Summary report

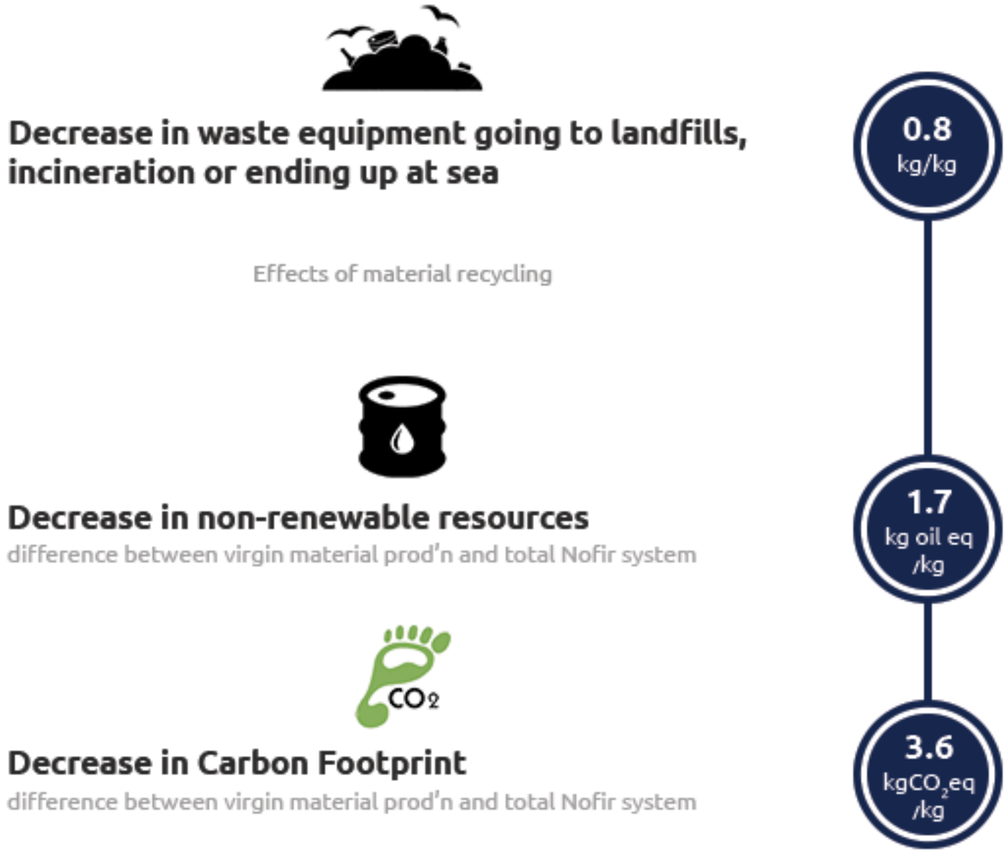
Life Cycle Assessment of EUfir system. A European system for collecting and recycling discarded equipment from the fishing and fish farming industry

Executive summary

This report provides a summary of the EUfir system environmental performances related to discarded equipment from fishing and fish farming industry collection and recycling.

Life Cycle Assessment (LCA) methodology is used to calculate relevant environmental impacts of an extended system that goes from the availability of discarded fishing equipment to the production of secondary materials after recycling operations; the functional unit is “1 kg of average EUfir output composition” made by 76% PA6 (nylon), 13% PP (polypropylene), 9% HDPE (polyethylene, high density), 2% Pb (lead) and 1% steel”. Primary data for the LCA model comes from customised questionnaires through the first semester 2014.

Results are summarised in Figure 1, where the quantification of benefits coming out from the prevention of fishing and fish farming equipment landfilling at the end of their useful life is provided.



1. ***Figure 1 – Overall project's results per 1 kg of average output material.***

1. EUfir system

Norsk Fiskeriretur AS (Nofir AS) is the co-ordinator of the project "*A European system for collecting and recycling discarded equipment from the fishing and fish farming industry*" (**EUfir**), sponsored by the European Commission within the Eco-Innovation funding initiative.

EUfir aims at establishing a robust, reliable and sustainable system for collecting and recycling discarded equipment from the European fishing and fish farming industry.

Collected fishing equipment, composed by various types of plastics and metals, has first to be disassembled/separated into homogenous materials' classes to improve recycling efficiency. For this reason, EUfir is a true network that put together the following actors, each one with a specific role and duties:

- Transport means from collection to dismantling
- UAB Nofir: a fishnets dismantling/materials classification facility in Lithuania.
- PA6 (nylon) recycling plant;

- PE and PP recycling plant.
- Lead recycling plant.
- Steel recycling plant.
- Nets reuse service.

Life Cycle Assessment has the primary purpose of evaluating the sustainability of the EUfir system through the quantification of the life-cycle environmental performance resulting from a life cycle inventory analysis applied to the defined system.

According to the project proposal approved by the European Commission within the Eco-Innovation initiative, the EUfir environmental sustainability is explored through the identification and calculation of the following key indicators:

- Decrease of fishing and fish farming waste equipment ending at sea or in landfills.
- Effects of material recycling with a consequent
  - Decrease in non-renewable resources consumption
  - Decrease in CO_2eq emissions (carbon footprint)

2. LCA study overview

Life Cycle Assessment (LCA) is a scientific method to evaluate the environmental burden associated with a process or activity by identifying and quantifying energy, (raw) materials and semi-products use as well as emissions and waste to the environment by means of a life-cycle-thinking perspective. ISO 14040 and 14044 International Standards define the LCA approach and framework.

2.1 Functional Unit

EUfir system aims at recovering most of the fishing and fish farming equipment at the end of life by recycling or reuse actions.

The equipment is dismantled and divided into homogenous plastic or metal types at Nofir UAB factory in Lithuania and then addressed/delivered to reuse or recycling processes at Nofir partners' facilities.

The functional unit is **1 kg of average EUfir system output material** (Table 1).

Table 1 – EUfir system output material average composition

MATERIAL COMPOSITION (EUfir output product)	Percentage
PA6	76.2%
PP	12.6%
PE	8.7%
Lead	1.9%
Steel	0.6%

2.2 System boundaries

The boundaries start from the collection of fishing net equipment at the end of life (EoL), taking into account all transport and dismantling operations, ending with recycling processes at partners' plants; the system comprehends the production and transport of energy taking into account specific country energy mixes (Figure 2).

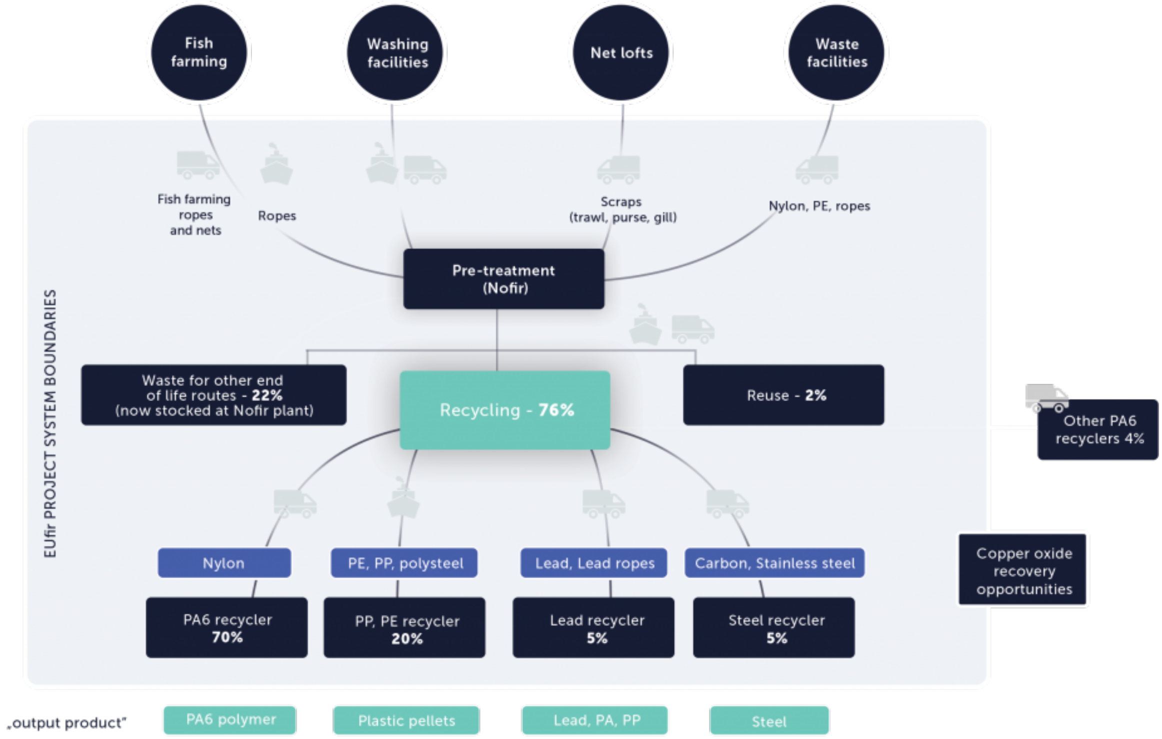


Figure 2 – Life cycle flow chart for EUfir system boundaries

2.3 Results

The output consists in a set of parameters to describe the environmental burden of the investigated system; life cycle inventory results are usually organized in terms of energy requirements and environmental consequences in order to identify the impacts' origins and contributors.

Considering the available potentially recyclable/reusable waste amount, two ways are possible (Figure 3):

1. Recycling/reuse within EUfir system
2. Waste management without EUfir system:
    1. Waste recycling
    2. Waste disposal
    3. Wastes dumping at sea

Figure 3 – Fishing and fish farming waste management: A) with EUfir system, B) without EUfir

Prevention of fish and fish farming waste equipment dumped at sea or landfilled/incinerated

The percentage of waste going to recycling within EUfir system is available in Figure 4.

Figure 4 – Prevention of plastic dumped at sea and waste diverted from disposal in the EUfir scenario

The estimated percentage of waste equipment going to be dumped at sea and addressed to disposal without the EUfir project comes from literature assumptions and is reported in Figure 5.

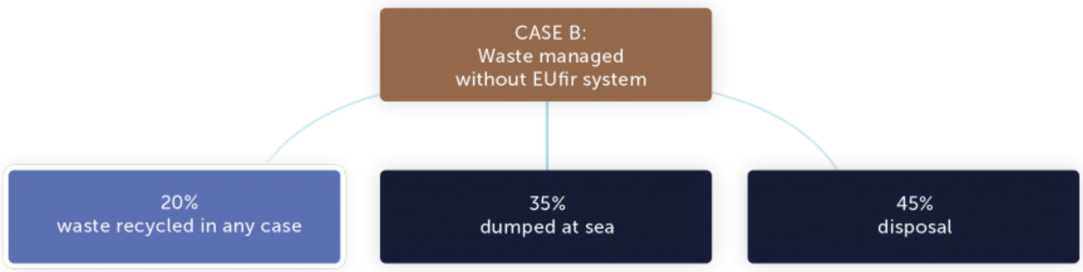


Figure 5 – Prevention of plastic dumped at sea and waste diverted from disposal in the Euorean scenario

The Norwegian fishing and fish farming recycling rate of 20%, set by the Norwegian Environment Agency in a recent report and supported by SINTEF, is assumed representative for Europe (Norway is probably the most important seafood supplier in Europe).

As declared in a FAO report and other literature, every year about 640 000 t of fishing gears are lost worldwide. Trying to extrapolate a reliable figure for Europe, a weighting factor of 10% is used, based on the population and fisheries amount in Europe. From Nofir knowledge, the fishing equipment legally discarded in Europe is about 114 000 t in a year. Then, the potential waste lost or dumped at sea is about 35% of the total waste availability in Europe.

On the other hand, waste occurring from fishing and fish farming not recycled and not lost/dumped at sea is assumed to go to landfill or incineration; in this case, the remaining percentage is about 45%.

Reduction of non-renewable resources consumption

Increasing in material recycling entails a reduction of non-renewable resource consumption.

To appreciate benefits of the EUfir system, a focus on output plastic materials is presented.

First, primary non-renewable resources demand data for virgin plastic materials provided by 2014 Plastics Europe eco-profiles are introduced (Table 2).

Table 2 – Primary non renewable energy demand for virgin plastic material (case B)

PLASTIC TYPE	Unit	A FUEL ENERGY INPUT	B FEEDSTOCK ENERGY INPUT	C PRIMARY non-renewable ENERGY DEMAND (A+B)
PA6	kg non-renewable resources/kg	1.76	0.75	2.5
PP	kg non-renewable resources/kg	0.66	1.03	1.7
PE (HDPE)	kg non-renewable resources/kg	0.76	1.04	1.8

The feedstock energy (column B in Table 2) means incorporating hydrocarbon resources into the polymer, the fuel energy (column A in Table 2) means generating process energy.

In the EUfir system, while feedstock energy is not lost during the recycling operations (this means that column B in Table 2, is preserved), fuel energy is used to process the plastic waste (column D in Table 3).

Table 3 – Primary non renewable energy demand for EUfir system (case A)

PLASTIC TYPE	Unit	EUFIR SYSTEM
PA6	kg non-renewable resources/kg	0.83
PP	kg non-renewable resources/kg	0.56
PE (HDPE)	kg non-renewable resources/kg	0.56

Considering the EUfir average output content (Table 1) and a recycling efficiency of 80%, 1 kg of virgin plastic material with the same composition needs about 2.3 kg of (primary) non-renewable energy resources (1.53 fuel + 0.81 feedstock respectively).

At the same time, the fuel energy demand in terms of (primary) non-renewable energy resources of 1 kg of EUfir plastic output product is of about 0.77 kg/kg, providing a decrease of about 1.5 kg of primary non-renewable energy resources per kg of output product (rounded value).

Reduction of Carbon Footprint

Like for non-renewable resources, increasing in material recycling through the EUfir system entails also a reduction of carbon footprint (CO_2eq emissions).

With a similar approach already explained in the previous point, the carbon footprint reduction is calculated as arithmetic difference between Figure 6 and Figure 7, resulting in a decrease of about 3,6 kg CO_2/kg of output product (the disclaimer in footnote 7 here applies again).

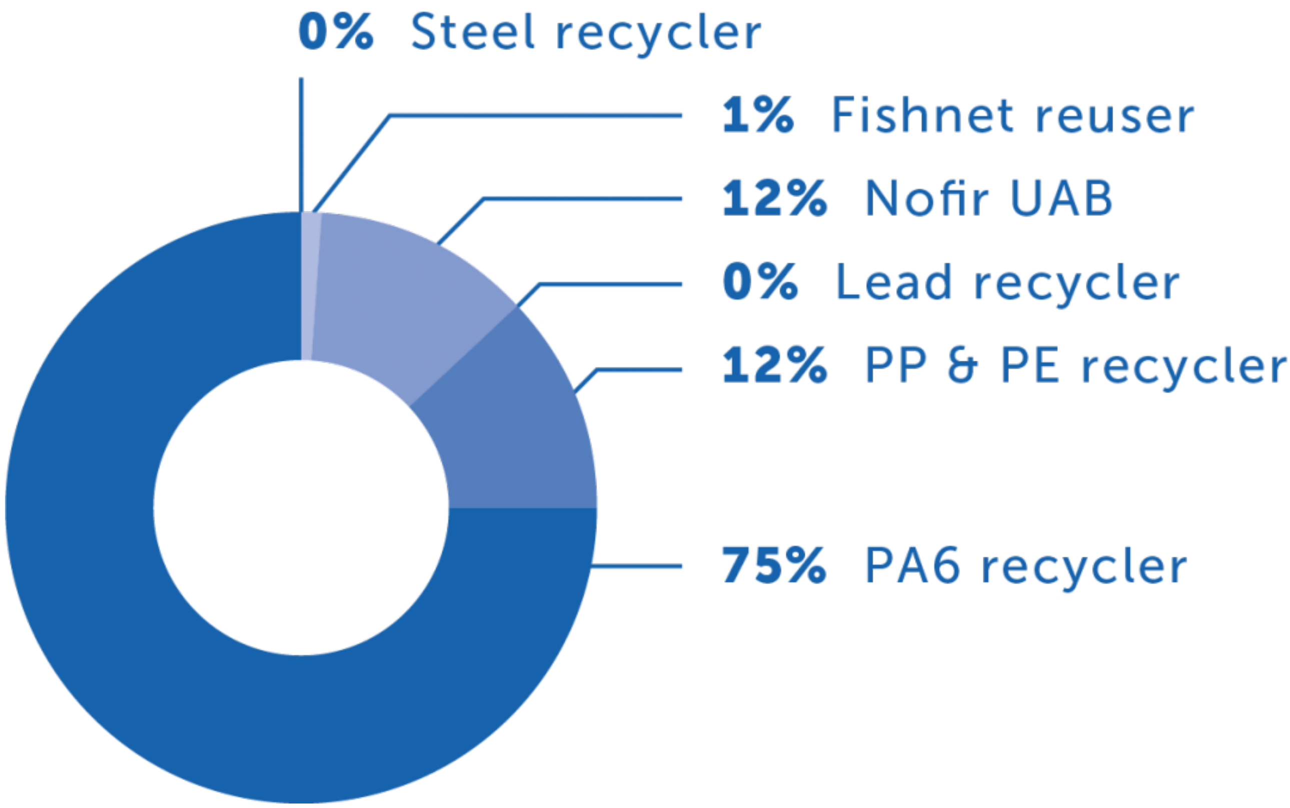


Figure 6 – EUfir greenhouse gases emission detail (case A)

GWP per kg of virgin material (case B)

Material composition (output product - EUfir project)	Percentage composition	Material CARBON FOOTPRINT kg CO_2eq/kg	Virgin output product CARBON FOOTPRINT kg CO_2eq/kg
PA6	76%	6.7	5.1
PP	13%	1.6	0.2
PE (HDPE)	9%	1.9	0.2
Lead	2%	1.8	<0.1
Steel	1%	1.4	<0.1
TOTAL	100%	-	**5.5**

To produce 1 kg of virgin material with a similar EUfir composition corresponds to a CARBON FOOTPRINT of about **5.5 kg CO_2eq/kg**

Figure 7 – GWP per kg of virgin material (case B)

Finally, a focus on transports says that an average contribution on EUfir system in terms of Carbon Footprint is of about 17% (Figure 8); when compared with the EUfir reduction (about 3.6 kg CO_2/kg of output product), the transport relevance is about 9%.

Figure 8 – EUfir Trasports average contribution (CO2 eq. emissions)

3. Critical Review

The following executive summary refers to a “Critical Review of an LCA” report, prepared by Dr. Goran Brohammer after a full ISO 14040 Third Part Verification on the LCA activities here introduced.

References

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