Fisheries Iceland

Resource Utilisation and Environmental Footprint

FI Environmental Report
12 December 2017

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Introduction

Icelandic fisheries are completely dependent upon conditions in the oceans. The unpolluted land and sea are of crucial importance for utilisation of the value available from marine resources. Proper treatment of the ocean and conducting fishing in harmony with nature are the premise for utilising fishing stocks in Icelandic waters, not only today but by future generations. A summary of the report from the Icelandic Institute of Economics on Iceland and climate change, published in February this year, states:

Emissions of greenhouse gases rose by 26% from 1990 to 2014 if net carbon capture through land reclamation and forestry is not included. CO_2 emissions were around 4,600 tonnes in 2014. The increase was about 15% if net land reclamation and forestry are included. Emissions increased most from manufacturing and chemical use, or by 79%, but also in energy production (69%), waste (52%) and transport (39%). Emissions from the fisheries sector, on the other hand, decreased by 43% and from agriculture by 4%.

Iceland is a signatory of the Paris Agreement and has announced national targets as its part in the European Union's common target of reducing greenhouse gas emissions by 40% by 2030 compared 1990. The major reduction in greenhouse gas emissions from the fisheries sector is truly gratifying. Simplifying slightly, it could be said that fisheries has, for its part, achieved the target of the Paris agreement. Of course, when it comes to climate change fisheries is not an isolated actor. The whole world is involved. Nonetheless, it is evident that fisheries in Iceland has achieved remarkable results in recent years - and is not about to stop now. Technological innovations of various kinds and alternative energy sources will help to further reduce greenhouse gas emissions in Icelandic fisheries in the coming years.

This report by Fisheries Iceland sets out the principal facts on energy use in Icelandic fisheries and forecasts for the future. Fisheries enterprises wish to set a good example and make a significant contribution towards the goals which Iceland and other nations of the world have adopted in the above-mentioned Paris Agreement and aim to achieve by 2030. The following enterprises provided material for the report, for which the authors express their gratitude:

Brim
Fisk Seafood
HB Grandi
Ísfélag Vestmanneyja
Loðnuvinnslan Fáskrúðsfjörður
Samherji
Síldarvinnslan Neskaupstaður
Skinney-Þinganes
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Vinnslustöðin í Vestmannaeyjum

The Paris Agreement was signed in Paris on 12 December 2015 and is therefore two years old. The aim of the agreement is to bring global greenhouse gas emissions to a halt and to keep global warming below 2°C. Iceland, together with EU states and Norway, will aim to achieve the target of a 40% reduction from emission levels of 1990 by the year 2030.

Highlights

Fisheries in Iceland are expected to reduce their fuel consumption by 134 thousand tonnes during the period from 1990 to 2030.

- Strong fishing stocks, advances in fishing and improved organisation of pursuit have resulted in substantially reduced fuel consumption in fisheries and a corresponding reduction in greenhouse gas emissions.
- Overall fuel consumption in fisheries has fallen by almost 43% from 1990 to 2016.
- Fisheries in Iceland are expected to reduce their fuel consumption by 134 thousand tonnes during the period from 1990 to 2030. By that time reduction plants will be almost completely electrified and electricity generation by diesel generators on board vessels in port will be an exception. If this becomes the reality, fuel consumption in the sector will have decreased by 54% during the period.
- By 2030 oil consumption by fisheries is expected to decrease by 19%.
- In 2016 total fuel consumption in fisheries, by both fishing vessels and fishmeal production, was the lowest since 1990.
- Emissions of greenhouse gases from fisheries have been declining year by year since 1990 when they were 19% of the country's total. In 2007 this had dropped to 13% and by 2014 to 9.7%.
- Fisheries in Iceland have already achieved the target of the Paris Agreement with regard to fish meal and fish oil production, and are well on the way to reach the target for fishing.
- Investment in vessels required until 2030 is estimated to be around ISK 180 billion. Newer, more technologically advanced vessels will further reduce the environmental impact of fisheries.
- Cost-efficiency calculations show the advantages of using dockside electricity when vessels are in port rather than operating diesel generators on board.
- From 2006 until 2016 Fisheries Iceland have themselves consigned or have had shipped for recycling 8,400 tonnes of discarded fishing gear.

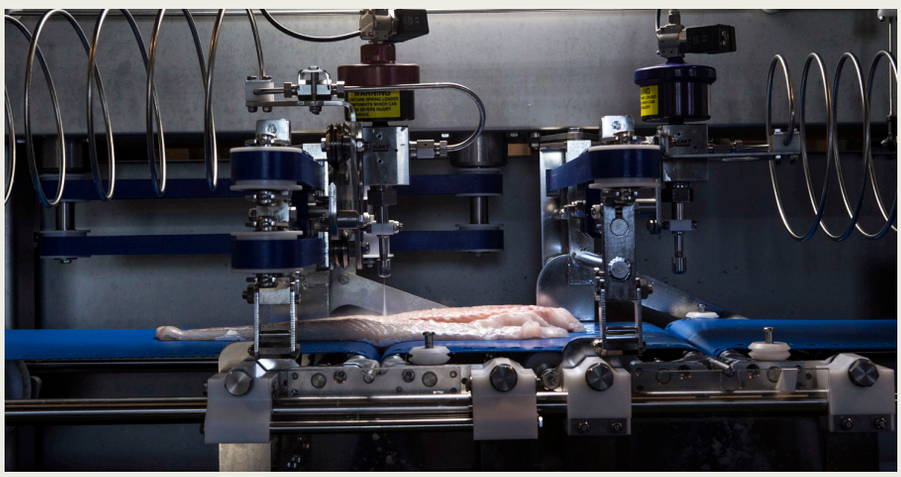


Photo: Marel

Overview

The reasons for the decrease in fuel consumption in the fisheries sector from 1990 to 2016 are primarily high oil prices, lower catches and technological advances which have boosted catch per unit of effort (CPUE) and sector consolidation.

The Icelandic fishing fleet has undergone a major transformation in recent decades. Until shortly after the turn of this century total engine power of fishing vessels grew, but has declined in recent years. Catches in Icelandic waters grew greatly during the previous century, although with large-scale fluctuations in the fishing. Major advances in shipbuilding and fishing technology have made an impact on fuel consumption. Newer, more powerful vessels have replaced older capelin vessels and smaller towing vessels.

Fuel consumption in fisheries was greatest in 1996 and 1997, when there was extensive fishing on distant banks, such as the Barents Sea Loophole. However, since 1997 fuel consumption in fisheries has decreased on average by over 4% annually and in 2016 was the lowest since 1990, by both fishing vessels and fish meal plants.

Overall fuel consumption in fisheries has decreased by 43% since 1990, that of fishing vessels by over 35% and by fish meal plants by almost 84%. Landing of catch by Icelandic vessels at foreign markets has become a rare occurrence. Icelandic vessels head abroad for major repairs and refurbishment, and often take such opportunity to fill their fuel tanks. Such refuellings are not included in the figures for the fleet's total fuel consumption but comprise a very small portion of the total.

HB Grandi Photo Library. Photographer: Kristján Maack

The reasons for the decrease in fuel consumption in the fisheries sector from 1990 to 2016 are primarily high oil prices, lower catches and technological advances which have boosted catch per unit of effort (CPUE) and sector consolidation. Iceland is a signatory of the Paris Agreement and has announced national targets as its part in the common target of European states of reducing greenhouse gas emissions by 40% by 2030 compared to the 1990 level. For fisheries, this means a reduction in fossil fuel usage of 40% over a 40-year period. iFisheries in Iceland has already achieved this target with regard to fish meal and fish oil production, and is well on its way to reach the target for fishing.

Oil Consumption in Fisheries – Fishing

Oil consumption peaked in 1996, when fishing on distant banks, such as shrimp fishing in the Flemish Cap and for demersal species in the Loophole and elsewhere in the Barents Sea, had a considerable impact.

The following sections deal with oil consumption in Icelandic fisheries, firstly, in fishing and, secondly, in the activities of fish meal plants. A good number of factors affect oil consumption, and this review focuses on the main factors and how they have developed in recent years and what can be expected by 2030.

As shown in Figure 1, oil consumption by fishing vessels rose until the mid-1990s, but has declined since that time in tandem with decreasing catches. In recent years higher catches per unit of effort (CPUE) have had some effect on consumption. Oil consumption peaked in 1996, when fishing on distant banks, such as shrimp fishing in the Flemish Cap and for demersal species in the Barents Sea Loophole, had a considerable impact. This fishing has shrunk substantially in more recent times, although Icelandic vessels still fish in the Barents Sea.

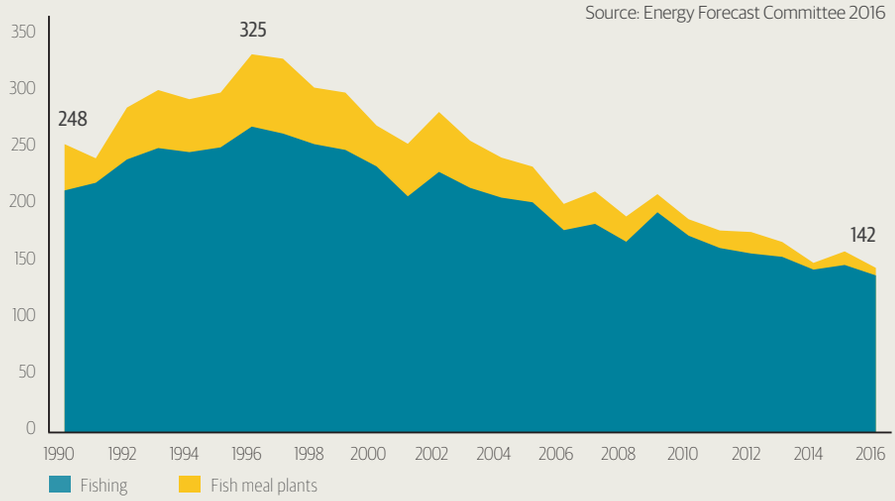
Table 1
Oil consumption in the fisheries industry was about 43% less in 2016 than in 1990
Catches and oil consumption in the fisheries industry

Catch - thousand tonnes		Oil consumption - thousand tonnes		
Year/status	Total catch	Icelandic fishing vessels	Fish meal reduction plants	Total fisheries
1990	1,351.8	208.2	39.9	248.1
2016	1,067.4	135.0	6.5	141.5
Decrease in quantity	284.4	73.2	33.4	106.6
Decrease as a %	-21	-35.2	-83.7	-43.0

Source: Statistics Iceland, Energy Forecast Committee 2016, and the Association of Icelandic Fishmeal Producers.

Figure 1
The fisheries sector is well on the way to reaching the target of the Paris Agreement
Oil consumption in fisheries (thousand tonnes)

Source: Energy Forecast Committee 2016



Fuel consumption by the fishing fleet is determined by the total allowable catch and pursuit of fish stocks is calculated or estimated as average consumption in litres or kilograms per unit of catch. The composition of the fleet is a major factor here, as oil consumption varies greatly depending upon the fishing gear and the type and size of vessel.

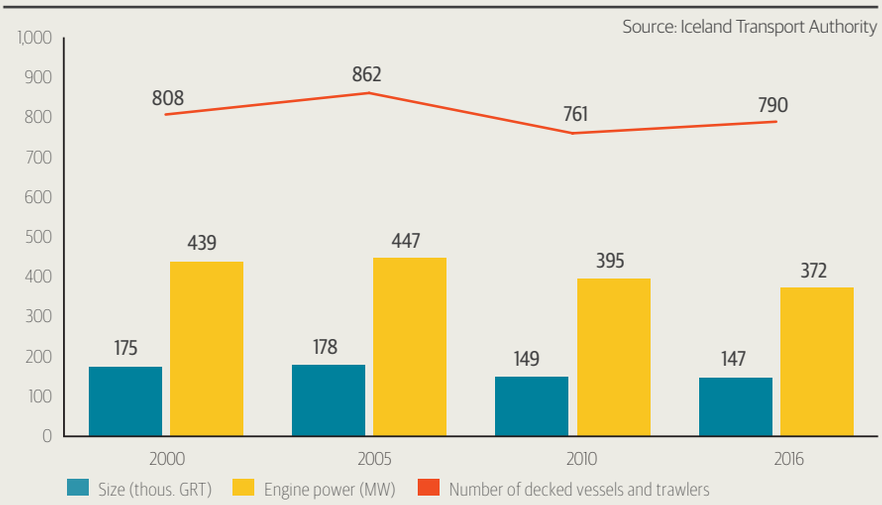
Fleet composition and power

While the size of the fishing vessel fleet in gross tonnage (GRT) has decreased by 16% in recent decades, the number of vessels has remained almost constant. The fleet's total engine power has also decreased considerably or by more than 15%. This is illustrated in Figure 2. Together with other factors, these changes to the fleet have contributed to more efficient fishing.

Fuel consumption by the fishing fleet is determined by the total allowable catch and pursuit of fish stocks is calculated or estimated as average consumption in litres or kilograms per unit of catch.

The composition of the fleet is a major factor here, as oil consumption varies greatly depending upon the fishing gear and the type and size of vessel. Numerous other factors also affect fuel consumption, such as weather conditions and currents, the state of and catchability of stocks, distance to fishing banks, engine and technological equipment. As a result, fluctuations in fleet consumption depend on a variety of these factors. Since 1990 and right up until today, trawlers and processing vessels have accounted for more than half of fuel consumption by the fishing fleet while boats burn around one-quarter and pelagic vessels about one-fifth. Vessels fishing for blue whiting and mackerel use more oil as a rule than traditional capelin seiners because they pull their fishing gear - midwater trawls - behind the ship, while seiners cast their nets around schools of fish.

Figure 2
Advances in technology have resulted in improved vessels and more efficient fishing
The fishing fleet in figures



Cost-efficiency

The past decade has witnessed extensive efficiency gains in fisheries and a reduction in vessel numbers. From the 2001/2002 to the 2017/2018 fishing year the number of fishing vessels with catch quotas decreased by 72, or by 16.3%. Trawlers are currently 43 in number, a substantial decrease since 1990, when there were 111. This trend is expected to continue and the number of quota vessels to decrease by as much as 16% by 2030. The number of trawlers is forecast to remain unchanged or decrease slightly.

At year-end 2016 the fishing fleet totalled almost 147,000 gross tonnes (GRT), after decreasing by 28,000 gross tonnes since 2000. The fleet expanded temporarily at the end of the last century, when the number of decked vessels rose, but has shrunk again since 2004.

> The stability of recent years and decades, along with responsible fisheries management, has resulted in fisheries companies which are stronger and more resilient than often before and give more attention to environmental issues. Since the Faroese announced wide-reaching changes in their system of fisheries management in 2007, no new vessels have joined the Faroese fleet. Under such circumstances it is difficult, if not impossible, to develop the sector towards more environmentally friendly fishing.
>
> "The Next Fisheries Revolution" 2017, p. 24

In 2016 there were 1,647 boats and decked vessels in the Icelandic fishing fleet, of which 857 were small, open fishing boats, 747 decked vessels and 43 trawlers. Open fishing boats decreased by 22% between 2000 and 2016. During this same period trawlers also decreased in number, from 84 to 43, or by 49%. Other decked vessels, however, increased rapidly in number from 1990 onwards and by 2002 their number peaked at 875. According to Statistics Iceland, from 2000 to 2016 the number of decked vessels other than trawlers decreased by 8%, falling from 808 to 747.

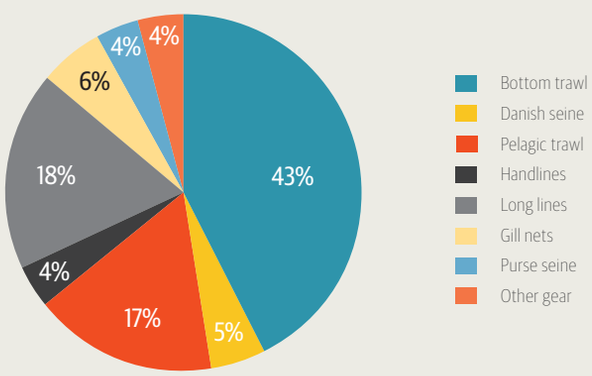
Catch and catch value

In 2016, the total catch value was ISK 133 billion, and 90% of this value came from Icelandic waters. Demersal species accounted for 70% of the catch value, with cod, redfish, haddock and saithe the leading contributors. Fishing of pelagics accounted for 21% of catch value, flat fish 7% and shellfish and crustaceans just under 3%. The value of catches in foreign waters was greatest in Norwegian and Russian jurisdictions, totalling ISK 4.8 billion, with cod around 88% of the catch.

The largest share of the demersal catch in 2016 (over 54%) was caught in bottom trawls and just over 25% by longline. The rest was caught in gill nets, Danish seines and other fishing gear. By far the greatest share of pelagic catch was caught using midwater trawls (around 81%) and purse seines (around 17%). Flatfish catch, primarily Greenland halibut, plaice and lemon sole, was caught using bottom trawls (around 69%), Danish seines and gill nets (around 27%) and a small amount using other gear.

Figure 3
Bottom trawls deliver the highest catch value.
Relative breakdown of catch value by fishing gear 2016

Source: Statistics Iceland



Effective fisheries management and increased CPUE

The cod catch of Icelandic fishing vessels has increased per unit of effort.

It appears evident that the fishing fleet was too large in previous years and used too much energy to obtain its allowable catch. The fleet capacity still far exceeds what is needed according to scientific advice on catch and fishing permits. Vessels also were and still are focused on catching stocks which are fully utilised. The reduction in numbers of fishing vessels in recent years boosted the harvest rights of the remaining vessels, their catches grew as did their profitability. A further reduction in vessel numbers would likely continue this trend.

Strengthening of cod stocks

Since 2008, when catches were limited to just over 150,000 tonnes, cod catches have been growing with

each passing year. In 2016 the catch was over 264,000 tonnes. During this same period other demersal catches have declined substantially. Svavar Svavarsson, Executive Director of Business Development at HB Grandi, said in an interview with Fishing News on 31 October 2017 that Iceland's successful performance in fisheries was not least due to responsible utilisation of fish stocks. The stocks were in good condition and therefore easier to catch than previously. "That in itself results in lower emissions (oil consumption). Focusing on efficiency and the proper incentives has been successful. Both in terms of new knowledge and skills in fishing, as well as the development of fishing gear, fishing techniques and handling of the catch on board. As a result, CPUE has almost tripled during the period, to take an example. In other words: strong fish stocks, advances in fishing and better organisation have resulted in significantly lower oil consumption and emissions of greenhouse gases." Which sums things up well.

Impact of gear on energy consumption

The fishing gear and the fishing itself are the most significant factors affect vessels' fuel consumption. The choice of fishing gear is determined, among other things, by the species sought, ocean depth and seabed type. Different types of fishing gear use varying amounts of energy, require different application of the vessel and equipment in accordance with size and type. Fishing gear can be divided into two categories: stationary and mobile.

The former category includes, for example, gill nets and long lines. The latter includes gear that are drawn by vessels, such as bottom and midwater trawls. Encircling gear, such as purse seines, requires little energy when cast and hauled in. The same applies to stationary gear. From 1991-2005 the share of trawlers in the fishing fleet's oil consumption was around 78% (Emil Ragnarsson, 2006). The varying energy needs of vessels is shown in Table 2.

Table 2
Decrease in oil consumption has been greatest in the most energy-intensive fishing
Oil use factors for fishing vessels in Iceland

Type of vessel	Oil consumption 1997 kg oil / kg catch	Oil consumption 2004 kg oil / kg catch	NEA 2016 forecast kg oil / kg catch
Boats <= 10 GRT	0.127	0.102	
Boats > 10 GRT	0.178	0.220	
Boats, average*		0.200	0.170
Trawlers	0.365	0.356	0.303
Processing vessels	0.602	0.432	0.368
Capelin/herring	0.025	0.034	0.029
Blue whiting/mackerel		0.078	0.066

Boats: * Weighted average of both categories of boats.
Source: Guðbergur Rúnarsson 1997 and 2004 - Energy Consumption Forecast by National Energy Authority 2016.

Table 3
Distance to fishing banks is very important
Relative fuel consumption by type of fishing gear in Iceland

Fishing gear	Fishing and other activities (%)	Travelling (%)
Bottom trawl	75	25
Pelagic trawl	50	50
Stationary fishing gear	50	50
Purse seine	30-45	55-70

Source: Emil Ragnarsson, Árbók VFI/TFI 2007 Energy forecast.

Oil use factors are calculated as kilograms of oil used on a fishing trip per kilogram of fish caught. For example, if one kg of oil is needed for each two kgs of fish caught, the factor would be 0.5, i.e. 0.5 kg of oil for each kg of fish catch.

It shows the oil use factors by category of vessel and fishing gear. Note the changes from one year to the next, showing that fuel consumption is decreasing most proportionally for the most energy-intensive fishing gear.

Distance to fishing banks is also important for fuel consumption of fishing vessels, as previously mentioned. The farther they need to travel, the higher their oil consumption. Table 3 shows a breakdown by oil consumption between travelling to and from fishing banks and during fishing.

Bottom trawling accounts for the greatest share of oil consumption. The explanation is that the fishing gear is drawn along the seabed or very close to it. Towing the bottom trawl consumes a lot of energy and using more energy-efficient fishing gear, e.g. long lines, nets, Danish seines, purse seines or a midwater trawl, where possible could save fuel.

In the context of climate change, the aim should be to obtain as must catch as possible using gear which requires the least oil consumption. This category includes purse seines and midwater trawls. On the other hand, the quality of catch could be relatively poor if time or technical capacity is lacking to handle and store the catch properly.

Fishing gear is constantly evolving to increase CPUE while reducing relative oil consumption. All the main fishing gear is undergoing development but it is most extensive for energy intensive types such as bottom and midwater trawls. As the accompanying figure shows, both bottom and midwater trawls are of key importance for Icelandic fisheries.

The main thrust in development and research on fishing gear comes from the collaboration between the fisheries industry with fishing gear manufacturers, academics and research funds that have supported fishing gear R&D. Since the 1980s, many improvements have been made in fishing gear manufacture that increase catch capacity and reduce oil consumption. These include development and construction of otter boards and new hi-tech materials such as Dyneema, a light and strong synthetic material used

Figure 4
Figures suggest that the oil consumption of new trawlers today is 40% less than the trawlers built in 1972

Comparison of fuel consumption of 1972 trawlers based on pulling thrust of 30 tonnes

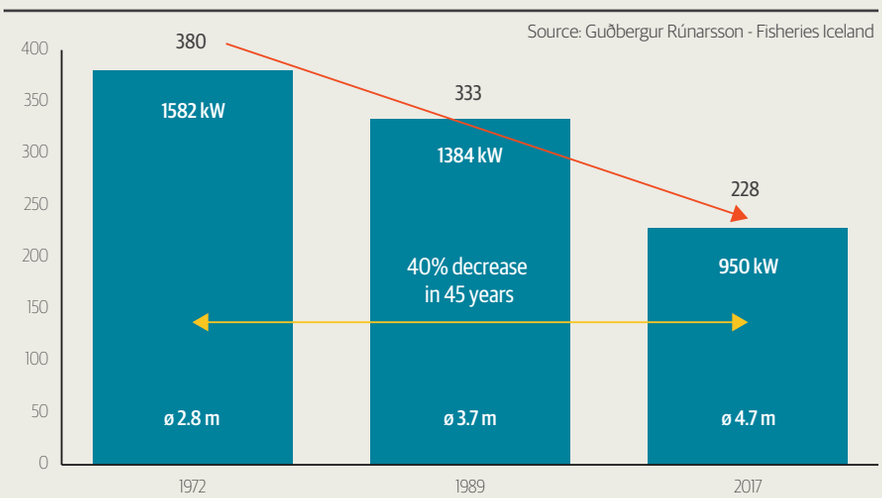


Photo: Skaginn 3X

for various types of tensile loads, which can replace wire trawl lines for midwater trawls. New types of trawls have emerged which reduce flow resistance, sort and release undersize catch from the trawl more effectively, and handle catch with less bruising in the codend.

Modern bottom trawls have ground ropes and so-called "rock-hoppers" instead of bobbins. The otter boards are therefore no longer drawn along the ocean bed, but held four to six feet off the bottom. This significant development of the bottom trawl reduces the power needed and oil consumption while trawling.

Technological advances

Major technical progress has been made in shipbuilding in recent years. Developments in trawler propulsion for instance, have been aimed at reducing consumption. Oil prices have been the main driver of this development, as oil costs are high in trawling. To judge by current expectations and indications, oil consumption of new vessels while trawling could be up to 40% lower for instance, than that of a stern trawler constructed in Japan in 1972. This is illustrated in Figure 4.

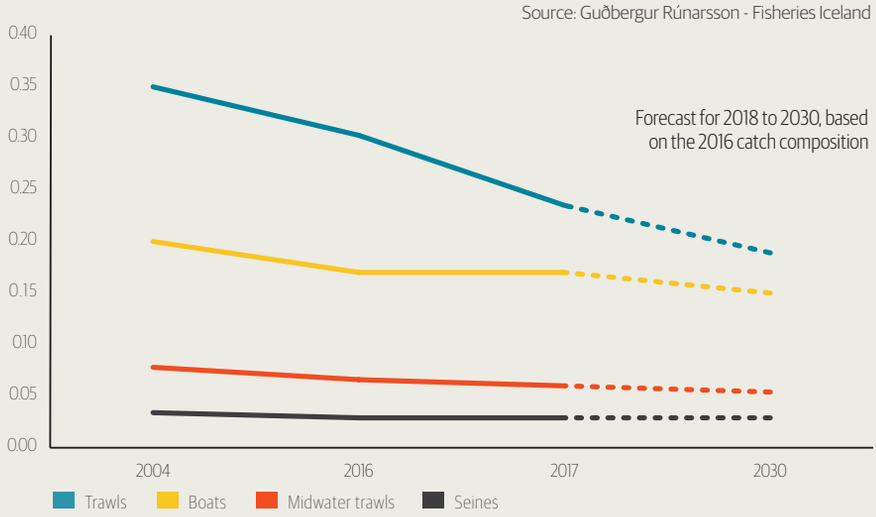
The diameter of the propeller and its rotational speed are key factors in reducing oil consumption by a trawler. The assumption is that the increased diameter of the ship's propeller gives greater pulling thrust. This is supported by examples, firstly, a trawler with a propeller from 1972, with a diameter of 2.8 metres, and secondly, a trawler from 1989, with a propeller 3.7 metres in diameter. The power of the 1972 vessel needed to reach a pulling thrust of 30 tonnes is just over 1580 kW, while the 1989 vessel with a 3.7 metre propeller needs just over 1380 kW. The estimated oil consumption of a new trawler, on order for this year or next year, is therefore 40% less for a pulling thrust of 30 tonnes than for the 1972 vessel.

Increased expertise and technology in vessels and equipment

As new vessels are more energy efficient than older ones their arrival reduces the oil consumption of the fishing fleet. This has a positive impact on the environment as well as the companies' operations, since oil costs are the second-largest expense item after wage costs. New vessels are technically more advanced and considerably more efficient than older ones that are retired from use. In many cases, one new vessel

Figure 5
Rising oil prices and environmental awareness are expected to result in lower fuel consumption
Fuel use factors by fishing gear and type of vessel (kg oil / kg catch)

Source: Guðbergur Rúnarsson - Fisheries Iceland



Further advances are expected in both vessels and equipment, to further reduce fuel consumption of fishing vessels in response to rising oil prices and society's demands for reduced environmental impacts from fishing and ocean transport by 2030.

can replace two or even three older ones if harvest rights allow it. The conclusion of the report published by COWI and FHF in Norway was that Norwegian trawlers consumed 0.245 kg of oil for each kg of fish caught. The Norwegian results correspond with the conclusions of a survey of 19 Icelandic fishing vessels in October this year. The outcome of the survey was used to reconcile fuel use factors based on the latest information in the autumn of 2017 and to forecast fuel consumption by Icelandic vessels until 2030.

Further advances are expected in both vessels and equipment, to further reduce fuel consumption of fishing vessels in response to rising oil prices and society's demands for reduced environmental impacts from fishing and ocean transport by 2030. A scientific assessment has been made of how this development will take place, based on current fuel consumption and trends in fuel consumption of new vessels that have joined the fleet in recent months or are expected in coming years.

As previously mentioned, fishing with bottom trawls is extremely important to the Icelandic economy. The share of bottom trawl catch in the total was 25% in 2016, while the value of the bottom trawl catch was 43% of the total value of catches on Icelandic banks that year. Approximately 50% of total oil consumption by fishing vessels was by bottom trawlers, but is now 48% and is estimated to be around 45% by 2030.

Fuel forecast for fishing vessels

During the period from 2016 to 2030, less change is anticipated in the oil consumption of vessels other than those fishing with bottom trawls based on the catch composition in 2016. According to the forecast, decked vessels using gear other than seines, bottom or midwater trawls will reduce their relative energy consumption from 29% to 25% by 2030. Vessels using midwater trawls will reduce their relative consumption from 21% to 19% while energy consumption of vessels fishing with purse seines will remain constant at around 3% of total fuel consumption by Icelandic fishing vessels, as is has been since measurements began.

This is shown in Table 4. The forecast is based on catch data after adjusting for new data on oil consumption of 19 vessels using bottom and midwater trawls, seines and long lines in the period 2016 to 2017.

Table 4
Decreasing oil consumption is forecast
Oil use factors for vessels fishing in Icelandic waters – actual figures and forecast for 2030

Vessel type	Oil consumption 1997 kg oil / kg catch	Oil consumption 2004 kg oil / kg catch	NEA forecast 2016 kg oil / kg catch	Fisheries Iceland oil use factors 2017 kg oil / kg catch	Fisheries Iceland fuel forecast to 2030 kg oil / kg catch
Boats > 10 GRT	0.178	0.220			
Boats, average*		0.200	0.170	0.170	0.15
Trawlers**	0.365	0.356	0.303	0.239	0.189
Processing vessels	0.602	0.432	0.368		
Capelin/herring	0.025	0.034	0.029	0.029	0.029
Blue whiting/ mackerel		0.078	0.066	0.060	0.054

* Boats: Weighted average of both categories of boats.
Trawlers and processing vessels 2017 and 2030 are combined under the heading Trawlers.
** Source: Guðbergur Rúnarsson, Fisheries Iceland, 1997, 2004 and 2017 – Energy Forecast of the National Energy Authority 2016.

The company Orkey in Akureyri, in collaboration with the fisheries company Samherji, is one of a group of entrepreneurial ventures. Orkey produces biodiesel from frying fat waste and animal fats; almost all other ingredients in its production are of renewable origin. Samherji has used this biodiesel with good results in several of its vessels.

Lower Fleet Energy Consumption, Analysis by Sjávarklasi 2015

Forecast of the Energy Forecast Committee

The so-called Energy Forecast Committee was set up around three decades ago and has issued regular forecasts for energy consumption. The Energy Forecast Committee is a forum of several leading commercial enterprises, institutions and organisations in the energy industry in Iceland, as well as Statistics Iceland, the Land Registry and the Ministry of Finance and Economic Affairs. An extract from the 2016 forecast is used in this chapter.

The first forecast of the Energy Forecast Committee was issued in 1980 and covered the period 1980-2000. The forecasts are based on oil company sales data in Iceland, both to Icelandic and foreign vessels, distinguishing between domestic and international use.

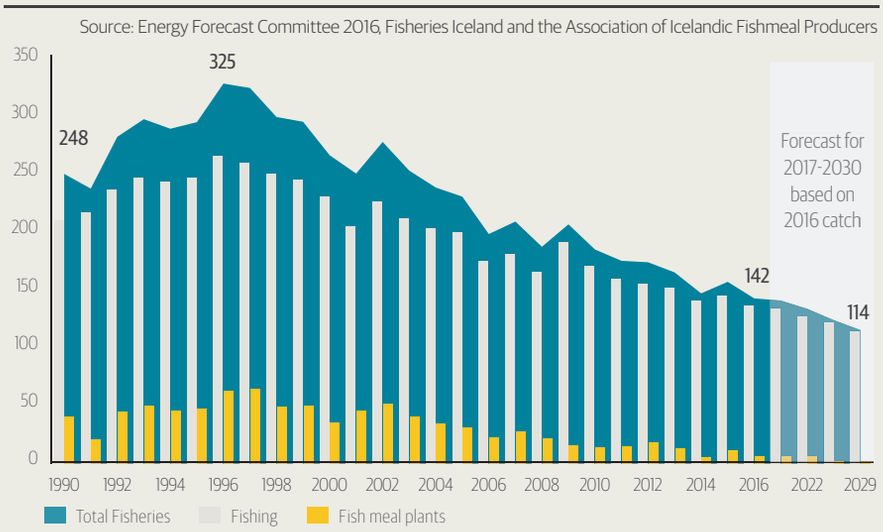
Fisheries are forecast to reduce their fuel consumption by 134 thousand tonnes during the period from 1990 to 2030. By that time reduction plants will be almost completely electrified and electricity generation by diesel generators on board vessels in port will be an exception. If this becomes the reality, fuel consumption in the sector will have decreased by 54% during the period.

It should be borne in mind that both the quantity and composition of catch were different in 1990. On the other hand, the forecast from 2016 to 2030 is based on the same quantity and composition of catch, and fuel consumption by the fishing industry is expected to contract by more than 19%, a significant decline over a relatively short period.

The same trend is anticipated for capelin, herring and blue whiting vessels. These assumptions are based on discussions with those parties best acquainted with the situation and the Energy Forecast Committee regards this as the most likely development path. The conclusions of the Energy Forecast Committee, based on the above assumptions, are shown in Figure 6.

Figure 7 compares the fuel consumption of fishing vessels with previous forecasts by the Energy Forecast Committee. It shows that vessels' fuel consumption was roughly as expected in 2008 and 2012, but older forecasts overestimated fuel use. The 2016 forecast covers a longer period and is lower

Figure 6
Fisheries are expected to reduce their fuel consumption by 134 thousand tonnes during the period from 1990 to 2030
Oil consumption in fisheries (thousand tonnes)



than previous forecasts due to the projected lower long-term catches. It must also be borne in mind that fishing on distant banks has largely disappeared and the number of freezer trawlers has declined. On the other hand, a 24% increase in pelagic catches is expected until 2050. At the end of the forecast period, some of the oil consumption will have shifted to new energy sources, but the figure shows total consumption, i.e. both oil consumption and the use of new energy sources in oil equivalents

Oil consumption differs widely depending on the method of fishing, and therefore use factors have been calculated showing use in relation to catch for different fishing methods, as shown in Table 2. In preparing its 2001 fuel forecast the National Energy Agency (NEA), in collaboration with the Fisheries Association of Iceland, used a catch breakdown by type of vessel, based on data in the publication *Útvegur*. The same division is used here, with the modification that shellfish catch is now included under figures for boats instead of trawlers. The figures show the entire catch of Icelandic fishing vessels, whether landed in Iceland or abroad (Energy Forecast Committee 2016).

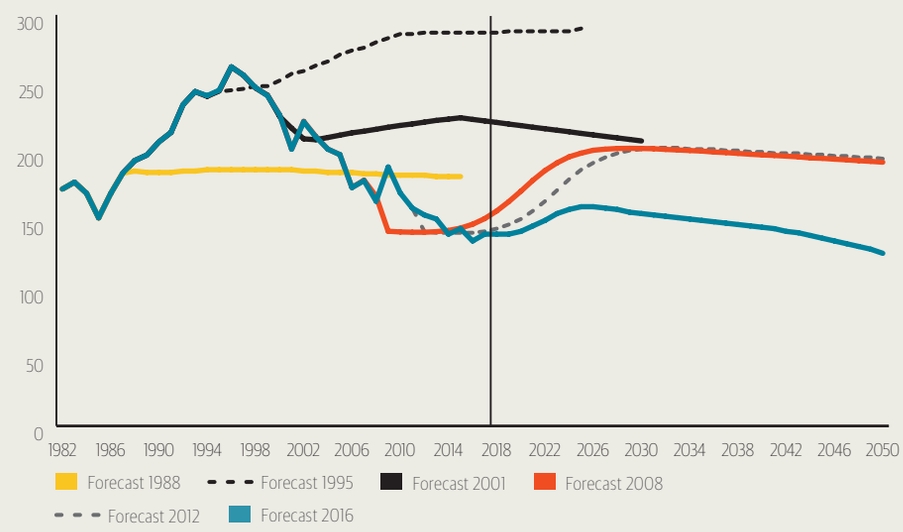
If total oil consumption of the fishing fleet is compared to estimates based on oil consumption factors from 2004 to 2009, it turns out that actual fuel figures for recent years are slightly lower than the forecasts, and the deviation is 2-10% over the period. This is shown in Figure 7. Oil consumption for the period 2009-2011 however, is higher than the calculations with the oil use factors suggested (Energy Forecast Committee 2016).

On the Statistics Iceland website catches are, among other things, classified by category of vessel, fishing gear and processing method, and the data is therefore well suited for use with the oil consumption factors of fishing vessels. Based on these factors, fuel consumption of trawlers and processing vessels in the period 2010-2014 represents on average 50% of the total oil consumption of the fishing fleet while boats account for just over than 25% and pelagic vessels for 20%. The breakdown is somewhat different if the catch of these vessels is considered. The aggregate catch of trawlers and processing vessels is 19% of the total, small boats account for 19% and pelagic vessels 62%. Vessels fishing blue whiting and mackerel with midwater trawls use more oil than the usual capelin vessels using seines, as has previously been mentioned (Energy Forecast Committee 2016).

The factors for Icelandic trawlers, as shown in the table, are very similar to the results for Norwegian fishing

Figure 7
The 2016 forecast is lower due to forecasts of lower catches and the practical disappearance of fishing on distant banks
Forecasts for vessels' consumption of oil and new energy sources in oil equivalents
(thousand tonnes)

Source: Efla, Jón Vilhjálmsson - Energy Forecast Committee 2016



HB Grandi Photo Library. Photographer: Kristján Maack

Figure 8
Pelagic catches are the dominant factor in total catch figures
Total Icelandic catch on all banks (thousand tonnes)

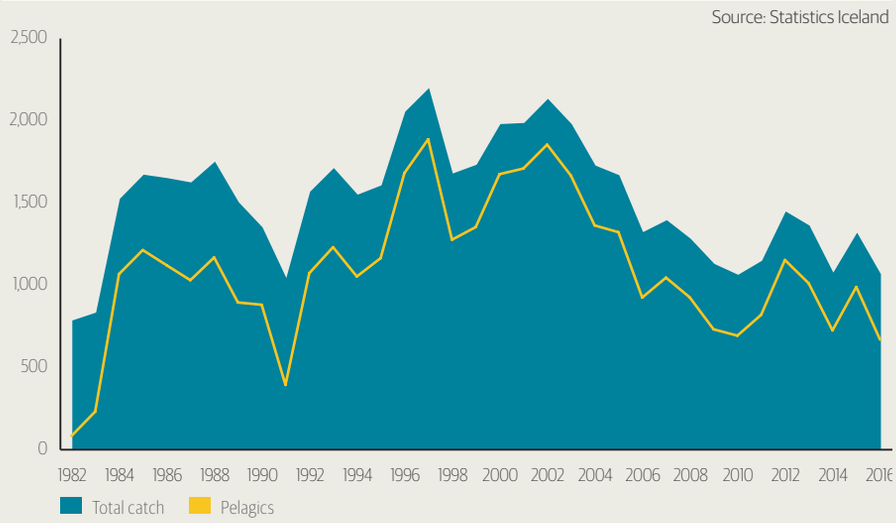
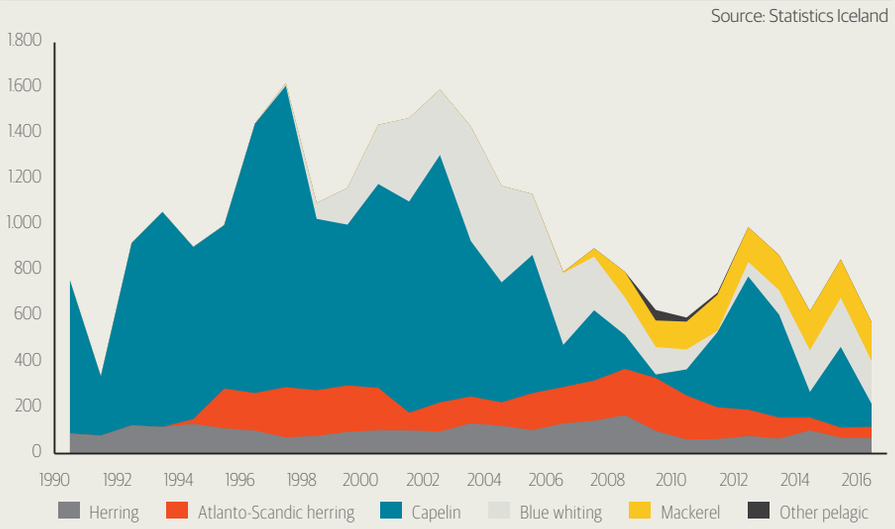


Figure 9
Pelagic catch is difficult to predict
Pelagic catch by species (thousand tonnes)



vessels during the period 2000-2004. Comparison with other foreign research indicates that oil use differs somewhat from one country to another and is determined by numerous factors, such as how harvest rights are allocated, as well as by fishing customs and arrangements.

Fishing and landing of catch by the Icelandic fleet is fuelled by fossil fuels. Pursuit patterns have a major impact on the energy consumption of the fishing fleet. The largest share of the catch comes from Icelandic waters, but fishing has also been pursued on distant banks, such as shrimp fishing in the Flemish Cap in the 1990s and fishing for cod in the Barents Sea and in Russian and Norwegian jurisdictions. A major drop in catch occurred in 2016: in 2015 total catch was 1,319 thousand tonnes but in 2016 it was only 1,067 thousand tonnes. Although demersal catches increased by over 20 thousand tonnes, the catches of capelin and blue whiting were lower. In 2016, the cod catch was 264 thousand tonnes, an increase of 113 thousand tonnes since its low point in 2008. The cod catch of Icelandic vessels on distant banks was about 16 thousand tonnes.

Travel to distant banks affects the vessels' oil consumption and the farther distant the bank, the greater is the impact. The pelagic catch is the largest component in catch by Icelandic vessels, and capelin is

usually the mainstay of this. This is illustrated in Figure 8.

The long-term pelagic catch is subject to uncertainty. It is difficult to predict pelagic fishing because of the uncertainty of capelin and other pelagic stocks Iceland shares with other nations. The capelin catch fluctuates sharply from one year to the next, sometimes comprising a major portion and other times only a small share of the pelagic catch. Because there is no way of predicting the long-term capelin catch it is unrealistic to forecast the oil consumption for this fishery in the future.

To explain the problem more clearly, an example can be taken in which the estimated oil consumption for a 500 thousand tonne capelin catch would be around 13 thousand tonnes, or 26 thousand tonnes for a catch of a million tonnes. The share of catches in other pelagic species, such as mackerel and blue whiting, is also highly uncertain due, among other things, to disputes among states utilising the stocks. For these reasons it is impossible to forecast what oil consumption for pelagics could be during the period 2018-2030. The quantities of pelagic catch during the period 1990-2016 can be seen in Figure 9.

The demersal catch is the most valuable part of Icelandic catch, with a value of around ISK 103 billion in 2015 and around IS 93 billion in 2016.

Figure 10
Demersal catch is considerably more stable than pelagic catches
Demersal catch by species (thousand tonnes)

Source: Statistics Iceland

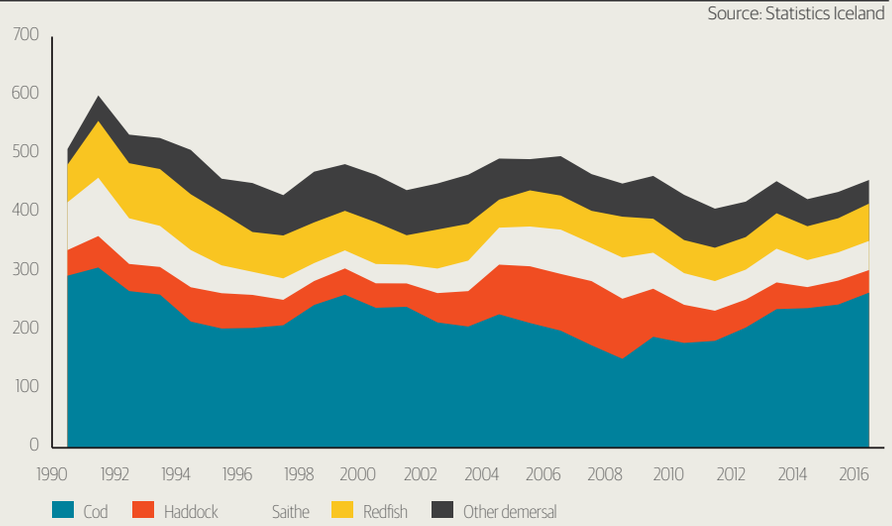


Figure 11
Cod catch has increased, while catches of other demersal fish, shellfish and flatfish have decreased
Total catch excluding pelagics (thousand tonnes)

Source: Statistics Iceland

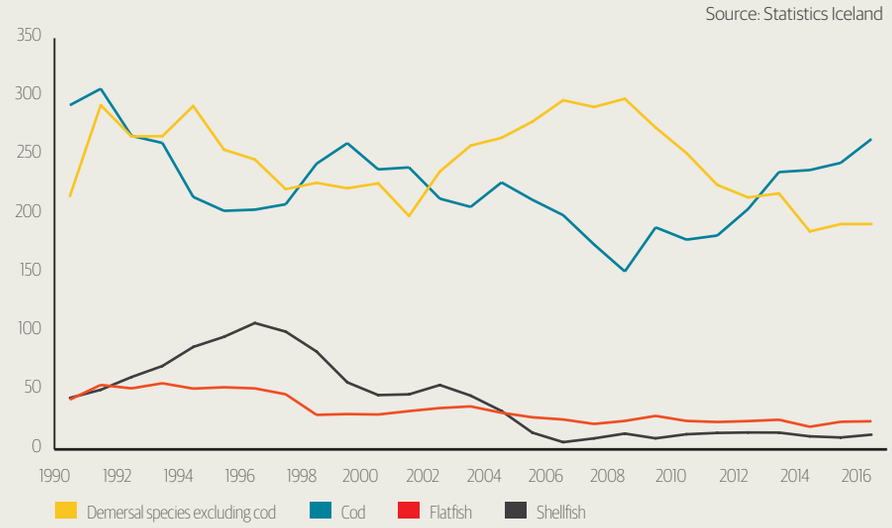


Figure 12
The cod catch is primarily obtained in Icelandic waters, but partly in Norwegian and Russian jurisdictions
Cod catch by fishing grounds (thousand tonnes)

Source: Statistics Iceland

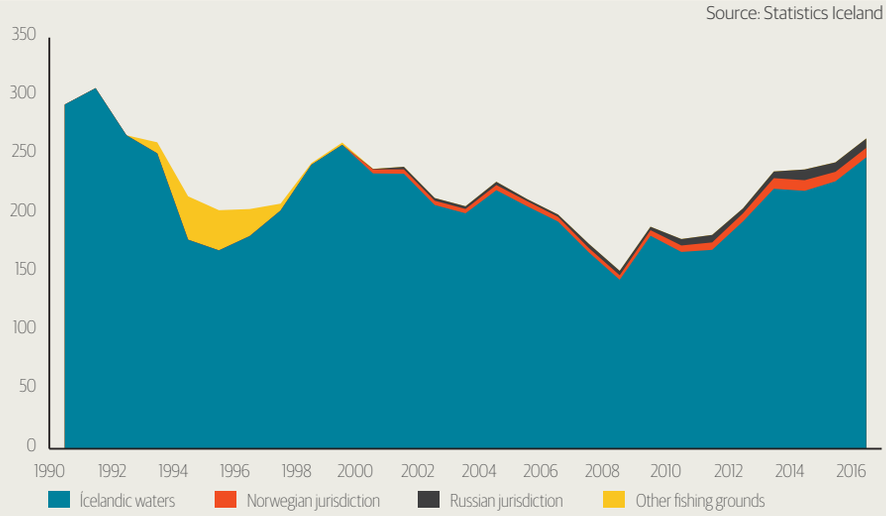
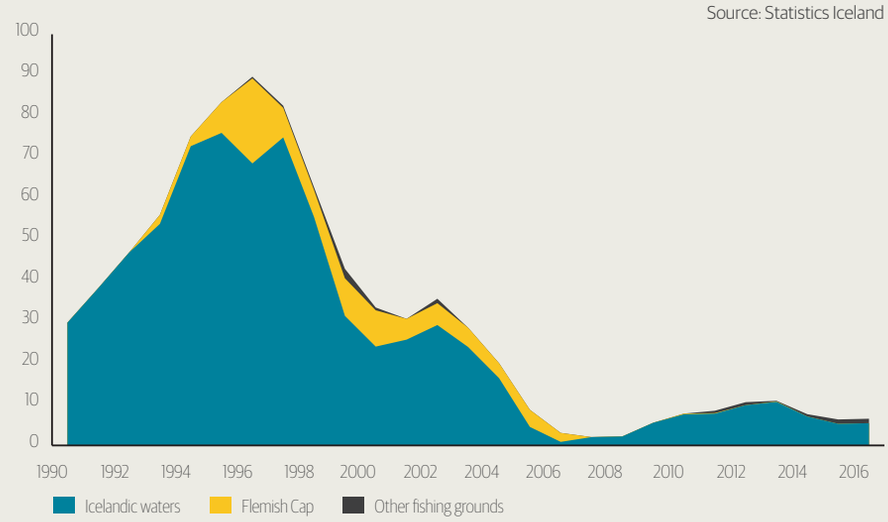


Figure 13
Shrimp catches have been at low levels over the last decade, with fishing carried out almost exclusively in Icelandic waters.
Shrimp catch by fishing grounds (thousand tonnes)

Source: Statistics Iceland



Cod is the most valuable species that Icelanders catch. In 2015 the value of the cod catch was ISK 61 billion and 58 billion in 2016. The share of demersal fish in the total catch value was 68% in 2015 and 70% in 2016.

Demersal catch is considerably more stable than pelagic catches. On average, the demersal catch was 469 thousand tonnes from 1990 to 2016 or similar to the 1998 catch. In 2016 the demersal catch was 456 thousand tonnes. It has increased slightly over the past three years, with the increased cod catch offsetting a contraction in other species and resulting in fairly steady total demersal catches. The cod catch was 264 thousand tonnes in 2016, as previously mentioned, and shellfish and crustacean catches were also at minimum levels that same year, amounting to not quite 13 thousand tonnes.

The cod catch is caught primarily in Icelandic waters, but fishing on distant banks provides a welcome additional catch. In 1993-2000 Icelandic vessels fished in the Barents Sea and in more recent years in Norwegian and Russian jurisdictions. Barents catch was highest in 1994 at almost 37 thousand tonnes, and slightly lower in 1995 or over 34 thousand tonnes. In recent years catch from Norwegian and Russian jurisdictions has been around 8-9 thousand tonnes from each or 17 thousand tonnes in total.

In November of this year contracts were signed for the building of seven new trawlers for four Icelandic fishing operators. Two ships are being built for Berg Huginn, a subsidiary of Síldarvinnslan, two ships for Gjögur, two for Skinney-Þinganes and one for Útgerðarfélag Akureyringa.

Morgunblaðið, 4 December 2017, pp. 1 and 4.

The shrimp catch has fallen greatly since the 1990s, when it peaked at around 90 thousand tonnes. Part of the shrimp catch came from the Flemish Cap, where it reached a peak in 1996. That year catch from the Flemish Cap totalled around 21 thousand tonnes, but it declined after that as did the catch in Icelandic waters. Shrimp catches have been at very low levels all the past decade.

Given the above information on catches during the past decade it was decided to use here 2016 catches (of all species) as the baseline for a fuel forecast for 2018-2030 and show what impact the changes will have on the oil consumption of Iceland's fishing fleet.

Comparison with Norway

An assessment has been made of the oil use factors used in Norwegian fisheries for the period 2000-2004 and again in the project "Fishing Fleet Energy Network - an Energy-saving and Competition-enhancing Programme 2011, 2012 and 2013" (Energinettverk fiskeflåte - energisparende og konkurranse- fremmende tiltak), which has recently been completed. The Norwegian consultancy (COWI) and the Norwegian Fisheries Research Fund in Norway (Fiskeri - og havbruksnæringens forskningsfond, FHF) carried out these projects.

Oil use factors for different fishing gear and fishing for different species were calculated for the years 2000-2004. Fishing of capelin and herring and mackerel fishing with a midwater trawl had the factor 0.09 kg oil / kg catch. This is somewhat higher fuel consumption than for herring and capelin fishing in Iceland. Bottom trawling had the factor 0.280 and for individual species the factors were estimated to be 0.350 for cod and 0.400 for haddock (Fisheries Climate Change Committee, 2009). In the latter project, oil consumption of Norwegian fishing vessels was analysed for 2009, 2011 and 2012. The conclusion was that fuel usage overall is decreasing in Norway. Fuel consumption by the Norwegian vessels using seines or midwater trawls remains steady, with use factors of 0.073 and 0.064 respectively.

Fuel consumption by longline vessels has decreased from 0.240 to 0.147. Oil consumption by small boats in offshore fishing has increased, as the use factor has risen from 0.150 to 0.185. Bottom trawlers are in a class of their own, as their oil consumption factor has declined from 0.299 to 0.228, or by almost 24% over this period. Increased trawler catches in Norway can be explained by higher CPUEs, increased harvest rights and better better catchability, combined with improvements in fishing gear and fishing equipment and more cost-efficient vessels. The same developments have taken place in Iceland. Demersal catch, which is principally cod, has increased in recent years after a major decline. Higher catches are reflected in higher CPUEs and a lower oil use factor in bottom trawling, which is currently 0.239, whereas the Energy Forecast Committee estimated 0.303 in its forecast. Oil consumption in bottom trawling is currently similar in Norway and Iceland, in so far as they can be compared.

In summary, the main findings of the project are that Norwegian fisheries uses relatively more fuel for fishing than does the Icelandic fisheries industry.

Fleet renewal - investment needs

New vessels and innovation

Fisheries enterprises have made extensive investments in recent years. In 2015-2017 twelve new large fishing vessels have joined, or are joining, the country's fleet. The total investment involved is at least ISK 35 billion.

- HB Grandi has invested in five vessels - four of which have arrived.
- Samherji and Útgerðarfélag Akureyringa have purchased three - two of which have been delivered.
- Two vessels purchased by FISK Seafood and Rammi have arrived.
- Hraðfrystihúsið Gunnvör and Vinnslustöðin in the Westman Islands each have one ship under construction in China.
- Ísfélag Vestmannaeyja had two new vessels built in 2012-2014.

It is worth noting that out of twelve vessels eight are wetfish trawlers, two are freezer trawlers and two are pelagic fishing vessels. Two factors explain the large number of wetfish trawlers. On the one hand, it was time for renewal of these vessels, which were getting on in years and, on the other hand, more emphasis has been placed on icing catches for further processing on land. In addition, Eskja, Síldarvinnslan and Loðnuvinnslan have recently acquired relatively new used vessels. HB Grandi and FISK Seafood have also converted two freezer trawlers to wetfish vessels.

These investments reflect the companies' new focus on reducing the importance of freezing at sea and increasing onshore processing in their utilisation of fishery resources. New decked vessels have been added to the fleet, e.g. Þórsnes in Stykkishólmur renewed its longliner of the same name last summer. New builds and major alterations to Icelandic fishing vessels are also planned in shipyards in Norway, Denmark and Poland.

As the above examples show, the development and renewal of the fleet is in full swing and will continue. The trend in decked vessels is expected to continue in similar fashion as in recent years.

1) Fishing vessels with catch quotas decreased in number by 72 from the 2001/2002 fishing year to the 2017/2018 fishing year, a reduction of 16%.

2) Registered trawlers are now 43 in number, and have decreased from 111 in 1990. This fleet is expected to remain little changed at 43-45 vessels, although there is a major need for renewal. Currently the trawlers are 30 years old on average whereas in 1990 the average ages was 20 years. A total of 35 trawlers are 20 years of age or older and most, if not all, of them are likely to be renewed by 2030.

3) Many other decked vessels have seen long service, e.g. there are approximately 75 vessels built between 1955 and 1981, and around 100 from 1982 to 1987. By 2030, dozens of these vessels are expected to be retired, some of them replaced by new vessels while others will be sold for export or for scrap.

New vessels will partly replace older ones retired from the fleet, which will be either sold for use abroad or scrapped. These vessels have low sales or residual value, but on average this should be equal to the cost of removing them from the Icelandic Vessel Registry. Fishing vessels are expected to continue to decline in number and many to be retired. Demands for optimisation, increased CPUEs and reduced greenhouse gas emissions, as well as renewal requirements due to age and inefficiency, require this rationalisation and renewal of the fishing fleet by 2030.

Investment needed

This analysis is limited to the need for investment in larger vessels and trawlers, and excludes undecked vessels and smaller decked vessels. The estimate is based on the latest publicly available figures reported by fisheries companies concern-

Oil consumption in Icelandic fisheries, both for fishing and land processing, will decrease in coming years. New technology in fishing and processing will play a major role and investments in it and new and better vessels will continue in the coming years and decades.

ing investments in new or recent vessels. The following investment is expected in vessels:

- Wetfish trawlers, e.g. comparable to Engey RE, with an estimated cost of ISK 2.25 billion per vessel. A total of 35 vessels.
- Processing vessels (freezer trawlers). Few vessels are expected but each of those built could replace 2-3 older vessels, at an estimated cost of ISK 6 billion per vessel. A total of 1 vessel.
- Decked vessels - pelagic vessels with processing and freezing capacity, at an estimated cost of ISK 5-5.5 billion per vessel. A total of 2 vessels.
- Decked vessels - pelagic vessels with cooling tanks, at an estimated cost of ISK 3 billion per vessel. A total of 10 vessels.
- Other decked vessels. Construction of each new vessels is estimated to cost ISK 0.9-1.2 billion. A total of 25 vessels.

The renewal will affect 35 trawlers and over 100 decked vessels, including both new builds and vessel modifications. The investment expenditures set out here are a rough estimate in order to give an overall outline or indication of the maintenance investment in fishing vessels during the 12-year period until 2030. It is not intended for use in planning for individual investments.

In total, the need for investment in trawlers and decked vessels is as follows:

Trawlers: An estimated 35 trawlers will need to be renewed, including one freezer vessel. Total investment in trawlers and equipment for fishing therefore estimated as ISK 84 billion.

Decked vessels: Decked vessels with catch quotas are expected to decrease in number by as much as 15%, and a major portion of the remaining fleet will be renewed during the period. This will mean as many as 110 vessels needing renewal by 2030. The cost of renewal is estimated at up to ISK 95 million.

Investment in vessels required until 2030 is therefore estimated here to be around ISK 180 billion. This is consistent with the assessment by the auditing firm Deloitte, which has regularly analysed performance in the fisheries industry on the so-called annual Fisheries Day, which is held jointly by Deloitte, the Confederation of Icelandic Employers and Fisheries Iceland. It was stated on the 2017 Fisheries Day, held in October, that the annual investment requirement in fisheries in the coming years would amount to about ISK 20 billion. It was also noted that in recent years PPE investment in fisheries has been high, amounting to ISK 27 billion in 2014, ISK 26 billion in 2015 and ISK 22 billion in 2016. Investment was considerably lower in the preceding years, with the exception of 2012, when fisheries companies made PPE investments of some ISK 17 billion.

Summary

Oil consumption in Icelandic fisheries, both for fishing and land processing, will decrease in coming years. New technology in fishing and processing will play a major role and investments in it and new and better vessels will continue in the coming years and decades. Optimisation efforts are also expected to continue which will reduce greenhouse gas emissions in the fisheries sector.

Fish meal production

Due to environmental considerations, pressure on fish meal producers to utilise electricity rather than oil in their production can be expected to continue. Given the forecast oil price development, it will also likely be more economical to use electricity.

Electrification of production plants
Major progress has been made in recent years in electrification of fish meal production plants. In 2016 seven of the eleven fish meal plants in Iceland were fully electrified. Three others, two in the Westman Islands and one in Þórshöfn on Langanes, currently use primarily oil. A new electricity transmission cable to the Westman Islands will increase the possibility of further electricity utilisation. The distribution network to Þórshöfn and several other locations, however, impedes further electrification of plants. It is therefore necessary for the government to ensure secure power supplies to the plants in order for all of them to be electric-powered by 2030. Electricity prices also need to be competitive with other energy sources for electricity to be regarded as preferable to oil, which has not always been the case.

Major investments have been made to fish meal plants in recent years, as electricity has replaced oil. In these plants, the raw material is first cooked and investments related to increased electricity usage were initially directed at this part of the process. Oil-fired boilers are used in some plants for the cooking process and are available as back-ups in others.

In recent years investments have also been made in equipment for drying the raw material with electricity, although oil is also used for this process in some plants. The availability of electricity at favourable prices for these uses has justified investment in conversion from oil to electricity. At times purchase of electricity, as well as its delivery, has been subject to cuts. As a result, the plants have used oil when electricity has not been available or if it was more economical. The requirement is generally set that investments in the plants pay for themselves relatively quickly, due to the high uncertainty regarding the availability of raw material.

Electricity system
The advent of the Blanda River power plant in the latter half of the 1990s resulted in some overcapacity in the electricity system, prompting the National Power Company (Landsvirkjun) to encourage sale of off-peak or unsecure electricity. Landsvirkjun discontinued general sale of unsecure electricity some time ago, but the plants have reached agreements with the company for the purchase of energy subject to delivery cuts. The plants continue to have access to transmission subject to cuts. They assess and select the most economical energy in each instance and, as a result, price fluctuations in electricity or oil can change the usage pattern. Electricity usage has increased in recent years, but in 2015-2016 low global oil prices have encouraged oil usage. It is likely that in the longer term, however, the use of electrical energy will become dominant in fish meal plants, due to rising oil prices as well as environmental and market conditions. However, it must be borne in mind that in order for manufacturers to be able to use electricity almost exclusively, investing in transmission and distribution systems is needed.

Fish meal plants have decreased in number in recent years. In 1999, 21 such plants operated, in 2006 they were 15 and in 2015 only 11. Síldarvinnslan in Neskaupstaður is the largest company in this sector, re-

Oil Consumption in Fisheries
- Fish meal plants

ceiving almost 35% of raw materials landed for reduction in 2015. Síldarvinnslan operates three plants: in Neskaupstaður, Helguvík and Seyðisfjörður. HB Grandi has two plants, in Vopnafjörður and Akranes. In 2015, HB Grandi's market share was 16%. Vinnslustöðin and Ísfélag Vestmannaeyja (with operations in the Westman Islands and in Þórshöfn) together accounted for 23% of the raw materials received. These four companies processed around three-quarters of the catches landed for reduction in 2015, operating eight plants for the purpose.

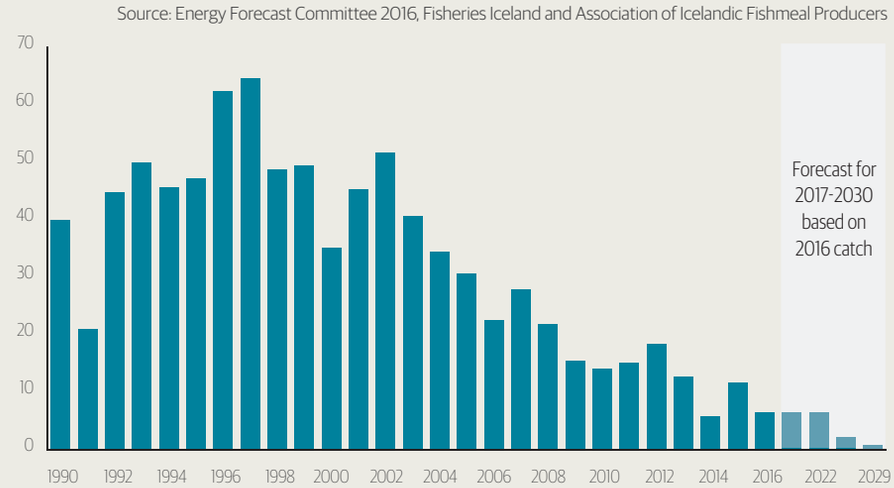
Distance from the banks determines to a large extent where catch is landed. Most of the plants are in East Iceland, where most of the processing took place in 2015, about 67%. That same year 17% of the raw material was processed the Westman Islands. Figure 14 shows oil consumption at fish meal plants from 1990 to 2016 and the forecast to 2030. As can be seen, the burning of oil in fish meal plants has been rapidly declining, and this trend is expected to continue.

According to the Electricity Forecast electricity can be used exclusively for the reduction of 95% of the catch processed in 2017. The Energy Forecast Committee estimates that the oil consumption of fish meal plants currently corresponds to 15 kg of oil per tonne of raw material and that it will be 10 kg per tonne in 2020 and 2 kg per tonne at the end of the forecast period. This is in line with trends in the industry, provided that electricity prices are competitive with oil prices.

Summary
As in the case of fishing, greenhouse gas emissions from the production of fish meal and fish oil will decrease in the coming years and further investment will be undertaken. In order to speed up the process, the electricity distribution system needs to be strengthened and the price of electricity must be competitive with oil prices.

Figure 14
The targets of the Paris Agreement have already been reached by fish meal and fish oil producers
Oil consumption of fish meal plants (thousand tonnes)

Source: Energy Forecast Committee 2016, Fisheries Iceland and Association of Icelandic Fishmeal Producers

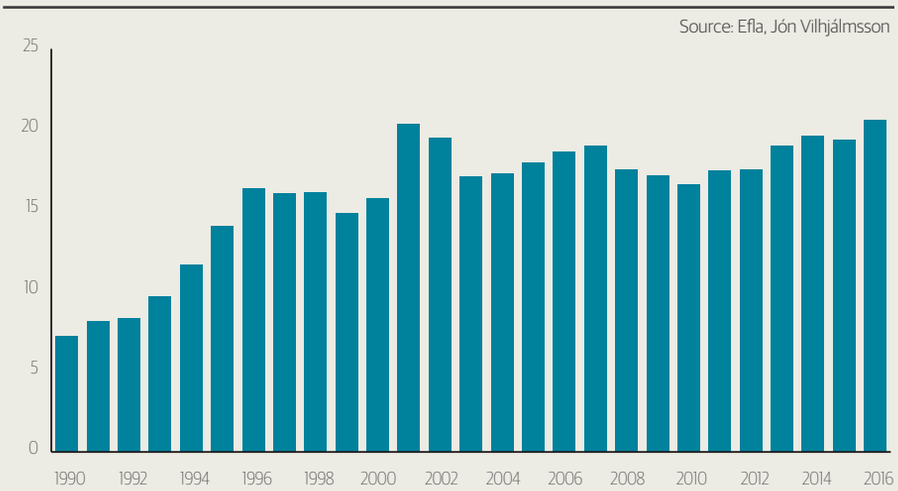


Other aspects

Since they began taking action to encourage it, Fisheries Iceland have themselves consigned or have had shipped for recycling over 8,400 tonnes of discarded fishing gear, which corresponds to approximately 15-16,000 m^3 or 260 forty-foot containers.

Ports - mains electricity
Icelandic fishing vessels today can connect with electricity when docked. This system has been in effect since around since 1980 and has not actually changed much in recent decades. The electricity system that vessels have access to in Icelandic ports is generally quite good. In recent years, the ports have purchased electricity directly from utilities, and themselves handled sales, infrastructure, distribution and connections within port areas. A situation can, however, arise where connections cannot manage the vessel's energy needs, e.g. when landing catch. If vessels need more energy than is available at the dockside, they have to resort to the diesel generators on board. Around 0.6% of total emissions from the fishing fleet occur in the country's ports. Students at Reykjavík University conducted a survey for Fisheries Iceland on how long a time it took for equipment purchased to enable a vessel to use mains electricity to pay for itself. The conclusion was that this would pay for itself in a year and a half. As shown in Figure 15, average electricity sales to ships have been fairly constant in recent years.

Figure 15
Electricity sales to vessels have grown slightly in recent years
Fishing vessels' use of mains electricity (GWh)



Cost-efficiency calculations show that mains electricity is a favourable energy source for fishing vessels in port. The following calculations are based on data and methodology from a report prepared by Sætækni for the Port of Hafnarfjörður, with prices as of April 2017 net of VAT.

To produce 1 kWh requires about 0.3 litres of diesel oil. According to oil distributor Skeljungur's price list in April 2017, a litre of diesel cost ISK 97.03 excluding VAT. The cost of purchasing 1 kWh of mains electricity was ISK 17.80 while output of 1 kWh from a generator cost ISK 29.11. On this basis, mains electricity is therefore around 61% cheaper than producing electricity with a diesel generator.

In 2016 fishing vessels used over 20,000 kWh of mains electricity or the equivalent of 6,174 tonnes of fuel. This meant avoiding around 19.6 tonnes of CO2 emissions that year by using mains electricity, based on a conversion factor from oil to kWh of 300 g/kWh.

It is evident from Figure 15 that the demand for mains electricity from fishing vessels in port is increasing. However, the number of vessels linking up with mains electricity

while in port has fallen overall and this target group is unlikely to grow in the coming years.

To increase the use of electricity the number of high-power connections in ports needs to be increased to ensure a sufficient supply of power. Placing disconnectors on board vessels, so that all electricity for general use would be obtained from mains sources, could also be considered. In the event that equipment has to be used which requires more power than is available from the mains connection a diesel generator will need to be operated separately. The engineering firm Mannvit submitted the following proposals for improving land connections in a report in 2012:

- When vessels have a crane or cooling equipment in operation, it often requires more electricity than its connection can handle and a circuit blows. Adding a second connection to the vessel reduces the likelihood of a power outage.
- Vessel operators are advised to keep their power consumption on board at a minimum while in port, to lower electricity costs. This is done, for example, by turning off lights and other equipment not in use.
- It is suggested that connecting equipment in several Icelandic ports be upgraded, more connections and connection boxes added, and the distance between connection boxes decreased.
- Hot water should be provided to vessels during extended stays in port and preferably always at the same location. The water is used for heating the vessel and a heat exchanger used to heat the vessel's closed radiator system. This would be most useful for those vessels which already have a closed radiator system. Ports and vessel operators should examine this option well because the hot water could reduce electricity consumption in ports considerably.

Upgrading the infrastructure in the country's ports needs to continue, to ensure that electricity and hot water (where appropriate) is available for fishing vessels. Increased demand already exists for mains electricity in ports. The utilisation of mains electricity by fishing vessels in 2016 was equivalent to the burning of nearly 6,200 kilograms of fuel. Which means that more than 20 tonnes of greenhouse gases emissions were avoided in 2016 by the use of electricity instead of oil. While this may not make an enormous difference in the overall context of oil consumption in fisheries, it is important to bear in mind that here the needs of the fisheries industry and the objective of reducing emissions go hand in hand.

Recycling of fishing gear

On 29 August 2005, the predecessor of Fisheries Iceland, the National Association of Icelandic Vessel Owners, concluded an agreement with the Board of the Icelandic Recycling Fund for recycling of discarded fishing gear made of synthetic material. The agreement is based on statutory authorisation of undertakings and sectors to reach agreement on measures to ensure the recycling of discarded gear, cf. the third paragraph of Art. 8, of Act No. 162/2002, on Recycling Fees, as subsequently amended. Fishing gear made of synthetic materials, cf. Annex XVII to the Act, is as a result exempted from the levying of a recycling fee, which would otherwise have been imposed as of 1 September 2005. The agreement took effect on 1 January 2006.

Under the agreement, the organisation undertook to operate or negotiate with third parties for the operation of a designated receiving station for recyclable fishing gear of synthetic materials and send this for final recycling. The receiving station

must be licensed by the Environment Agency. Receipt of fishing gear waste under the agreement began on 1 January 2006. In addition, the Association undertook to look after the stocks of all holders of discarded gear in Iceland which had arisen from normal use.
As long as conditions for receipt are satisfied, all Icelandic entities can deliver discarded gear from synthetic materials arising from the use by Icelandic vessel operators to the receiving station without charge. Foreign operators, or their agents, can also deliver discarded fishing gear of synthetic material from foreign vessels to the receiving station for a charge and provided they satisfy the conditions for receipt.

The objective of the agreement is to have operators bear the responsibility for recycling of fishing gear made from synthetic materials so that during its period of validity the gear will be exempt from fees provided for in Act No. 162/2002, on Recycling Fees. According to the agreement, in 2006 at least 45% of the fishing gear discarded was expected to be recycled, at least 50% in 2007 and at least 60% in 2008. These estimates were exceeded considerably. The Association's objective with the agreement is simply to take advantage of the above-mentioned statutory authorisation, and in so doing minimise the environmental impact and keep the costs involved in disposing of discarded gear to a minimum. Each year a report on the collection and recycling of discarded gear is prepared for the Recycling Fund as part of the above-mentioned agreement. Since they began taking action to encourage it, Fisheries Iceland have themselves consigned or have had shipped for recycling over 8,400 tonnes of discarded fishing gear, which corresponds to approximately 15-16,000 m^3 or 260 forty-foot containers. This was achieved during the 11-year period from 2006 to 2016 inclusive. Of the discarded gear made from synthetic materials which was collected during this period almost 96% was recycled. This is far above the proportion specified in the objectives of the agreement with the Recycling Fund.

Discarded fishing gear from Iceland is now exported to Lithuania for recycling. Good results have been achieved in this regard, and most of the production is used in the electrical and automotive industry in Germany, for example, for the production of plastic automobile components. The success has enabled the recycling company to pay more for the discarded material. The accompanying table shows the disposal of discarded fishing gear by Fisheries Iceland in 2016. It shows that of the 1,300 tonnes of fishing gear (Rockhoppers are not included in the agreement with the Fund) received 1,165 tonnes were sent for recycling, while 132 tonnes ended as landfill.

As an example, 37% of waste at HB Grandi in Reykjavík in 2015 was sorted and 63% unsorted. This year, the figures have been almost reversed, as unsorted waste is only 42% while 58% is sorted. This is a good example of the development and consciousness-raising that has taken place. The company also operates a waste disposal station, where all waste is collected, classified and delivered to the appropriate locations. A system is also followed on board its vessels to sort waste, including an electronic waste journal, in which all waste is specifically recorded. The same applies to a large number of other vessel operators.

Photo: Samherji

Table 5
Approximately 90% of the fishing gear received in the country's ports was recycled
Disposal of fishery waste organised by Fisheries Iceland in 2016 (kg)

Material / Type	Quantity	Recycling	Landfill
PE/PP/PEP trawls	517,731	517,731	
PA Multifilament midwater trawls	132,620	132,620	
PA Multifilament seine material	380,250	380,250	
Net cuttings PA Monofilament	42,250	42,250	
PA impregnated lines	36,000		36,000
PES PE + PA head and foot ropes and cables	18,000	12,400	5,600
Floats	4,800	4,800	
Rockhoppers	90,680		90,680
Scrap iron	75,000	75,000	
Total	**1,297,331**	**1,165,051**	**132,280**

Source: Guðfinnur Johnsen, Fisheries Iceland.

All waste brought ashore
Icelandic law aims at protecting the ocean and country's shores against pollution and actions which could present a danger to human health, damage ocean resources or the ocean biosphere, contaminate the environment or impede the legitimate utilisation of ocean and shorelines (Act No. 33/2004).
As described in the preceding chapter, Icelandic vessel operators have for many years brought all unusable fishing gear ashore for recycling. This applies not only to fishing gear, as all refuse and waste produced on board is brought ashore, including waste oil, hydraulic fluid, gaskets, metal, plastic and glass. The objective is to recycle as much as possible and reduce all waste.

Sources

Fisheries Climate Change Committee, 2009

Energy Forecast 2016

Marine Research Institute, 2015

Statistics Iceland

Association of Fishmeal Producers

COWI og FHF - COWI and FHF - Energy Networkfiskefláte - energisparende og konkurransefremmende tiltak 2011, 2012 and 2013

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