

WP2 Report

D.2.3.2 End of Life Fishing Gear

Technology best practice report

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GLOSSARY

Fishing port. A port that is mainly used by fishing vessels, i.e. vessels that are used to catch fish or other living natural resources mainly commercially.

Ghost Nets. Ghost nets are runaway or abandoned nets, trolls or other scammers. They are part of the plastic garbage problem of the oceans. They cause harm to the fishing industry, the environment and shipping. In addition, they continue their task, i.e. fishing, for a long time after they have been abandoned. Fish, but also other animals, such as birds and marine mammals, can get stuck in the nets. (Finnish Environment Institute, 2022).

Plastic containing fishing gear.” Any item or piece of equipment that is used in fishing or aquaculture to target, capture or rear marine biological resources or that is floating on the sea surface and is deployed with the objective of attracting and capturing or of rearing such marine biological resources”. (Directive (EU) 2019/904).

ACRONYMS AND ABBREVIATIONS

EEA	European Economic Area
EU	European Union
WFD	Waste Framework Directive (2008/98/EC)
SuP	Single-use plastics
SuPD	Single-use plastics directive (2019/904/EC)
EPR	Extended producer responsibility
NPA	Northern Periphery and Arctic
CIRCNETS	Blue Circular Nets project
EOL	End-of-life
MARPOL	International Convention for Prevention of Pollution from Ships
ALDFG	Abandoned, lost or discarded fishing gear
PE	Polyethylene
HDPE	High density polyethylene
UHMWPE	Ultra-high molecular weight polyethylene
PP	Polypropylene



1 INTRODUCTION

Blue Circular Nets (CIRCNETS) is an INTERREG project funded by Northern Periphery and Arctic 2021–2027 (NPA) programme, which addresses marine litter issues. Single-use plastics and fishing gear are the most significant sources of marine plastic litter also in Europe, and the European Union has taken substantial steps in tackling these threats to the marine environment. Many single-use plastic (SUP) items have been banned and replaced with items made from more sustainable materials, but a similar approach is not yet possible with plastic containing fishing gear. Therefore, a different kind of approach has been taken. End-of-life (EOL) fishing gear, nets and other fishing equipment, which are approaching their best before date, should be collected separately and recycled in order to prevent them from ending in the waterways and contributing to the marine plastic pollution.

The more specific aim of CIRCNETS is to support the setting up of a collection system for EOL fishing gear in the NPA region. The EU's SUP directive requires that producers and importers of plastic containing fishing gear in all EU member countries organise the collection of EOL fishing gear based on the extended producer responsibility (EPR) principle. Finding out, how collection can be organised regionally in a most efficient and economical way, which also adheres to the "do no significant harm" principle, requires solutions to be looked at from other regions, which have already taken steps towards this. However, the collection of fishing gear opens a possibility to proceed towards a more circular economy and find ways that the collected materials can be recycled locally and regionally.

The aim of this deliverable report is to provide a summary of a Regional Technology Audit and details on best practices in emerging technologies in relation to reuse and recycling of marine plastics from end-of-life fishing gear.

Acknowledgements

Western Development Commission engaged Mr. Colman McCarthy and Mr. Colum Gibson of the Clean Technology Centre as subcontracted researchers to undertake the primary research underpinning this report. The content that follows substantially reflects the results of that commissioned work.

For more information about the project, visit the website of the project at <https://www.interreg-npa.eu/projects/CIRCNETS/home/>



2

SUMMARY AND CONCLUSIONS



2. SUMMARY AND CONCLUSIONS

This report summarises the regional technology audits of relevant stakeholders in CIRCNETS participating partner countries, Norway, Finland, Ireland, Iceland and Sweden. A survey template was prepared for recyclers of fishing gear containing plastics and a separate survey sent to other stakeholders including fishing gear importers, manufacturers, gear users (fishers and their representative bodies), other plastics manufacturers (already using recycled plastics in their manufacturing processes) and plastic waste recyclers. Responses have been collated by each partner country into those received from companies already involved in recycling fishing gear and also feedback from other stakeholders. In addition, a summary of what is happening in selected other European countries in terms of fishing gear recycling is included in this report. The schematic below summarises the sources and destinations of end-of-life fishing gear and the regional technology audits endeavoured to address those involved across the whole value chain, from producers, to users, EOL collection and recycling/disposal with some closed loop recycling steps along the chain.

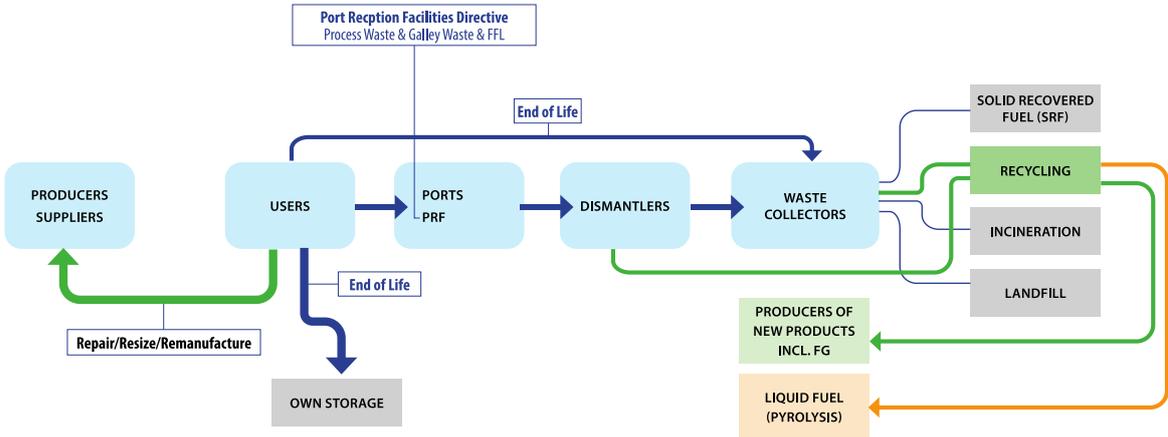


Fig. Schematic showing end-of-life fishing gear destinations

2.1 Summary of Technologies from around Europe

The regional technology audit investigated what are the emerging technologies for advancing end-of-life fishing gear containing plastics reuse and recycling in the CIRCNETS partner countries. The survey reviewed materials collected, processing technologies, tracking, as well as barriers and opportunities. In addition, the activities of other European countries dealing with end-of-life fishing gear were also researched and the following table summarises the different plastics, their sources and the technologies involved. Examples of companies using the relevant technologies are also included. There is a well-established market for recycling Nylon. In addition, other polymers including PE, PP and HDPE are granulated for use in plastics manufacturing but typically for lower value products than that for polyamide (Nylon).

Table: Existing and emerging technologies and products for fishing gear containing plastics

Material	Source(s)	Technology	Examples
Nylon	Monofilament nets	Chemical recycling process to produce polyamide 6.	Aquafil (Slovenia) produce Econyl®. Fil & Fab (France) produce Nylo®.
Nylon	Monofilament nets	Clean, pelletise then 3D print products.	Fishy Filaments- UK
High Density Polyethylene (HDPE)	Oyster bags, mussel barrels/floats	Injection moulding after granulation.	Ørskog Plastindustri (Norway)
HDPE	Floating rings in fish farms	Granulate	Oceanize (Norway)
Polyethylene (PE)	Trawl nets, purse seine nets	Cut and reinforce edge of net. Repurpose as sports nets and trailer nets. Supply material to make bracelets* and necklaces from nets.	Nofir (Norway) BTG Nets† (Ireland)
Polyethylene (PE)	rope	granulate	Oceanize (Norway)
Mixed plastics (PE and PP)	Fishing and aquaculture gear	Pyrolysis to produce oils, waxes and parafins.	Wastewise Group (Finland) Trifol‡ (Ireland) Quantafuel§ (Denmark) Fraunhofer** (Germany)
Polypropylene PP	rope	granulate	Oceanize†† (Norway)

Other materials used in fishing gear include **metals** (steel and lead) and **rubber**. There are established recycling streams for waste metals, and most port reception facilities have scrap metal skips. Combination ropes are more problematic due to the mix of steel or lead and plastic and, for example, in Ireland are not now being accepted by metal recyclers.

* <https://bracenet.net/en-eu>

† <https://btgnets.ie/>

‡ <https://www.trifol.ie/>

§ <https://www.quantafuel.com/skive>

** https://www.umsicht-suro.fraunhofer.de/en/Our_Solution/chemical-recycling.html

†† <https://oceanize.no/en/>

Pyrolysis is an emerging technology in dealing with plastic waste, particularly PE and PP. In the pyrolysis process plastic waste is converted into liquid oil products, paraffins and waxes*. This takes place in a pyrolysis reactor at high temperature in the absence of oxygen. Long-chain plastic polymers are broken down into gaseous, short-chain hydrocarbons from which pyrolysis oil is recovered by condensation. Typically, the non-condensable hydrocarbon gases are utilised as a source of energy in the process. Pyrolysis may offer a solution for combination ropes (lead or steel coated in plastic) by freeing the metal which can then be recycled, UHMWPE ropes (e.g. Dyneema®) or other difficult to recycle fishing gear containing plastic. Pyrolysis may offer a circular economy solution to close the loop on energy and materials† (by non-renewable fossil fuel substitution).

2.2 Best Practice

There are existing well established recycling systems in place for end-of-life fishing and aquaculture gear, for example, Odyssey Innovation in Cornwall, UK‡ Net Regeneration scheme (see figure below).

Odyssey Innovation
www.odysseyinnovation.com

Marine Plastic Recycling Guidelines

WE ACCEPT

polypropylene polyethylene - rigid plastic	plastic bottles and caps	plastic food containers	plastic toys	plastic buoys	plastic drums	floating pontoons	whelk pots (nets and weights removed)	net bins	plastic crates	loose rope (bagged separately and free from contamination)	gill nets (bagged separately from ropes)	net trimmings / fisherman's kisses (if bagged separately)	trawl nets (if stripped of metal and rubber and bagged separately or in a bundle)
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NOT ACCEPTED

rubber	general rubbish	sanitary products, cotton buds	polystyrene	heavily contaminated materials	traps/pots	containers with any contents or contamination inside/outside	glass	fiberglass	metal	lead-lined ropes
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About the Marine Regeneration Scheme

Globally only 8% of plastic waste is recycled, 12% is incinerated, whilst the remaining 78% is either sent to landfill, stockpiled in developing countries or dumped on land or in the marine environment. This is not due to the lack of recyclability but a lack of recycling infrastructure and consumer demand. In 2016, Odyssey Innovation pioneered the UK's first marine litter recycling scheme to counteract this issue. By adopting a circular economy business model we add value to the recovered plastic by creating award-winning sustainable products and by doing so, change the way marine plastic is viewed, 'from waste to resource'. The MRS collaborates with numerous communities across the UK to recycle marine plastic, including plastic recovered via its Paddle For Plastic campaign.

Follow Us @OdysseyInnovation @NetRegeneration @PaddleforPlastic

Fig. Odyssey Innovation Marine Plastic Recycling Guidelines

* <https://www.trifol.ie/eu-plastic2waxlife-project>

† <https://www.sciencedirect.com/science/article/pii/S0959652623001798>

‡ <https://odysseyinnovation.com/pages/net-regeneration>

Project Partner, Sotenäs Marine Recycling Centre (SMRC) was founded in 2018 as part of Symbioscentrum* to support innovation and knowledge in ocean plastics and waste fishing gear reuse and recycling along the whole value chain from product design to materials collection and recycling. Materials accepted and processed by SMRC include PE, PP and nylon from EOL nets, ropes, and pots as well as marine plastics from beach cleans. The Centre has an innovation test bed, TOW, that works with recyclers and manufacturers to explore outlets for recycled polymers.

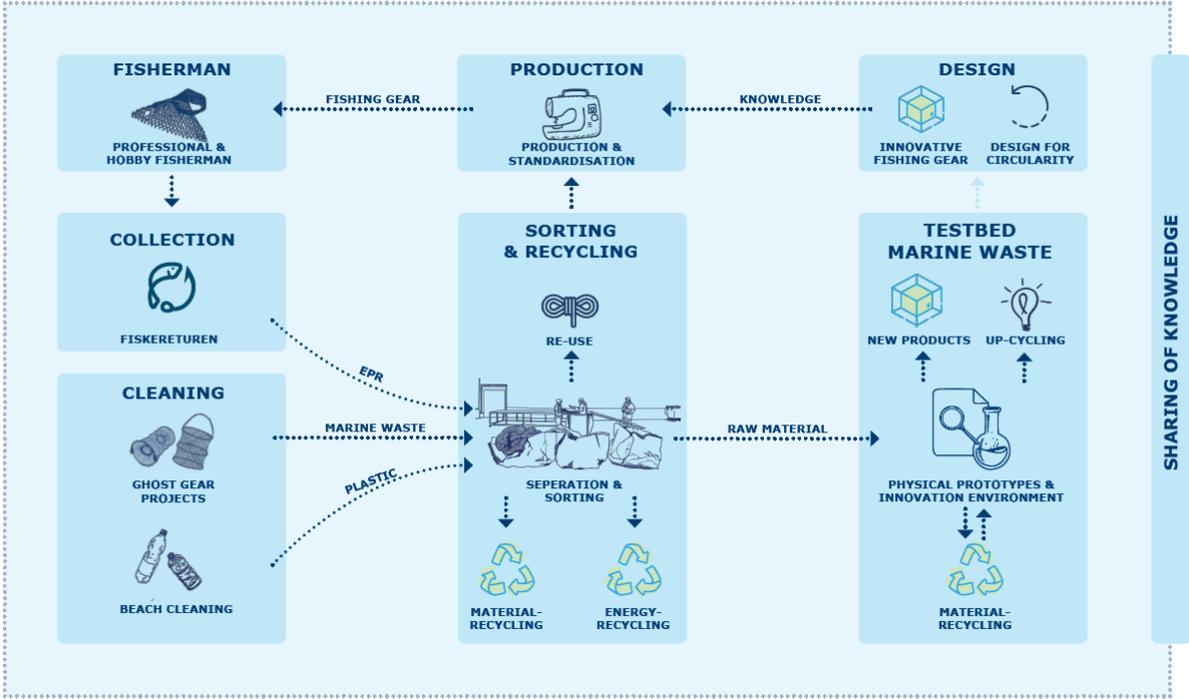


Fig. Flowchart for Sotenäs Marine Recycling Centre (SMRC)

2.3 Reuse

It is common practice to resize nets suitable for smaller inshore vessels. This is done at ports by fishers or returned to local net manufacturers for resizing. Ropes from fishing are also reused as longlines in mussel farming to attach the mussel floats/barrels in lines. A lot of this reuse is ‘informal’ and, considering the implications of the EPR, it will be important that this reuse is formally addressed in the future (for example via Blockchain tracking).

* <http://www.symbioscentrum.se/symbiosisdevelopment.4.63823e331859e02e4ce1b618.html>



Photo: Mussel farm in Kenmare Bay, Ireland using ropes from fishing to tether mussel floats

Rubber discs used in trawls can be reused ('as is' or after reshaping if worn flat by the ocean floor) or shredded at end of life (for use as rubber crumb in playgrounds, artificial playing pitches and in some countries in construction (Finland^{*}). Rubber floats can also be stripped from nets and reused if undamaged. Trawl doors (steel) and chains can also be used many times over when nets are retired.

2.4 Barriers to Fishing Gear Plastics Recycling

2.4.1 Logistics

Logistics is repeatedly highlighted as a major barrier across nearly all countries. Companies emphasised that proximity to the source for sorting and compacting is key. Logistics is a reoccurring cost concern, especially with scattered collection points nationally with ports typically in isolated and poorly serviced areas. L&T, PlastEco (Finland) and Novoplast (Sweden) also flagged transport cost as a crucial barrier, especially due to the light weight of plastics making it economically inefficient to transport over long distances. This is because light weight leads to low density, requiring more space which increases shipping costs.

2.4.2 Contamination and Mixed Materials

Contamination is another common issue identified by all companies. Contamination due to marine based materials (e.g., sand, salt, fish debris) as well as contamination of materials (e.g. mixed materials like metals, ropes, seams) is a major processing challenge. Preparing cross contaminated gear for further processing needs to be carried out by people with knowledge specific to the industry which is why segregation into constituent material streams as close to source is ideal. Additionally, contaminated gear, or the gear in general, is hard on the processing equipment by virtue to the durability implicit in its construction. In this regard,

^{*} <https://www.wastewise.fi/mekaaninen-kasittely/>

WasteWise (Finland) highlighted poor product design as a problem with some materials (e.g. plastics that are laminated) not having an alternative option once segregated.

2.4.3 Traceability & Tracking Systems

While some companies are piloting or using blockchain (e.g., Empower AS in Norway, Verifact in Ireland), many others still rely on manual batch tracking or basic enterprise resource planning (ERP) systems. Lack of standardised, transparent tracking systems limits trust and marketability for recycled materials.

2.4.4 Lack of Investment & High Capital Costs

This is especially prominent in Ireland and Sweden, where respondents cited the cost of equipment like shredders, extruders, and transport tools as a significant barrier. For example, IFF Plastics estimated that between €95k – €110k would be needed for a shredder alone, excluding the generator and transport. While many processors in these countries already have this type of equipment it is largely for softer plastics and, due to the inherent durability of EOL gear, additional investments are required. Additionally, due to the lack of certainty in terms of volumes of materials available each year, and the future trends within the industry, plastics recyclers are reluctant to make these investments at this moment in time.

2.4.5 Inconsistent Supply & Volume

Oceanize (Norway) and others pointed out the difficulty in securing long term contracts for material supply, making it hard to invest confidently in infrastructure. Many companies also pointed out that getting reasonable volumes of fishing gear was a problem.

2.5 Opportunities in Fishing Gear Plastics Recycling

2.5.1 Track and Trace Innovations

Companies such as Ogoori AS (Norway) and IFF Plastics (Ireland) are exploring blockchain solutions to create a traceable chain of custody. Novelplast (Ireland) used Net360 by Verifact to track materials, enabling higher-value applications by proving sourcing. Digital product passports are another approach available to verify the origin and increase the potential value of recyclable materials.

2.5.2 Telling the Story

An emerging opportunity is the ability to tell the story of recycled materials. Brands can gain a competitive edge by highlighting that their product is made from recycled fishing gear, this strengthens their brand image and increases the perceived value of the product. When supported by a traceability tool like blockchain the storytelling is especially effective.

2.5.3 Product Development & Circular Design

Ørskog Plastindustri (Norway) and IFF Plastics (Ireland) are already using local supplies of recycled plastics to manufacture products like fence posts, construction materials, and boxes. Polar Fishing Gear (Iceland) developed recyclable fishing doors (from fishing nets), while another company mentioned developing products for circular material flows with a lifespan of 100 years.

2.5.4 Chemical Recycling

Companies have been using chemical recycling (pyrolysis) for hard to recycle waste streams for a while and this route is now being explored more widely. Oceanize (Norway) also cited chemical recycling as a future opportunity, pending equipment and process development.

2.5.5 High Value Recycled Applications

Fishy Filaments (UK) and Fil & Fab (France) transform nets into 3D printing filament and Nylo® pellets respectively. Aquafil (Italy) processes PA6 nets into Econyl® for textiles, showing the potential for international markets and branding. Ecoalf (Spain) uses marine litter in clothing. These are products made from recycled gear but are very high value.



3

TECHNOLOGY AUDIT SURVEY RESPONSES



3 TECHNOLOGY AUDIT SURVEY RESPONSES

The following section outlines the responses from the individual partner countries to the Technology Audit Survey. Two separate survey templates were prepared, one for fishing gear recyclers and one for other stakeholders including plastics recyclers, gear manufacturers, manufacturers using recycled plastics in their products and fishers (and their representative bodies).

3.1 Norway

3.1.1 Fishing Gear Plastics Recyclers

There were two responses from 39 companies contacted. The respondents were Ogoori AS (a non-profit organisation that focus on cleaning up and sorting plastics) and Oceanize (a sorting and recycling facility for plastics from the fishing and aquaculture industries). Both companies responded that they collect, store, clean, macerate, dry, pelletize, package and warehouse waste plastic.

The materials both companies seem to be handling are PP, PE and high-density Polyethylene (HDPE). Tonnes per year of the most dominant fraction is 3,000 tonnes.

Ogoori AS

Ogoori AS operates across Europe and has handled approximately 50 tonnes of accumulated plastic waste between 2020 and 2025. The company has no facilities; they only receive collected plastic from volunteer beach cleaners and then sort it. From the webpage there seems to be three employees and three board members, who also seem to have an active role in the running of the organization.

In terms of **innovations**, to improve the process of plastic recycling, Ogoori identified logistics as the primary cost driver, and they see a great room for efficiency improvements here. The company collaborates with Clean Oceans Business Cluster to address these challenges. As a **barrier**, logistics is repeatedly mentioned, with particular emphasis on the benefits of sorting and compacting plastic waste near the source of collection. To track the materials, they use blockchain technology provided by Empower AS.

To **support plastic recycling**, they suggested imposing a fee on virgin plastics. The “**hotspots**” mentioned to prevent recycling were logistics costs again. They currently produce only pellets but have customers that request flakes.

Both companies have responded that they collect, store, clean, mark, dry, pelletise, package and warehouse although in the next questions they point out that they only sort plastic waste themselves. The rest of the process is carried out by partners (e.g. wash, dry, pelletise).

The materials both companies seem to be handling are PP, PE and high-density Polyethylene (HDPE). The dominant fraction is HDPE and PP the second largest fraction, but no numbers (tonnes/year) were given.

An **opportunity** identified is the potential for integrating recycled raw materials (i.e., recycled beach litter) into consumer products. They see a growing interest for this. They do not see any significant opportunities for recycling that they have not pursued.

Oceanize AS

This company covers Norway and has handled a total of 10,000 tonnes of plastic waste (from different sources). The company runs one site in Norway and employs 30 staff.

The **opportunities** they see in terms of plastic recycling include the establishment of specialized sorting and mechanical recycling systems. With regard to significant opportunities for recycling, they mentioned chemical recycling. When it comes to **innovations** that could improve the process, they did not mention any specific examples but noted that various types of recycling equipment are available and could be tested. They find it difficult to source specialized equipment. When asked about the adoption of innovative technologies, Oceanize indicated that they use some but did not provide further details. They produce pellets and send sorted waste to other recyclers.

The most important **barriers** include the complexity of materials in fishing gear: too many materials are mixed in the products. For instance, the products have ropes, seams and straps that are made of different materials that cannot be recycled together. In addition, it is difficult to get information about the products. When it comes to business, it is difficult to get binding long-term agreements for collection, which makes it difficult to guarantee the outgoing volume of granulate. Oceanize do not use blockchain for tracking, but digital batch tracking with manual registrations.

When it comes to what can be done to **support plastic recycling**, they noted that they are expecting improvement with the implementation of EPR and also hope that manufacturers will utilise the EU Eco-design Regulation and produce recyclable products. The “hotspots” to prevent recycling are separation, planning, confidentiality from manufacturers to material content.

3.1.2 Other Stakeholders

A total of six responses were received from a diverse group of stakeholders: Ørskog Plastindustri AS, Norges Fishermen Organisation, E.Karstensen/Marø Havbruk, Frøystad Finnsnes AS, Plasto AS*, Flokenes Fishfarm AS). Ørskog Plast and Plasto make new products out of recycled fishing gear made of plastic, there are two fish farms (Flokenes and Marø), one fishing equipment manufacturer (Frøystad) and one organisation representing the fishers.

They all operate in Norway. Three reported nationwide coverage, while one operates in the northern part of the country. Only three of the respondents handle fishing equipment and they

* <https://plasto.no/en>

handle between 100 and 250 tonnes. With regard to the total estimated volume of fishing equipment handled in their area, five were unsure and one estimated approximately 5,000 tonnes. When it comes to the number of facilities they have, only two respondents answered and noted that they have two and four facilities. Facility sizes appear modest, with reported employee numbers ranging between 3 to 14. None of the respondents have any facilities outside of Norway.

With regard to the **processes** they are involved, only one responded saying their firm is involved in a number of process steps, which included collection, storage and cleaning. Two answered that they are involved in processing plastic into products, while one is involved in the production of salmon. When asked about relevant processes they are involved in, two answered that they produce fish/salmon, one reported using plastic granulates to make plastic products mainly for the building industry, one carries out injection moulding and another collects ropes and other fish equipment.

When it comes to **material handled** for two companies it is irrelevant, four stated they handle PE and high-density polyethylene, three answered that they handle Nylon (PA) and mixed plastic and 2 that they handle PP and metals, and finally one answered polyethylene terephthalate (PET). With regards to volume it varies a lot, two were uncertain, and one responded 250 tons (a lot of which goes into landfill). Another answered 1.5 tonnes of mainly worn-out ropes, one answered hundreds of tons, and one answered large aquaculture cages, but did not quantify volume.

When asked about **type of equipment**, three answered uncertain or not relevant, and three answered ropes and one respondent each identified, monofilament nets, trawl nets, crab and lobster cages, metals, floats and large cages (for aquaculture).

Stakeholders Identified the **EPR** as a key opportunity for improving the recycling of fishing gear. One stated that they send their nets and ropes to Nofir and their metal waste for recycling. Two respondents reported that they try to recycle as much as possible, despite higher costs. Another noted they send their waste to Senja Waste Handling, while one company (likely Plasto) mentioned developing products for circular material flows with a lifespan of 100 years.

When asked about **recycling methods they have not yet implemented**, most either said no, deferred to Senja Waste Handling or reiterated the importance of EPR. One mentioned fish feeding pipes as a recyclable stream but noted the volume is too small to justify sending it for proper recycling. Oceanize, however may be able to handle larger volumes through its partnerships with aquaculture companies.

When asked about their **knowledge of innovations** to improve the recycling of fishing gear, most had no input. One mentioned the initiatives “In the Same Boat” and “Profa,” which are working towards becoming a producer responsibility company. They also referenced a company in the north that recycles nets, ropes, metals, and feeding pipes, although the company was not named. None of them use any such innovations.

Barriers to proper recycling of fishing gear mentioned are: high recycling costs, bureaucratic challenges and taxation, inadequate logistics between ships and recycling facilities, transport, low standardisation of materials, market acceptance, and regulations and standards.

Regarding **material tracking**, three out of six stated they do not track materials or considered it not relevant to their operations. The other three answered that they put their company name on the equipment so that it can be returned if found. They also use batch documentation, and a programme called Selstadlog.

To **incentivise recycling**, three suggested that the state should provide grants or financial aid to make recycling more economically viable, introduce a deposit return system (like for bottles), and the use of more recycling-friendly materials.

Only one respondent identified a specific “hotspot” **barrier**: material quality and accessibility. Two respondents reported using recycled pellets in their production processes (Ørskog plast and Plasto). The rest stated that it is not relevant to them.

Nofir

Although they did not participate in the survey, Nofir*, headquartered in Bodo, Norway, but partly owned by Italian Aquafil (32%) is a leading company in the collection and recycling of discarded equipment from the fishing industry. Nofir handles a variety of materials, including fish farming nets, purse seine nets, tarpaulins, fish cleaning shelters, trawl nets, gill nets, ropes, and sludge. Nofir has processing facilities in Lithuania and Turkey, where collected gear is dismantled, cleaned, and sorted for recycling. It is then sent to their recycling partners to make a base (filaments or granules) for brand new products.

3.2 Ireland

A total of 40 companies were contacted by telephone and email. Six surveys were completed. A small number of additional companies did not formally participate in the surveys but provided some insight into their relevant experience of the sector during the follow up telephone calls.

3.2.1 Fishing Gear Plastics Recyclers

IFF Plastics Ltd

IFF Plastics Ltd, based in Country Clare on Ireland’s west coast, is a farm plastics waste recycler and a manufacturer of plastic fence post and rails. The company processes approximately 800-900 tonnes of farm plastic waste annually. It holds a permit to store up to 50k tonnes of waste onsite and collects plastic waste from farms under the IFFPG† scheme. Some clean silage bale wrap is exported for recycling under a Green List TFS (transfrontier shipment) permit. Most of the farm plastics they process are baled and exported under green

* <https://nofir.no/>

† <https://farmplastics.ie/>

list. Other plastics are processed into fence posts and rails for Irish Rail (800-900 t.p.a.). A typical 14kg post stake contains c. 5% HDPE for strength, with the rest made from LDPE.

The company's injection moulding process uses a mix of PE (c.800 tonnes LLDPE bags and LDPE), PP (c. 100 tonnes of 500kg manure bags) and HDPE (c. 100 tonnes of 5-gallon drums).

In terms of **opportunities implemented**, IFF Plastics has carried out trials using plastic waste streams from the fishing and aquaculture sectors. For example, they produced oyster poles from recycled oyster bags, noting that improved cleaning of the contaminated bags results in higher quality end products. They have also designed an automated baler for bale silage covers for export and has plans to upgrade processing capabilities if additional materials become available.

In terms of **opportunities identified but not implemented**, initial trials revealed a need for a shredder capable of processing trawl nets and ropes, which are too durable for the company's current equipment. Estimated investment required €95-110k for the shredder, excluding the cost of a 300 kVA generator (e.g. Ulster Shredder). Other equipment needed include a second hand Palfinger crane (€15-18k + VAT), a log grab with rotator (€5.5-7.5k), and a Skelly trailer suitable for container or step frame trailer lower to ground.

Potential applications for recycled PE nets include cargo nets (for skips and trucks), nets for behind goals in field sports and silage pit nets. The expertise of fishers could be used to cut nets to smaller sizes and fix ropes to outsides. There is also an opportunity to produce plastic lumber for benches, boxes (e.g. circular product for net storage boxes on piers), for import substitution. This could be financially supported to provide local employment.

Innovation that can assist with/improve collection systems/recyclability/processing:

The company has piloted blockchain-based **track and trace**, in collaboration with Verifact, for regional EOL gear collections. This system involves a truck that returns waste to a shed for onsite sorting. A twin-shaft primary shredder is required as well. While LDPE can be processed via sink-float separation, HDPE may require a separate production line. Innovation has been implemented on a pilot basis, for example producing oyster tether poles for BIM. IFF Plastics also developed a custom machine from repurposed components (e.g., paper pulper, harvester and digger track motors), powered by a mini digger, allowing a mobile deployment at ports for local use.

Regarding barriers, lack of funding remains the biggest challenge, especially given IFFG's operational model, which is based on a certain volume throughput each day. The recycling of fishing and aquaculture plastics requires a massive investment, time, and experimentation. Very few people have the skills required to incorporate these materials into existing processes. Volumes of suitable materials are low and though HDPE is valuable, likewise PET, limited supplies due to low population and sector size in Ireland are important factors. Contamination is another important issue and again requires trial and testing to refine.

Farm plastics traceability is maintained via a Log of farmers name, herd no., plastic collected, weighed on truck, record on excel sheet, material type, and is all recorded in an Annual

Environmental Report. A similar system for EOL gear would facilitate the story element of their products.

IFF Plastics highlighted that no “one-size-fits-all” solution exists. Equipment must be modified to handle different feed types. Wiema Germany, Ulster shredders (higher power requirement than German equipment) are the main plastics shredder suppliers. Cost of extruder €300-400k.

Hotspots identified: twin shaft shredder required for initial size reduction. IFF Plastics noted that the Repak fee payment system in Ireland supports collectors of plastic (waste management companies) not plastics recyclers/manufacturers.

3.2.2 Other Stakeholders

Novelplast

The company processes 24,000 tonnes of PET plastic waste into pellets annually at their licensed waste facility in Navan, Co. Meath (Permit no. WFP-MH-21-0010-01).

Several years ago, the company explored the potential market for recycling fishing gear. In collaboration with Verifact, Novelplast sourced materials from Greencastle and tracked them through a recovery process to assess whether there was a high-value market could be accessed. They previously utilized Net 360 by Verifact to support **traceability**. According to Novelplast, tracking of the materials and verified sourcing is essential to attract premium buyers in high value products, which is the only way to make recycling economically viable at scale.

While there is significant international **market potential** for recycled fishing gear, current barriers include the lack of collection and segregation into individual materials, which prevents sector growth. In terms of collection, proper segregation into individual plastic materials as close to source as possible is needed. There is plenty of technology already out there to support this sector and the use of EOL materials. Therefore, what is missing is a structured, source-streamed collection system, which must precede any substantial businesses investment.

Government support, especially in the form of grants and structured **funding**, is necessary to establish a functioning system under the EPR framework. Novelplast advocates that early-stage funding is essential to get a proper system in place that can leverage the 1,000 tonnes of EOL fishing gear produced annually. Due to the small volume, the material must be processed into high-value products (e.g. clothing) to ensure economic viability.

Hotspots are a lack of material segregation and clean single source streams.

Obru Plastics Limited T/A Thormac

Obru Plastics is a contract injection moulding company based in Co. Clare. Their products are developed using 80% single-sourced recycled plastic. The company is actively working to adopt bioplastics and increase the use of recycled polymers in their processes. They currently process around 3.3 tonnes of polymer annually, generating less than 5% waste, all of which is recycled.

Their plastic waste is sent to Clean Ireland instead of using it in-house. Obru Plastics notes that integrating recycled material into, for instance, medical product is currently infeasible due to stringent quality requirements. However, with access to grant funding, they could invest in a new machine (estimated at €500,000) capable of incorporating recycled material into their manufacturing processes, facilitating closed-loop reuse.

In terms of **traceability**, the company uses an ERP system. Blockchain technology is not currently viable or appropriate for their operations.

3.3 Finland

The survey was sent to 11 plastic recyclers in Finland, but only three responded, despite follow-up reminders.

The recyclers that replied were L&T (Lassila & Tikanoja, a large waste management and recycling company operating one mechanical plastic recycling centre), PlastEco (a startup with a chemical plastic recycling centre which started operating in 2025), and WasteWise Group (chemical plastic recycling centre).

Of the three, L&T provided the most comprehensive information about their operations. In contrast, PlastEco and WasteWise Group answered only a few of the open questions.

3.3.1 Fishing Gear Plastics Recyclers

L&T (Lassila & Tikanoja)

L&T operates a mechanical plastic recycling centre in Merikarvia, located on the west coast of Finland. The facility has the capacity to process 20,000 tonnes of plastic annually and presents 30 employees. L&T stores, washes (washing line with water treatment), shreds (with two different size pre shredders), and dries (as a part of the washing process) plastic waste. They also produce pellets using three separate extruder lines and one line for creating powder from granulates. Finally, the final recycled product is stored in the warehouse. In recent years, besides the traditional buying of plastic waste, processing it to pellets and then selling these pellets forward, L&T has also started to sell a service where they process customer’s plastic waste into pellets and send the pellets back to the customer (the customer owns the plastic throughout the process and only pays for the service). This is, however, not the core activity of L&T.

They handle the following volumes:

Plastic type	Volume (tonnes)
PA	<100
PP	>2000
PE	>2000
HDPE	> 800
PET	0-50
EPS and PS	>100
Other plastics	>200

Sources for all of these are industrial reject plastics (production quality issues etc.) which are separately collected. With PA and PET, the company does not process those materials, they only collect and sell them. In recent years they have also started to process plastic waste from construction sites and retail sector (but they still do not process municipal waste).

Plastic type	Volume (tonnes)	Processing
PA	<100	Collected only
PP	>2000	Processed
PE	>2000	Processed
HDPE	> 800	Processed
....

In terms of significant **opportunities**, the company is actively seeking innovative solutions to improve the consistency of recycled granulates. One promising initiative involves a significant collection of EPS fish boxes from fish refineries. These are transferred to their plastic recycling centre, processed into pellets, and used in the manufacture of insulation sheets. Other similar pilot projects are currently early development stages.

The company identifies several key **barriers** to scaling plastic recycling. The main challenge lies on public and industry attitude towards plastics and recycling in general. Lack of material purity also results a barrier, since it is difficult to get **non multilayer plastics** in their own collections and without any impurities such as metal, cardboard or paper. Another challenge is related to getting **reasonable sized** collections. Since plastic is relatively light, transportation costs are usually too high to make it financially viable.

Regarding their **material tracking**, L&T uses a custom-tailored ERP system to track the incoming material waste, processed products and every step in between those. They can also track the sold pellets back to the material, allowing full traceability by matching individual batches of pellets back to their original waste source and the operator responsible for their processing.

L&T recommends the implementation of mandatory percentage of recycled material in new plastic products, with regulatory oversight to ensure compliance. This could significantly boost demand for recycled plastic materials.

Hotspots that prevent L&T from recycling some materials are the ones already mentioned. Firstly, contamination is one of the biggest cases of turning down offers to recycle some plastics. There can be problems with metals, especially the ones that cannot be collected via a magnet (stainless steel, aluminium), and plastics that have gathered big amounts of sand or soil so they always require a washing and the fact that they are so durable and hard on the knives of extruders and shredders. Secondly, transportation cost and effectiveness are almost always a big yes or no, because plastic tends to be light and might be difficultly sized for transportation. The waste is transported via trucks since the amounts are small (and railway network is limited). Plastics are light and take up space which raises the transportation costs

since, the max transportation capacity is not used. Separating and crushing the plastics in the collection points could help with this.

3.3.2 Other Stakeholders

PlastEco Ltd

PlastEco has launched a new chemical plastic recycling plant in Lahti, southern Finland, scheduled to begin operations in April 2025. The plant is designed to process 1,650 tonnes of plastic annually and will operate with a team of two employees. The processed plastic is converted into plastic oil, which serves as a feedstock for the petrochemical industry.

PlastEco's operations include storage, shredding and drying plastic waste streams. Future plans involve developing pellet production and processing those pellets into new products. The facility handles PP, PE, and HDPE, all coming from municipal waste. The sorting of these plastics from the municipal waste is done by Salpakierto Ltd (public waste management company owned by nine municipalities). Once separated, the plastic is chemically recycled by PlastEco.

Significant **opportunities** in recycling that they have identified are industrial waste and agricultural waste, while the main **barrier** of plastic recycling is the pre-handling of waste for pyrolysis. PlastEco emphasizes the importance of both technical assistance and regulatory backing to scale plastic recycling efforts. A **hotspot** that prevents PlastEco from recycling certain waste streams is the material quality.

WasteWise Group

WasteWise Group operates a chemical plastic recycling centre in Nokia, southern Finland. The facility has the capacity to process 8,000 tonnes of plastic per year and has 15 employees. The company carries out the collection, storage and shredding of plastic waste. The shredded product is then processed into new products and packaged. They handle a wide range of materials including PA, PP, PE, HDPE and PET. WasteWise is also planning to recycle rubber in the future. The company has ISCC Plus certification. The material they process becomes pyrolysis oil which is used to substitute fossil fuels in production of new plastics.

A significant **opportunity** the company has implemented is the chemical recycling of hard-to-recycle plastic waste. However, the main **barrier** the company sees in plastic recycling is that consumers cannot sort plastic waste other than packaging waste. In addition, poor product design that does not support recycling (e.g., lamination of several materials into non-separable format) can also prevent plastic recycling.

3.4 Sweden

3.4.1 Fishing Gear Plastics Recyclers

Out of a sample of ten plastic recyclers contacted in Sweden, only one response was received (i.e., Novoplast AB) despite a follow-up reminder two weeks later.

Novoplast AB

Novoplast is a well-established player in the Nordic plastic industry, specializing in customized recycled materials and services sourced from various industrial waste streams. In close collaboration with their customers, Novoplast processes industrial plastic waste, using advanced processing technologies, into high-quality regranulates and ground material. These materials are then reused as raw inputs in a wide range of manufacturing processes. Novoplast operates across the Nordics and Baltics, with two facilities and employs 25 people in total. The total volume of accumulated plastic waste handled is 5,083 tonnes.

Novoplast has been a pioneer in several areas of plastic recycling:

- 2019: Introduced plastic pipe recycling
- 2021: First in Sweden to invest in dry washing of plastic film
- 2023: Developed recycling methods for labels made from PET bottles
- 2024: Recycling of plastic pallets used in Swedish grocery supply chains

The company primarily produces plastic pellets but also supplies flakes. They maintain close partnerships with customers who use these materials in the production of end products.

Novoplast's in-house processes include washing, shredding, drying, and pelletizing. Other processes such as segregation, collection and storage, are handled by suppliers. The transformation of granulates into final products, including packaging and warehousing, is carried out by customers.

In terms of materials, they process:

Materials processed
PA (20 tonnes) from engineering plastics
PP (500 tonnes) as their third-largest fraction
HDPE (2,500 tonnes) and PE (2,000 tonnes) as the dominant fractions
UHMWPE, PET, and EPS (one tonne each)
Approximately 60 tonnes of other plastics (including PC, ABS, PBT, TPE, TPU, etc.)

Novoplast sees a major **opportunity** in solving the odour issues associated with HDPE. In 2019, they conducted trials using HDPE from the fishing industry but abandoned the initiative due to market conditions and technical problems with odour. Since then, market conditions have improved, and they have found ways to address this issue.

Regarding **innovations**, Novoplast continuously refine and optimize their processing steps to reduce problems. As for **barriers**, they mention the limited access to large processing volumes in Sweden. Most of the material collected through EPR schemes is exported.

Material traceability is done through a batch identification system in which every tonne of incoming and outgoing material is registered in a business system. Materials are physically tagged with paper labels for complete traceability.

To **support plastic recycling**, Novoplast advocates for grants and regulatory support. Co-investment opportunities are also highlighted, as capital expenditure for washing and pelletizing equipment is very high. Their equipment is primarily suitable for PE and PP; for other materials, they must collaborate with external partners.

3.5 Other Stakeholders

Three responses were received from FF Norden, Båtskroten, and the Marine Recycling Centre (MÅVC). All three organizations operate within a system designed to address marine waste from used fishing gear in Sweden.

- **FF Norden** is one of the few remaining net producers in Sweden and works with innovation in sustainable fishing gear and related technologies.
- **Båtskroten** is a collector of EOL ALDFG.

- **MÅVC** is a recycling centre that receives, separates, shreds, and packs materials. They collaborate with producers of recycled plastics and operate a testbed for innovative projects.

Volumes and Operations

In terms of estimated annual volumes of fishing equipment handled:

- MÅVC: approx. 120–180 tonnes
- Båtskroten: approx. 90 tonnes
- FF Norden: approx. 2 tonnes

Each respondent reported having between one and three facilities, with staff ranging from three to seven employees per facility. None of the facilities operate abroad.

Regarding their involvement in the recycling process:

- All three are engaged in collecting and storage.
- One is also involved in shredding and packing.
- Two operate warehousing functions.

Material-wise, respondents reported handling:

- Nets from Nylon (PA) and PE
- Braided twines from PET/Polyester
- Mixed plastics used in floats
- One handles all mentioned materials except UHMWPE, which none use
- One noted that metal is the heaviest fraction, while PA and PE dominate by volume
- One reported handling all fractions except UHMWPE but did not specify tonnage

Types of Equipment and Accepted Materials

Two respondents accept all gear types except oyster bags. One specified trawl nets, ropes, crab/lobster cages, metals, rubber, and floats.

Opportunities and Innovation

Opportunities identified include:

- Increased collaboration between actors

- Automation of the sorting process
- Finding recyclers for rubber
- Addressing the financial challenges in recycled plastic markets
- Implementation of hot-water washing for pre-sorting
- Measures implemented in environmental and transport studies

On innovations:

- Two had no input
- One mentioned projects on fishing gear design and recyclability, as well as studies on transport systems and environmental impact

Barriers to Fishing Gear Recycling

The following barriers were identified:

- Financial challenges with recycled plastic
- Low volumes of material
- Lack of plastic recyclers for fishing gear in Sweden
- Absence of long-term financial support
- Insufficient communication/dialogue with authorities
- High costs for attended collection points and organized pickups
- Logistics challenges (e.g. using appropriate carriers)
- Mixed quality of material due to salt and water exposure

Regarding traceability:

- One respondent tracks material using an Excel file with data on incoming material, sorted fractions, incinerated and recycled amounts
- Two did not answer the question

Recommendations

All respondents called for:

- Financial support from the government

- Technical and regulatory support
- Standardization of fishing gear (to simplify sorting and recycling of EOL-products)
- Market development for recycled materials

Hotspots and challenges were further identified in areas such as permitting, planning, transport, and technical capacity. Financial constraints, material quality, and sorting issues remain key barriers.

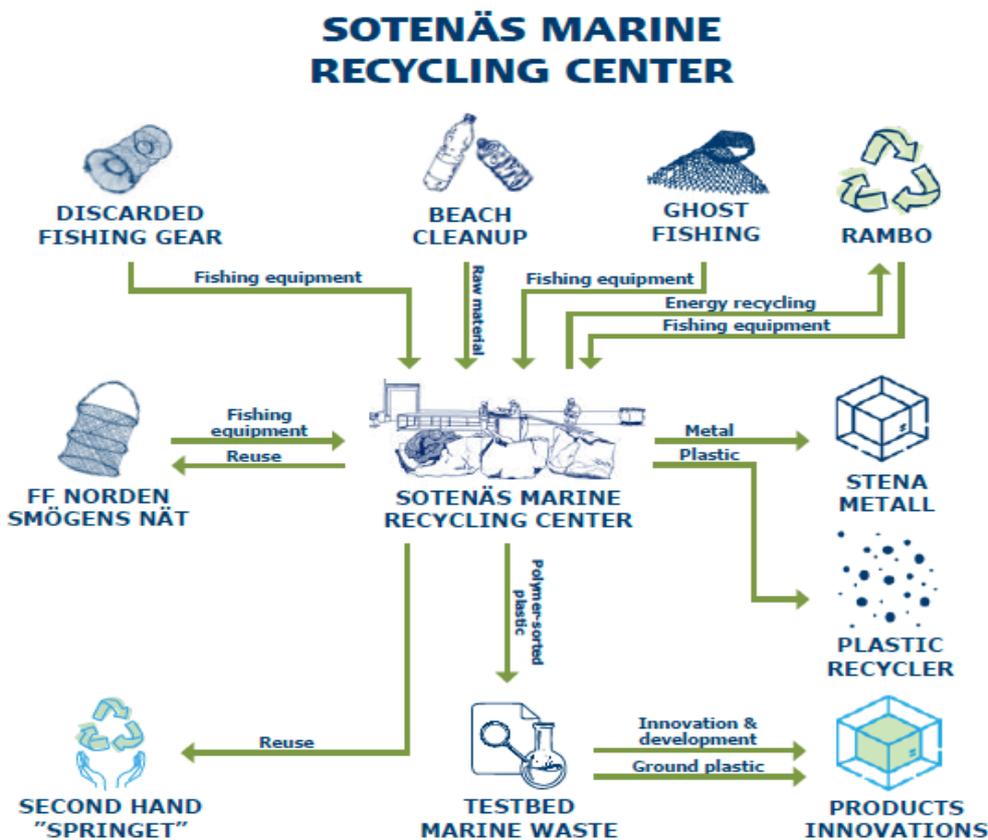


Fig. Flowchart for SMR material supply chain

3.6 Iceland

Polar Fishing Gear

Polar Fishing gear is based in Reykjavík, Iceland. They designed the Pluto fishing doors*; these are trawl doors designed to minimise environmental impact. They are made from recycled plastic and are fully recyclable at the end of their lifecycle.

The doors have Mar Eco branding on them, this refers to Marine Ecological Solutions (CIRCNETS project partner), who support sustainable fisheries by improving fishing gear technology and to restore biodiversity.

* <https://polardoors.com/>



4

EOL FISHING GEAR RECYCLING IN OTHER EUROPEAN COUNTRIES



4 FISHING GEAR RECYCLING IN OTHER EUROPEAN COUNTRIES

This chapter provides an overview of fishing gear recycling in selected countries in Europe.

4.1 United Kingdom

Fishy Filaments - Cornwall

Fishy Filaments*, based in Cornwall, takes mono-filament nylon netting from end-of-life retired fishing gear that has been used for around 6 months by fishers in Cornwall. They are routinely swapped out because their surfaces become cloudy with age due to wear and the build-up of an algal biofilm. With time and repeated use eventually, the fish can sense them in the water and avoid them. Once they are retired, Fishy Filaments collect the material and transform it into a new product suitable for 3D printing.

Odyssey Innovations – Southwest England and Wales

Odyssey Innovation† are involved in recycling marine plastics, including end of life fishing gear. The company collects discarded nets and marine litter from various harbours and beach cleans in the Southwest of England. They are solely focused on processing marine plastic debris and fishing gear. HDPE, PP and PET are amongst the most common forms. These materials are then processed into plastic pellets, which are used to manufacture products like kayaks. This has been done in the past by Plastix, a Danish company.

Keep Britain Tidy – across UK

Keep Britain Tidy's Ocean Recovery Project‡, managed by Neil Hembrow, coordinates beach clean ups and recycling initiatives across the UK. The project aims to recover and recycle litter from coastal clean ups. They helped develop the first UK system for processing fishing trawl nets. Giant nets recovered from fishing harbours, beaches and are transported to a recycling partner, Milspeed, where they are processed into recycled plastic pellets. These pellets are then used in UK manufacturing, including as components in shoe production, creating a circular solution that gives marine litter a new life in commercial products.

Milspeed

MILGUARD OCEAN C™ (patent pending) is an innovative next-generation filmic counter material designed for use in shoe manufacturing. It features a unique polymer blend that incorporates reprocessed plastics, including end-of-life fishing nets, providing stiffness, shape and comfort when used as a shoe component.

* <https://fishyfilaments.com/>

† <https://odysseyinnovation.com/>

‡ <https://www.keepbritaintidy.org/>

The product is made with an extruded copolymer core, laminated on both sides with polyester non-woven fabric, and coated with an exclusive lower activating EVA based hot melt adhesive. MILGUARD OCEAN C™ contains up to 65% recycled plastic, including reprocessed EOL fishing nets as part of the mixture.

4.2 France

Fil & Fab - Brest

Fil & Fab*, based in Brest, has evolved from a regional pilot project into a much larger organisation. The company focuses only on retired monofilament/nylon nets. Their main product, a pellet called Nylo is 100% recycled polyamide 6, made from discarded fishing nets. Initially focused on Brittany, Fil & Fab has expanded its operations to cover 40 harbours in 4 regions of France and collect nets from over 200 fishers. Fil & Fab has developed a technique to transform Nylo into plastic sheets, which are then used to create a series of new plastic products.

4.3 Italy

Aquafil - Arco

Aquafil†, headquartered in Arco, Italy produce Econyl which is made from different types of nylon waste (polyamide 6) including retired/end-of-life polyamide fishing nets. This is done in their processing and recycling plant based in Slovenia. Aquafil sources nylon waste globally, collaborating with various organizations to collect discarded fishing nets and other nylon materials.

4.4 Denmark

Plastix

Plastix‡, based in Lemvig, Denmark is a clean-technology recycling company. Plastix receives components from end-of-life fishing gear from harbours, waste collectors and fisheries, as well as offcuts from netting and rope producers. They take these after non-recyclable elements have been removed. Plastix specialise in converting end of life maritime plastic waste such as nets and ropes into high quality materials called Green Plastics which are high quality pellets that can be used to make new products.

* <https://www.fil-et-fab.fr/>

† <https://www.aquafil.com/>

‡ <https://plastixglobal.com/>

4.5 Spain

Ecoalf

Ecoalf's* main project is Upcycling the Oceans. The project partners deal directly with fishermen to recover marine waste. The project started in Spain but has since expanded to Thailand, Greece, Italy, France, and Egypt. It involves 4,000 fishermen across 72 ports collecting PET bottles and discarded nylon nets. The waste is transported to treatment plants for classification and is then recycled. PET plastic is transformed into polyester yarn and fishing nets are turned into nylon yarn. Since its inception Spain has recovered 850 tonnes of marine litter.

4.6 Other Projects

Blue Point

The Blue Point Project† is an initiative aimed at addressing marine plastic pollution by promoting sustainable and circular solutions. There are countries involved such as Ireland, Spain, Portugal, and France including governments and universities, in Ireland's case, ATU Sligo and UL are involved.

PLAST4H2‡

PLAST4H2‡ seeks to establish a transnational network to combat plastic pollution by converting plastic waste into hydrogen and other valuable products. Some of their objectives include, developing a pilot mobile app for early detection of floating plastics in the Atlantic, deploy a pilot boat for efficient plastic waste collection, develop a pyrolysis plant for plastic valorisation into syngas/hydrogen, and construct a pilot for hydrogen purification coupled to a fuel cell system. It is co funded by the European Union and has an Irish partner, TUS Athlone.

* <https://ecoalf.com/>

† <https://www.bluepointproject.eu/>

‡ <https://plast4h2.com/>

circnets

Improving the management of end-of-life fishing gear

Blue Circular Nets (CIRCNETS) supports collection, treatment and recycling of fishing gear, so that these end-of-life nets are disposed appropriately, and they will not end up in seas and degrade the marine environment.

interreg-npa.eu/projects/circnets/



OLLSCOIL NA GAILLIMHÉ
UNIVERSITY OF GALWAY