagement	x	√	x	x
Human safety	x	√	√	x

Table 6: Overview of Social Indicator based on Green bond impact report of 4 salmon[1]

Economic Indicator	Mowi	SalMar	Lerøy	Grieg
Labor & employment	x	√	x	x
Value Chain	x	√	√	x
Investment in technology &Innovation	√	√	√	√

Table 7: Overview of Economic Indicator based on Green bond impact report of 4 salmon[1]

6.4 Overview of overall sustainable practices by 4 companies from 2018 to 2022

Mowi

For the past four years, Mowi has been recognized as the foremost sustainable animal protein producer on a global scale. During the previous half-decade, Mowi has undertaken noteworthy endeavours to mitigate its ecological footprint and provide assistance to community outreach initiatives. The absolute water withdrawal of Mowi in the year 2022 amounted to 387,105,333 cubic meters, demonstrating consistency with the figures from prior years. The Mowi group has reported 4% decrease in absolute water withdrawal in 2022 compared to previous year, 2021. In 2022, Mowi's processing plants achieved a 95% rate of recycling, reusing, or recovering non-hazardous waste. The aforementioned percentage has exhibited a sustained level of consistency throughout the preceding years (Mowi, 2019, 2020, 2021, 2022, 2023). In 2022, Mowi refrained from utilizing roughly 2,314 metric tons of newly produced plastic. There has been a substantial increase in this numerical value as compared to the preceding years. Farm-raised salmon that escape may harm the environment by disrupting ecological interactions and interbreeding with wild populations. In the year 2022, the recorded count of fish escapes amounted to 50,138 fishes (Mowi, 2023). The numerical value in question has exhibited an upward trend in comparison to preceding years, however, it remains comparatively modest when juxtaposed with established benchmarks within the industry. Regarding community engagement, Mowi conducted 96 events and contributed 3000 hours of volunteer work in 2022, thereby impacting a total of 31,000 individuals. There has been a substantial increase in this figure compared to previous years. Mowi's sustainability strategy in 2022 resulted in reduced GHG emissions, optimized packaging, increased recyclability of farming equipment, improved freshwater use at processing plants and smolt/post-smolt units, and enhanced circularity of waste streams such as sludge from freshwater units and processing plant by-products. The feed is sustainably sourced and the soy from Brazil is completely free of deforestation (Mowi, 2023). Table 8 presents a comprehensive overview of significant events that have occurred within the Mowi group over the past five years, offering additional details and information.

2022	2021	2020	2019	2018
Sustainable				
Most sustainable animal protein producer globally for the fourth year in a row	Most sustainable animal protein producer globally for the third year in a row	Most sustainable animal protein producer globally for the 2nd year in a row	Most sustainable animal protein producer globally for the year	No data
Water				
Absolute water withdrawal was 387105333 m3	Absolute water withdrawal was 387105333 m3	Absolute water withdrawal was 386245165 m3	Absolute water withdrawal was 360,672,814 m3	Absolute water withdrawal was 91,637,897 m3
Waste				
Recycled, reused, or recovered 95% of its non-hazardous garbage	Recycled, repurposed, or recovered 96% of non-hazardous garbage	Recycled, repurposed, or recovered more than 80% of non-hazardous garbage	94% of all Mowi's processing plants recycled EPS boxes	A total of 302,987 kg of fish farming nets were upcycled
Avoided the use of approximately 2,314 tons of virgin plastic	Avoided nearly 380 tons of virgin plastic, composted, or used	Avoided nearly 2000 tons of virgin plastic	Preventing nearly 3500 tons of plastic from being landfilled	Reduced its plastics consumption by 96 tons per year in the area of MAP trays at its processing plant in Bruges, Belgium
Mowi upcycled 31 893 m3 tons of dry and wet sludge	9,800 tons of solid and wet sludge for biogas generation	1 235 tons of solid and 13 061 tons of wet sludge were	reused a total of 166 tons of solid sludge and	reused a total of 209 tons of solid sludge and 5985

	and recovered 13,000 tons of fish oil from Norwegian industrial leftovers.	composted or used for biogas production	12,511 tons of wet sludge as composting or fuel for biogas production	tons of wet sludge as composting or fuel for biogas production
Fish escape				
number of fish escapes were 50,138 fish	number of fish escapes were 20599	number of fish escapes were 146873	number of fish escapes were 68145	number of fish escapes were 783323
Carbon/GHG emission				
Total GHG emissions (scope 1, 2, and 3) were 2013800 tons CO2e, down 4% from 2021	Total GHG emissions (scope 1, 2 and 3) was 2089405 tons CO2e	Total GHG emissions (scope 1, 2 and 3) was 2064 219 tons CO2e	Total GHG emissions (scope 1, 2 and 3) was 212416 tons CO2e	Total GHG emissions (scope 1, 2 and 3) was 2076227 tons CO2e
saved the worldwide 2 million tons of CO2 emissions annually by replacing the corresponding amount of land animal protein production	saved the worldwide 1.9 million tons CO^2 e emissions are avoided annually by replacing the corresponding amount of land animal protein production	saved the worldwide 1.8 million tons CO^2 e emissions are avoided annually by replacing the corresponding amount of land animal protein production	No data	No data
Treatment				
Non-medicinal treatment devices treated 60% of fish	Non-medicinal treatment devices treated 56% of fish	64% of sea lice treatments were non-medicinal	68% of sea lice treatments were non-medicinal	62% of sea lice treatments were non-medicinal
Feed				
Feed (100%) comes from environmentally friendly sources	100% sustainable feed according to Mowi's policy, Brazil's soy suppliers achieved zero-deforestation.	100% sustainable sourced feed according to Mowi's policy	The sourcing of the marine and vegetable raw materials was 84.3% and 100% compliant with our policy.	The sourcing of the marine and vegetable raw materials was 83% and 100% compliant with our policy .

Survival rate				
Monthly survival rate of fish was 99.2% in 2022.	The Group's seawater fish survival rate was 99.2% in 2021	The Group's seawater fish survival rate was 98.7% in 2020	The Group's seawater fish survival rate was 98.5% in 2019	The Group's seawater fish survival rate was 98.7% in 2018
Certification				
Total of 120 ASC certified sites in 2021	Total of 133 ASC certified sites in 2021	Total of 128 ASC certified sites in 2020	Total of 99 ASC certified sites in 2019	Total of 78 ASC certified sites in 2018
99% of our 2022 harvest was GSSI-certified (ASC, BAP, or Global GAP).	98% of our 2021 harvest was GSSI-certified (ASC, BAP, or Global GAP).	100% of our harvest was certified (GSSI)	No data	No data
People				
Improved safety record with all-time low rolling LTIs per million hours worked at 2.34	Improved safety record with all-time low rolling LTIs per million hours worked at 2.5	Improved safety record with all-time low rolling LTIs per million hours worked at 2.7	Improved safety record with the time low rolling LTIs per million hours worked at 4.3	Improved safety record with all-time low rolling LTIs per million hours worked at 5.2
Wild fish used				
It takes only 0.65 kg of wild fish to produce 1 kg of Atlantic salmon	It takes only 0.68 kg of wild fish to produce 1 kg of Atlantic salmon	It takes only 0.68 kg of wild fish to produce 1 kg of Atlantic salmon	It takes only 0.66 kg of wild fish to produce 1 kg of Atlantic salmon	It takes only 0.75 kg of wild fish to produce 1 kg of Atlantic salmon
Community engagement				
Mowi had 96 events and 3000 hours of volunteer work in 2022, reaching over 31,000 individuals.	Mowi hosted 430 events and donated more than EUR 1.2 million to community projects and gatherings.	Mowi hosted 467 events and donated more than EUR 2 184 700 to community projects and gatherings	Mowi hosted 498 events and donated more than EUR 1465900 to community projects and gatherings, reaching over 193 529 individuals	Mowi donated more approximately 998.6 thousand EURO to community projects and gatherings
SDG Goals				
Mowi is supporting the SDG goals: SDG 3, SDG 5, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13, SDG 14, SDG 17	Mowi is supporting the SDG goals: SDG 3, SDG 5, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13, SDG 14, SDG 17	Mowi is supporting the SDG goals: SDG 3, SDG 5, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13, SDG 14, SDG 17	Mowi is supporting the SDG goals: SDG 3, SDG 5, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13, SDG 14, SDG 17	Mowi is supporting the SDG goals: SDG 5, SDG 8, SDG 9, SDG 10, SDG 11, SDG 12, SDG 13, SDG 14, SDG 17

Paris Agreement				
Mowi aims to establish greenhouse gas emission reduction objectives that are based on impartial climate science and are consistent with the Paris Agreement.	Mowi aims to establish greenhouse gas emission reduction objectives that are based on impartial climate science and are consistent with the Paris Agreement.	Mowi aims to establish greenhouse gas emission reduction objectives that are based on impartial climate science and are consistent with the Paris Agreement	Mowi aims to establish greenhouse gas emission reduction objectives that are based on impartial climate science and are consistent with the Paris Agreement.	Mowi aims to establish greenhouse gas emission reduction objectives that are based on impartial climate science and are consistent with the Paris Agreement.

Table 8: Overview of Mowi sustainable practices from 2018 to 2022
Source: (Mowi, 2019, 2020, 2021, 2022, 2023)

SalMar

SalMar was recognized as one of the leading sustainable protein producers globally in 2022. The corporation augmented its portion of smolt originating from recirculating aquaculture system (RAS) establishment to 97% while upholding a substantial proportion of Aquaculture Stewardship Council (ASC) authorized locations. SalMar's Scope 1+2+3 carbon emissions experienced a significant increase, reaching 1,202,357 tonnes CO2e. Also, the volume of freshwater utilized by SalMar and Icelandic salmon has been observed to rise, with respective values of 45,053 m3 and 16,232 m3 (SalMar, 2022, 2023). The total count of fish escapes was documented as 11. In Norway, Salmar has achieved a 43% reduction in freshwater withdrawal over the past two years, excluding the acquired companies in 2022. This indicates a decrease in the amount of freshwater withdrawan by 21.6 million cubic meters (SalMar, 2021, 2022, 2023). SalMar has pledged to adhere to multiple Sustainable Development Goals (SDGs) and the Paris Agreement. SalMar's targeted Sustainable Development Goals (SDGs) include SDG 12, which pertains to Responsible Consumption and Production, SDG 13, which focuses on Climate Action, SDG 14, which concerns Life Below Water, and SDG 17, which emphasizes Partnerships for the Goals.

If resources cannot be efficiently reused, responsible disposal is necessary. SalMar prioritizes minimizing its impact on wildlife and is actively engaged in preventing such impact. The presence may impact other animals. SalMar's departments have waste management plans that specify the approved receiving facilities for different types of waste. Reused materials, including packaging and fish farming equipment such as collars, nets, and mooring devices, are delivered to businesses for their utilization. SalMar is committed to responsible resource management and waste reduction. They facilitate the recycling of outdated plastic equipment by transporting it to authorized return programs and gathering additional waste for conveyance to local waste management systems. They enhance plastic reuse and recycling. Enhancing the quality of the materials that enclose our final goods and augmenting our utilization of recyclable containers is the means by which this objective is attained (SalMar, 2023, p. 52). SalMar in Norway has secured agreements with its main electricity provider to ensure that the energy supplied is derived entirely from renewable sources. Several facilities utilized waste heat and local power sources in 2022. Table 9 presents a comprehensive overview of significant events that have occurred within the SalMar group over the past five years, offering additional details and information.

2022	2021	2020	2019	2018
In 2022, SalMar was ranked among the world's top ten most sustainable protein producers	No Data	No Data	No Data	No Data
Carbon/GHG emission				
Carbon emission of Scope 1+2+3 (GHG tCO2e) is approximately 1,202,357 tons	Carbon emission of Scope 1+2+3 (GHG tCO2e) 1,378,810 tons	Carbon emission of Scope 1+2+3 (GHG tCO2e) 1,539,780 tons	Total carbon emissions (Scope 1 & 2) tCO2e is 17,623 and Upstream activities (Scope 3) tCO2e is 11,950	Total carbon emissions (Scope 1 & 2) tCO2e is 16,173 and Upstream activities (Scope 3) tCO2e is 17, 143
Water Consumption				
Consumption of fresh water (1000 m3) in SalMar was 45053 and in Icelandic salmon was 16232	Consumption of fresh water (1000 m3) in SalMar was 36878 and in Icelandic salmon was 5535	Consumption of fresh water (1000 m3) in SalMar was 50470 and in Icelandic salmon was 5505	Consumption of fresh water (1000 m3) in SalMar was 39062 and in Icelandic salmon was 5456	Consumption of fresh water (1000 m3) in SalMar was 36998
Share of smolt from RAS facility was 97%	Share of smolt from RAS facility was 89%	Share of smolt from RAS facility was 86%	Share of smolt from RAS facility was 82%	Share of smolt from RAS facility was 73%
Fish escape				
overall number of fish escapes were 11	number of fish escapes in Noway 226 and in Iceland 81564	number of fish escapes in Norway 29645	number of fish escapes in Norway 5907 and in Iceland 185,885	number of fish escapes in Norway 15903

Certification				
certification of marine ingredients in fish feed 94% in Norway and 100% in Iceland	certification of marine ingredients in fish feed 97% in Norway and 98% in Iceland	certification of marine ingredients in fish feed 93% in Noway and 97% in Iceland	certification of marine ingredients in fish feed 99% in Norway	certification of marine ingredients in fish feed 99% in Norway
Certification of Soya ingredients in fish feed 100%	Certification of Soya ingredients in fish feed 100%	Certification of Soya ingredients in fish feed 100%	Certification of Soya ingredients in fish feed 100%	Certification of Soya ingredients in fish feed 100%
100% of active sites are certified in Norway and Iceland	100% of active sites are certified in Norway and 83% in Iceland	100% of active sites are certified in Norway and 86% in Iceland	100% of active sites are certified in Norway and Iceland	100% of active sites are certified in Norway
Survival rate				
survival rate in Norway and Iceland was 94.6% and 89.7% respectively	survival rate in Norway and Iceland was 95% and 93.3% respectively	survival rate in Norway and Iceland was 95.6 and 90.5% respectively	survival rate in Norway and Iceland was 95.3% and 91.2% respectively	survival rate in Norway was 94.1%
Waste				
They deliver the sludge to other company to produce biogas, fertiliser	They deliver the sludge to other company to produce biogas, fertiliser	They deliver the sludge to other company to produce biogas, fertiliser	They deliver the sludge to other company to produce biogas, fertiliser	They deliver the sludge to other company to produce biogas, fertiliser
People				
Lost Time Injuries (LTI) is 10	Lost Time Injuries (LTI) is 17	Lost Time Injuries (LTI) is 24	Lost Time Injuries (LTI) is 27	Lost Time Injuries (LTI) is 19
% Of Sickness absence is 5.7	% Of Sickness absence is 6.1	% Of Sickness absence is 5.3	% Of Sickness absence is 5.3	% Of Sickness absence is 5.5
Antibiotics				
Antibiotics used: Grams of active pharmaceutical ingredient (API) / tonne produced	Antibiotics used: Grams of active pharmaceutical ingredient (API) / tonne produced	Antibiotics used: Grams of active pharmaceutical ingredient (API) / tonne produced	Antibiotics used: Grams of active pharmaceutical ingredient (API) / tonne produced 0.0001 in SalMar	Antibiotics used: Grams of active pharmaceutical ingredient (API) / tonne produced 0.05 in SalMar
Lice				
No. of observations above the lice threshold % is 3.3	No. of observations above the lice threshold % is 2.2	No. of observations above the lice threshold % is 2.2	No. of observations above the lice threshold % is 3.3	No. of observations above the lice threshold % is 0.3
Community engagement				
Donate to the local community and sponsored worldwide	Donate to the local community and sponsored worldwide	Donate to the local community and sponsored worldwide	Donate to the local community and sponsored worldwide	Donate to the local community and sponsored worldwide

SDG Goals				
supporting the SDG goals: SDG 2, SDG 3, SDG 5, SDG 6, SDG 7, SDG 8, SDG 9, SDG 11, SDG 12, SDG 13, SDG 14, SDG 15, SDG 16 and SDG 17	supporting the SDG goals: SDG 2, SDG 3, SDG 12, SDG 13, SDG 14, SDG 17	supporting the SDG goals: SDG 2, SDG 3, SDG 12, SDG 13, SDG 14, SDG 17	supporting the SDG goals: SDG 2, SDG 3, SDG 12, SDG 13, SDG 14, SDG 17	supporting the SDG goals: no sign of supporting sdg goal

Table 9: Overview of SalMar sustainable practices from 2018 to 2022

Source: (SalMar, 2019, 2020, 2021, 2022, 2023)

Grieg

The available data on Greig in 2022 comprised the following information: The survival rate of individuals at sea was recorded to be 91.3%. Additionally, a total of 29 active sites belonging to Greig were certified by the Aquaculture Stewardship Council (ASC). The carbon emissions were quantified in kilograms of carbon dioxide equivalent per tonne of global warming potential. According to the report, the utilization of antibiotics was observed to be 41.6 grams per tonne of live weight equivalent. However, the administration of pharmacological treatments for sea lice was maintained at a minimal level of only 2 grams per tonne (Greig, 2023). Table 10 presents a comprehensive overview of significant events that have occurred within the Greig group over the past five years, offering additional details and information.

2022	2021	2020	2019	2018
Survival rate				
Survival rate at sea is 91.3%	Survival rate at sea is 93%	Survival rate at sea is 90.5%	Survival rate at sea is 91%	Survival rate at sea is 92%
Certifications				
29 active sites are certified by ASC	30 active sites are certified by ASC	26 active sites are certified by ASC	10 active sites are certified by ASC	4 active sites are certified by ASC
Carbon/GHG emission				
Carbon emission (kgCO2e per tonne GWT) Scope 1 + 2 location based is 359 and Scope 3 is 4120	Carbon emission (kgCO2e per tonne GWT) Scope 1 + 2 location based is 429 and Scope 3 is 4843	Carbon emission (kgCO2e per tonne GWT) Scope 1 + 2 location based is 456 and Scope 3 is 5720	Carbon emission (kgCO2e per tonne GWT) Scope 1 + 2 location based is 431 and Scope 3 is 6359	Carbon emission (kgCO2e per tonne GWT) Scope 1 + 2 location based is 346 and Scope 3 is 6655

Antibiotics/treatment				
Use of antibiotics (g per tonne LWE) 41.6	Use of antibiotics (g per tonne LWE) 47.7	Use of antibiotics (g per tonne LWE) 62.3	Use of antibiotics (g per tonne LWE) 87	Use of antibiotics (g per tonne LWE) 151.3
Minimize use of pharmaceutical treatments of Sea lice treatments (g per ton LWE) 2.7	Minimize use of pharmaceutical treatments of Sea lice treatments (g per ton LWE) 5.2	Minimize use of pharmaceutical treatments of Sea lice treatments (g per ton LWE) 1.2	Minimize use of pharmaceutical treatments of Sea lice treatments (g per ton LWE) 0.	Minimize use of pharmaceutical treatments of Sea lice treatments (g per ton LWE) 2.2
Fish escape				
Total fish escape is 2878	Total fish escape is 4356	Total fish escape is 0	Total fish escape is 4500	Total fish escape is 22212
People				
Workplace culture Above average score in Great Place to Work survey is 85%	Workplace culture Above average score in Great Place to Work survey is 85%	Workplace culture Above average score in Great Place to Work survey is 84%	Workplace culture Above average score in Great Place to Work survey is 79%	Workplace culture Above average score in Great Place to Work survey is 89%
Community engagement				
Active Collaboration and contribute to local community	Active Collaboration and contribute to local community	Active Collaboration and contribute to local community	Active Collaboration and contribute to local community	Active Collaboration and contribute to local community
SDG Goals				
supporting the SDG goals: SDG 2, SDG 3, SDG 4, SDG 5, SDG 6, SDG 8, SDG 9, SDG 12, SDG 13, SDG 14, SDG 15, SDG 16 and SDG 17	supporting the SDG goals: SDG 2, SDG 3, SDG 4, SDG 5, SDG 6, SDG 8, SDG 9, SDG 12, SDG 13, SDG 14, SDG 15, SDG 16 and SDG 17	supporting the SDG goals: SDG 2, SDG 3, SDG 4, SDG 5, SDG 8, SDG 12, SDG 13, SDG 14, SDG 16 and SDG 17	supporting the SDG goals: SDG 2, SDG 3, SDG 4, SDG 5, SDG 6, SDG 8, SDG 9, SDG 12, SDG 13, SDG 14, SDG 15, SDG 16 and SDG 17	No SDG goal supporting

Table 10: Overview of Grieg sustainable practices from 2018 to 2022

Source:(Greig, 2019, 2020, 2021, 2022, 2023)

Lerøy

According to data from 2022, Lerøy achieved a fish survival rate of 92.5% in aquatic environments and 91.4% in terrestrial habitats. The corporation experienced 10,540 instances of fish escaping and achieved a 100% certification rate for farming localities under the GLOBALG.A.P./ASC standards. Lerøy achieved a complete share of deforestation-free soy protein concentrate from Brazil that was traceable. The overall percentage of certified raw materials was 42%, with a high certification rate of 94.60% for marine raw materials. Furthermore, the aggregate amount of carbon dioxide equivalent emissions (including Scope 1, Scope 2, and Scope 3) attributed to Lerøy was 1,262,117 during the year 2022 (Lerøy, 2023).

Lerøy endeavours to safeguard the environment. Efforts are made to prevent water contamination in environments such as the deep sea. Lerøy and its providers have implemented an effective method to reduce the ecological footprint of production through the collection of sludge beneath the cages. This method has been extensively implemented in Western Norway, where the sludge is gathered and subjected to additional treatment. Lerøy has implemented measures to reduce food waste and eliminate non-recyclable or non-reusable plastics. The group have participated in various projects pertaining to fish health and welfare, lice, diverse certification schemes, and feed ingredients. Efforts are being made to mitigate the environmental impact of raw material production for feed, while also investing in the exploration of alternative raw materials for fish feed (Lerøy, 2023). Table 11 presents a comprehensive overview of significant events that have occurred within the SalMar group over the past five years, offering additional details and information.

2022	2021	2020	2019	2018
		Survival		
Fish survival rate is 92.5% in sea and 91.4% in land	Fish survival rate is 92.5% in sea and 88.8% in land	Fish survival rate is 92.3% in sea and 93.5% in land	Fish survival rate is 93.4% in sea and 91.4% in land	Fish survival rate is 93.9% in sea and 92.8% in land
		Climate/GHG		
Total, tonn CO2e (Scope 1, Scope 2 and Scope 3) is 1262117	Total, tonn CO2e (Scope 1, Scope 2 and Scope 3) is 1357487	Total, tonn CO2e (Scope 1, Scope 2and Scope 3) is 1472799	Total, tonn CO2e (Scope 1, Scope 2 and Scope 3) is 1491587	Total, tonn CO2e (Scope 1, Scope 2) is 125428

Biodiversity				
Number of fish escapes 10540	Number of fish escapes 4	Number of fish escapes 208	Number of fish escapes 85	Number of fish escapes 115
Percentage of localities with GLOBALG.A.P./ ASC certificate for farming is 100%	Percentage of localities with GLOBALG.A.P./ ASC certificate for farming is 100%	Percentage of localities with GLOBALG.A.P./ ASC certificate for farming is 100%	Percentage of localities with GLOBALG.A.P./ ASC certificate for farming is 100%	Percentage of localities with GLOBALG.A.P./ ASC certificate for farming is 100%
Fish feed				
Share of deforestation-free soy protein concentrate from Brazil with traceability (%) is 100%	Share of deforestation-free soy protein concentrate from Brazil with traceability (%) is 100%	Share of deforestation-free soy protein concentrate from Brazil with traceability (%) is 100%	Share of deforestation-free soy protein concentrate from Brazil with traceability (%) is 100%	Share of deforestation-free soy protein concentrate from Brazil with traceability (%) is 100%
Total percentage of certified raw materials is 42%	Total percentage of certified raw materials is 49.20%	Total percentage of certified raw materials is 40.85%	Total percentage of certified raw materials is 40.20%	No Traceability
Percentage of marine raw materials certified is 94.60 %	Percentage of marine raw materials certified is 92.5%	Percentage of marine raw materials certified is 90.50%	Percentage of marine raw materials certified is 89.53%	No Traceability
Wild Catch				
Percentage of MSC-certified marine species caught is 95%	Percentage of MSC-certified marine species caught is 93%	Percentage of MSC-certified marine species caught is 86%	Percentage of MSC-certified marine species caught is 91%	Percentage of MSC-certified marine species caught is 90%
Water				
Consumed water LSG (m3) is 145 258 and Water withdrawal LSG (m3) is 96775397	Water consumption production facility (litres) is 85,011,921	Water consumption production facility (litres) is 86,698,937	Water consumption production facility (litres) is 91,353,323	No Traceability
Waste				
Food waste industry: reduction in fish on floor and unsold products (kg) is 293 893	Food waste industry: reduction in fish on floor and unsold products (kg) is 167 383	Food waste industry: reduction in fish on floor and unsold products (kg) is 76 868	Food waste industry: reduction in fish on floor and unsold products (kg) is 412,321	No Traceability

Percentage of non-organic waste, recycled, reused, or recovered is 47.25%	Percentage of non-organic waste, recycled, reused, or recovered is 53.31%	Percentage of non-organic waste, recycled, reused, or recovered is 51.19%	Percentage of non-organic waste, recycled, reused, or recovered is 58.18%	No Traceability
Lice				
Average number of fully grown lice per fish in LSG Farming (number) is 0.18	Average number of fully grown lice per fish in LSG Farming (number) is 0.18	Average number of fully grown lice per fish in LSG Farming (number) is 0.16	Average number of fully grown lice per fish in LSG Farming (number) is 0.15	Average number of fully grown lice per fish in LSG Farming (number) is 0.12
Antibiotics				
Antibiotics used in sea (kg active substance) is 0	Antibiotics used in sea (kg active substance) is 0	Antibiotics used in sea (kg active substance) is 18.99	Antibiotics used in sea (kg active substance) is 0	Antibiotics used in sea (kg active substance) is 0
Antibiotics used on shore (kg active substance) is 0	Antibiotics used on shore (kg active substance) is 0	Antibiotics used on shore (kg active substance) is 0	Antibiotics used on shore (kg active substance) is 0	Antibiotics used on shore (kg active substance) 7.4

Table 11: Overview of Lerøy sustainable practices from 2018 to 2022

Source: (Lerøy, 2019, 2020, 2021, 2022, 2023)

Chapter 7

7. Discussion

The purpose of this thesis has been to study the role of green bond in advancing sustainability in Norwegian Salmon industry based on the research questions: "How does green bond advances sustainability in Norwegian salmon industry?" To support our main research aim we also addressed four sub questions: 1. What sustainability initiatives are the 4 companies funding through their green bonds? 2. How effective are each of these initiatives towards sustainability? 3. What is the economic rationale of the companies to acquire green bonds? 4. Is there any greenwashing present in the practices of the companies?

To answer these questions, the study consisted of theoretical and empirical parts. The empirical part of the study consisted of analyzing green bond impact reports from 2020 to 2022 and additionally annual reports from 2018 to 2022 of four salmon companies i.e., Mowi, SalMar, Grieg and Lerøy in Norway based on the theoretical framework that was built on three dimensions: Environment, Social and Economic. All findings are examined to determine whether they align with the SDGs and support the goals of the EU Taxonomy. In this chapter, we aim to discuss the findings for the research questions, as well as the value and contribution thereof. The study will additionally assess its limitations and suggest possible directions for future research.

Our study revealed several key findings that are worth discussing in detail. The analysis with regards to green bond shows that the salmon companies who issue green bond are more focused on environment indicators in comparison to social and economic indicators. Most of the proceeds of green bond are allocated in environment that shows greater impact in sustainability. This finding is similar to what Bhutta et al. (2022) shows the interconnectedness of the SDGs recognizes that environmental protection is integral to achieving sustainable development in areas such as health, education, and economic upgrade. The clear visualization can be viewed in the Table 2 shared by ICMA (2020) that shows that relation between the green bond categories and SDGs. Since EU Taxonomy aligns with EU policy commitments, including the Paris Agreement and the UN Sustainable Developments Goals (SDGs) (EU, 2020a), this result shows that the more SDGs are achieved the more objectives of EU taxonomy are accomplished resulting to sustainability.

The green bond impact reports were also analysed based on sustainability corporate strategy. The findings point out that the issuers in salmon companies use combination of both inside-out and outside-in approach to support the sustainability. For instance, green bond issuers in salmon industry are to follow different regulation and standards set out by the concerned organization, just like all the green bond issuers around the different field, in order to be eligible. This includes criteria like sharing transparent report, certifications and so on. In order to fulfil these criteria, issuers of green bond either modifies or establish new sets of innovation within the company that leads to external success like direct financial incentives, business case benefits and legitimacy and institutionally oriented incentives as discussed by Maltais & Nykvist (2020). This demonstrated the potential of green bonds to motivate issuers for the involvement with positive environmental impacts. According to Ning et al. (2022) and Wurgler & Baker (2018), investors are willing to pay a high price for green bonds despite the fact that they will receive a lower return due to the fact that they are interacting with sustainability from both an environmental and social perspective. Likewise, the economic rationale was further supported by SRI and CSR initiatives. These initiatives enhance the rationale for firms to acquire green bonds by attracting sustainable investors, improving reputation, controlling risks, accessing green financing opportunities, and gaining a competitive advantage (Chueca & Ferruz, 2021; Tennberg et al., 2019).

Another interesting result of this study was the commitment of all four companies towards RAS that aligns with EU taxonomy goals and supports the majority of the SDGs. This result in line with the research done by Martins et al. (2010). RAS brings together intensive fish production with environmental sustainability. These systems have the advantages of multilevel conservation (e.g., land and water resources), wide adaptability (e.g., climate, geography and seasonal) and convenient management (e.g., infrastructure and daily operation). Therefore, these systems can meet the requirements of sustainable development and are regarded as an inevitable trend in the future development of aquaculture. Hence, the Food and Agriculture Organisation has promoted efficient intensive aquaculture, represented by RASs, in both core and frontier areas (Nie & Hallerman, 2021). This shows that the green bond projects like this one have a positive impact in sustainability. For instance, SalMar has achieved a 43% reduction in freshwater withdrawal for the last two years in Norway by utilizing RAS technology, resulting in a significant increase in production. Similarly, the Mowi group has achieved an overall reduction of 4%. This reduction of using freshwater encompasses sustainability and supports UN SDG 6. The EU Taxonomy objectives include promoting the sustainable use and protection of water and marine resources, which aligns with the reduction of freshwater usage.

However, the benefits of RAS contradicts with the finding by Badiola et al. (2018) that use of RAS has drawback of using high energy increasing both operational costs and potential consequences of using fossil fuels that has a potential in increment in gas emissions. Thus, in order to highlight the benefits of RAS, energy consumption relative to production should be minimized. This issue has served as an opportunity for research and development. The development of energy-efficient technologies based on RAS has the potential to mitigate the problem of excessive energy consumption, thereby enhancing sustainability.

In relation to minimize the drawbacks, Lerøy shares an interesting practice in its Kjaerelva plant that generates energy by utilizing wastewater. Prior to its discharge, preheated water is used to generate electricity. Additionally, the Lerøy factory in Jøsnøya uses automated technology to cut fuel and water use. Furthermore, their processing technology generates fresh fillets that are shipped directly from the facility, leading in lower CO2 emissions. Likewise, SalMar's Innovanor processing factory processes whole salmon and creates fresh fillets, creating jobs for locals. Their fresh fillets are transported from the facility, decreasing transportation-related CO2 emissions and energy use. These findings support Tveterås et al. (2020) contention that innovation have the ability to lower the number of negative externalities per ton of salmon produced. This development supports sustainability and correlates with several SDGs, including reduced freshwater usage, increased workplace safety, lower energy consumption, and reduced transportation-related CO2 emissions. As a result, it contributes to the achievement several EU Taxonomy goals.

Another key finding is the commitment of all four companies towards minimizing the fish escape. Despite some technical issues, SalMar had only 11 fish escapes in 2022. Also, Greig experienced a reduction in fish escapes. However, Mowi reported to 50138 and Lerøy reported to 10540 fish escape in 2022 which was a massive record that has a negative impact on environment. This result in lines with Atalah & Sanchez-Jerez (2020) who has found that fish escape has negative ecological impact of introducing non-native species, creates genetic diversity with wild population and the spread of pathogens and parasites. Hence, reducing fish escapes has ecological and economic implications, including maintaining ecological balance, enhancing resource efficiency, reducing costs, and improving profitability. Reducing fish escapes has supported the EU Taxonomy objective of protection and restoration of biodiversity and ecosystems and contributed to achieving SDG 14 Life Below Water.

However, there are several contrary results during the analysis that did not provide strong evidence in support of the research objective that is to examine the role of green bonds in supporting sustainability in Norwegian salmon industry, leading to the greenwashing strategy. For instance, the transparency of Grieg's allocation of proceed in the sustainable feed category is not shown clearly. They claim that they are using 100% segregated deforestation free SPC and but there is no record any calculation of the volume consumed in their green bond impact report and annual report. However, such transparency can be seen in the report of other three companies.

To go deeper into greenwashing, the annual reports of these four companies were analyzed for sustainable practices over a five-year period from 2018 to 2022 to see how committed they are to sustainability and if there is anything that appears out in their overall activities and directs them to do the same in these green bond projects.

Based on the annual report, the findings on few sustainable practices also contradicts with the result of certification associated with most proficient certification i.e., ASC. In terms of Mowi, one key findings from annual report that directed towards the greenwashing strategy. Their 13 farming sites were uncertified by ASC within a year. There were 133 certified farms in 2021 but in 2022 it decreased to 120. This shows they may have some issues to maintain the sustainable practices as required by the standard of ASC. It can be seen in Grieg as well that recorded to have ASC certification in 30 sites in 2021 but in 2022 it decreased to 29. This result leads to the misleading customers and undermining sustainable development as argued by Kolcava (2023). Not only is the ASC accreditation a representation of sustainability. Additional metrics must be considered when representing sustainability. Moreover, there exists a social metric imbalance in these companies. The result shows that Mowi and Grieg doesn't have proceeds allocated towards the social dimension. It is critical to recognize that sustainable development is the result of a complex interplay of economic, social, and environmental factors. Concerning Grieg seafood's chemical treatments, it should be noted that they have not been specific about the chemical treatments in any of their transparent reports, which can be perceived as a greenwashing strategy to reduce their operating costs on chemicals, which was the same scenario when the concept of Green Washing was first introduced (Chen, Bernard, & Rahman, 2019).

7.1 Limitations of the study

While this study provided valuable insights in to the given topic, it is important to acknowledge it's limitation. The study was carried out in a particular geographic area, namely Norway, which may limit the applicability of the findings in other contexts. In addition, the data were collected from limited reports of only four salmon companies that may limit the observation to achieve significance in the study. Most of the information found that includes green bond and EU taxonomy in relation to salmon aquaculture are reports and government websites. Aside from that, there were no research articles available in the salmon sector worldwide that explored green bonds, EU taxonomy, and SDGs on a single framework. Likewise, the research was conducted within a limited time frame, which impacted the depth of the analysis. As a result, certain aspects under investigation may not have been fully explored.

7.2 Practical application of the findings

The practical application of the findings in this thesis on the research question "How does green bond advance sustainability in the Norwegian salmon industry?" and its sub-research questions has several implications for industry stakeholders and policymakers. Firstly, the identification of specific sustainability initiatives funded through green bonds can be used as a reference point for in the Norwegian salmon industry. Secondly, companies and investor can focus on those initiatives that have successfully driven sustainability outcomes and can serve as industry best practices. Thirdly, understanding of the economic rationale behind green bond encourages more companies to consider green bond increasing the capital available for sustainability practices in the Norwegian salmon industry. Finally, the practical application of the identification of potential greenwashing practices raises awareness among industry stakeholders. Companies can utilize this data to ensure that their sustainability claims and actions are real and valid, resulting in increased trust among investors, customers, and other stakeholders. These findings provide a foundation for sound decision-making, strategic planning, and continuous development towards advancing sustainability in the Norwegian salmon industry and potentially in other industries as well.

7.3 Suggestions for further research

Several studies have been conducted on the topic of green bonds in general, however, there is a significant lack of research when it comes to studying the specific use of green bonds within the seafood industry. As a result, more research concentrating on the seafood industry's use of green bonds is required to provide a more comprehensive knowledge of this sustainable financing tool in this specific context.

Based on our analysis, all four companies that we analyzed has invested their green bond proceeds in RAS. Hence, in particular, further study is needed to understand how allocating green bond proceeds to RAS can effectively meet goals for sustainability while taking into account the drawbacks of this technology in the seafood the industry. This research could include evaluating the environmental, economic, and social consequences of investing in RAS with green bond proceeds. Further study in this area should prioritize environmental concerns. Studies can assess how allocating green bond proceeds to RAS projects can address and minimize the environmental concerns often associated with RAS systems, such as energy consumption, water usage, waste management, and so on.

Furthermore, social dimensions should be addressed in further research. It is critical to investigate how allocating green bond proceeds to RAS projects affects local communities, job opportunities, and social equality. Researchers can contribute to a broader knowledge of the sustainability impacts of green bond finance in the seafood industry by considering the social dimensions as well as the potential benefits and limitations of RAS implementation. Researchers can provide significant insights to enhance sustainable seafood production techniques by investigating the environmental, economic, and social aspects of green bond investments in RAS.

Chapter 8

8. Conclusion

This chapter will bring the study to a close by summarizing the most important research results in terms of the research questions and aims. In this thesis, a study into the role that green bonds have in advancing sustainability within the Norwegian salmon sector was conducted. The research investigated the sustainability initiatives funded through the green bonds, assessed their effectiveness, explored the economic rationale for acquiring green bonds, and investigated the presence of greenwashing in the practices of four companies i.e. Mowi, SalMar, Grieg and Lerøy that operate within the industry. The findings provide useful insights into the impact and potential of green bonds in the process of promoting sustainability within the Norwegian salmon industry.

The analysis of the sustainability initiatives funded through the green bonds showed that a wide range of activities are carried out by the four companies. These initiatives covered various areas such as logistical efficiency, investment in new technology like RAS, post-smolt strategy, reducing fish escape, reducing sea lice treatment, improving feed efficiency, enhancing fish health and welfare, community engagement, managing wastewater and many interesting practices. The companies showed that they were committed to addressing the major sustainability issues affecting this industry. According to the findings of this thesis, companies in the Norwegian salmon industry are mostly allocating green bond proceeds to initiatives that prioritize the environmental dimension of sustainability, while dedicating fewer resources to social and economic aspects. It is essential to understand that obtaining the best overall sustainability outcomes requires a careful balancing of all three dimensions: environmental, social, and economic. One of the ways could be broadening green bond categories towards social and economic as well. Future initiatives should aim for a more holistic strategy that recognizes the interplay and equal importance of all of these aspects, ensuring that social and economic factors are effectively handled alongside environmental objectives in order to optimize sustainability impact.

The thesis analysis of the sustainability initiatives funded by green bonds demonstrates the effectiveness of each initiative toward sustainability within the Norwegian salmon industry, aligning with the United Nations Sustainable Development Goals (SDGs) and the EU Taxonomy objectives. The activities, which included logistical efficiency, investment in new technology like RAS, post-smolt strategy, reducing fish escape, reducing sea lice treatment, improving feed efficiency, enhancing fish health and welfare, community engagement, managing wastewater and more, all contributed significantly to several SDGs. Furthermore, these initiatives are directly aligned with the objectives of the EU Taxonomy, which attempts to promote environmentally friendly economic activity. However, while certain initiatives, such as investing in RAS, significantly reduced freshwater demand, they also resulted in higher energy consumption. This finding highlights the interdependence of environmental issues and the need for businesses to handle such parallel challenges. The analysis demonstrates that companies are committed to dealing with these challenges by undertaking activities targeted at balancing their impact on the environment. The companies have not only showed their commitment to sustainability but also made significant progress towards tackling global challenges and promoting the transition to a more sustainable future because of allocating the proceeds from green bonds to these initiatives. However, additional research and monitoring are needed to assess the long-term sustainability benefits and deal with any potential limitations or trade-offs connected with such initiatives.

According to the findings, the key motivators for acquiring green bonds are access to direct financial benefits such as additional capital, business case benefits such as image and branding, and legitimacy and institutionally oriented incentives. The companies hold to a sustainable corporate strategy that assists them in achieving these economic goals by acquiring green bonds. The economic rationale was further supported by SRI and CSR initiatives. These initiatives enhance the rationale for firms to acquire green bonds by attracting sustainable investors, improving reputation, controlling risks, accessing green financing opportunities, and gaining a competitive advantage.

A thorough study was carried out to investigate the presence of potential greenwashing in the companies' activities, taking into account their sustainability promises and the connection between their actions and objectives. While the companies showed an honest dedication to sustainability, the research found that there were few instances of Mowi and Grieg where contradictions occurred between their statements and actual actions. For example, a massive reduction of ASC certification in case of Mowi and no transparent information regarding SPC and chemical treatments consumed in case of Grieg. In addition, the observed trade-offs, such as the rise in energy consumption that was the outcome of various initiatives, raise issues regarding the actual environmental impact and effectiveness of the measures that were adopted.

These inconsistencies need constant evaluation and transparency in order to reduce the risk of greenwashing and assure the reliability of their sustainability efforts.

In sum, green bonds have emerged as an important financial tool for increasing sustainability in the Norwegian salmon sector. The companies under consideration have used green bonds to fund a variety of sustainability projects, thereby contributing to the industry's sustainable future. While the effectiveness of these practices varies, they reflect progress toward overcoming important sustainability concerns. However, one must take measures to avoid engaging in greenwashing and ensure that sustainable activities are conducted in a transparent and ethical way. Continuous evaluation, stakeholder engagement, broadening categories of green bond towards social and economic, and transparency will be essential for in maximizing the full potential of green bonds to advance sustainability in the Norwegian salmon industry.

References

Abeywardhana, D. K. Y. (2017). Capital Structure Theory: An Overview. *Accounting and Finance Research*, *6*(1), 133. https://doi.org/10.5430/afr.v6n1p133

Abualtaher, M., Rustad, T., & Bar, E. S. (2021). Systemic Insights on the Integration of UN Sustainable Development Goals within the Norwegian Salmon Value Chain. *Applied Sciences*, *11*(24), 12042. https://doi.org/10.3390/app112412042

Ace, S. (2023, February 6). Reducing the climate footprint of the salmon farming industry. Retrieved May 6, 2023, from SINTEF website: https://www.sintef.no/en/latest-news/2023/reducing-the-climate-footprint-of-the-salmon-farming-industry/

Ahmad, A., Sheikh Abdullah, S. R., Hasan, H. A., Othman, A. R., & Ismail, N. 'Izzati. (2021). Aquaculture industry: Supply and demand, best practices, effluent and its current issues and treatment technology. *Journal of Environmental Management*, *287*, 112271. https://doi.org/10.1016/j.jenvman.2021.112271

Ahmed, N., & Thompson, S. (2019). The blue dimensions of aquaculture: A global synthesis. *Science of The Total Environment*, *652*, 851–861. https://doi.org/10.1016/j.scitotenv.2018.10.163

Ahmed, N., & Turchini, G. M. (2021a). Recirculating aquaculture systems (RAS): Environmental solution and climate change adaptation. *Journal of Cleaner Production*, *297*, 126604. https://doi.org/10.1016/j.jclepro.2021.126604

Ahmed, N., & Turchini, G. M. (2021b). Recirculating aquaculture systems (RAS): Environmental solution and climate change adaptation. *Journal of Cleaner Production*, *297*, 126604. https://doi.org/10.1016/j.jclepro.2021.126604

Ahmed, R., Yusuf, F., & Ishaque, M. (2022). Green bonds as a bridge to the UN sustainable development goals on environment: A climate change empirical investigation.

International Journal of Finance & Economics, *n/a*(n/a). https://doi.org/10.1002/ijfe.2787

Alam, M. F. R. (2018). *Salmon economic analysis: An operational cost study, finding better ways to ensure efficient resource utilization, improves profitability and environmental sustainability for the salmon aquaculture in Norway.* (Master thesis, The University of Bergen). The University of Bergen. Retrieved from https://bora.uib.no/bora-xmlui/handle/1956/20636

Amundsen, V. S., & Osmundsen, T. C. (2018). Sustainability indicators for salmon aquaculture. *Data in Brief*, *20*, 20–29. https://doi.org/10.1016/j.dib.2018.07.043

Andronie, M., Simion, V.-E., Gurgu, E., Dijmărescu, A., & Dijmărescu, I. (2019). SOCIAL RESPONSIBILITY OF FIRMS AND THE IMPACT OF BIO-ECONOMY IN INTELLIGENT USE OF RENEWABLE ENERGY SOURCES. *Amfiteatru Economic*, *21*(52).

ASC. (2023). About ASC. Retrieved May 9, 2023, from ASC International website: https://asc-aqua.org/about-asc/

Atalah, J., & Sanchez-Jerez, P. (2020). Global assessment of ecological risks associated with farmed fish escapes. *Global Ecology and Conservation*, *21*, e00842. https://doi.org/10.1016/j.gecco.2019.e00842

Badiola, M., Basurko, O. C., Piedrahita, R., Hundley, P., & Mendiola, D. (2018a). Energy use in Recirculating Aquaculture Systems (RAS): A review. *Aquacultural Engineering*, *81*, 57–70. https://doi.org/10.1016/j.aquaeng.2018.03.003

Badiola, M., Basurko, O. C., Piedrahita, R., Hundley, P., & Mendiola, D. (2018b). Energy use in Recirculating Aquaculture Systems (RAS): A review. *Aquacultural Engineering*, *81*, 57–70. https://doi.org/10.1016/j.aquaeng.2018.03.003

Bailey, J. L., & Eggereide, S. S. (2020). Mapping actors and arguments in the Norwegian aquaculture debate. *Marine Policy*, *115*, 103898. https://doi.org/10.1016/j.marpol.2020.103898

Baker, M., & Wurgler, J. (2002). Market Timing and Capital Structure. *The Journal of Finance*, *57*(1), 1–32. https://doi.org/10.1111/1540-6261.00414

Băndoi, A., Bocean, C. G., Del Baldo, M., Mandache, L., Mănescu, L. G., & Sitnikov, C. S. (2021). Including Sustainable Reporting Practices in Corporate Management Reports: Assessing the Impact of Transparency on Economic Performance. *Sustainability*, *13*(2), 940. https://doi.org/10.3390/su13020940

Banque De France. (2022, July 12). Green bonds: Is their growth sustainable? Retrieved May 2, 2023, from Banque de France website: https://blocnotesdeleco.banque-france.fr/en/blog-entry/green-bonds-their-growth-sustainable

BAP. (2023). BAP: Seafood that's Delicious, Nutritious, and Responsibly Produced. Retrieved May 9, 2023, from https://bap.globalseafood.org

Bekhet, H. A., & Latif, N. W. A. (2018). The impact of technological innovation and governance institution quality on Malaysia's sustainable growth: Evidence from a dynamic relationship. *Technology in Society*, *54*, 27–40. https://doi.org/10.1016/j.techsoc.2018.01.014

Bélanger-Lamonde, A., Sarker, P. K., Ayotte, P., Bailey, J. L., Bureau, D. P., Chouinard, P. Y., … Vandenberg, G. W. (2018). Algal and Vegetable Oils as Sustainable Fish Oil Substitutes in Rainbow Trout Diets: An Approach to Reduce Contaminant Exposure. *Journal of Food Quality*, *2018*, e7949782. https://doi.org/10.1155/2018/7949782

Bergesen, O., & Tveterås, R. (2019). Innovation in seafood value chains: The case of Norway. *Aquaculture Economics & Management*, *23*(3), 292–320. https://doi.org/10.1080/13657305.2019.1632391

Bhutta, U. S., Tariq, A., Farrukh, M., Raza, A., & Iqbal, M. K. (2022). Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Technological Forecasting and Social Change*, *175*, 121378. https://doi.org/10.1016/j.techfore.2021.121378

Black, A. W. (2004). The Quest for Sustainable, Healthy Communities. *Australian Journal of Environmental Education*, *20*(1), 33–44. https://doi.org/10.1017/S0814062600002287

Blowfield, M., & Frynas, J. G. (2005). Setting New Agendas: Critical Perspectives on Corporate Social Responsibility in the Developing World. *International Affairs (Royal Institute of International Affairs 1944-)*, *81*(3), 499–513. Retrieved from https://www.jstor.org/stable/3569630

Boerlage, A. S., Ashby, A., Herrero, A., Reeves, A., Gunn, G. J., & Rodger, H. D. (2020). Epidemiology of marine gill diseases in Atlantic salmon (*Salmo salar*) aquaculture: A review. *Reviews in Aquaculture*, *12*(4), 2140–2159. https://doi.org/10.1111/raq.12426

Breitschopf, B., & Alexander-Haw, A. (2022). Auctions, risk and the WACC. How auctions and other risk factors impact renewable electricity financing costs. *Energy Strategy Reviews*, *44*, 100983. https://doi.org/10.1016/j.esr.2022.100983

Brundtland, G. H. (1987). Our Common Future—Call for Action. *Environmental Conservation*, *14*(4), 291–294. https://doi.org/10.1017/S0376892900016805

Brundtland World Commission Report. (1987). Our common future. *New York University Press*.

Bultheel, C., Morel, R., Hainaut, H., Deheza, M., Shishlov, I., Depoues, V., & Leguet, B. (2015). *COP21: Success at "the end of the beginning" Climate Brief No38* (p. 16). France.

Burridge, L., Weis, J. S., Cabello, F., Pizarro, J., & Bostick, K. (2010). Chemical use in salmon aquaculture: A review of current practices and possible environmental effects. *Aquaculture*, *306*(1–4), 7–23. https://doi.org/10.1016/j.aquaculture.2010.05.020

Carlowitz, H. (1713). Sylvicultura oeconimica. *Nachhaltigkeit Auf Zeit*, 78.

Carroll, A. B. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons*, *34*(4), 39–48. https://doi.org/10.1016/0007-6813(91)90005-G

CBI. (2018a). *BONDS AND CLIMATE CHANGE THE STATE OF THE MARKET 2018*. Retrieved from https://www.climatebonds.net/files/reports/cbi_sotm_2018_final_01k-web.pdf

CBI. (2018b). *Green Bonds – A Bridge to the SDGs*. Climate Bond Initiative. Retrieved from Climate Bond Initiative website: https://www.climatebonds.net/files/reports/green-bonds_a-bridge-to-the-sdgs_062018.pdf

CBI. (2020). *Green bond market summary H1 2020* (p. 1). Retrieved from https://www.climatebonds.net/files/reports/h1_2020_highlights_final.pdf

CBI. (2022). *Sustainable Debt, Global State of the Market 2022*. Retrieved from https://www.climatebonds.net/files/reports/cbi_sotm_2022_03c.pdf

Chava, S. (2014). Environmental Externalities and Cost of Capital. *Management Science*, *60*(9), 2223–2247. Retrieved from https://www.jstor.org/stable/24550583

Chen, H., Bernard, S., & Rahman, I. (2019). Greenwashing in hotels: A structural model of trust and behavioral intentions. *Journal of Cleaner Production*, *206*, 326–335. https://doi.org/10.1016/j.jclepro.2018.09.168

Chueca Vergara, C., & Ferruz Agudo, L. (2021). Fintech and Sustainability: Do They Affect Each Other? *Sustainability*, *13*(13), 7012. https://doi.org/10.3390/su13137012

Clark, K. (2015). Growing a green bonds market in China. *Foreign & Commonwealth Office*, 2.

Climate Bond. (2015, June 30). Climate Bonds Taxonomy. Retrieved May 6, 2023, from Climate Bonds Initiative website: https://www.climatebonds.net/standard/taxonomy

Cortellini, G., & Panetta, I. C. (2021). Green Bond: A Systematic Literature Review for Future Research Agendas. *Journal of Risk and Financial Management*, *14*(12), 589. https://doi.org/10.3390/jrfm14120589

Cubas-Díaz, M., & Martínez Sedano, M. (2018). Do Credit Ratings Take into Account the Sustainability Performance of Companies? *Sustainability*, *10*(11), 4272. https://doi.org/10.3390/su10114272

Dahl, R. (2010). Green Washing: Do You Know What You're Buying? *Environmental Health Perspectives*, *118*(6). https://doi.org/10.1289/ehp.118-a246

Dan, A., & Tiron-Tudor, A. (2021). The Determinants of Green Bond Issuance in the European Union. *Journal of Risk and Financial Management*, *14*(9), 446. https://doi.org/10.3390/jrfm14090446

Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting. *The Accounting Review*, *86*(1), 59–100. https://doi.org/10.2308/accr.00000005

Dong, Y., & Hauschild, M. Z. (2017). Indicators for Environmental Sustainability. *Procedia CIRP*, *61*, 697–702. https://doi.org/10.1016/j.procir.2016.11.173

Doronzo, R., Siracusa, V., & Antonelli, S. (2021). Green Bonds: The Sovereign Issuers' Perspective. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3854966

Dörry, S., & Schulz, C. (2018). Green financing, interrupted. Potential directions for sustainable finance in Luxembourg. *Local Environment*, *23*(7), 717–733. https://doi.org/10.1080/13549839.2018.1428792

Eadie, R., Mckeown, C., & Anderson, K. (2011). The Social Element of Sustainable Civil Engineering Public Procurement in Northern Ireland. *International Journal of Business and Social Science*, *2*, 36–43.

Ehlers, T., & Packer, F. (2017). Green bond finance and certification. *BIS Quarterly Review*, 90–91.

EIB. (2023). Climate Awareness Bonds (CAB). Retrieved May 2, 2023, from EIB.org website: https://www.eib.org/en/investor-relations/cab/index.htm

El Ghoul, S., Guedhami, O., Kwok, C. C. Y., & Mishra, D. R. (2011). Does corporate social responsibility affect the cost of capital? *Journal of Banking & Finance*, *35*(9), 2388–2406. https://doi.org/10.1016/j.jbankfin.2011.02.007

Elkington, J. (1997). Cannibals with forks: The triple bottom line of 21st century business. *Oxford: Capstone*.

Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management*, *8*(1), 37–51.

EU. (2020a). EU green bond standard usability guide. *EU Technical Expert Group on Sustainable Finance*. Retrieved from https://finance.ec.europa.eu/system/files/2020-06/200309-sustainable-finance-teg-green-bond-standard-usability-guide_en.pdf

EU. Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (Text with EEA relevance). , 198 OJ L § (2020).

EU. (2021, July 14). A European Green Deal. Retrieved May 3, 2023, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

European Commission. (2023). EU Taxonomy Navigator [Text]. Retrieved June 10, 2023, from European Commission—European Commission website: https://ec.europa.eu/sustainable-finance-taxonomy/

FAO. (2020). *The State of World Fisheries and Aquaculture 2020*. FAO. https://doi.org/10.4060/ca9229en

Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. W. (2020). Strategies for mitigation of climate change: A review. *Environmental Chemistry Letters*, *18*(6), 2069–2094. https://doi.org/10.1007/s10311-020-01059-w

Feldhoff, E., & Metzner, N. (2021). Examining legal requirements for a ground infrastructure at airfields as part of an automated, emission-free airfreight transport chain. *Transportation Research Procedia*, *52*, 461–468. https://doi.org/10.1016/j.trpro.2021.01.054

Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, *142*(2), 499–516. https://doi.org/10.1016/j.jfineco.2021.01.010

Flores, A.-M., Davies, M. M., Kushneryk, K., Lawn, P. T. E. S., Helms, S., Thomson, H. M., … Gerwing, T. G. (2021). Declines of Juvenile Coastal Cutthroat Trout and Coho Salmon over Fifteen Years in a Salmon-Bearing Stream in the Salish Sea. *Western North American Naturalist*, *81*(4). https://doi.org/10.3398/064.081.0407

Fredricks, K. T. (2015). *Literature Review of the Potential Effects of Formalin on Nitrogen Oxidation Efficiency of the Biofilters of Recirculating Aquaculture Systems (RAS) for Freshwater Finfish* [Open-File Report]. Virginia: U.S. Geological Survey. Retrieved from U.S. Geological Survey website: https://pubs.usgs.gov/of/2015/1097/pdf/ofr2015-1097.pdf

Free, C. M., Cabral, R. B., Froehlich, H. E., Battista, W., Ojea, E., O'Reilly, E., … Gaines, S. D. (2022). Expanding ocean food production under climate change. *Nature*, *605*(7910), 490–496. https://doi.org/10.1038/s41586-022-04674-5

Freshwater Policy, M. (2022). *Policy on freshwater use and water discharge*. Retrieved from https://mowi.com/wp-content/uploads/2022/07/220713-Mowi-Freshwater-use-Policy.pdf

General Assembly. (2017). *Resolution adopted by the General Assembly on 6 July 2017*. United Nations.

Glomsrød, S., & Wei, T. (2018). Business as unusual: The implications of fossil divestment and green bonds for financial flows, economic growth and energy market. *Energy for Sustainable Development*, *44*, 1–10. https://doi.org/10.1016/j.esd.2018.02.005

Goodland, R. (1995). The Concept of Environmental Sustainability. *Annual Review of Ecology and Systematics*, *26*(1), 1–24. https://doi.org/10.1146/annurev.es.26.110195.000245

Greig. (2019). *Greig Seafood Annual Report 2018* [Annual Report]. Retrieved from https://cdn.sanity.io/files/1gakia31/production/5bdf99b39fafa4acd0594e787cc03e86612971eb.pdf

Greig. (2020). *Greig Seafood Annual Report 2019* [Annual Report]. Retrieved from https://cdn.sanity.io/files/1gakia31/production/f02f99493b5af629a2c5857171a75c60c2633117.pdf

Greig. (2021). *Greig Seafood Annual Report 2020* [Annual Report]. Retrieved from https://cdn.sanity.io/files/1gakia31/production/00b861e440a33024de1ef91cfd70fc2beb48bc3e.pdf

Greig. (2022). *Greig Seafood Annual Report 2021* [Annual Report]. Retrieved from https://cdn.sanity.io/files/1gakia31/production/8699f764225f2b441044453452ada7923cca1994.pdf

Greig. (2023). *Greig Seafood Annual Report 2022* [Annual Report]. Retrieved from https://cdn.sanity.io/files/1gakia31/production/2699fb944e6f7253449c370f0e2bb1ef91fff4d0.pdf

GRI. (2013). G4 Sustainability Reporting Guidelines – Reporting Principles and Standard Disclosures | RESPECT. Retrieved May 12, 2023, from https://respect.international/g4-sustainability-reporting-guidelines-reporting-principles-and-standard-disclosures/

Grieg. (2020). *Green Bond Report 2020* (pp. 1–24). Retrieved from https://investor.griegseafood.com/share-&-bond#the-bond

Grieg. (2021). *Green Bond Report 2021* (pp. 1–23). Retrieved from https://investor.griegseafood.com/share-&-bond#the-bond

Grieg. (2022). *Annual Report 2022* (pp. 1–149). Retrieved from https://cdn.sanity.io/files/1gakia31/production/2699fb944e6f7253449c370f0e2bb1ef91fff4d0.pdf

Hadaś-Dyduch, M., Puszer, B., Czech, M., & Cichy, J. (2022). Green Bonds as an Instrument for Financing Ecological Investments in the V4 Countries. *Sustainability, 14*(19), 12188. https://doi.org/10.3390/su141912188

Hamilton, H. A., Brod, E., Hanserud, O. S., Gracey, E. O., Vestrum, M. I., Bøen, A., … Brattebø, H. (2016). Investigating Cross-Sectoral Synergies through Integrated Aquaculture, Fisheries, and Agriculture Phosphorus Assessments: A Case Study of Norway. *Journal of Industrial Ecology, 20*(4), 867–881. https://doi.org/10.1111/jiec.12324

Hamre, L. A., Eichner, C., Caipang, C. M. A., Dalvin, S. T., Bron, J. E., Nilsen, F., … Skern-Mauritzen, R. (2013). The Salmon Louse Lepeophtheirus salmonis (Copepoda: Caligidae) Life Cycle Has Only Two Chalimus Stages. *PLoS ONE*, *8*(9), e73539. https://doi.org/10.1371/journal.pone.0073539

Han, P., Lu, Q., Fan, L., & Zhou, W. (2019). A Review on the Use of Microalgae for Sustainable Aquaculture. *Applied Sciences*, *9*(11), 2377. https://doi.org/10.3390/app9112377

Hanif, I., Aziz, B., & Chaudhry, I. S. (2019). Carbon emissions across the spectrum of renewable and nonrenewable energy use in developing economies of Asia. *Renewable Energy*, *143*, 586–595. https://doi.org/10.1016/j.renene.2019.05.032

Hansen, L. (2019). The Weak Sustainability of the Salmon Feed Transition in Norway – A Bioeconomic Case Study. *Frontiers in Marine Science*, *6*, 764. https://doi.org/10.3389/fmars.2019.00764

Hertwich, E. G., & Wood, R. (2018). The growing importance of scope 3 greenhouse gas emissions from industry. *Environmental Research Letters*, *13*(10), 104013. https://doi.org/10.1088/1748-9326/aae19a

Herzig, C., & Schaltegger, S. (2011). Corporate Sustainability Reporting. In J. Godemann & G. Michelsen (Eds.), *Sustainability Communication: Interdisciplinary Perspectives and Theoretical Foundation* (pp. 151–169). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-1697-1_14

Hodar, A. R., Vasava, R. J., Mahavadiya, D. R., & Joshi, N. H. (2020). Fish meal and fish oil replacement for aqua feed formulation by using alternative sources: A review. *J. Exp. Zool. India*, *23*(1), 13–21. Scopus. Retrieved from Scopus.

Hoekstra, A., Chapagain, A., & Van Oel, P. (2017). Advancing Water Footprint Assessment Research: Challenges in Monitoring Progress towards Sustainable Development Goal 6. *Water*, *9*(6), 438. https://doi.org/10.3390/w9060438

Husgafvel, R., Pajunen, N., Virtanen, K., Paavola, I.-L., Päällysaho, M., Inkinen, V., … Ekroos, A. (2015). Social sustainability performance indicators – experiences from process industry. *International Journal of Sustainable Engineering*, *8*(1), 14–25. https://doi.org/10.1080/19397038.2014.898711

ICMA. (2015). *Green Bond Principles, 2015 Voluntary Process Guidelines for Issuing Green Bonds*. Retrieved from https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/GBP_2015_27-March.pdf

ICMA. (2017). *The Green Bond Principles 2017* (p. 2). ICMA. Retrieved from ICMA website: https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/GreenBondsBrochure-JUNE2017.pdf

ICMA. (2020). *Green, Social and Sustainability Bonds: A High -Level Mapping to the Sustainable Development Goals* (pp. 4–5). ICMA Groups.

ICMA. (2021). *Green Bond Principles Voluntary Process Guidelines for Issuing Green Bonds* (p. 1). ICMA.

IFC. (2020). *Green Bond Handbook: A Step-By-Step Guide to Issuing a Green Bond*. Retrieved from https://www.ifc.org/wps/wcm/connect/f11546a9-b986-4b0d-b1fc-93d798ce86dc/202203-IFC-Green-Bond-Handbook.pdf?MOD=AJPERES&CVID=n.wxr2b

Ioannou, I., Kassinis, G., & Papagiannakis, G. (2022, July 21). How Greenwashing Affects the Bottom Line. *Harvard Business Review*. Retrieved from https://hbr.org/2022/07/how-greenwashing-affects-the-bottom-line

IPCC. (2022). *Intergovernmental panel on climate change press release*. Retrieved from https://www.ipcc.ch/site/assets/uploads/2022/04/IPCC_AR6_WGIII_PressRelease_English.pdf

IUCN, UNEP, WWF. (1980). *World Conservation Strategy*. International Union for the Conservation of Nature, Gland.

Jagtap, M. (2013). Capital mix & cost of capital. *Tactful Management Research Journal*, *1*(10).

Jain, K., Gangopadhyay, M., & Mukhopadhyay, K. (2022). Prospects and challenges of green bonds in renewable energy sector: Case of selected Asian economies. *Journal of Sustainable Finance & Investment*, 1–24. https://doi.org/10.1080/20430795.2022.2034596

Johansen, H. S. (2022). *Lerøy Seafood Group Green Financing Report 2022*. Retrieved from https://www.leroyseafood.com/globalassets/leroy-seafood/investor/green-bonds--rating/the-green-finance-report/221223-green-bond-report.pdf

Johansen, U., Nistad, A. A., Ziegler, F., Mehta, S., & Langeland, M. (2022). *Greenhouse gas emissions of Norwegian salmon products*. Retrieved from https://sintef.brage.unit.no/sintef-xmlui/bitstream/handle/11250/3044084/Rapport_klimafotavtrykk.pdf?sequence=1&isAllowed=y

Johnson, B. M., Kemp, B. M., & Thorgaard, G. H. (2018). Increased mitochondrial DNA diversity in ancient Columbia River basin Chinook salmon Oncorhynchus tshawytscha. *PLOS ONE*, *13*(1), e0190059. https://doi.org/10.1371/journal.pone.0190059

Jones, R., Baker, T., Huet, K., Murphy, L., & Lewis, N. (2020). Treating ecological deficit with debt: The practical and political concerns with green bonds. *Geoforum*, *114*, 49–58. https://doi.org/10.1016/j.geoforum.2020.05.014

Jones, S. W., Karpol, A., Friedman, S., Maru, B. T., & Tracy, B. P. (2020). Recent advances in single cell protein use as a feed ingredient in aquaculture. *Current Opinion in Biotechnology*, *61*, 189–197. https://doi.org/10.1016/j.copbio.2019.12.026

KBN. (2021). *Impact Report Green Loans Financed with Green Bonds*. The Norwegian Agency for Local Governments. Retrieved from The Norwegian Agency for Local Governments website: https://www.kbn.com/globalassets/dokumenter/funding/green-bond-documents/kbn-impact-report-2021.pdf

Kedia, N., & Joshipura, M. (2022). Green bonds for sustainability: Current pathways and new avenues. *Managerial Finance*, *49*(6), 948–974. https://doi.org/10.1108/MF-08-2022-0367

Kleindorfer, P. R., Singhal, K., & Van Wassenhove, L. N. (2005). Sustainable Operations Management. *Production and Operations Management*, *14*(4), 482–492. https://doi.org/10.1111/j.1937-5956.2005.tb00235.x

Kolcava, D. (2023). Greenwashing and public demand for government regulation. *Journal of Public Policy*, *43*(1), 179–198. https://doi.org/10.1017/S0143814X22000277

Kontuš, E., Šorić, K., & Šarlija, N. (2022). Capital structure optimization: A model of optimal capital structure from the aspect of capital cost and corporate value. *Economic Research-Ekonomska Istraživanja*, *36*(2), 2147565. https://doi.org/10.1080/1331677X.2022.2147565

Lee, H. C. B., Cruz, J. M., & Shankar, R. (2018). Corporate Social Responsibility (CSR) Issues in Supply Chain Competition: Should Greenwashing Be Regulated?: Should

Greenwashing be Regulated? *Decision Sciences*, *49*(6), 1088–1115. https://doi.org/10.1111/deci.12307

Lerøy. (2019). *Lerøy Seafood Group Annual Report 2018* [Annual Report]. Retrieved from https://www.leroyseafood.com/globalassets/02--documents/english/annual-reports/annual-report-2018.pdf

Lerøy. (2020). *Lerøy Seafood Group Annual Report 2019* [Annual Report]. Retrieved from https://www.leroyseafood.com/globalassets/02--documents/english/annual-reports/annual-report-2019.pdf

Lerøy. (2021). *Lerøy Seafood Group Annual Report 2020* [Annual Report]. Retrieved from https://www.leroyseafood.com/globalassets/02--documents/english/annual-reports/annual-report-2020.pdf

Lerøy. (2022). *Lerøy Seafood Group Annual Report 2021* [Annual Report]. Retrieved from https://www.leroyseafood.com/globalassets/02--documents/rapporter/arsrapporter/arsrapport-2021/leroy-annual-report-eng-2021.pdf

Lerøy. (2023). *Lerøy Seafood Group Annual Report 2022* [Annual Report]. Retrieved from https://www.leroyseafood.com/globalassets/02--documents/english/annual-reports/leroy-annual-report-22-pdf240523.pdf

Lewis, A. (2001). A focus group study of the motivation to invest: 'Ethical/green' and 'ordinary' investors compared. *The Journal of Socio-Economics*, *30*(4), 331–341. https://doi.org/10.1016/S1053-5357(01)00103-2

Liu, Y., & Bjelland, H. vanhauwaer. (2014). Estimating costs of sea lice control strategy in Norway. *Preventive Veterinary Medicine*, *117*(3), 469–477. https://doi.org/10.1016/j.prevetmed.2014.08.018

Liu, Y., Olaf Olaussen, J., & Skonhoft, A. (2011). Wild and farmed salmon in Norway—A review. *Marine Policy*, *35*(3), 413–418. https://doi.org/10.1016/j.marpol.2010.11.007

Maltais, A., & Nykvist, B. (2020a). Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance & Investment*, *0*(0), 1–20. https://doi.org/10.1080/20430795.2020.1724864

Maltais, A., & Nykvist, B. (2020b). Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance & Investment*, 1–20. https://doi.org/10.1080/20430795.2020.1724864

Maragopoulos, N. (2021). Towards a European Green Bond: A Commission's proposal to promote sustainable finance. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3933766

Martin, J. P. (2001). *The Social Dimensions of Sustainable Development, Speech delivered to the Conference on the European Social Agenda and EÚs International Partners*.

Martins, C. I. M., Eding, E. H., Verdegem, M. C. J., Heinsbroek, L. T. N., Schneider, O., Blancheton, J. P., … Verreth, J. A. J. (2010). New developments in recirculating aquaculture systems in Europe: A perspective on environmental sustainability. *Aquacultural Engineering*, *43*(3), 83–93. https://doi.org/10.1016/j.aquaeng.2010.09.002

McCormick, K., Richter, J. L., & Pantzar, M. (2015). Greening the Economy Compendium. *Lund University*.

McGuinn, J. (2020). Social Sustainability – Concepts and Benchmarks. *European Parliament*.

Mente, E., Pierce, G. J., Santos, M. B., & Neofitou, C. (2006). Effect of feed and feeding in the culture of salmonids on the marine aquatic environment: A synthesis for European aquaculture. *Aquaculture International*, *14*(5), 499–522. https://doi.org/10.1007/s10499-006-9051-4

Milman, O. (2021, September 13). Meat accounts for nearly 60% of all greenhouse gases from food production, study finds. *The Guardian*. Retrieved from https://www.theguardian.com/environment/2021/sep/13/meat-greenhouses-gases-food-production-study

Milne, M. J., & Gray, R. (2013). W(h)ither Ecology? The Triple Bottom Line, the Global Reporting Initiative, and Corporate Sustainability Reporting. *Journal of Business Ethics*, *118*(1), 13–29. https://doi.org/10.1007/s10551-012-1543-8

Moe Føre, H., Thorvaldsen, T., Osmundsen, T. C., Asche, F., Tveterås, R., Fagertun, J. T., & Bjelland, H. V. (2022). Technological innovations promoting sustainable salmon (Salmo salar) aquaculture in Norway. *Aquaculture Reports*, *24*, 101115. https://doi.org/10.1016/j.aqrep.2022.101115

Moldan, B., Janoušková, S., & Hák, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. *Ecological Indicators*, *17*, 4–13. https://doi.org/10.1016/j.ecolind.2011.04.033

Mountford, H. (2015). NCE Welcomes the Paris Agreement. Retrieved May 2, 2023, from The New Climate Economy website: https://newclimateeconomy.net/content/nce-welcomes-paris-agreement

Mowi. (2020a). *Green Bond impact report 2020* (pp. 1–14). Retrieved from https://mowi.com/wp-content/uploads/2021/03/Mowi-Green-Bond-Impact-Report-2020.pdf

Mowi. (2021a). *Green Bond impact report 2021* (pp. 1–13). Retrieved from https://corpsite.azureedge.net/corpsite/wp-content/uploads/2022/03/Mowi-Green-Bond-Impact-Report-2021.pdf

Mowi. (2022a). *Green Bond impact report 2022* (pp. 1–13). Retrieved from https://mowi.com/wp-content/uploads/2023/03/Mowi-Green-Bond-Impact-Report-2022.pdf

Mowi. (2022b). *Integrated Annual Report 2022* (pp. 1–324). Retrieved from https://mowi.com/wp-content/uploads/2023/03/Mowi-Integrated-Annual-Report-2022.pdf

Mowi, A. (2019). *Mowi Integrated Annual Report 2018* [Annual Report]. Retrieved from http://hugin.info/209/R/2239765/882920.pdf

Mowi, A. (2020b). *Mowi Integrated Annual Report 2019* [Annual Report]. Retrieved from https://corpsite.azureedge.net/corpsite/wp-content/uploads/2020/03/Mowi_Annual_Report_2019.pdf

Mowi, A. (2021b). *Mowi Integrated Annual Report 2020* [Annual Report]. Retrieved from https://corpsite.azureedge.net/corpsite/wp-content/uploads/2021/03/Mowi_Integrated_Annual_Report_2020.pdf

Mowi, A. (2022c). *Mowi Integrated Annual Report 2021* [Annual Report]. Retrieved from https://mowi.com/wp-content/uploads/2022/03/Mowi_Annual_Report_2021.pdf

Mowi, A. (2023). *Mowi Integrated Annual Report 2022* [Annual Report]. Retrieved from http://hugin.info/209/R/2239765/882920.pdf

Munasinghe, M., & Shearer, W. [editors. (1995). *Defining and measuring sustainability: The biogeophysical foundations*. Retrieved from https://policycommons.net/artifacts/1514089/defining-and-measuring-sustainability/2187757/

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, *13*(2), 187–221. https://doi.org/10.1016/0304-405X(84)90023-0

Nassiry, D. (2018). *Green Bond Experience in the Nordic Countries*. Retrieved from https://www.adb.org/sites/default/files/publication/408336/adbi-wp816.pdf

Ngwenya, N., & Simatele, M. D. (2020). Unbundling of the green bond market in the economic hubs of Africa: Case study of Kenya, Nigeria and South Africa. *Development Southern Africa*, *37*(6), 888–903. https://doi.org/10.1080/0376835X.2020.1725446

Nie, P., & Hallerman, E. (2021). Advancing the sustainability of aquaculture. *Reviews in Aquaculture*, *13*(2), 781–782. https://doi.org/10.1111/raq.12548

Nilsen, O. B. (2010). LEARNING-BY-DOING OR TECHNOLOGICAL LEAPFROGGING: PRODUCTION FRONTIERS AND EFFICIENCY MEASUREMENT IN NORWEGIAN SALMON AQUACULTURE. *Aquaculture Economics & Management*, *14*(2), 97–119. https://doi.org/10.1080/13657301003776649

NOU. (2018). *Climate risk and the Norwegian economy*. Official Norwegian Reports. Retrieved from Official Norwegian Reports website: https://www.regjeringen.no/contentassets/c5119502a03145278c33b72d9060fbc9/en-gb/pdfs/nou201820180017000engpdfs.pdf

OBX. (2019). How to list on Oslo Børs | euronext.com. Retrieved May 3, 2023, from https://www.euronext.com/en/list-products/bonds/how-list-oslo-bors

OECD. (2001). *OECD Environmental Strategy for the First Decade of the 21st Century*. OECD Environment Ministers. Retrieved from OECD Environment Ministers website: https://www.oecd.org/env/indicators-modelling-outlooks/1863539.pdf

OECD. (2003). OECD Environmental Indicators. *Environment Directorate*.

Oikonomou, I., Brooks, C., & Pavelin, S. (2014). The Effects of Corporate Social Performance on the Cost of Corporate Debt and Credit Ratings. *Financial Review*, *49*(1), 49–75. https://doi.org/10.1111/fire.12025

Olaussen, J. O. (2018). Environmental problems and regulation in the aquaculture industry. Insights from Norway. *Marine Policy*, *98*, 158–163. https://doi.org/10.1016/j.marpol.2018.08.005

Omri, A. (2020). Technological innovation and sustainable development: Does the stage of development matter? *Environmental Impact Assessment Review*, *83*, 106398. https://doi.org/10.1016/j.eiar.2020.106398

Overbosch, P., & Blanchard, S. (2023). Chapter 25—Principles and Systems for Quality and Food Safety Management. In V. Andersen, H. Lelieveld, & Y. Motarjemi (Eds.), *Food Safety Management (Second Edition)* (pp. 497–512). San Diego: Academic Press. https://doi.org/10.1016/B978-0-12-820013-1.00018-8

Patterson, C. S. (1995). *The Cost of Capital: Theory and Estimation*. Greenwood Publishing Group.

Pullman, M. E., Maloni, M. J., & Carter, C. R. (2009). Food for Thought: Social Versus Environmental Sustainability Practices and Performance Outcomes. *Journal of Supply Chain Management*, *45*(4), 38–54. https://doi.org/10.1111/j.1745-493X.2009.03175.x

Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: In search of conceptual origins. *Sustainability Science*, *14*(3), 681–695. https://doi.org/10.1007/s11625-018-0627-5

Reichelt, H. (2010). *Green bonds: A model to mobilise private capital to fund climate change mitigation and adaptation projects* (p. 1). West LB. Retrieved from West LB website: https://documents1.worldbank.org/curated/en/680921507013408005/pdf/120168-BRI-PUBLIC-euromoney-handbook-2010-green-bonds.pdf

Reichelt, H., & Cantor, S. (2023, January 20). Why green bonds matter—It may be more than you think. Retrieved May 12, 2023, from World bank blogs website:

https://blogs.worldbank.org/climatechange/why-green-bonds-matter-it-may-be-more-than-you-think

Ritchie, H. (2020, October 3). The carbon footprint of foods: Are differences explained by the impacts of methane? Retrieved May 6, 2023, from Our World in Data website: https://ourworldindata.org/carbon-footprint-food-methane

Robert, K. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is Sustainable Development? Goals, Indicators, Values, and Practice. *Environment: Science and Policy for Sustainable Development*, *47*(3), 8–21. https://doi.org/10.1080/00139157.2005.10524444

Ronæss, C. (2022). *SALMAR ASA GREEN BOND REPORT 2021* (No. 9578-5994-4–555967). Retrieved from https://www.salmar.no/wp-content/uploads/2016/06/Green-Bond-Report_Attestert.pdf

Ronæss, C. (2023). *SALMAR ASA GREEN BOND REPORT 2022*. Retrieved from https://www.salmar.no/wp-content/uploads/2016/06/Green-Bond-Report-2022.pdf

Rud, I., Kolarevic, J., Holan, A. B., Berget, I., Calabrese, S., & Terjesen, B. F. (2017). Deep-sequencing of the bacterial microbiota in commercial-scale recirculating and semi-closed aquaculture systems for Atlantic salmon post-smolt production. *Aquacultural Engineering*, *78*, 50–62. https://doi.org/10.1016/j.aquaeng.2016.10.003

Rumbos, C. I., Karapanagiotidis, I. T., Mente, E., & Athanassiou, C. G. (2019). The lesser mealworm *Alphitobius diaperinus*: A noxious pest or a promising nutrient source? *Reviews in Aquaculture*, *11*(4), 1418–1437. https://doi.org/10.1111/raq.12300

Russo, M., & FOUTS, P. (1997). Russo M. V., P. A. Fouts: 1997, A Resource-Based Perspective on Corporate Environmental Performance and Profitability. Academy of Management Journal. *Academy of Management Journal*, *40*. https://doi.org/10.2307/257052

Saeed, S., Yousafzai, S., Paladino, A., & De Luca, L. (2015). Inside-out and outside-in orientations: A meta-analysis of orientation's effects on innovation and firm performance. *Industrial Marketing Management, 47*. https://doi.org/10.1016/j.indmarman.2015.02.037

SalMar. (2019). *SalMar Annual Report 2018* [Annual Report]. Retrieved from https://hugin.info/138695/R/2242726/885263.pdf

SalMar. (2020). *SalMar Annual Report 2019* [Annual Report]. Retrieved from https://ml-eu.globenewswire.com/Resource/Download/74e5d277-5302-41ee-af23-4a7785858807

SalMar. (2021). *SalMar Annual Report 2020* [Annual Report]. Retrieved from https://ml-eu.globenewswire.com/Resource/Download/3a869ed4-be25-4ad7-b1c1-39e901bb207f

SalMar. (2022). *SalMar Annual Report 2021* [Annual Report]. Retrieved from https://ml-eu.globenewswire.com/Resource/Download/3781f230-d728-4a34-9ba3-53d59a8db537

SalMar. (2023). *SalMar Annual Report 2022* [Annual Report]. Retrieved from https://ml-eu.globenewswire.com/Resource/Download/a1b33242-6c5a-4ebf-96d6-e6870f9d8994

Salmon Group. (2023). Vårt ansvar. Retrieved May 10, 2023, from Salmon Group website: https://salmongroup.no/vart-ansvar/

Salze, G., McLean, E., Battle, P. R., Schwarz, M. H., & Craig, S. R. (2010). Use of soy protein concentrate and novel ingredients in the total elimination of fish meal and fish oil in diets for juvenile cobia, Rachycentron canadum. *Aquaculture*, *298*(3), 294–299. https://doi.org/10.1016/j.aquaculture.2009.11.003

Sandvold, H. N., & Tveterås, R. (2014). INNOVATION AND PRODUCTIVITY GROWTH IN NORWEGIAN PRODUCTION OF JUVENILE SALMONIDS. *Aquaculture Economics & Management*, *18*(2), 149–168. https://doi.org/10.1080/13657305.2014.903313

Sapkota, A., Sapkota, A. R., Kucharski, M., Burke, J., McKenzie, S., Walker, P., & Lawrence, R. (2008). Aquaculture practices and potential human health risks: Current knowledge and future priorities. *Environment International*, *34*(8), 1215–1226. https://doi.org/10.1016/j.envint.2008.04.009

Saunila, M., Ukko, J., & Rantala, T. (2017). Sustainability as a driver of green innovation investment and exploitation. *Journal of Cleaner Production*, *179*. https://doi.org/10.1016/j.jclepro.2017.11.211

SEC. (2021). SEC.gov | Climate and ESG Risks and Opportunities. Retrieved May 12, 2023, from U.S. SECURITIES AND EXCHANGE COMMISSION website: https://www.sec.gov/sec-response-climate-and-esg-risks-and-opportunities

Seebode, D., Jeanrenaud, S., & Bessant, J. (2012). Managing innovation for sustainability. *R&D Management*, *42*(3), 195–206. https://doi.org/10.1111/j.1467-9310.2012.00678.x

Serageldin, I., & Streeter, A. (1993). *Valuing the environment: Proceedings of the First Annual Conference on Environmentally Sustainable Development*.

Shahbandeh, M. (2022, August 19). Global animal protein consumption by source 2021. Retrieved May 4, 2023, from Statista website: https://www.statista.com/statistics/1025784/human-consumption-of-protein-by-type-worldwide/

Shephard, S., & Gargan, P. (2021). System-specific salmon louse infestation thresholds for salmon farms to minimize impacts on wild sea trout populations. *Aquaculture Environment Interactions*, *13*, 377–388. https://doi.org/10.3354/aei00413

Sprague, M., Dick, J. R., & Tocher, D. R. (2016). Impact of sustainable feeds on omega-3 long-chain fatty acid levels in farmed Atlantic salmon, 2006–2015. *Scientific Reports*, *6*(1), 21892. https://doi.org/10.1038/srep21892

Stellner, C., Klein, C., & Zwergel, B. (2015). Corporate social responsibility and Eurozone corporate bonds: The moderating role of country sustainability. *Journal of Banking & Finance*, *59*, 538–549. https://doi.org/10.1016/j.jbankfin.2015.04.032

Stentiford, G. D., Neil, D. M., Peeler, E. J., Shields, J. D., Small, H. J., Flegel, T. W., … Lightner, D. V. (2012). Disease will limit future food supply from the global crustacean fishery and aquaculture sectors. *Journal of Invertebrate Pathology*, *110*(2), 141–157. https://doi.org/10.1016/j.jip.2012.03.013

Stern, L. N. (2015). NCE Welcomes the Paris Agreement. Retrieved May 2, 2023, from The New Climate Economy website: https://newclimateeconomy.net/content/nce-welcomes-paris-agreement

Sutton, P. (2004). A Perspective on environmental sustainability? *Victorian Commissioner for Environmental Sustainability*.

Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance*, *61*, 101427. https://doi.org/10.1016/j.jcorpfin.2018.12.001

Tennberg, M., Lempinen, H., & Pirnes, S. (Eds.). (2019). *Resources, Social and Cultural Sustainabilities in the Arctic* (1st ed.). Routledge. https://doi.org/10.4324/9780429057366

Tolliver, C., Keeley, A. R., & Managi, S. (2019). Green bonds for the Paris agreement and sustainable development goals. *Environmental Research Letters*, *14*(6), 064009. https://doi.org/10.1088/1748-9326/ab1118

Torjman, S. (2000). *The Social Dimension of Sustainable Development*.

Tveterås, R., Misund, B., Roche Aponte, F., & Pincinato, R. B. (2020). Regulation of salmon aquaculture towards 2030: Incentives, economic performance and sustainability. In *82*. NORCE Norwegian Research Centre AS. Retrieved from NORCE Norwegian Research Centre AS website: https://uis.brage.unit.no/uis-xmlui/handle/11250/3050414

UN. (2023a). Communications materials. Retrieved May 9, 2023, from United Nations Sustainable Development website: https://www.un.org/sustainabledevelopment/news/communications-material/

UN. (2023b). Population. Retrieved May 4, 2023, from United Nations website: https://www.un.org/en/global-issues/population

UNDP. (2022). Sustainable Development Goals | United Nations Development Programme. Retrieved May 9, 2023, from UNDP website: https://www.undp.org/sustainable-development-goals

UNPRI, 15. (2023). An introduction to responsible investment: Fixed income. Retrieved June 10, 2023, from UNPRI website: https://www.unpri.org/introductory-guides-to-responsible-investment/an-introduction-to-responsible-investment-fixed-income/4986.article

Valdenegro-Vega, V. A., Polinski, M., Bridle, A., Crosbie, P., Leef, M., & Nowak, B. F. (2015). Effects of single and repeated infections with Neoparamoeba perurans on antibody levels and immune gene expression in Atlantic salmon (Salmo salar). *Fish & Shellfish Immunology*, *42*(2), 522–529. https://doi.org/10.1016/j.fsi.2014.11.031

Venier, S. (2018). Waste Water Management in Seaside Tourism Areas: The Rimini Seawater Protection Plan. In A. Gilardoni (Ed.), *The Italian Water Industry: Cases of Excellence* (pp. 225–235). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-71336-6_16

Wang, J., Chen, X., Li, X., Yu, J., & Zhong, R. (2020). The market reaction to green bond issuance: Evidence from China. *Pacific-Basin Finance Journal*, *60*, 101294. https://doi.org/10.1016/j.pacfin.2020.101294

Wang, Y., Delgado, M. S., & Xu, J. (2023). When and where does it pay to be green? – A look into socially responsible investing and the cost of equity capital. *International Journal of Corporate Social Responsibility*, *8*(1), 1. https://doi.org/10.1186/s40991-023-00077-5

World Bank. (1992). *World development report. 1992: Development and the environment* (2. print).

World Bank. (2021). The World Bank Impact Report Sustainable Development Bonds & Green Bonds 2021. Retrieved May 2, 2023, from Issuu website: https://issuu.com/jlim5/docs/world_bank_ibrd_impact_report_2021_web_ready_r01/1

Wurgler, J., & Baker, M. (2018). Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds. *National Bureau of Economic Research*. Retrieved from https://www.nber.org/system/files/working_papers/w25194/w25194.pdf

Yermo, J., & Croce, R. D. (2013). *Institutional Investors and Green Infrastructure Investments: Selected Case Studies* (OECD Working Papers on Finance, Insurance and Private Pensions No. 35). OECD. https://doi.org/10.1787/5k3xr8k6jb0n-en

Yue, K., & Shen, Y. (2022). An overview of disruptive technologies for aquaculture. *Aquaculture and Fisheries*, *7*(2), 111–120. https://doi.org/10.1016/j.aaf.2021.04.009

Zhang, Dayong, Zhang, Z., & Managi, S. (2019). A bibliometric analysis on green finance: Current status, development, and future directions. *Finance Research Letters*, *29*, 425–430. https://doi.org/10.1016/j.frl.2019.02.003

Zhang, Dongyang. (2023). Subsidy expiration and greenwashing decision: Is there a role of bankruptcy risk? *Energy Economics*, *118*, 106530. https://doi.org/10.1016/j.eneco.2023.106530

Zhang, Dongyang, & Du, P. (2020). How China "Going green" impacts corporate performance? *Journal of Cleaner Production*, *258*, 120604. https://doi.org/10.1016/j.jclepro.2020.120604

Zhao, Y., Xue, B., Bi, C., Ren, X., & Liu, Y. (2022). Influence mechanisms of macro-infrastructure on micro-environments in the recirculating aquaculture system and biofloc technology system. *Reviews in Aquaculture*, *15*(3), 991–1009. https://doi.org/10.1111/raq.12713

Appendix

Appendix 1

Source: (IFC, 2020)

Appendix 2

Table 1. Summary of environmental sustainability indicators in different area

Impacts on		Drivers	Pressures	States	Impacts	Responses
Climate change	LCA			- Radiative forcing as Global Warming Potential (GWP100)	- Ecosystem damages - Human health damages	
	PB			- Atmospheric CO_2 concentration - Energy imbalance at top-of-atmosphere		
	SDGs	- GHG emissions intensity of areas under forest management ($GtCO_2e$ / ha) - CO_2 intensity of new power generation capacity installed (gCO_2 per kWh), and of new cars (gCO_2/pkm) and trucks (gCO_2/tkm)	- Net GHG emissions in the Agriculture, Forest and other Land Use (AFOLU) sector (tCO_2e) - Total energy and industry-related GHG emissions by gas and sector, expressed as production and demand-based emissions (tCO_2e)		- Losses from natural disasters, by climate and non-climate-related events (in US$ and lives lost)	- [Climate Change Action Index] – to be developed - Implicit incentives for low-carbon energy in the electricity sector (measured as US$/MWh or US$ per ton avoided CO_2) - Availability and implementation of a transparent and detailed deep decarbonization strategy, consistent with the 2°C - or below - global carbon budget, and with GHG emission targets for 2020, 2030 and 2050. - [Disaster Risk Reduction Indicator] – to be developed
Acidification	LCA			- Land and water: Accumulated Exceedance	- Ecosystem damages	
	PB			- Ocean: carbonate ion concentration		
	SDGs			- Ocean acidity (measured as surface pH)		
Ozone depletion	LCA			- Ozone Depletion Potential (ODP)	- Human health damages	
	PB			- Stratospheric O_3 concentration		
	SDGs		- Consumption of ozone-depleting substances (MDG Indicator)			
Atmospheric aerosol loading	PB			- Aerosol Optical Depth (AOD)		
	SDGs			- Aerosol Optical Depth (AOD)		
Eutrophication	LCA			- Accumulated Exceedance	- Ecosystem damages	
	PB		- Global: P flow from freshwater into ocean - Regional: P flow from fertilizers to erodible soils - Global: industrial and intentional biological fixation of N			
	SDGs	- Nitrogen use efficiency in food systems - Phosphorus use efficiency in food systems			- Eutrophication of major estuaries	
Air pollution	LCA			- Intake fraction for fine particles (kg PM2.5-eq/kg)	- Human health damages	
	SDGs			- Mean urban air pollution of particulate matter (PM10 and PM2.5)	- [Mortality from indoor air pollution] – to be developed	
Ionizing radiation	LCA			- Human exposure efficiency relative to U^{235}	- Human health damages	
Photochemical ozone formation	LCA			- Tropospheric ozone concentration increase	- Human health damages	
Chemical pollution/ introduction of novel entities	LCA				- Ecosystem damages - Human health damages	
	PB	- No indicator currently defined. It may be for example chemical emissions, concentrations, or effects on ecosystem and earth system functioning				
	SDGs		- [Indicator on chemical pollution] – to be developed			

Impacts on		Drivers	Pressures	States	Impacts	Responses
Waste treatment	SDGs	- Proportion of the population connected to collective sewers or with on-site storage of all domestic wastewaters	- Percentage of urban solid waste regularly collected and well managed - Percentage of wastewater flows treated to national standards [and reused] – to be developed	- Global Food Loss Index [or other indicator to be developed to track the share of food lost or wasted in the value chain after harvest]		
Land system change	LCA			- Soil Organic Matter	- Ecosystem damages - Natural resource damages	
	SDGs	- [Ratio of land consumption rate to population growth rate, at comparable scale] – to be developed		- Annual change in degraded or desertified arable land (% or ha)		- [Indicator on the conservation of mountain ecosystems] – to be developed
Marine system change	SDGs			- Share of coastal and marine areas that are protected - Area of coral reef ecosystems and percentage live cover		- [Indicator on the implementation of spatial planning strategies for coastal and marine areas]– to be developed
Change in biosphere integrity /biodiversity	LCA			- Potential affected fraction of species	- Ecosystem damages	
	PB			- Extinction rate - Biodiversity intactness index		
	SDGs			- Genetic diversity of terrestrial domesticated animals - [Indicator on genetic diversity in agriculture] – to be developed - Red List Index - Living Planet Index - Abundance of invasive alien species		- [Indicator on global support to combat poaching and trafficking of protected species] – to be developed - Protected areas overlay with biodiversity
Freshwater use	LCA		- Water use related to local scarcity of water		- Natural resource damages	
	PB		- blue water use			
	SDGs	- [Crop water productivity (tons of harvested product per unit irrigation water)] – to be developed		- Proportion of total water resources used (MDG Indicator)		- [Indicator on water resource management] – to be developed - [Reporting of international river shed authorities on transboundary river-shed management] – to be developed
Forest resources	PB			- Area of forested land as % of original or potential forest cover		
	SDGs			- Annual change in forest area and land under cultivation (modified MDG Indicator) - Area of mangrove deforestation (hectares and as % of total mangrove area)		- Area of forest under sustainable forest management as a percent of forest area - Improved tenure security and governance of forests
Fish resources	SDGs			- Proportion of fish stocks within safe biological limits (MDG Indicator) - Percentage of fish tonnage landed with Maximum Sustainable Yield (MSY)		- Percentage of fisheries with a sustainable certification - [Use of destructive fishing techniques] - Indicator to be developed
Energy resources	SDGs	- Presence of urban building codes stipulating either the use of local materials and/or new energy efficient technologies or with incentives for the same - Rate of primary energy intensity improvement		- Primary energy by type - Share of energy from renewables		Fossil fuel subsidies ($ or %GNI)
Fossil and mineral resources	LCA			- Scarcity	- Natural resource damages	
Food and agricultural resources	SDGs		- Global Food Loss Index [or other indicator to be developed to track the share of food lost or wasted in the value chain after harvest]	- Crop yield gap (actual yield as % of attainable yield) - Cereal yield growth rate (% p.a.) - Livestock yield gap (actual yield as % of attainable yield)		

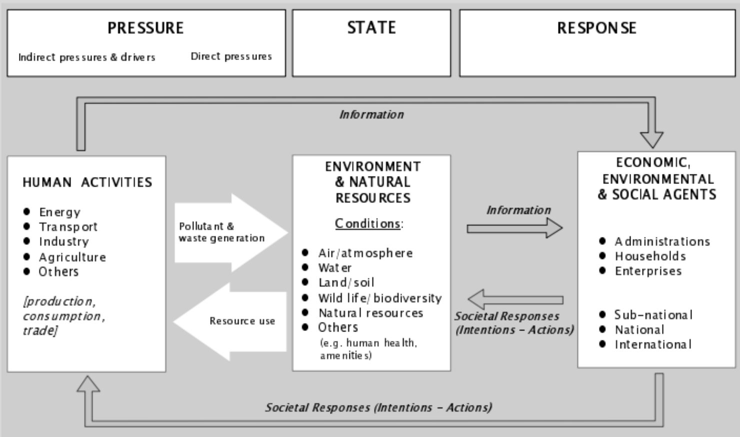
Source: (Dong, 2017)

Appendix 3

Annex II. THE PRESSURE-STATE-RESPONSE (PSR) MODEL

The PSR model has initially been developed by the OECD to structure its work on environmental policies and reporting. It considers that: human activities exert pressures on the environment and affect its quality and the quantity of natural resources ("state"); society responds to these changes through environmental, general economic and sectoral policies and through changes in awareness and behaviour ("societal response").

- The PSR model highlights these cause-effect relationships, and helps decision makers and the public see environmental, economic, and other issues as interconnected. It thus provides a means of selecting and organising indicators (or state of the environment reports) in a way useful for decision-makers and the public, and of ensuring that nothing important has been overlooked.
- The PSR model has the advantage of being one of the easiest frameworks to understand and use, and of being neutral in the sense that it just says which linkages exist, and not whether these have negative or positive impacts. This should however not obscure the view of more complex relationships in ecosystems, and in environment-economy and environment-social interactions.
- Depending on the purpose for which the PSR model is to be used, it can easily be adjusted to account for greater details or for specific features. Examples of adjusted versions are the Driving force - State - Response (DSR) model formerly used by the UNCSD in its work on sustainable development indicators, the framework used for OECD sectoral environmental indicators and the Driving force-Pressure-State-Impact-Response (DPSIR) model used by the EEA.



- Environmental pressures describe pressures from human activities exerted on the environment, including natural resources. "Pressures" here cover underlying or indirect pressures (i.e. human activities themselves and trends and patterns of environmental significance) as well as proximate or direct pressures (i.e. the use of resources and the discharge of pollutants and waste materials). Indicators of environmental pressures are closely related to production and consumption patterns; they often reflect emission or resource use intensities, along with related trends and changes over a given period. They can be used to show progress in decoupling economic activities from related environmental pressures, or in meeting national objectives and international commitments (e.g. emission reduction targets).
- Environmental conditions relate to the quality of the environment and the quality and quantity of natural resources. As such they reflect the ultimate objective of environmental policies. Indicators of environmental conditions are designed to give an overview of the situation (the state) concerning the environment and its development over time. Examples of indicators of environmental conditions are: concentration of pollutants in environmental media, exceedance of critical loads, population exposure to certain levels of pollution or degraded environmental quality and related effects on health, the status of wildlife and ecosystems and of natural resource stocks. In practice, measuring environmental conditions can be difficult or very costly. Therefore, environmental pressures are often measured instead as a substitute.
- Societal responses show the extent to which society responds to environmental concerns. They refer to individual and collective actions and reactions, intended to:
  - mitigate, adapt to or prevent human-induced negative effects on the environment;
  - halt or reverse environmental damage already inflicted;
  - preserve and conserve nature and natural resources.

Examples of indicators of societal responses are environmental expenditure, environment-related taxes and subsidies, price structures, market shares of environmentally friendly goods and services, pollution abatement rates, waste recycling rates, enforcement and compliance activities. In practice, indicators mostly relate to abatement and control measures; those showing preventive and integrative measures and actions are more difficult to obtain.

Source: (OECD, 2003)

Appendix 4

Source: (UN, 2023)

Appendix 5

Box 7. **Key environmental indicators**

OECD CORE SET OF ENVIRONMENTAL INDICATORS

OECD SET OF KEY ENVIRONMENTAL INDICATORS

Pollution issues		Available indicators*	Medium term indicators**
Climate change	1.	CO2 emission intensities	Index of greenhouse gas emissions
Ozone layer	2.	Indices of apparent consumption of ozone depleting substances (ODS)	Same, plus aggregation into one index of apparent consumption of ODS
Air quality	3.	SOx and NOx emission intensities	Population exposure to air pollution
Waste generation	4.	Municipal waste generation intensities	Total waste generation intensities, Indicators derived from material flow
Freshwater quality	5.	Waste water treatment connection rates	Pollution loads to water bodies
Natural resources & assets			
Freshwater resources	6.	Intensity of use of water resources	Same plus sub-national breakdown
Forest resources	7.	Intensity of use of forest resources	Same
Fish resources	8.	Intensity of use of fish resources	Same plus closer link to available resources
Energy resources	9.	Intensity of energy use	Energy efficiency index
Biodiversity	10.	Threatened species	Species and habitat or ecosystem diversity Area of key ecosystems

** indicators for which data are available for a majority of OECD countries and that are presented in this report*

*** indicators that require further specification and development (availability of basic data sets, underlying concepts and definitions).*

Source: (OECD 2003)

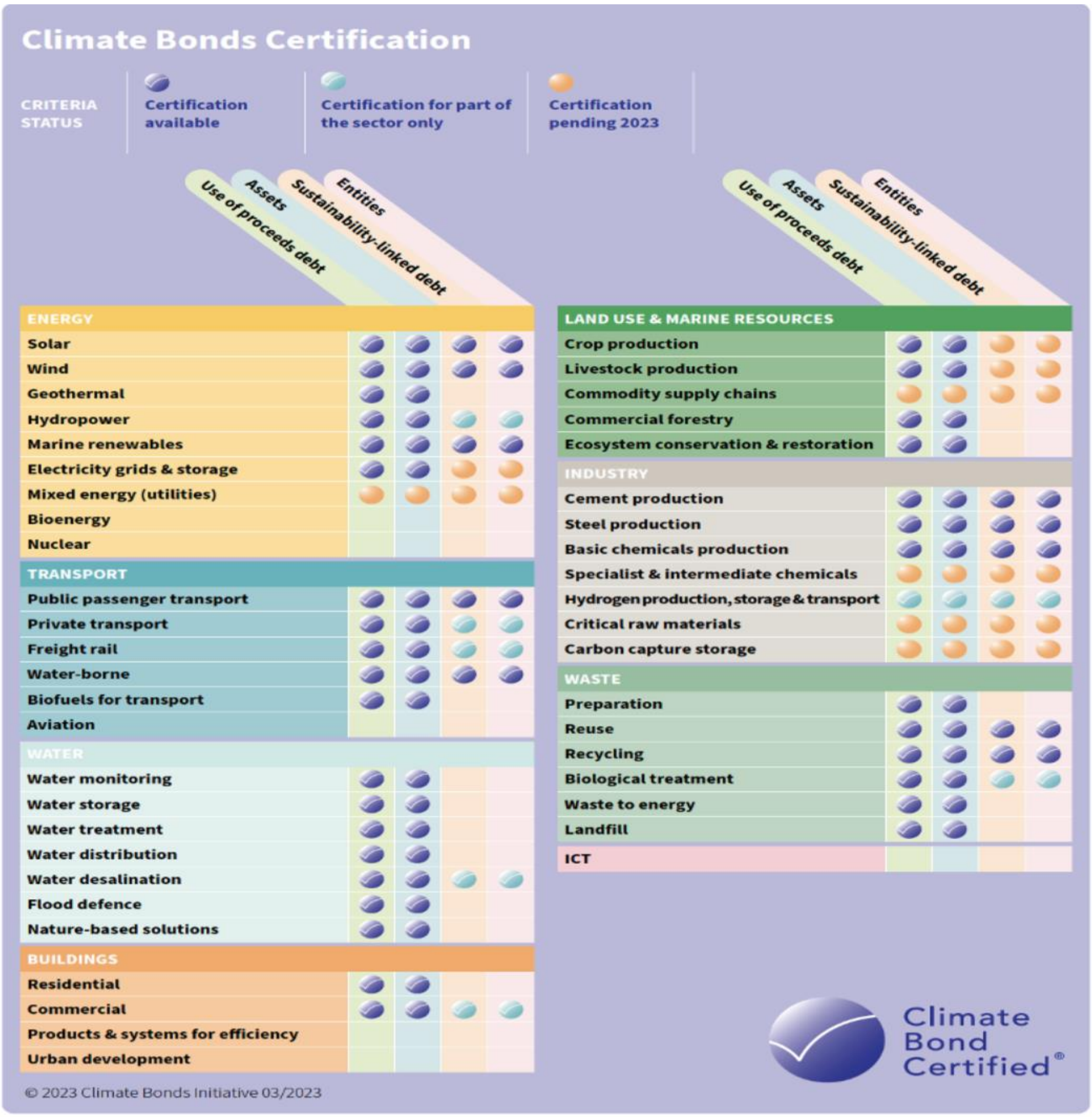
Appendix 6

Box 5 Structure of the OECD indicators Core Set by environmental issue

Major issues	PRESSURE **Indicators of environmental pressures**	STATE **Indicators of environmental conditions**	RESPONSE **Indicators of societal responses**
1. Climate change			
2. Ozone layer depletion			
3. Eutrophication			
4. Acidification			
5. Toxic contamination			
6. Urban environmental quality			
7. Biodiversity			
8. Cultural landscapes			
9. Waste			
10. Water resources			
11. Forest resources			
12. Fish resources			
13. Soil degradation (desertification, erosion)			
14. Material resources			
15. Socio-economic, sectoral and general indicators			

Source: (OECD, 2003)

Appendix 7



Source: (Climate Bond, 2015)

Appendix 8

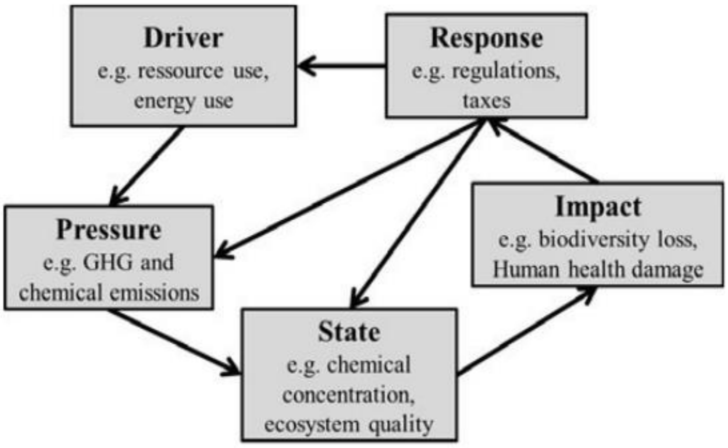
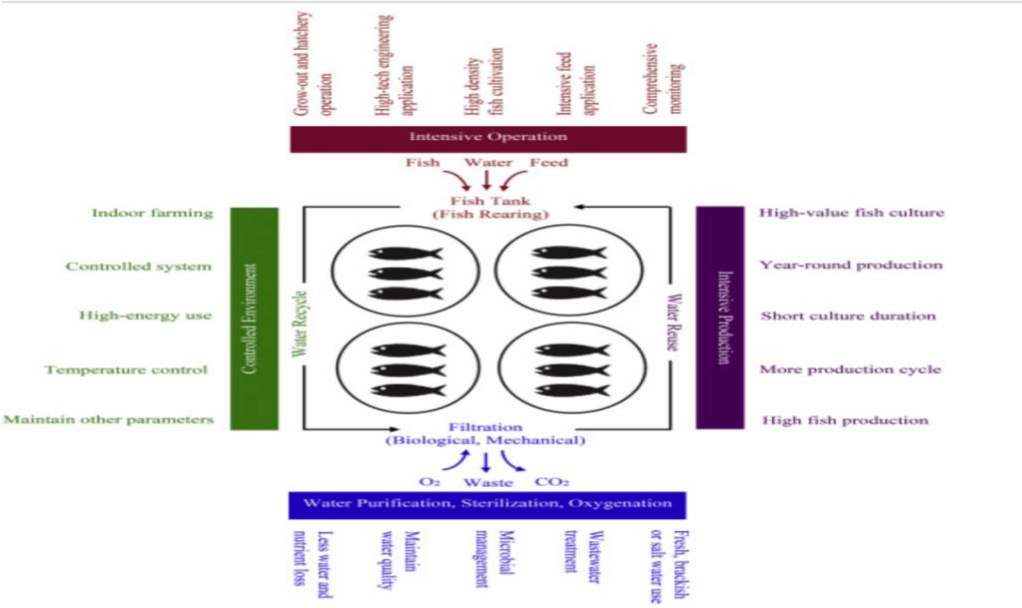


Figure 1. The DPSIR framework, adapted from EEA [12]

Source: (OECD, 2003)

Appendix 9



Source: (Ahmed & Turchini, 2021)