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Fuel optimisation in the Faroese fishing fleet

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***Abstract*—The economy of the Faroe Islands hinge on the fisheries. An increase in energy expenses has a major impact on the profitability of the fisheries and without adjustments the viability of many fisheries is questionable.**

A questionnaire survey of fuel use in the different metiers in the Faroese fishing fleet confirmed that passive fishing methods such as longline is more energy efficient per kilo fish than active fishing methods such as trawl, but there are considerable variances within metiers. This indicates scope for improvements.

In many aspects the environmental impact is directly proportional to energy input. Energy use is therefore not only an economic issue but also an environmental conservation issue. Consequently, the research and development on reduction of fuel use and improvement of passive fishing gear has a very high priority in the Faroe Islands.

Keywords- Faroe Islands, fishing gears, energy efficiency

I. INTRODUCTION

The Faroe Islands, inhabited by around 50,000 people, are an autonomous archipelago comprising 18 small islands in the Northeast Atlantic at 62°N, 7°W. The economy of the islands hinge on the fisheries and more than 95% of the export originates from fish and fish products.

Annually around 120,000 tonnes of demersal fish species are taken within the Faroese EEZ. Cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*) are the most important local fish species both in catch quantity and value. Faroese fishing vessels also catch large quantities of pelagic species such as blue whiting (*Micromesistius poutassou*), herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) within the Faroese EEZ and in adjacent waters. In addition to the local fish stocks Faroese fishing vessel through bilateral agreement have access to fish in the Barents Sea mainly for cod and in Greenland and Newfoundland waters mainly for shrimps (*Pandalus borealis*).

The Faroese fishing fleet includes a wide variety of size and type of fishing vessels using different fishing gear techniques. Most of the local fishery is a mixed fishery. Cod and haddock are mainly taken by longline with bycatch of tusk (*Brosme brosme*), ling (*Molva molva*) and halibut (*Hippoglossus hippoglossus*). Most of the saithe is taken by pair trawl with bycatch of cod, haddock and monkfish (*Lophius piscatorius*). Pair trawlers also target argentine (*Argentina silus*) part of the year. Flatfishes (plaice (*Pleuronectes platessa*) and lemon sole (*Microstomus kitt*) and monkfish are targeted by smaller trawlers. The deeper waters around the Faroes are fished by deep-sea trawlers targeting redfishes (*Sebastes sp)*, blue ling (*Molva dypterygia*), roundnose grenadier (*Coryphaenoides rupestris*) and black scabbard fish (*Aphanopus carbo*) and by gill-netters targeting Greenland halibut (*Reinhardtius hippoglossoides*) and monkfish.

The number and type of vessels in the Faroese fleet is summarized in table 1.

TABLE I. SUMMARY OF THE FISHING FLEET IN THE FAROE ISLANDS

Some 600-800 small near shore fishing boats, crew 1-2
12 long-line boats 15-40 GRT, crew of 2-3
20 long-line boats 40-110 GRT, crew of 3-4
22 long-liners >110 GRT, crew 11-13
10 small trawlers, crew 3-5
26 pair-trawlers, crew of 6-7
7 gill-netters, crew 6
10 deep sea trawlers, crew 13

1 scallop dredger specialized in queen scallop fishing

8 large combined purse seine/pelagic trawl vessels

3 large factory trawlers, mainly working distant waters

2 shrimp trawlers, mainly working distant waters

All fishing vessels are dependant on fuel use for propulsion and manoeuvring the fishing gear. Especially vessels using mobile gears are heavy fuel users. This implies that an increase in energy prices may have a major impact on the viability of most fisheries. In 1973-74 and again in 1979-82 the world saw a major increase in fuel prices. In the Faroe Islands an Energy Council was established to generate ideas how to compensate for the severe increase in fuel expenses. The Council determined that while the fuel price had doubled during the period 1979-82 fish prices had only increased by 40% and this had a major impact on the profitability of the fisheries. The Council initiated several tasks to explore households and industry dependency of fuel. One result of the fuel price increase these years was that many fishing vessels targeting saithe converted from single trawl to pair trawl. Fuel consumption per vessel decreased from more than 3000 litres per day to 2000 litres per day, see figure 1. The conclusion from the vessel owner was, that they got the same catch quantity, saved 40-45 per cent on fuel, and by eliminating the trawl doors there was a reduction of about 15 per cent on fishing gear expenses.

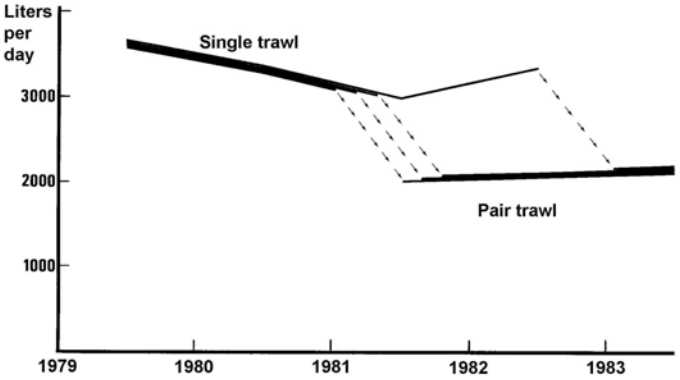

Figure 1. Fuel consumption per vessel before (left) and after (right) conversion to pair-trawl (Reprint from Nyt om OLIEFISK-projektet, Nr. 15, juni 1984).

In recent years another dimension has emerged with regard to the use of fossil fuel as energy source. The emission of greenhouse gasses (CO2 etc) has been the focal point of recent world leader meetings and there seems to be a general agreement that the emission should be curbed and preferably reduced immediately. In the Faroe Islands 40-45% of the greenhouse gas emission is coming from the fishing fleet. This means that the fishing industry does have a major role to play, when it comes to the question how to reduce the Faroese emission of greenhouse gasses.

This paper reports from initiatives in recent years to clarify the overall use of fuel in the fishing fleet and preparations for future project to find indications how to decrease the fuel use and dependency on fuel in the Faroese fishing fleet.

II. MATERIAL AND METHODS

In 2006 the Faroese Earth and Energy Directorate (Jarðfeingi) sent out questionnaires to all major fishing companies and ship owners on the Faroe Island. The purpose was to quantify the fuel energy consumed by the Faroese fishing fleet in the years from 2001 to 2005. Questions were asked about power and age of main engine as well as auxiliary engines, fuel consumption in quantity and value, catch quantity and value, crew number and number of fishing days used per year. From more than 100 questionnaires sent out 35 were returned. The answers represented most metiers in the Faroese fishing fleet. Data from the answers have been categorized within metiers and compared within the metier and between metiers. The data has also been scrutinized against knowledge of the vessels such as age and history of the vessels.

A new initiative has been started in 2010 to clarify in more detail the fuel consumed by the fishing fleet and to generate ideas how to compensate for the increasing fuel expenses. As part of this project an interview was carried out in February 2010 among mechanical engineers employed on Faroese fishing vessels. Questions were asked about new ideas on technical measures as well as change in procedures to reduce the fuel consumption.

III. RESULTS

The average fuel consumption in relation to catch quantity (liters per kg fish) is given in table 2.

TABLE II. FUEL CONSUMPTION BY METIER AS LITRES PER KG FISH FOR THE YEARS 2001-2005

	Average (min-max)
• Pair trawlers	0.36 (0.21 – 0.70)
• Large single trawlers	0.78 (0.47 – 1.10)
• Large longliners	0.24 (0.17 – 0.60)
• Small single trawlers	0.50
• Factory trawlers	0.63 (1.5 l/kg fillets)
• Pelagic vessels	0.08 (0.07 – 0.09)

Pair trawlers have an annual catch per vessel of 2000-3000 tons, mainly saithe. A few years ago with fuel price below 2 DKK/litre the fuel expense was only 8-10% of landing value. Now, with fuel price around 3-4 DKK/litre the fuel expense is 15-20% of landing value. There is considerable variation in the fuel consumption within the par trawler group, from 0.21 to 0.71 litres/kg fish. This can mainly be ascribed to the difference between old inefficient vessels and new vessels with more fuel-efficient engines and propeller systems.

The longliner fleet, comprising 22 vessels, has on average much lower fuel consumption per kg fish (0.24) than trawlers, even if trawlers usually catch larger quantities. However, there is great variation within this group from 0.17 to 0.60 litres per kg fish. Longliners working in Faroese waters delivers fresh fish for processing in land-based factories. It appears that only a few longliners are purpose built to operate as fresh fish fishers. Most longliners can be grouped into two groups. In the first group are vessels built in the early 1960s for long duration trips in distant waters in Greenland and Newfoundland. The crew was usually 25 men and the gear hand-baited and maintained onboard. The catch, which was mainly cod, was worked by hand onboard and stored in salt for markets in Mediterranean countries. When this fishery ceased these vessels were rebuilt with a shelter deck and later also equipped with auto-line systems. These vessels typically have engine power of 500-700 kW (including auxiliary) and fuel consumption is around 900-1000 litres per day. The other group is newer and larger vessels and many were built in the 1980s as Norwegian freezer longliner for distant fishery. These have larger main engine as well as much larger auxiliary engines. The fuel consumption is much higher and often more than 2000 litres per day. For longliners with the lowest fuel consumption the fuel expense is around 2.7% of landing value, whereas the vessels with highest consumption the fuel expense is above 10% of landing value.

From the recent telephone interview with mechanical engineers employed on different size and type of fishing vessel some general patterns for fuel saving have emerged, but also more innovative solutions have surfaced. All participants seem to agree that the installation of instruments to display the continuous fuel consumption has had a tremendous effect on the attitude how the vessel is operated. Also there is a general agreement, that the best way to reduce fuel consumption is to lower the speed of the vessel. Here the attitude of the skipper is most important as he makes most of the decisions how to run the vessel. One example is given of an agreement between the skipper and the engineer that the maximum load of the engine is lowered with a mechanical stop and can only be removed under special circumstances. One ship owner company is working with their trawlers to find an automatic system that continuously can adjust engine revolutions and propeller pitch to an optimum without reducing the minimum towing speed. On many vessels more attention is now paid to hydraulic and water pumps that in periods are running for no use. Also ideas to install smaller auxiliary engines and smaller pumps have emerged, as the experience is often, that a bigger system than needed is running most of the time. A considerable amount of fuel energy is used to heat the accommodation and other parts of the vessel. Examples of energy saving here is to lower the heat in the central heating tank from 90 to 60 degree Celsius. Another idea is to use the cooling water from the engines as heating energy. The fishing gear has also been a subject for discussions when it comes to energy saving. One obvious solution is to implement new trawls with thinner threads and netting material to reduce the drag of the trawl. One example mentioned is a pair trawler that used to steam between fishing places with some of the gear (chain weights) in the water is now pulling all the gear on deck to save on fuel when steaming. There are examples of new installations that have increased the fuel consumption. One example is ice machines installed onboard some vessels to make them more flexible and not dependent on loading ice when in the harbour.

IV. DISCUSSION

The increase in fuel prices has a severe negative impact on the profitability of most fisheries. Many fisheries are already struggling and with the high fuel prices as experienced in the summer of 2008 most European fisheries are not economically viable (ESIF, 2009). Another side of the medal is the request of decreasing the emission of greenhouse gasses, which obviously is closely related to the use of fossil fuel as energy source. Given these outlook many research milieus are working on the energy issue and numerous projects have been initiated to find ways to make fishing more energy efficient both with regard to improving existing fishing practices and to seek alternative fishing methods. With the overwhelming dependency on fisheries in the Faroe Islands, the energy question is of course of uttermost interest for all stakeholders in the Faroese fishing industry and related research.

Most of the cod and haddock catch in the Faroese area is taken by longline. In the metier of large longliners there is a considerable variation in fuel consumption per kg fish. The difference is mainly ascribed to the difference in engine size. The more powerful main engine leads to a higher service speed and the larger auxiliary engines are uneconomic when running in a low loading condition. In this segment of the Faroese fleet considerable fuel could be saved if vessels were purpose built for their present operation.

Most of the saithe from the Fareose area is taken by pair trawl. This is not a new fishing method and has been widely used e.g. in Spain from the mid 1950s. A first attempt of pair trawling in the Faroes was made after the severe increase in fuel prices in 1979. There were difficulties in the beginning but soon it became successful and nowadays all vessels targeting saithe as the principal fish species are using pair trawl. Generally it is estimated that there is a 30% fuel saving by using pair trawl compared to conventional bottom trawling.

Within the pair trawler fleet there is considerable variation in fuel consumption per kg fish. This can be explained by comparing the old inefficient vessels with the new more efficient vessels with more energy efficient engines. Investment in new vessels has been successful, not only because of fuel saving using new engines, but also because new vessels appear to increase the catch considerably. One example was seen in 2003 when two new vessels replaced two old vessels of similar size and engine power. The days at sea increased 41% and catches per day increased 47-48% which

doubled the annual catch of the new vessels compared to the old vessels (Tietze et all., 2005)

The energy consumption is primarily related to the propulsion of the boat and operation of fishing gear. The energy consumption when catching fish depends on several factors e.g. the type of gear, size of the vessel, power of main and auxiliary engines and the distance between the boat's homeport and fishing grounds. When comparing the energy use as consumption per kg fish cautions should be taken, especially when comparing between metiers as the catch quantities varies considerable between metiers. When fishing for high value fish such as cod and haddock, the fishery might be economically viable with smaller quantities compared to fishery for lower value fish, such as saithe. The difference is clearly seen when comparing pelagic vessels with other metiers, as the pelagic fishery is characterized by having very large catches and hence low fuel consumption per kg fish.

The number of fishing vessels has not increased during the last decades, but the average size of the vessels and their engine power has increased. Vessel size and engine power has doubled over the last 20-30 years. Fuel consumption of fishing vessels has increased as much as their engine power has increased, but in most recent years the fuel consumption has decreased slowly, mainly as a result of different saving initiatives.

The experience in the Faroese fleet, and in most other studies on fishing vessel energy consumption, is that passive fishing gears, such as longline fishing, are less energy intensive compared to active methods such as trawling. However, not all fish species can be taken by longline. One example is saithe, which only occasionally will take a baited hook on a longline. Saithe, on the other hand, can be successfully fished using jigging, but the quantities per vessel will be much lower compared to the efficient pair trawlers, especially when fishing small size saithe. With increasing fuel prices jigging might become a viable alternative to pair trawl. Similar changes or replacement of fishing gears might be relevant, especially if passive fishing gears can be developed and improved. If low energy passive gears can replace active fishing gears, it will not only be an economical advantage with reduced fuel expenses. Generally the environmental impact (e.g. bottom impact) is closely related to the energy used in the fishing activities. Therefore a low energy intensive fishing gear would generally have lower impact on the environment as well as have less emission of greenhouse gasses. Therefore development of passive fishing gears has had a high priority in the Faroe Island in the most recent years.

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