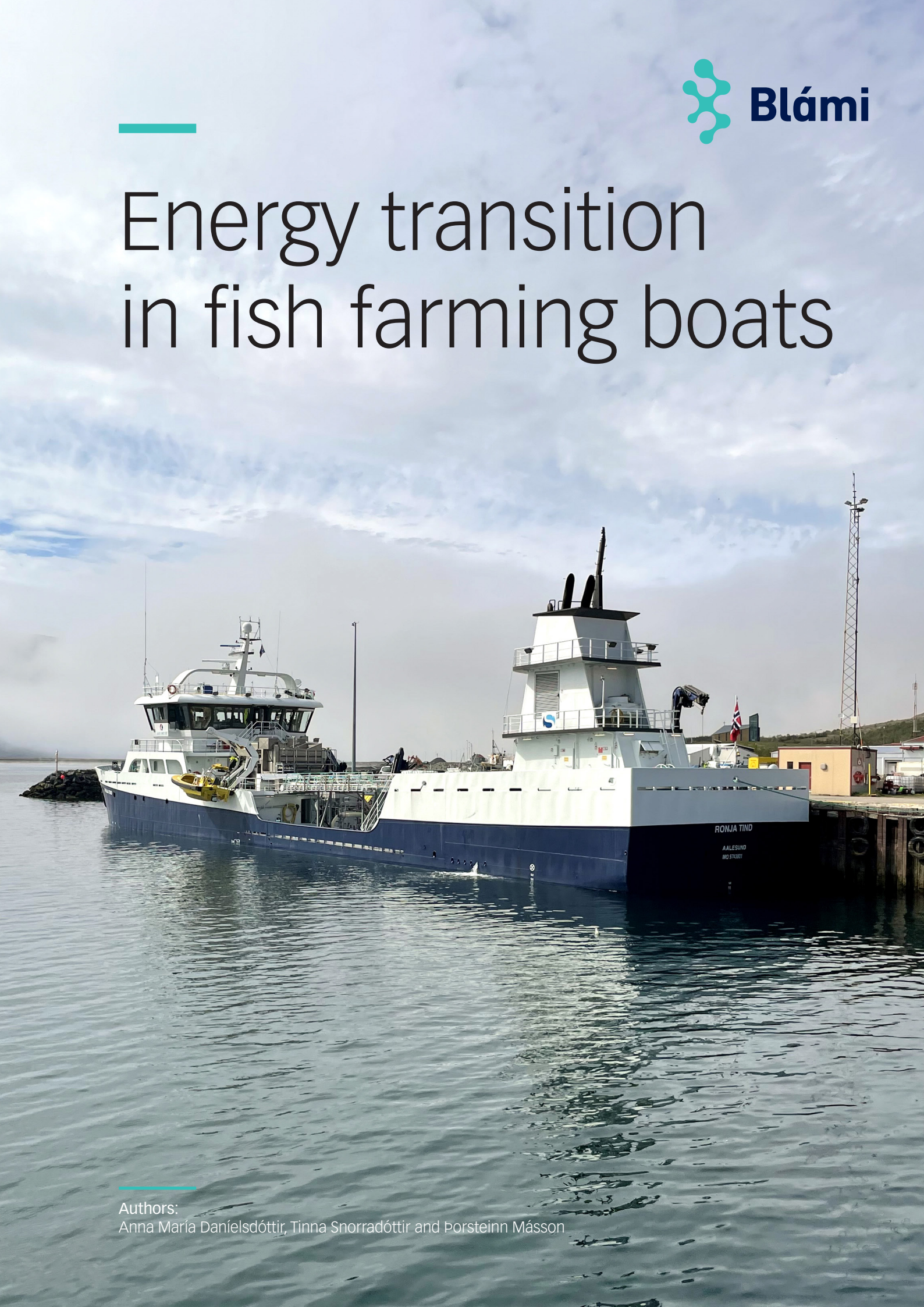
Blámi

Energy transition in fish farming boats



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Summary

In recent years, sea cage aquaculture has grown significantly in Iceland. In 2021 a total of 46,500 tons of salmon was exported from Iceland, of which about 96%[1] came from sea cage aquaculture.

Sea cage aquaculture is conducted in the West Fjord region and certain areas of the Eastern Region. Production takes place in demarcated aquaculture locations that are serviced by boats and ships owned by the fish farming companies themselves or other service providers.

The total oil consumption of these boats and ships is about 2,700,000 liters of oil per year, which results in carbon dioxide emissions roughly equivalent to that of 3,600 passenger cars. The introduction of the green solutions discussed in this report could significantly decrease those emissions.

It is assumed that salmon production from sea cage aquaculture will increase in the future based on the assessment of risk with regard to genetic mixing, the available license applications and the plans made by the fish farming companies. From that data it may be estimated that annual production will reach 70-100 thousand tons in the next 3-4 years. Due to the nature of the issue, the fish farming companies will need to acquire more boats and ships, and such investments offer opportunities for the introduction of green energy solutions. However, there are various obstacles that can prevent fish farming companies from choosing more environmentally favourable solutions, such as a lack of infrastructure and increased expense. In this report, various proposals are presented regarding incentives and cooperation that will make it more feasible to invest in green energy solutions and bring Iceland closer to its goal of achieving carbon neutrality by the year 2040.[3]

[1] Radarinn.is/fiskeldi

[2] An average passenger car emits about 2 tons of CO_2 per year

[3] https://www.stjornarradid.is/efst-a-baugi/frettir/stok-frett/2021/06/15/Markmid-um-kolefnishlutleysi-logfest-a-Althingi/

Introduction

This report is compiled by Blámi, which is a collaborative project of Landsvirkjun, Orkubú Vestfjarða and Vestfjarðastofa. The primary objective of Blámi is to promote innovation and development of energy transition projects by expanding the role of environmentally friendly fuel, hydrogen and electrofuel in transportation and marine-related industry.

Iceland has established the goal of reducing greenhouse gas emissions by 55% by the year 2030 and achieving carbon neutrality by 2040.[4] It is stated in the energy policy that the objective with energy transition at sea is that all ships, boats and other seaborne craft, whether used for fishing, transporting cargo or passengers or other purposes, will be powered with energy sources of renewable origin. It is also stated that incentives and direct measures that promote energy transition shall be employed.

In Iceland, sea cage aquaculture takes place in the West Fjord region and certain areas of the Eastern Region. In 2021, the production of salmon was about 46,500 tons, the majority of which, about 96%, came from sea cage aquaculture.[5] Sea cage aquaculture has seen much growth in recent years, and in the period 2015-2021 production increased significantly, as shown in figure 1. In 2020, an updated risk assessment was issued for a maximum biomass of 106,500 tons for all of Iceland, and it may be assumed that the sector will continue to see growth in the next years.

In Iceland, operating licences have been issued for a total maximum biomass of 80,000 tons in nine fjords, and each fjord is divided into sea cage aquaculture areas, with one or more aquaculture areas within each area. Each aquaculture area area requires small work boats, conventional work boats and also specialized service boats and well boats for transporting fry to the marine pens and collecting fish for processing. All such boats and ships use fossil fuel, and this report includes an account of the current energy consumption and ways in which it would be possible to increase the use of green energy for fish farming boats.

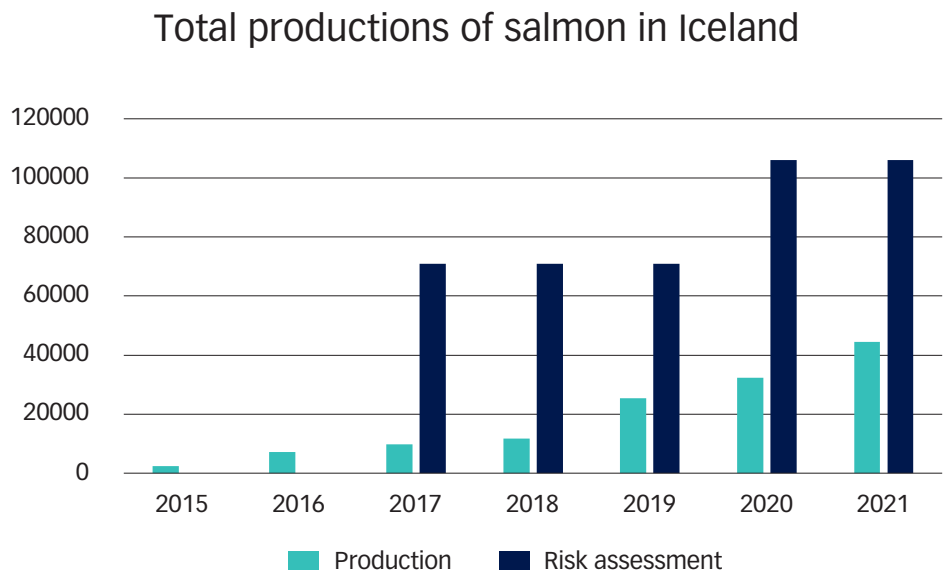

Figure 1. Showing production and risk assessment by year. There was no risk assessment for the years 2015 and 2016.

[4] https://www.stjornarradid.is/efst-a-baugi/frettir/stok-frett/2020/12/10/Ny-metnadarfull-markmid-i-loftslagsmalum-kynnt/

[5] Radarinn.is/fiskeldi

Boats in sea cage aquaculture

Boats and ships that are used for sea cage aquaculture can be divided into four categories: smaller work boats, work boats, well boats and service boats. The following information about tonnage, quantity, consumption and other items is obtained from the fish farming companies and service providers.

■ Smaller work boats

■ Work boats

Smaller work boats

In Iceland there are 6-10 smaller work boats in use, and such boats are commonly 7-10 meters in length, with an engine power of about 100-200 kW. Use of those boats mostly involves patrolling marine pens and feed barges, and smaller work boats usually move at fast speeds between 13-25 nautical miles/hour. About half of these boats are equipped with gasoline-powered outboard motors, and others have diesel engines. The average energy consumption of smaller work boats in Iceland is about 8,500 liters of oil or gasoline per year, and it may therefore be assumed that the total consumption of smaller work boats in Iceland is about 51,000 – 85,000 liters of fossil fuels per year. It may be expected that the number of smaller work boats will increase by 2-4 in the next 3 years.

Work boats

There are 20-24 work boats used for fish farming in Iceland. Most of these boats are 12-15 meters long, twin-hulled with two motors and equipped with powerful cranes. The average age of work boats in Iceland is 10 years, and the average size of their engines is 360 kW. These boats are used for patrol duties, installation and maintenance, as well as for assisting with gathering fish or releasing fish into marine pens. Work boats are used most days of the week, for work shifts that commonly last for 7-12 hours. The average energy consumption of work boats is about 41,000 liters of oil per year and the total consumption of oil for work boats in Iceland is 820,000-1,000,000 liters per year. It may be expected that the number of work boats will increase by 3-4 in the next 3 years.

Well boats

Well boats are the boats that gather live fish from marine pens and pump them into processing facilities on land, and also provide transportation of fry from farming plants on land into marine pens. These boats are usually equipped with powerful pumping mechanisms, cranes and other features for working around marine pens and for transporting fish. There are 2-3 well boats in operation in Iceland, and it may be expected that they will

■ Well boats

■ Service boats

increase in number by 1-2 in the next 5 years. These boats are usually equipped with a main engine and 2-3 auxiliary engines, which are used among other things to provide the electricity required by the well boats. The amount of time which these boats can be used at sea varies and the same applies to the pattern in which they are used, depending on whether they gather fish for processing or transport fry to marine pens. It may be assumed that each well boat uses 700,000 – 800,000 liters of oil per year, based on continuous use over the year. The total oil consumption for well boats could be about 1,700,000 liters per year, and will increase to 2,100,000 liters in the next three years.

Service boats

Service boats are boats and ships that are used for installation of marine pen fish farms, research, cleaning and maintenance of fish farming equipment. Most of these boats are comparable to traditional work boats, yet some are larger and more powerful, equipped with powerful cranes and specialized equipment for installing marine pens. In Iceland there are about 6-8 service boats and ships, operated by Icelandic, Norwegian and Scottish companies. These ships vary in size, with a gross register tonnage of anything between 20 and as high as 500 tons. The amount of time which they can be used at sea can be very different between ships, anything from a few hours to several days, and larger service ships can be sailed between parts of the country and over oceans. It may be assumed that each service boat in operation in Iceland uses about 40,000-60,000 liters of oil per year, and that the total consumption of service boats is about 300,000-400,000 liters of oil per year. It is to be expected that the number of service boats will increase by two in the next three years, in step with the increase activities of the fish farming companies.

Annual emissions and carbon footprint

It may be assumed that the total use of fossil fuel for boats and ships in fish farming is about 2,700,000 liters per year, which results in the emission of about 7,300 tons of CO_2 each year.[6] Use of fossil fuel is likely to increase by 20% in the next five years concomitantly with increased activities, unless measures are taken to increase the use of renewable energy.

[6] It is assumed that each liter of diesel oil corresponds to 2.7 kg of CO_2

Potential green energy solutions

As aforesaid, a wide variety of ships and boats is required for aquaculture work, and therefore green energy solutions and the time required for their introduction will also vary. The role supplied by smaller work boats and conventional work boats is well suited for *hybrid boats*, and today such boats are available partially or completely equipped with green energy technology. Service boats and well boats will probably use electrofuel solutions and the introduction thereof will take longer than for smaller work boats and work boats.

Type	100% batteries	Hybrid	Electrofuel	Land connections
Smaller work boats				
Work boats				
Well boats				
Service boats				

■ The green color means that the relevant solution is likely to work, yellow means that the solution could potentially be feasible and red means that it is unlikely that the relevant solution is suitable as a replacement for fossil fuel

Smaller work boats

The energy requirements and operation area[7] of smaller work boats means that they are well suited for battery solutions. These boats are either powered with outboard motors or diesel engines. Smaller work boats that are entirely powered by electricity are available and it is also possible to acquire electric-powered outboard engines that can be installed on boats currently in use.

Work boats

The energy requirements, size and operation area of work boats used in aquaculture means they are suitable for *hybrid solutions* and in some cases it would be possible to use work boats that are 100% powered by electricity. Norway has a significant number of hybrid boats that use batteries and diesel engines, and in the Faroe Islands a 100% electrically powered boat is under construction. It is also possible that electrofuel such as methanol or hydrogen could be suitable for these boats, and such solutions could be suitable for boats that require a wider operation area.

The investment costs of electric-powered boats or hybrid boats are 30-70% higher than the costs involved with conventional fossil fuel boats, and it may be expected that savings can be achieved in energy costs to an extent of 50-70%. The cost of boats powered by methanol or hydrogen has not been determined.

[7] Operation area is the distance which the boats travel or the working area in which the boats conduct their operations

[8] Combustion engines are engines that burn fuel in combustion chambers. Conventional combustion engines use diesel or gasoline but it is possible to use electrofuel in combustion engines that are similar to those that burn fossil fuel.

Well boats

Well boats require extensive engine power for sailing and also for pumping fish out of and into tanks. The area of operation for well boats varies greatly, from a few nautical miles within fjords up to the potential for sailing between countries. It is therefore unlikely that battery solutions can be used for well boats except to a small extent. It is likely that electrofuel in combustion engines[8] is the most suitable option to phase out fossil fuel use in well boats. Well boats use a considerable amount of energy to pump fish into processing facilities, and by connecting well boats to a land-based current during pumping, oil consumption could be reduced by 20-30%.

Service boats

Service boats are of varied sizes and the pattern in which they are used also varies between boats. The area of use for smaller service boats means they are suitable for *hybrid solutions*. Larger service boats that sail further and require more power could potentially use battery solutions but it would probably be necessary to mostly use electrofuel. Hydrogen or methanol are likely green energy sources for such boats in the future through the use of *fuel-cells* or combustion engines that use electrofuel. In larger service boats it would also be possible to reduce the use of fossil fuel by using connections to land-based currents to a greater extent.

Benefits of green energy solutions

As aforesaid, boats and ships used in sea cage aquaculture use about 2,700,000 liters of fossil fuel per year and emit about 7,300 tons of CO_2. Through targeted measures and with support from the government, CO_2 emissions from fish farming boats could realistically be reduced by 20% in the next five years and 50% in the next 10 years.

Type	Current emission	Emission in 5 years	Emission in 10 years
Smaller work boats	100%	60%	0%
Work boats	100%	60%	20%
Well boats	100%	80%	60%
Service boats	100%	80%	70%

Measures for energy transition

Infrastructure

When fish farming boats will use batteries, demand for electricity will increase greatly in harbor areas that provide service for such activities. Consideration must be given to the production, storage and delivery of electrofuel such as hydrogen and it is likely, as aforesaid, that larger service boats and work boats will use such energy sources instead of fossil fuel. It is therefore important that municipalities and utility companies give due consideration to charging infrastructure, sites and switching stations for potential electrofuel production in the harbors where sea cage aquaculture takes place. The government could also provide special support for municipalities that wish and need to invest in infrastructure and supply capacity with regard to electricity for boats and ships.

The Energy Fund

The function of the Energy Fund is to promote the efficient use of energy resources by providing grants or loans, especially for actions that are taken with the aim of reducing the use of fossil fuels and increase the use of domestic, renewable sources of energy[9].

Companies can apply for grants from the Energy Fund for the purchase of boats that use green energy in part or in full. Municipalities could apply to the Energy Fund to obtain grants for the purchase of electric charging stations that would be used to charge work boats that are powered with electricity, and to install more powerful land connections for well boats.

The Sea Cage Aquaculture Environmental Fund

The objective of the Fund is to finance projects that concern adapting fish farming in Iceland as much as possible to the existing environmental conditions and thereby minimizing the environmental impact of enclosure fish farming[10]. In 2021, energy transition was one of the priorities of the Fund, and therefore it was possible to apply for grants to use for the promotion of green energy solutions. It is important that the Energy Fund continues to emphasize projects that reduce the use of fossil fuel.

The Fish Farming Fund

The Fish Farming Fund is a new fund that operates on the basis of Article 7 of Act no. 89/2019 on the levy of fees for fish farming in the sea. The Fund is intended to provide subsidies to municipalities for the creation of infrastructure in locations where sea cage aquaculture takes place, and thereby supporting the communities and foundations of the economy in those areas[11]. Municipalities could apply for support in order to install charging stations and strengthen the infrastructure of harbors with a view towards implementing green energy solutions. It would be possible to use the Fund to promote and accelerate energy transition in the fish farming sector.

Rebate on fees to the Environmental Fund

The government collects 20 SDR[12] for each ton of authorized production, and 10 SDR for rainbow trout and sterile salmon, which goes to the Sea Cage Aquaculture Environmental Fund. It would be possible to grant a temporary rebate on this fee based on investments in green energy boats and this would be consistent with the Fund's objective to reduce the environmental impact of sea cage aquaculture.

Cooperation between municipalities and fish farming companies

Municipalities and fish farming companies could establish joint goals to achieve a reduction in oil use and increase in the use of renewable energy. The companies submit a plan for the green energy requirements over a given period of time, and municipalities use that information to invest in charging infrastructure and take this into consideration with regard to planning.

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[9] https://orkustofnun.is/orkustofnun/rad-og-nefndir/orkusjodur/
[10] Risk assessment with regard to genetic mixing
[11] https://www.stjornarradid.is/verkefni/atvinnuvegir/sjavarutvegur-og-fiskeldi/fiskeldissjodur/
[12] SDRs are defined in terms of a basket of major currencies used in international trade and finance.

Conclusion

It may be assumed that boats and ships used in sea cage aquaculture use about 2,700,000 liters of oil per year. Measures towards energy transition in marine-related industries will be implemented in the near future, and work boats used in fish farming are in many ways suitable to be the focus of the first efforts to introduce green energy resources in the Icelandic fishing fleet. The reason is their operation area, engine power, and the fact that in Norway and the Faroe Islands green energy boats are already being used in fish farming.

Infrastructure and access to green energy are required if it is to be possible to reduce the use of fossil fuel. It is therefore important that municipalities join forces with the fish farming companies to analyze the requirements for beginning work on the strengthening of infrastructure and ensuring access to green energy. It is essential for municipalities to seek and obtain support from the government and utility companies when it comes to strengthening electricity infrastructure in harbor areas, as such undertakings are in many cases expensive.

Fish farming companies are in an ideal position to apply for grants from the Energy Fund to use for financing green energy solutions. It is also proper to examine the feasibility of further measures such as temporary rebate on fees to encourage green energy solutions in fish farming.

There is a wealth of opportunities in land-based current connections for well boats and such projects are well suited for cooperation between municipalities, fish farming companies and even energy companies.

Through targeted measures and using the available technological solutions it is possible to reduce oil use in sea cage aquaculture by 20% in the next five years and 50% in the next 10 years. This could improve the viability of the industry and strengthen the image of the fish farming companies. In addition, targeted efforts towards energy transition in sea cage aquaculture require more technical knowledge and maintenance capacity, which will support communities where fish farming takes place, as well as providing grounds for green energy solutions in other activities.

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Blámi is a collaborative project of Landsvirkjun, Orkubú Vestfjarða and Vestfjarðastofa.

The primary objective of Blámi is to support and promote innovation and development of energy transition projects by expanding the role of environmentally friendly fuel, hydrogen and electrofuel in transportation and industry. Blámi wishes to encourage energy and climate related innovation, support entrepreneurs and improve the innovation environment in the West Fjords.

The purpose of Blámi is to bring together individuals and companies that can work together towards obtaining international financing for experimentation, research and development in energy and climate friendly solutions. By increasing cooperation between companies and government bodies it is possible to support projects and opportunities, while increasing the creation of value and competitiveness.

Blámi will make use of local strengths, human resources and companies to create a fertile soil for innovation and increased creation of value.