Nofir

BRINGING VALUE TO MARINE WASTE

SUMMARY REPORT

Life Cycle Assessment of EUfir system

A European system for collecting and recycling discarded equipment from the fishing and fish farming industry

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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[1] 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.

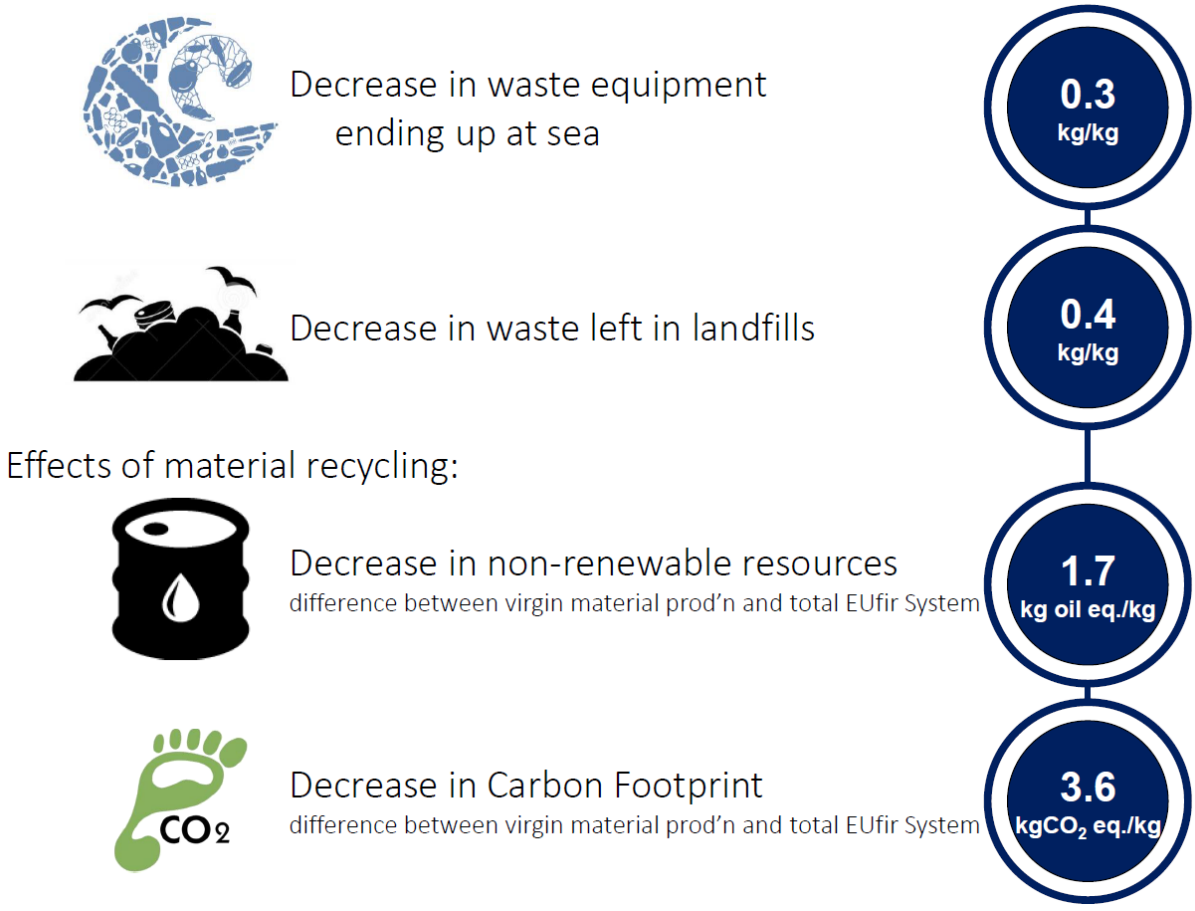

Figure 1 – Overall project's results per 1 kg of average output material.

[1] LCA is a method for the systematic evaluation of the environmental aspects of a product or service system through all stages of its life cycle. LCA provides an adequate instrument for environmental decision support and a reliable LCA performance is crucial to achieve a life-cycle economy.

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 (kg oil eq.)[2]
    - Decrease in CO_2 eq. emissions (carbon footprint)

[2] Kilogram(s) of oil equivalent (kgoe) is a normalised unit of energy. By convention it is equivalent to the approximate amount of energy that can be extracted from one kilogram of crude oil. Here, the gross calorific value is used for conversions.

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).

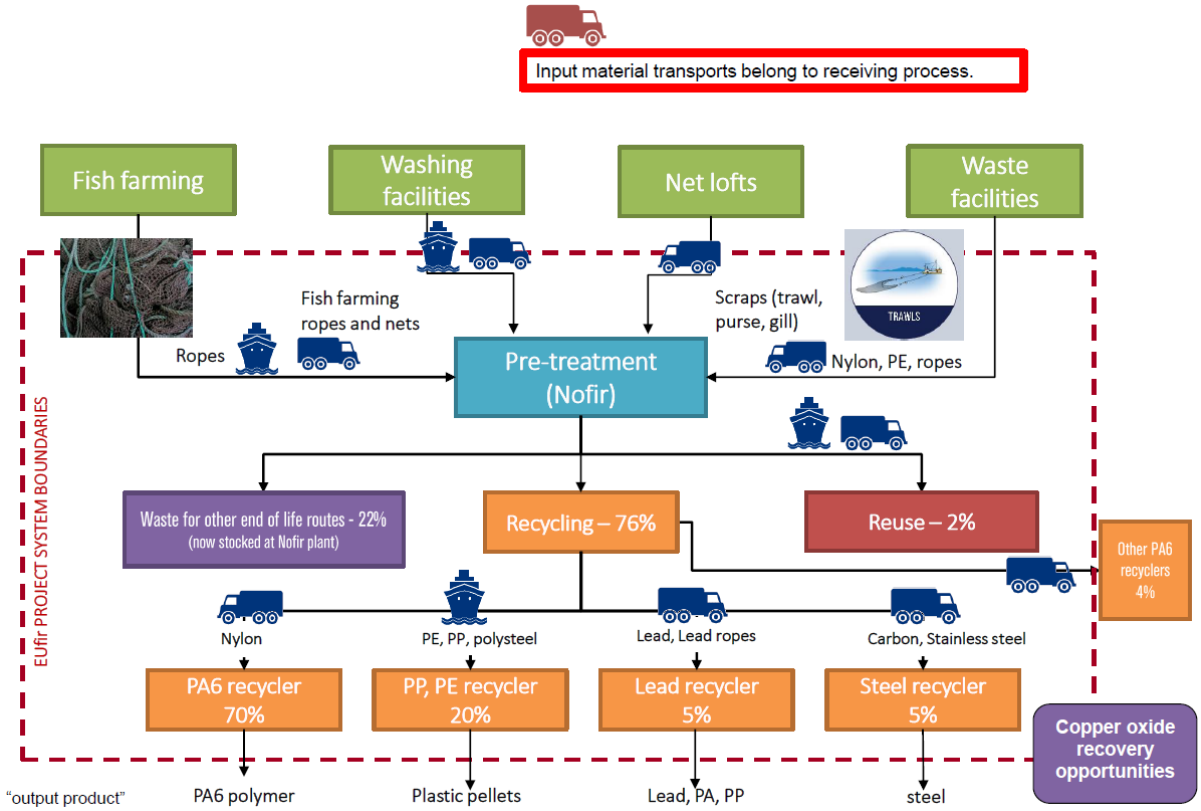

Figure 2 - Life cycle flow chart for EUfir system boundaries

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):

A. Recycling/reuse within EUfir system
B. Waste management without EUfir system:
    a. Waste recycling
    b. Waste disposal
    c. Waste dumping at sea

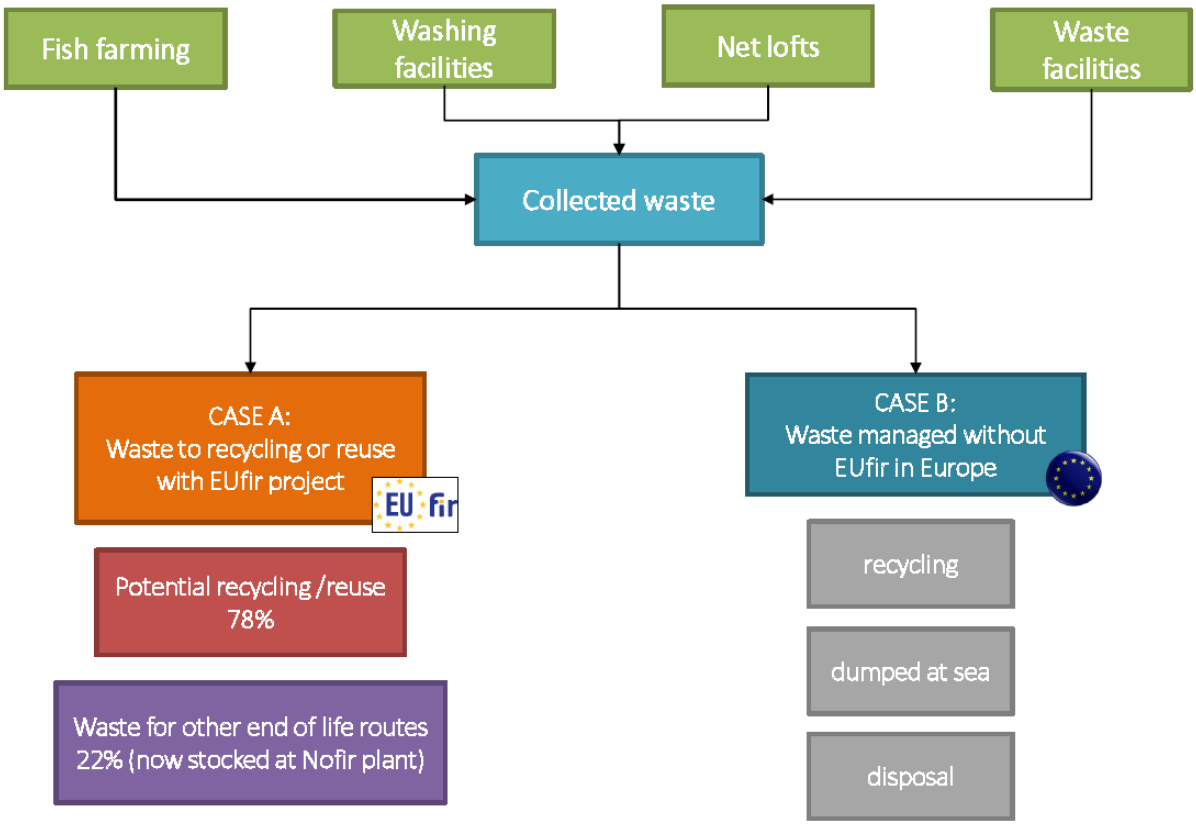

Figure 3 - Fishing and fish farming waste management: A) with EUfir system, B) without EUfir

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

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

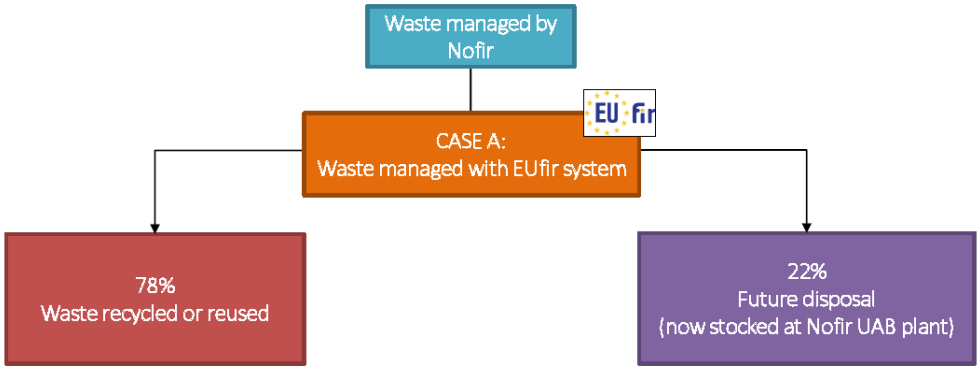

Figure 4 - Prevention of plastic dumped at sea and waste diverted from disposal in the EUfir scenario

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

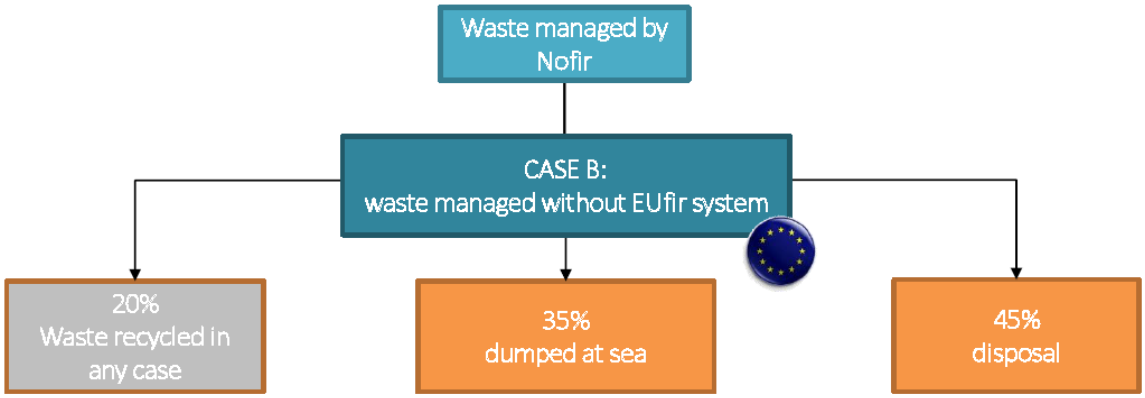

Figure 5 - Prevention of plastic dumped at sea and waste diverted from disposal in the Euorean scenario

Here, the Norwegian fishing and fish farming recycling rate of 20%, set by the Norwegian Environment Agency in a recent report[3] and supported by SINTEF[4], is assumed to be representative for Europe (Norway is probably the most important seafood supplier in Europe).

As declared in a FAO report[5] and other literature[6], every year about 640 000 t of fishing gears at the end of life 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 managed in Europe.

45% is the remaining percentage of waste from this sector not recycled and not lost/dumped at sea that is assumed to go to landfill or incineration.

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[7] eco-profiles are introduced (Table 2).

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[3] Norwegian Environmental Agency (Miljødirektiratet) "Sources of microplastic pollution to the marine environment", December 2014

[4] SINTEF is the largest independent research organization in Scandinavia, analysing the Norwegian fisheries and aquaculture situation

[5] Macfadyen, G., Huntington, T., & Cappell, R. (2009). 'Abandoned, lost or otherwise discarded fishing gear'. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. Rome: UNEP/FAO

[6] World Society for the Protection of Animals, "Fishing's phantom menace", 2014
Issue Paper to the "International Conference on Prevention and Management of Marine Litter in European Seas" Berlin 10-12 April 2013

[7] PlasticsEurope is one of the leading European trade associations for plastics; www.plasticseurope.org

Table 2 - Primary non renewable energy demand for virgin plastic material (case B), rounded values

PLASTIC TYPE	Unit	A FUEL ENERGY INPUT	B FEEDSTOCK ENERGY INPUT	C PRIMARY non-renewable ENERGY DEMAND (A+B)
PA6	kg oil eq./kg	1.9	0.8	2.7
PP	kg oil eq./kg	0.7	1.0	1.7
PE (HDPE)	kg oil eq./kg	0.8	1.0	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), rounded values

PLASTIC TYPE (EUfir project)	Unit	D EUFIR SYSTEM FUEL ENERGY INPUT
PA6	kg oil eq./kg	0.7
PP	kg oil eq./kg	0.5
PE (HDPE)	kg oil eq./kg	0.5

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 2.4 kg of oil equivalent (1.7 fuel + 0.7 feedstock respectively) as (primary) non-renewable energy resources.

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 0.7 kg oil eq./kg, providing a decrease of about 1.7 kg oil eq. per kg of output product (rounded value)[8].

[8] Due to differences in some physical properties, a direct comparison between virgin and recycled plastics should be done taking into account the final use of the polymer. On the other hand, recycled and virgin lead and steel have similar properties.

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 eq/kg of output product (the disclaimer in footnote 7 here applies again).

Partner	Partner processes CARBON FOOTPRINT kg CO_2eq/kg	Partner contribution to EUfir project	EUfir system CARBON FOOTPRINT kg CO_2eq/kg
Nofir UAB	0.2	Pre-treatment 100%	0.2
Fishnet reuse partner	0.4	Re-use 2%	<0.1
PA6 recycler	2.5	Recycling 56%	1.4
PP and PE (HDPE) recycler	1.3	Recycling 17%	0.2
Lead recycker	0.1	Recycling 2%	<0.1
Steel recycler	0.7	Recycling 1%	<0.1
TOTAL			1.9

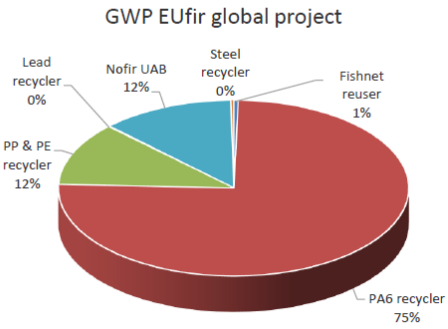

Figure 6 - EUfir carbon footprint detail (case A), rounded values

Material composition (output product – EUfir project)	Percentage composition	Material CARBON FOOTPRINT kg CO_2eq/kg	Virgin output product CARBON FOOTPRINT kg CO_2eq/kg of
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 – Carbon footprint per kg of virgin material (case B), rounded values

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 (that is about 3.6 kg CO_2 eq/kg of output product), the transport relevance is about 9%.

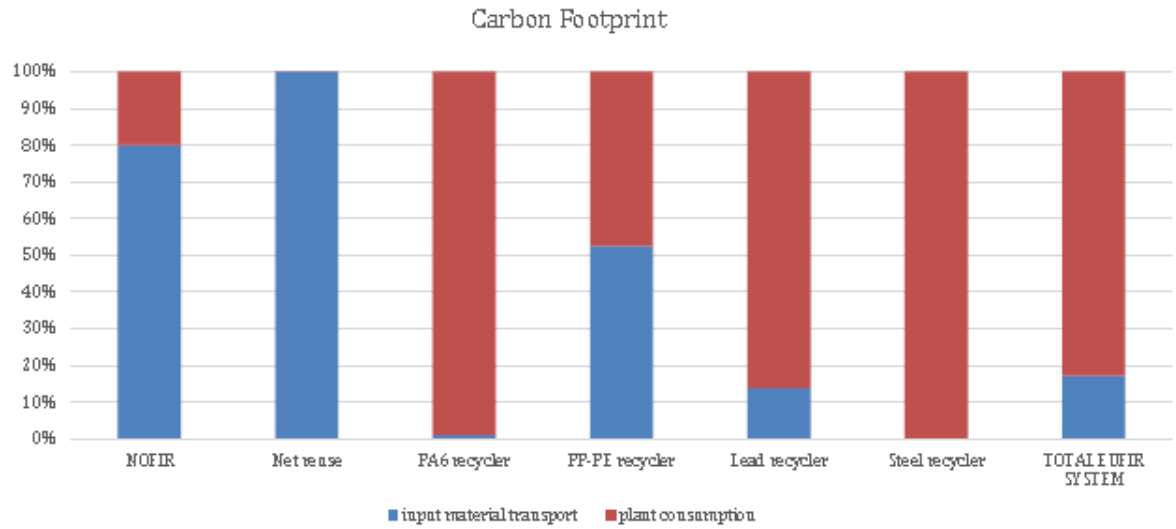

Figure 8 - EUfir Trasports average contribution (CO2 eq. emissions)

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.

Executive summary

This is a summary of the LCA critical review report dated 2015-10-27, performed by Extracon AB for Nofir AS, as part of the EUfir project. For more details, see the full version of the report.

The review has been done according to the procedures in ISO14040:2006 and ISO14044:2006, the activity has consisted of both documentation review and site visit of the Nofir plant in Lithuania. Review criteria description:

- Relevant and realistic description of the outcome
- The accuracy in basic models for the dominant parts of the life cycle (sample)
- Relevance to the assumptions that are made and the modifications of the models that are made.
- Relevance and representation of the data sources impacting in the most significant parts of the final result.
- Selected characterization

The LCA result in the report has been judged relevant and where uncertainties exist, there is transparency for the reader, the main comments for adjustments has been of cosmetic character for easier understanding of the LCA study and its result.

References

- ISO 14040:2006
- ISO 14044:2006
- ISO 14025:2010
- General Programme Instructions for the International EPD® System v. 2.01 (2013)
- Product Category Rules PCR 2013:08, "Plastic waste and scrap recovery (recycling) services", version 1.01
- Baldo, Marino, Rossi; "Analisi del ciclo di vita LCA – Nuova edizione aggiornata"; Edizioni Ambiente; 2008
- IEA Report "Energy balance of non-OECD countries", 2012 edition
- Environmental Product Declaration for Econyl polymer rev 1, S-P-00500 (20/11/2014)
- Environmental Product Declaration for merchant bars production at Trith Saint Léger (France) and Vicenza (Italy) plants rev 1, S-P-00252 (26/02/2014)
- Norwegian Environmental Agency (Miljødirektiratet) "Sources of microplastic pollution to the marine environment", December 2014
- Macfadyen, G., Huntington, T., & Cappell, R. (2009). 'Abandoned, lost or otherwise discarded fishing gear'. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. Rome: UNEP/FAO
- World Society for the Protection of Animals, "Fishing's phantom menace", 2014
- Issue Paper to the "International Conference on Prevention and Management of Marine Litter in European Seas" Berlin 10-12 April 2013
- UNEP "Marine litter, an analytical overview", 2005 United Nations Environment Programme
- Food and Agriculture Organisation of the United Nations "The state of World Fisheries and Aquaculture – opportunities and challenges", 2014
- Arena U., Mastellone M.L., Perugini F. "Life cycle assessment of aplastic packaging recycling system", Int. J. LCA 8 (2) 92-98 (2003)
- FAO website, http://www.fao.org/statistics/en/
- Plastics Europe, www.plasticseurope.org
- Ecoinvent database