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Scalable full-cycle marine litter remediation in the Mediterranean: Robotic and participatory solutions

SeaClear2.0

https://www.seaclear2.eu

D8.2
Local sorting/treatment possibilities, for each demo site
WP8 –Full-Cycle Framework

Grant Agreement no. 101093822

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Deliverable description	This deliverable identifies ways to valorize waste identified and taken out on each demo site.

1 R = Document, report, DEM = Demonstrator, OTHER = Software, technical diagram, etc., DMP = Data Management Plan

2 PU = Public, C-UE/EU-C = EU Confidential under Decision 2015/444, SEN = Sensitive

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Definitions

- **Beneficiary:** A legal entity that is signatory of the EC Grant Agreement no. 101093822.
- **Consortium:** The SeaClear2.0 Consortium, comprising the list of beneficiaries below.
- **Consortium Agreement:** Agreement concluded amongst the SeaClear2.0 beneficiaries for the implementation of the Grant Agreement.
- **Grant Agreement:** The agreement signed between the beneficiaries and the EC for the undertaking of the SeaClear2.0 project (Grant Agreement no. 101093822).

Beneficiaries of the SeaClear2.0 Consortium are referred to herein according to the following abbreviations:

- **TU Delft**: TECHNISCHE UNIVERSITEIT DELFT
- **DUNEA**: REGIONALNA AGENCIJA DUNEA
- **Fraunhofer**: FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV
- **HPA**: HAMBURG PORT AUTHORITY
- **ISOTECH**: ISOTECH LTD
- **MDanchor**: M. DANCHOR LTD
- **Subsea Tech**: SUBSEA TECH SAS
- **TECNOSUB**: TÉCNICAS Y OBRAS SUBACUÁTICAS, SLU
- **TUM**: TECHNISCHE UNIVERSITÄT MÜNCHEN
- **UNIDU**: SVEUČILIŠTE U DUBROVNIKU
- **UTC**: UNIVERSITATEA TEHNICA CLUJ-NAPOCA
- **VEO**: VEOLIA PROPRETE
- **VLPF**: VENICE LAGOON PLASTIC FREE

Abbreviations

- **EC**: European Commission
- **GA**: Grant Agreement
- **WP**: Work Package
- **ML**: Marine Litter
- **MSW:** Municipal Solid Waste
- **ALDFG**: Abandoned, Lost, and Discarded Fishing Gear
- **ELV**: End-of-Live Vehicle
- **WEEE:** Waste from Electrical and Electronic Equipment
- **PVC**: PolyVinyl Chloride
- **PE**: PolyEthylene
- **HDPE**: High Density PolyEthylene

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- **LDPE**: Low Density PolyEthylene
- **VCR:** VideoCassette Recorder
- **LED:** Light-Emitting Diode
- **NIR:** Near Infrared Spectroscopy
- **PET**: PolyEthylene Terephthalate
- **PP**: PolyPropylene
- **PS**: PolyStyrene
- **MSW** : Municipal Solid Waste
- **EPR** : Extended Producer Responsibility
- **SRF** (Solid Recovered Fuels) ou **RDF** (Refuse Derived Fuels)

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Executive Summary

The SeaClear 2.0 project aims at creating an autonomous waste management system for marine litters. Autonomous robots are used for the detection and the collection of marine litter across two critical zones: the sea surface and the seafloor. The project is separated into different work packages, where WP8 focuses on the circular economy aspect of the project.

WP8 aims at developing and implementing a comprehensive waste management protocol. Waste management is the sum of collection, transport, treatment, recovery and disposal of waste. It is important for that implementation to understand that materials go through what we call a **material lifecycle**. Firstly it is **produced** then **manufactured**. The production covers the primary industries that provide feedstocks (mining, agriculture…) whereas manufacturing covers the transformation of the feedstocks (e.g. iron ore or steel scrap) into an everyday product (.g. steel). After the products have been manufactured, they are **used** or **consumed** in different applications like building filling or fishing gear. Upon their discard, the used products are handled in a **treatment facility then recovered or repurposed**. Treatment includes the separation of the waste into valuable components whereas the recovery tackles the revalorization of the product's materials or energy value. The final stage is **land disposal**, the products that cannot at the moment be cycled back to the previous stages are moved into landfill and await the discovery of new treatment or recovery process.

This document is the Deliverable 8.2 of the SeaClear2.0 project, in the context of WP8 "Full-Cycle Framework" and is related to Task 8.5 Sorting and repurposing solutions. It focuses on recovery solutions that are present near demo sites of SeaClear 2.0. A focus on the dominant categories of waste present in marine litter has been done.

The main target audience are the direct project participants, but it also concerned the managers of the demo site. Indeed the dissemination level of D 8.2 is public (PU).

This deliverable aims to identify ways to valorize waste issued on each demo site, in a practical, local, pragmatic and realistic approach. The demo sites are:



- Dubrovnik, Croatia



- Marseille, France



- Tarragona, Spain

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Introduction

To determine the possible future of marine litter, we must structure our thinking in several steps:

1. What are the regulatory obligations concerning this waste?
2. What are the operational possibilities for valorizing this waste?
3. Does the waste meet the specifications of those operational units?

Regarding the previous marine litter collection, in SeaClear 1 & SeaClear 2.0 but also in others programs, we will focus on the main marine litter :


Fishing gear


Plastics mix


Glass


Textiles


Inerts


Tires


Metals (without WEEE)


WEEE

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1. Regulatory obligations

Countries may have specific regulations but all the demo sites are done in Europe, therefore regulatory prerequisites have a common core.

1.1. Common Core

Here is the detail of European regulations for each type of waste.

Fishing gear:

- SUP Directive 2019/904
  - **Extended Producer Responsibility (EPR) mandatory since January 2025**
  - Producers must finance collection, transport and treatment of used fishing gear
  - Obligation to raise awareness among fishermen
  - Collection systems in ports

Plastics mix:

- Directive 94/62/EC
  - Recycling targets 50% (2025) and 55% (2030) for plastic packaging
- Directive 2008/98/EC
  - **Waste hierarchy (prevention, reuse, recycling, recovery, disposal)**
  - **Prohibition of landfilling without prior treatment**
  - Mandatory traceability

Glass:

- Directive 94/62/EC
  - Recycling 70% (2025) and 75% (2030) for glass packaging
  - Mandatory separate collection
  - Material recovery as priority
  - Prohibition of mixing with other waste

Textiles:

- Directive 2008/98/EC
  - **Mandatory separate collection since 01/01/2025**
- EU Strategy 2022
  - Mandatory eco-design, digital product passport planned
  - **EPR being deployed in Member States**
  - Ban on destruction of unsold goods (planned)
  - Priority: reuse and recycling

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Inerts:

- Directive 2008/98/EC
  - Obligation of maximum recovery
- Directive 1999/31/EC
  - Progressive reduction of landfilling
  - Use in backfilling, road construction encouraged
  - Traceability of movements
  - Leaching tests for classification

Tires:

- Directive 2008/98/EC
  - **Mandatory EPR**
- Directive 1999/31/EC
  - **Landfill ban since 2006**
- REACH Regulation
  - Limitation of PAHs (polycyclic aromatic hydrocarbons)
- Recovery obligation: material recycling, energy recovery or reuse
- Free collection for end users

Metals (without WEEE):

- Directive 2008/98/EC
  - **Priority to recycling**
- Directive 94/62/EC
  - 70% recycling ferrous packaging (2025), 80% (2030); 50% aluminium (2025), 60% (2030)
- Regulation 333/201
  - End-of-waste criteria for scrap metal
- Regulation 1013/2006
  - Traceability of transboundary shipments

WEEE:

- Directive 2012/19/EU
  - Minimum collection 65% of average weight of EEE placed on market (or 85% of WEEE generated)
  - Recovery rates: 80-85% depending on categories
  - Recycling rates: 70-80% depending on categories
  - **Mandatory EPR: financing by producers**
  - Free collection for holders
  - Mandatory selective treatment of hazardous substances
  - Mandatory crossed-out wheelie bin marking
  - Mandatory registration of producers
- RoHS Directive 2011/65/EU

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- Restriction of hazardous substances (lead, mercury, cadmium, etc.)

1.2. Specific regulation in Croatia

Here is the specific national regulation of Croatia for each type of waste.

Fishing gear:

- Waste Management Act (NN 84/21, 143/22): Implementation of SUP Directive 2019/904
- **EPR system established in 2024-2025**
- Collection points in fishing ports managed by local authorities
- Producers must register with Croatian Environmental Agency (CAEN)

Glass:

- Waste Management Act (NN 84/21): **Separate collection mandatory**
- Packaging Waste Ordinance (NN 97/15, 88/18): Recycling targets aligned with EU (70% by 2025, 75% by 2030)
- Deposit-refund system for glass bottles in place
- **EPR system managed by authorized operators** (e.g., Zelena Točka)

Inerts:

- Waste Management Act (NN 84/21): Classification and management requirements
- Construction and Demolition Waste Ordinance (NN 69/16): 70% recovery target
- Permits required for inert waste landfills
- Reuse in construction projects encouraged
- Registration in waste tracking system mandatory

Metals (without WEEE):

- Waste Management Act (NN 84/21): Priority to recycling
- Packaging Waste Ordinance: Recycling targets for metal packaging (70% ferrous, 50% aluminium by 2025)
- Scrap metal dealers must be licensed
- Export documentation required for transboundary shipments
- **EPR system for metal packaging**

Plastics mix:

- Waste Management Act (NN 84/21): **Separate collection mandatory**
- Packaging Waste Ordinance: 50% recycling target by 2025, 55% by 2030
- Single-Use Plastics Ordinance (NN 148/21): Implementation of SUP Directive
- **EPR system for plastic packaging** (Zelena Točka, EKO-OZRA)
- Landfill ban for untreated plastic waste

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Textiles:

- Waste Management Act (NN 84/21): **Separate collection mandatory since January 1, 2025**
- Textile Waste Management Plan (2023): Framework for collection and treatment
- **EPR system in development phase**
- Collection containers in municipalities required
- Priority to reuse and preparation for reuse

Tires:

- Waste Management Act (NN 84/21): **EPR system mandatory**
- Waste Tire Ordinance (NN 40/06, 31/09): Management requirements
- **Landfill ban enforced**
- Collection system managed by authorized operators (e.g., CIAK)
- Producers must pay EPR fees
- Free take-back at tire retailers
- Annual reporting to CAEN mandatory

WEEE:

- Waste Management Act (NN 84/21): Implementation of WEEE Directive
- WEEE Ordinance (NN 42/14, 48/15, 107/15): Detailed management requirements
- Collection target: 65% of EEE placed on market
- **EPR system managed by authorized collective schemes** (e.g., EE-FOND, ELEKRTRO-EKO)
- Free take-back at retailers (1-for-1 or 1-for-0 for small WEEE)
- Producers must register with CAEN
- Treatment facilities must be licensed
- RoHS requirements implemented through national legislation

1.3. Specific regulation in France

Here is the specific national regulation of France for each type of waste.

Fishing gear:

- AGEC Law (Anti-Waste for a Circular Economy) of February 10, 2020: **Implementation of EPR**
- Decree No. 2022-748 of April 29, 2022: EPR for fishing gear containing plastic since January 1, 2025
- Approved eco-organization: ADEPALE (being deployed)
- Collection points in fishing ports mandatory
- Financial contribution from producers and importers

Glass:

- Environmental Code (Art. L541-10): EPR for packaging
- Decree No. 92-377 of April 1, 1992 amended: Packaging management

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- Recycling target: 75% in 2025, 85% in 2030 (more ambitious than EU)
- Approved eco-organizations: Citeo, Adelphe, Léko
- **Selective collection mandatory in all municipalities**
- Deposit-refund for reuse authorized

Inerts:

- Environmental Code (Art. L541-1 and following)
- Decree No. 2011-828 of July 11, 2011: Inert waste from construction
- Target: 70% recovery of construction waste by 2020 (maintained)
- **Mandatory sorting on construction sites (Extended 5-stream decree)**
- Inert waste storage facilities (ISDI) regulated
- Traceability via tracking slip (BSD)
- On-site reuse encouraged

Metals (without WEEE):

- Environmental Code: **EPR for metal packaging**
- Decree No. 92-377 amended: Metal packaging
- Targets: 80% steel recycling, 60% aluminium by 2030
- Scrap metal: Order of February 29, 2012 on traders and brokers
- Mandatory approval for collectors and traders
- Transaction register mandatory
- Certificate of conformity for export

Plastics mix:

- AGEC Law 2020: Ambitious reduction and recycling targets
- Environmental Code: **EPR for plastic packaging**
- Target: 100% recycled plastics by 2025
- 3R Decree (Reduction, Reuse, Recycling): Binding targets for producers
- Extension of sorting instructions to all plastic packaging since 2022
- Ban on many single-use plastics (cups, plates, cotton swabs, etc.)
- Bonus-malus on eco-contribution according to recyclability

Textiles:

- AGEC Law 2020: Strengthening of textile EPR
- Decree No. 2022-748 of April 29, 2022: EPR for clothing, household linen and footwear
- Environmental Code (Art. L541-10-3): **Mandatory separate collection since January 1, 2025**
- Approved eco-organization: Refashion (formerly Eco TLC)
- Ban on destruction of non-food unsold goods since 2022
- Mandatory free take-back in stores (1 for 1)
- Target: 95% collection for reuse or recycling by 2028
- Mandatory repairability index (being deployed)

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Tires:

- Environmental Code (Art. R543-137 to R543-151): **EPR for tires**
- Decree No. 2002-1563 of December 24, 2002 amended: Disposal of used tires
- Order of January 28, 2022: EPR specifications for tires
- Approved eco-organizations: Aliapur, GIE France Recyclage Pneumatiques
- **Landfill ban since 2003**
- Mandatory free take-back by distributors
- Recovery target: 100% (95% material recycling, 5% energy recovery)
- Traceability via national register

WEEE:

- Environmental Code (Art. R543-172 to R543-206-4): **EPR for WEEE**
- Decree No. 2014-928 of August 19, 2014 amended: WEEE
- Order of August 28, 2020: EPR specifications for WEEE
- Approved eco-organizations: Ecologic, Ecosystem, PV Cycle (solar panels)
- Collection target: 65% of weight of EEE placed on market
- Mandatory free 1-for-1 take-back in stores
- 1-for-0 take-back for small WEEE (<25cm) in stores >400m²
- Reuse fund: 5% of eco-contributions to support reuse
- Mandatory free collection for online distributors
- Mandatory repairability index since 2021 (5 categories)
- Durability index planned from 2024

1.4. Specific regulation in Spain

Here is the specific national regulation of Spain for each type of waste.

Fishing gear:

- Law 7/2022 of April 8, 2022 on waste and contaminated soil for a circular economy: Implementation of SUP Directive
- Royal Decree 1055/2022 on packaging and packaging waste: EPR framework
- **EPR system for fishing gear containing plastic operational since January 2025**
- Producers must register with regional authorities
- Collection points in fishing ports managed by port authorities and fishermen's associations
- Approved collective schemes in development

Glass:

- Law 7/2022 on waste: **EPR for glass packaging**
- Royal Decree 1055/2022 on packaging: Recycling targets 70% (2025), 75% (2030)
- Approved eco-organizations: Ecovidrio (glass packaging), Ecoembes (mixed packaging)
- Selective collection mandatory in all municipalities
- Container system (green igloos) widespread

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- Deposit-refund system (SDDR) under consideration for 2027-2028
- Regional variations in collection systems (17 autonomous communities)

Inerts:

- Law 7/2022 on waste: Construction and demolition waste management
- Royal Decree 105/2008 on construction and demolition waste production and management
- Recovery target: 70% by weight of non-hazardous construction waste
- Mandatory waste management plan for construction projects >450m³
- Waste management study required in project phase
- Traceability via electronic documentation
- Authorized facilities for treatment and disposal
- Regional permits required for inert waste landfills

Metals (without WEEE):

- Law 7/2022 on waste: **EPR for metal packaging**
- Royal Decree 1055/2022: Metal packaging recycling targets 70% (2025), 80% (2030) for ferrous; 50% (2025), 60% (2030) for aluminium
- Scrap metal management: Royal Decree 110/2015 on waste electrical and electronic equipment (for metal components)
- Authorization required for scrap metal dealers and recyclers
- Traceability system mandatory
- Export documentation required (Regulation 1013/2006)
- Approved eco-organizations: Ecoembes, Ecoembalia

Plastics mix:

- Law 7/2022 on waste: Ambitious plastic reduction targets
- Royal Decree 1055/2022: Plastic packaging recycling 50% (2025), 55% (2030)
- Royal Decree 293/2018: Reduction of plastic bag consumption
- Ban on single-use plastics (SUP Directive implementation) since July 2021
- **Mandatory separate collection for plastic packaging**
- Tax on non-reusable plastic packaging (€0.45/kg) since January 2023
- Approved eco-organizations: Ecoembes, Ecoembalia
- Regional collection systems vary (yellow container system common)

Textiles:

- Law 7/2022 on waste: **Mandatory separate collection since January 1, 2025**
- Royal Decree 646/2020 on EPR for textile products: **EPR system established**
- Approved eco-organization: SIGRE (in development for textiles)
- Producers must register and contribute financially
- Collection containers in municipalities mandatory
- Ban on destruction of unsold textiles planned
- Priority to preparation for reuse and recycling

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- Regional collection systems coordinated with social economy entities
- Minimum collection target: 55% by 2025, 65% by 2030

Tires:

- Law 7/2022 on waste: **EPR for tires**
- Royal Decree 1619/2005 on tire waste management (updated by Law 7/2022)
- Approved collective schemes: SIGNUS Ecovalor, TNU (Tratamiento Neumáticos Usados)
- Landfill ban enforced
- Free take-back at tire retailers and workshops mandatory
- Producers and importers must register and pay EPR fees
- Recovery target: 100% collection and treatment
- Valorization: minimum 95% material recycling or energy recovery
- Annual reporting to Ministry for Ecological Transition (MITECO)
- Traceability system via electronic register

WEEE:

- Law 7/2022 on waste: **EPR for WEEE**
- Royal Decree 110/2015 on waste electrical and electronic equipment
- Collection target: 65% of average weight of EEE placed on market (or 85% of WEEE generated)
- Recovery rates: 80-85% depending on categories
- Recycling rates: 70-80% depending on categories
- Approved collective schemes: Ecoasimelec, Ecolec, Ecofimatica, Ecotic, ERP España, Fundación Ecolum, Ambilamp, Ecoraee's
- Free 1-for-1 take-back at retailers mandatory
- 1-for-0 take-back for very small WEEE in stores >400m²
- Producers must register in national registry (MITECO)
- Treatment facilities must be authorized
- RoHS Directive implemented via Royal Decree 219/2013
- Separate collection mandatory in all municipalities
- Awareness campaigns funded by producers

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2. Reprocessing activities overview

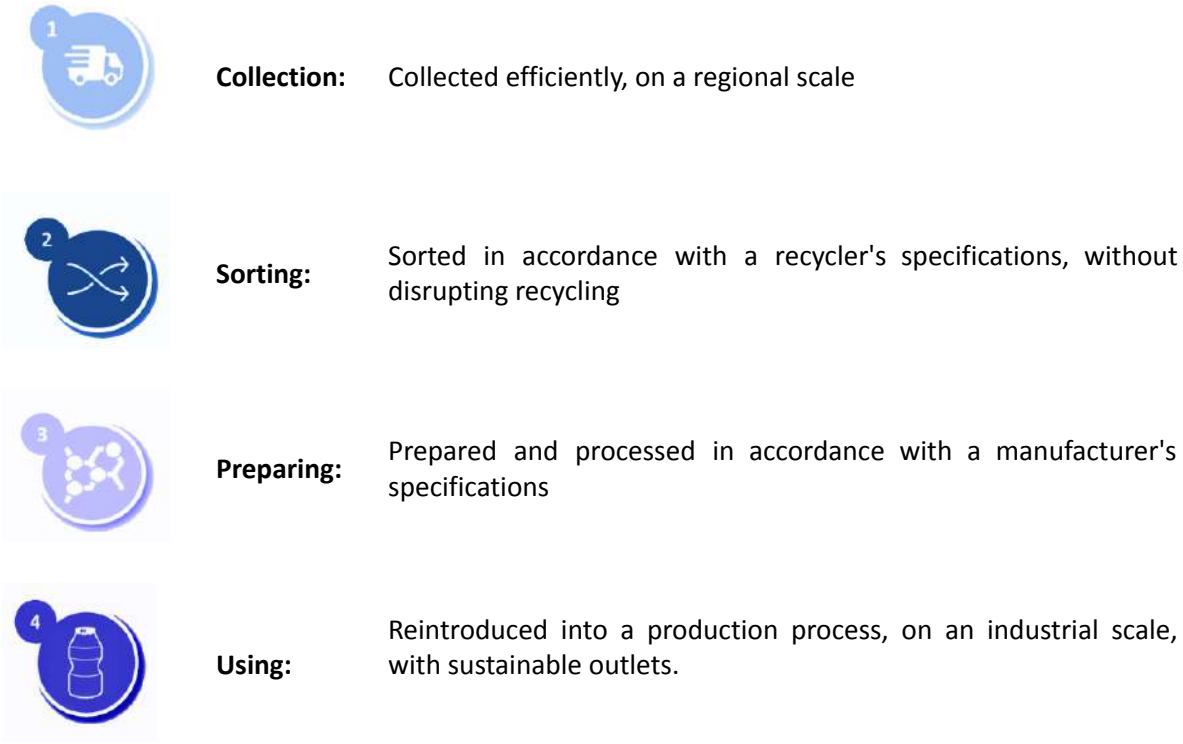
Reprocessing activities refer to the set of technical operations that transform collected waste into secondary raw materials, new products or recovered energy. In the context of marine litter, reprocessing encompasses all steps that occur after waste collection. It may include cleaning, shredding, recycling and when no material-recovery route is feasible, energy recovery.

Reprocessing is not a single operation but a sequence of value-restoring processes. Marine litter has complex composition, degradation, and contamination, reprocessing activities are essential for converting heterogeneous and often low-quality materials into streams that meet specifications and legislations. This section describes the available reprocessing activities in SeaClear2.0 demo sites.

2.1. General reprocessing process

In order to be recycled, **waste must be able to be reintroduced into a production cycle. Its ability to be recycled is called its "recyclability".**

In practice, recyclability requires that the waste can be:



Collection: Collected efficiently, on a regional scale

Sorting: Sorted in accordance with a recycler's specifications, without disrupting recycling

Preparing: Prepared and processed in accordance with a manufacturer's specifications

Using: Reintroduced into a production process, on an industrial scale, with sustainable outlets.

Figure 1. Recyclability

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The general operational treatment processes are:

Fishing gear

Collection	• Retrieval from ports, beaches, and at-sea recovery programs
Sorting and preparing	• Sorting : separation by material type (nylon nets, polyethylene ropes, polypropylene, metal components) • Cleaning: removal of biological matter, salt, sand, and contaminants • Shredding: mechanical size reduction
Recycling	• Nylon nets : depolymerization to caprolactam • PE/PP ropes : mechanical recycling → plastic pellets • Metal components : melting *Energy recovery: Non-recyclable portions incinerated with energy recovery* • Innovative processes: Chemical recycling, pyrolysis for mixed materials
Using	• Manufacturing: : new products

Glass

Collection	• Separate collection via containers (bottle banks) or curbside pickup
Sorting and preparing	• Collection:Sorting: manual and automated separation by color (clear, green, brown) • Cleaning: removal of labels, caps, rings, and contaminants • Crushing: breaking into cullet (small fragments) • Magnetic separation: removal of ferrous metals • Optical sorting: advanced color separation and contaminant removal
Recycling	• Melting: cullet melted at 1,400-1,600°C in furnaces
Using	• Manufacturing: new glass containers, fiberglass, glass wool insulation • Alternative uses: aggregate for construction, sandblasting, water filtration

Inerts

Collection	• Transport from construction/demolition sites
Sorting	• Primary sorting: separation from other waste streams on-site

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and preparing	● Crushing: reduction to required sizes using jaw crushers, impact crushers, cone crushers ● Screening: separation into different size fractions (0-4mm, 4-20mm, 20-40mm, etc.) ● Magnetic separation: Removal of ferrous metals ● Washing: removal of fines and contaminants (optional)
Recycling	● Reuse applications *Landfilling: Only for non-recoverable inert waste in authorized ISDI facilities*
Using	● Road base and sub-base materials ● Backfill material ● Concrete aggregate ● Drainage layers

Metals (without WEEE)

Collection	● Scrap yards, municipal collection, industrial sources
Sorting and preparing	● Sorting: separation by metal type (ferrous/non-ferrous) ● Ferrous metals processing: ○ Magnetic separation ○ Shredding and fragmentation ○ Baling or briquetting : compression for transport ● Non-ferrous metals processing: ○ Manual and automated sorting (aluminium, copper, brass, zinc, etc.) ○ Eddy current separation for aluminium ○ Shredding and granulation *CollectionAdvanced sorting: X-ray fluorescence (XRF), laser-induced breakdown spectroscopy (LIBS)*
Recycling	● Ferrous metals : ○ Melting in electric arc furnaces or blast furnaces ○ Refining and casting into new steel products ● Non-ferrous metals processing: ○ Melting in specific furnaces (lower temperatures than steel) ○ Refining and casting
Using	● Manufacturing: : refining and casting

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Plastics mix

Collection
- Curbside collection, drop-off centers

Sorting and preparing
- Pre-sorting: removal of non-plastic contaminants
- Automated sorting:
  - Near-infrared (NIR) spectroscopy to identify polymer types (PET, HDPE, PP, PS, PVC, etc.)
  - Air jets to separate materials
  - Density separation (float-sink tanks)
- Baling: compression for transport

Recycling
- Mechanical recycling:
  - Grinding/shredding into flakes
  - Washing (hot water, detergents) to remove labels, adhesives, food residues
  - Rinsing and drying
  - Further sorting (optical, electrostatic)
  - Extrusion into pellets/granules
  - Manufacturing new products
- Chemical recycling (emerging):
  - Pyrolysis: thermal decomposition to oils and gases
  - Gasification: conversion to syngas
  - Depolymerization: breaking down to monomers
  - Solvolysis: dissolution and purification

Energy recovery: Incineration with energy recovery for non-recyclable plastics

Using
- Manufacturing: : new products

Textiles

Collection
- Containers, charity shops, retailers, door-to-door

Sorting and preparing
- Sorting (manual, highly labor-intensive):
  - Wearable clothing for reuse (40-50%)
  - Non-wearable for recycling (30-40%)
  - Waste for disposal (10-20%)
  - Further sorting by: fiber type, color, quality, season, size
- Reuse pathway:
  - Cleaning/washing
  - Minor repairs
  - Resale in second-hand shops or export

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Recycling	● Mechanical recycling: ○ Cutting and shredding ○ Fiber separation (pulling/carding) ○ Spinning into new yarn (lower quality) ○ Products: insulation, padding, industrial wipes, mattress filling ● Chemical recycling (emerging): ○ Depolymerization of polyester to PTA and MEG ○ Dissolution and regeneration of cellulose ○ Products: new textile fibers *Energy recovery: Incineration for non-recyclable textiles*
Using	● Products: insulation, padding, industrial wipes, mattress filling ● Chemical recycling (emerging): ○ Depolymerization of polyester to PTA and MEG ○ Dissolution and regeneration of cellulose ○ Products: new textile fibers

Tires

Collection	● Retailers, garages, collection centers
Sorting and preparing	● Inspection: checking for reuse potential (retreading) ● Retreading (for suitable tires): ○ Inspection and buffing ○ Application of new tread ○ Curing and quality control
Recycling	● Shredding process: ○ Primary shredding: cutting into large pieces (50-300mm) ○ Steel liberation: magnetic separation of steel belts ○ Secondary shredding: reduction to chips (10-50mm) ○ Granulation: further reduction to granules (0.5-10mm) ○ Fine grinding: production of rubber powder (<0.5mm) ○ Fiber separation: removal of textile fibers ● Pyrolysis (thermal decomposition in absence of oxygen): ○ Products: pyrolysis oil, carbon black, steel, gas ○ Applications: fuel, reinforcing filler, energy ● Devulcanization: Breaking sulfur bonds to regenerate rubber (emerging technology) *Energy recovery: Cement kilns (whole tires), power plants (tire-derived fuel)*
Using	● Rubber granules: artificial turf, playgrounds, sports surfaces, equestrian

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surfaces
- Rubber powder: asphalt modification, molded products, rubber mats
- Steel: recycling in steel industry
- Textile fibers: energy recovery or reinforcement materials

WEEE

Collection
- Retailers, municipal collection points, producer take-back

Sorting and preparing
- Pre-treatment:
  - Manual dismantling of hazardous components (batteries, capacitors, mercury switches, CFC gases)
  - Removal of valuable components for reuse
- Depollution: Safe extraction and treatment of hazardous substances:
  - Refrigerants (CFC, HFC) from cooling appliances
  - Mercury from lamps and switches
  - PCBs from capacitors
  - Lead from CRT screens
  - Batteries removal
- Shredding: Mechanical size reduction
- Separation processes:
  - Magnetic separation: ferrous metals
  - Eddy current separation: non-ferrous metals (aluminium, copper)
  - Density separation: plastics from metals
  - Optical sorting: plastic types
  - Electrostatic separation: mixed materials

Recycling
- Ferrous metals: melting
- Non-ferrous metals (copper, aluminium, precious metals): refining
- Precious metals (gold, silver, palladium from PCBs): specialized smelting and refining
- Plastics: mechanical or chemical recycling
- Glass (from CRT screens): specialized lead recovery and glass recycling
- Specialized treatment:
  - CRT screens: separation of panel and funnel glass, lead recovery
  - Flat screens: mercury removal, indium recovery
  - PCBs: precious metal recovery through smelting
  - Batteries: separate recycling processes
  - Lamps: mercury recovery, phosphor powder treatment, glass recycling

Residue treatment: Incineration or landfilling of non-recoverable fractions

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Using
- Manufacturing: : new products

The quality of output from these processes is entirely dependent on the quality of input; recycling facilities are dependent on the homogeneity of material achieved through sorting (cf 3.1.3.).

2.2. Reprocessing activities in Croatia[3]

Croatia's waste management system currently faces significant challenges, primarily due to inadequate sorting facilities and a consequent high reliance on landfills. Despite the implementation of separate collection programmes aimed at promoting pre-collection sorting and the existence of post-collection sorting facilities, the country continues to struggle with processing high levels of mixed waste.

This inefficiency in sorting has led to an increased use of landfills for disposing of residual waste that cannot be recycled or recovered. Such reliance on landfills not only contributes to environmental pollution, including greenhouse gas emissions and leachate runoff, but also hinders the country's ability to reclaim valuable materials from its waste stream.

The underlying issues can be attributed to insufficient investment in waste management infrastructure and limited public awareness about the benefits of proper waste sorting and recycling. As a result, Croatia faces a complex challenge in developing more sustainable and resource-efficient waste management strategies while reducing its dependency on landfill usage. According to Eurostat, only about half of the packaging waste placed on the Croatian market is sorted for recycling, highlighting the need for substantial improvements in waste processing systems.

Zagreb is advancing its waste management strategy with the planned CGO Zagreb centre, aimed at modernising the city's system and enabling the closure of the Jakuševac landfill. The selected technological solution from a feasibility study, Solution C, will involve mechanical and biodrying of mixed municipal waste, and mechanical processing of separately collected packaging, paper, cardboard, and biowaste from Zagreb and its surrounding county. The project aims to start trial operations by the end of 2028, with construction commencing in October 2026.

While landfills remain prevalent in Croatia, there is a growing emphasis on implementing more sustainable and efficient waste management solutions. The country grapples with challenges posed by approximately 100 non-compliant municipal landfills, some of which are involved in illegal activities. In 2022, over 56%[4] of all municipal waste was deposited in the country's active landfills, a figure substantially higher than the EU average landfilling rate of 23%.

Efforts are being intensified to raise public awareness about the importance of waste sorting and recycling. Separate collection reached 49%, reflecting ongoing infrastructure investments, while the recycling rate increased to 37%, still below the 50% target. Significant investments are being directed

[3] Source : https://recore-circpack.veolia.com

[4] According to the National Report on Municipal Waste for 2024 (Ministry of Environmental Protection and Green Transition, 2025), in 2024, landfilling remains dominant at 51%, far above the 2035 target of 10%

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towards improving waste management infrastructure. As of 2019, Croatia operated three waste management centres, collectively processing 285,000 tonnes of waste annually. However, only one of these centres focuses on recycling, with the others utilising mechanical biological treatment methods such as composting and anaerobic digestion for mixed waste. Outside of deposit return schemes, recycling activities remain limited.

More than 50% of glass in household packaging fractions placed on the Croatian market is recycled, though the specific colour fractions this represents remain unclear.

The total reprocessing figures for metals in Croatia are still in the developing stages, primarily due to capacity constraints in sorting and recycling.

The recycling of plastic in Croatia is a developing process, with the country lacking significant processing capabilities. In Croatia, the focus is primarily on PET, with limited processing capabilities for other polymers. In 2023 Croatian PET recycler Rekis invested an undisclosed sum to create a PET Recycling plant in Donja Dubrava region of Croatia, capable of producing 18,000 tonne per year or rPET pellets from post consumer plastic bottles.

2.3. Reprocessing activities in France

France has a dense and diverse network of facilities dedicated to sorting and treating waste, covering the entire territory.

With approximately 150 household packaging sorting centers, France has the most sorting facilities of any European country. Their individual capacity is nevertheless lower than in Germany, for example. However, the newest sorting centers have capacities equivalent to those in Germany.

Sorted materials are transported to either recycling or energy recovery facilities (approximately 120) for further processing. The use of landfills is uncommon in France, reserved theoretically to“non-recyclable waste”.

France has many recycling centers for metals, plastics, glass, etc with various actors, locals, nationals or internationals.

The construction of new incinerators is also being slowed down, so France is developing the Solid Recovered Fuels (SRF) sector. Solid Recovered Fuels (SRF) or Refuse-Derived Fuel (RDF) are playing an increasingly important role in France's energy transition, offering an alternative to fossil fuels while valorizing non-recyclable waste. Here is an overview of the national strategy, challenges, applications, and prospects for SRF in France.

SRF are a mix of non-hazardous and non-recyclable waste (plastics, paper, cardboard, wood, textiles) prepared for use as fuel in industrial facilities. European standard: EN 15359 (2011) defines the technical specifications (calorific value, chlorine content, heavy metals, etc.). SRF are not raw waste, they are treated (shredding, drying, sorting) to homogenize quality and reduce polluting emissions.

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SRF is primarily used in industrial plants with high energy requirements : cement plants, industrial boilers (paper mills, glass mills, chemical industries…) and sometimes energy recovery facilities, in co-incineration with household waste.

2.4. Reprocessing activities in Spain[5]

Spain has a well-established recycling system with over 300 active recycling facilities processing a wide variety of materials, including plastic, paper, metal, and glass.

The Spanish recycling infrastructure is very advanced and aims to improve the collection and sorting of recyclable materials in order to maximize resource recovery and minimize waste sent to landfill.

More than 40 glass recycling centers are listed in the country. The recycling of domestic glass is carried out by Camacho Recycling SL, Santos Jorge, SA and Revibasa.

More than 40 organizations are registered as metal and metal materials recovery facilities.

In plastic recycling, Repsol has significantly invested in its Reciclex production line, aiming to increase the output of recycled plastics to 25,000 tonnes annually by 2024, aligning with Europe's target of 30% recycled content in plastic packaging by 2030 Inserplasa operates a state-of-the-art facility equipped with advanced sorting technologies from Steinert, specialising in PE, PP, and PET recycling. Repetco Innovations has established a recycling facility in Albacete with a capacity to recycle 75,000 tonnes of multilayer PET/PE packaging waste annually into rPET and rPE pellets.Furthermore, La Red, managed by Veolia in Sevilla, plays a significant role in Spain's recycling capacity, processing approximately 125,000 tonnes of pre-selected packaging waste annually. Holding the UNE-EN 15343 certification, La Red sets a benchmark for traceability and quality in recycled plastics. Veolia's TorrePET facility in Badajoz processes over 40,000 tonnes of plastic waste annually, producing 20,000 tonnes of high-quality recycled PET, contributing to food-grade material.

[5] Source : https://recore-circpack.veolia.com

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3. Operational solutions

While the previous section outlined the theoretical pathways for reprocessing marine litter—covering recycling, preparation for reuse, and energy recovery—this chapter focuses on the practical, site-specific operational solutions available at each SeaClear2.0 demo location. As such it outlines the operational pathways available to manage marine litter collected at the demo sites. It translates the regulatory framework and the technical reprocessing capacities described in previous chapters into practical, site-applicable solutions. The objective is to ensure that all materials recovered by the robotic and surface systems follow a compliant, efficient, and locally relevant valorisation route.

3.1. Guidelines

3.1.1. Waste hierarchy

In order to have an effective marine litter valorisation, it must rely on the fundamental principles of waste management which is the **waste hierarchy.** It is a core principle of modern waste management and circular economy. It ranks waste management strategies from most favoured to least favoured according to their environmental impact.



Figure 2. Waste treatment hierarchy, according to the hierarchy established by the Lansink scale

The options included in the hierarchy are the following :

- Waste prevention calls for the reduction of waste generation. Avoiding waste from occurring is considered to be the best solution. A change in production and usage of products allows that prevention. An innovative manufacturing process or the design of durable products that can be reused multiple times is also a solution.
- Re-use is the integration of the waste in a closed-loop system, the waste is re-used as the same product repeatedly.
- Recycling encompasses the use of waste for a purpose that would otherwise be fulfilled by virgin materials. They could be used in the original production process, for example, some plastic waste are re-introduced in the production process and fulfill an open-loop recycling.
- Energy recovery is the extraction of value from waste, that value can either be energy from thermal treatment or fuels from numerous process (pyrolysis or anaerobic digestion)
- Elimination or disposal covers the long-term storage of waste in specially engineered facilities. They could have landfills that control pollutants emission and minimise risks to human health and environment.

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3.1.2. Decision tree

In order to have consistent decision-making across all demo sites, the following decision trees translate the waste-hierarchy principles into operational sorting and routing rules. They provide a step-by-step method to determine the most appropriate treatment option for the major marine litter items, taking into account contamination levels, recyclability constraints, and locally available facilities. These tools are intended for on-site operators, sorting-centre staff, and project partners to ensure that marine litter collected by SeaClear2.0 is channelled towards the highest-value and legally compliant outlet.

ALDFG

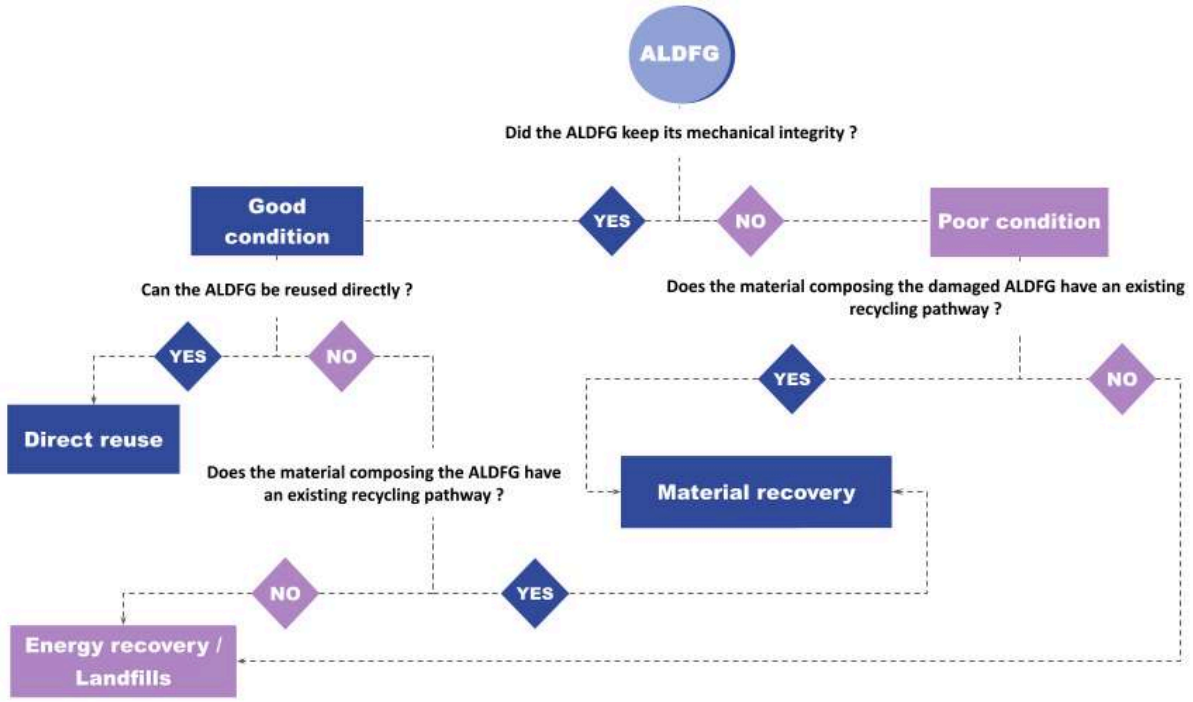


Figure 3. ALDFG Decision tree

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Plastics mix

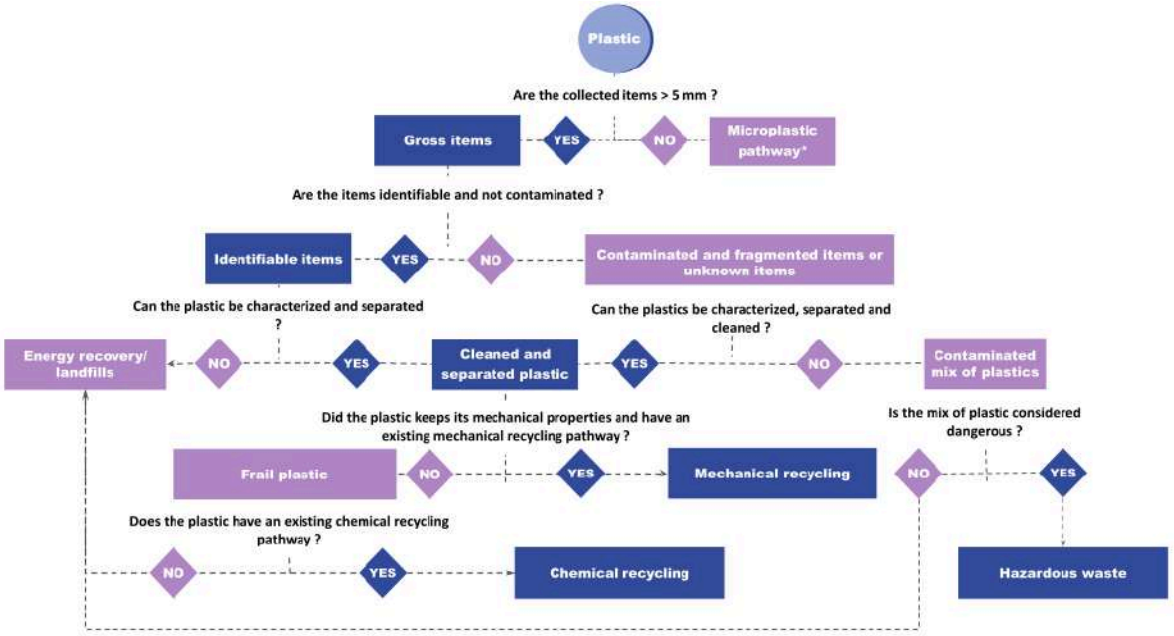


Figure 4. Plastics mix Decision tree

Metallic items

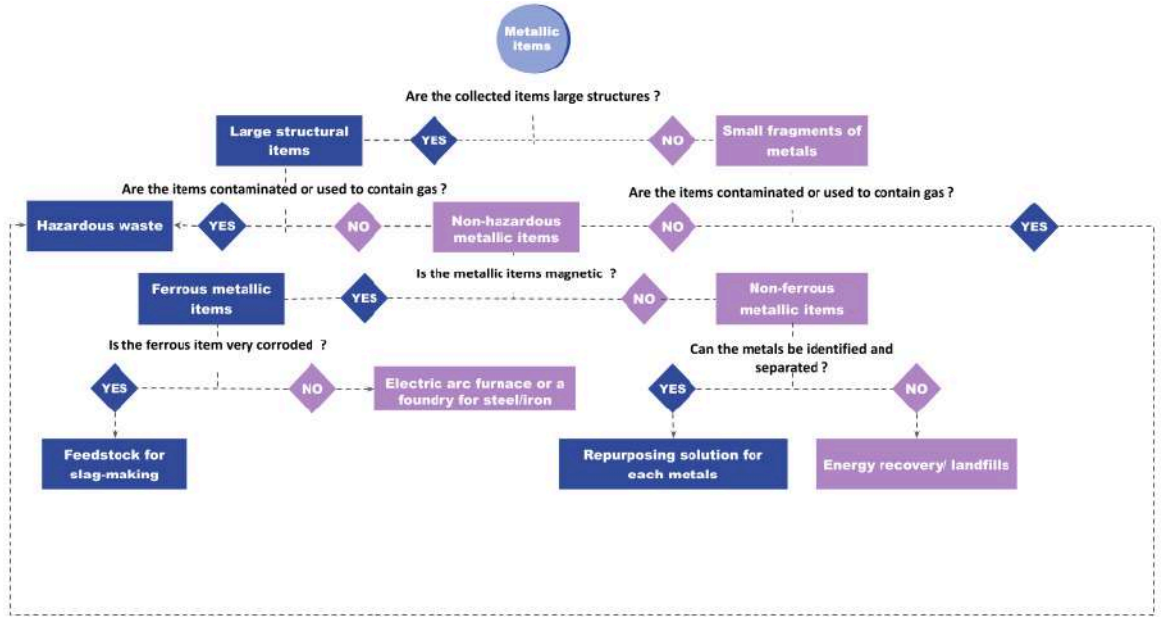


Figure 5. Metallic items Decision tree

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Rubber items

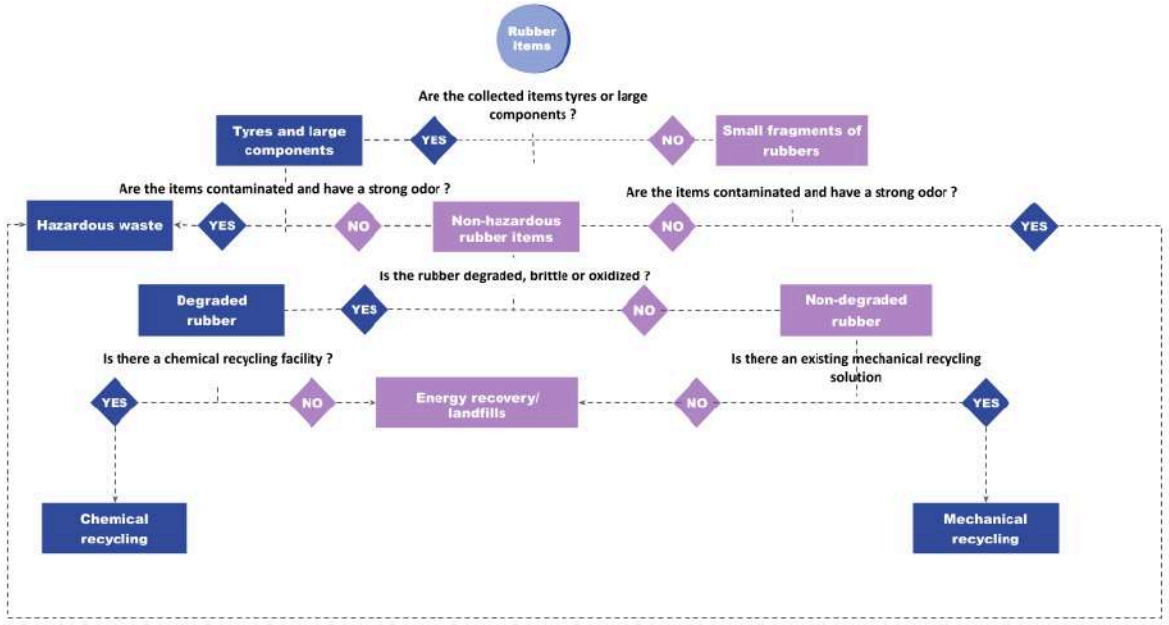


Figure 6. Rubber items Decision tree

Glass items

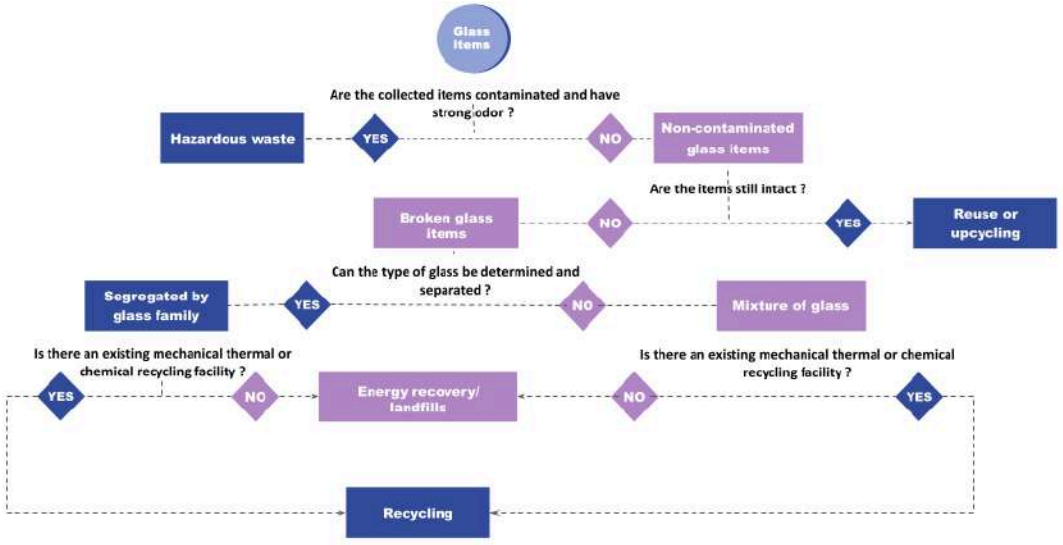


Figure 7. Glass items Decision tree

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Textiles

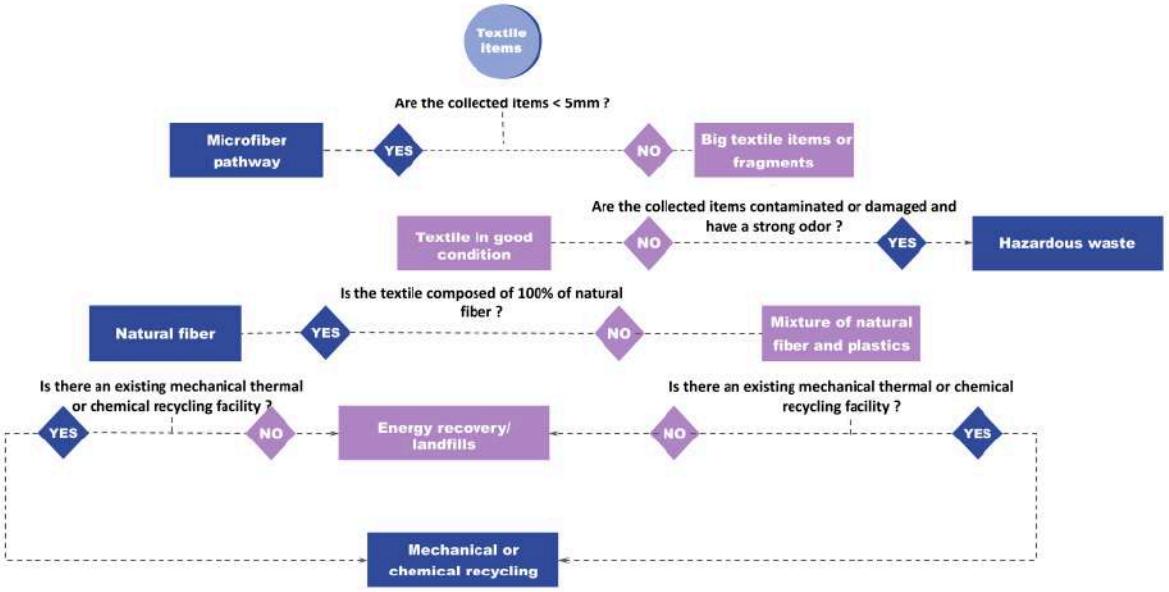


Figure 8. Textile Decision tree

3.1.3. Sorting center

Even though pre-sorting by waste type is carried out on the demo site (cf D8.1 Full check-list characterization of litter to address sorting/treatment possibilities), **the marine litter must pass through an industrial** (non-household/municipal) **waste sorting or transfer center** to:

- **Prepare the material**
  - further sorting of materials, e.g., by plastic resin
  - removal of unwanted materials from the recycling process, e.g., removal of residual metals from tires
- **Package according to industrial recycler specifications**
  - into bales for plastics, aluminum, textiles
  - into bundles for steel
  - bulk for glass, tires, WEEE
- **Consolidate into homogeneous batches of minimum quantity**.

It is during processing at the sorting center that compliance with the recycling companies' specifications can be examined and the destination validated, in accordance with the hierarchy of treatment methods and the decision trees previously presented.

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3.2. Solutions in Croatia

The waste treatment ecosystem in Dubrovnik is quite small, recycling and re-use solutions are still emerging[6].

Recycling in the Dubrovnik Neretva County is presently carried out by small companies that collect specific types of waste across the area and then transfer them to recycling centres across Croatia.

The following tables encompasses the solutions that were identified in Dubrovnik or in Croatia. The table showcases the waste or litters that are treated, the site of pre-treatment/sorting, the final usage of the treated waste and where can the method of treatment be put in the Landsik hierarchy.

Marine litters or items category	**Site for material preparation (sorting, baling / crushing…)**	**Final site**	**Method of treatment**	**Waste treatment hierarchy**
ALDFG	ČISTOĆA, Metković (HR) / RESPEKT, Metković (HR)	Maritimo recycling, Dubrovnik (HR)	Up-cycling	2
Glass		Vetropack, Dubrovnik (HR)	Recycling	3
Inerts		ČISTOĆA, Dubrovnik (HR) / KOMUNALNO ODRŽAVANJE, Ploče (HR)	Disposal	5
Metals (without WEEE)		JADRANSIROVINA, Ploče (HR)	Recycling	3
Plastics mix			Recycling	3

[6] According to the Waste Management Plan of Dubrovnik–Neretva County for the period 2024–2029, the entire Dubrovnik–Neretva County is covered by the public municipal waste collection service, with most elements of separate collection for recyclable and special waste streams in place. Municipalities provide access to recycling yards or mobile units, and waste fees are calculated uniformly for households and businesses based on container volume and collection frequency. Despite this organisational coverage, recycling and recovery performance remain below the Croatian average. In 2022, recovery within the public service was low, and overall recovery rates lagged behind national levels. This gap is primarily driven by high transport costs and market limitations, linked to the county's geographical fragmentation and distance from treatment facilities, which reduce the economic viability of recycling. Key infrastructure improvements include the construction of a waste-sorting facility and a composting plant in Metković in 2023. However, coverage with recycling yards remains insufficient, with several local authorities lacking facilities for special waste streams. Municipal waste continues to be disposed of at six active landfills, pending the opening of the Lučino Razdolje Waste Management Centre. Overall, while separate collection systems are in place, structural and logistical constraints continue to limit recycling outcomes, underscoring the need for further investment in treatment capacity and the regional integration of waste management systems.

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Textiles		ČISTOĆA, Dubrovnik (HR) / KOMUNALNO ODRŽAVANJE, Ploče (HR)	Disposal	5
Tires			Disposal	5
WEEE			Disposal	5

Table 1. Solutions in Croatia

Others solutions for ALDFG, plastic mix and tires -major marine lithers on demo sites- are presented in Annex 2.

3.3. Solutions in France

In Marseille, litters issues identified are :

Litters	**Site for material preparation (sorting, baling / crushing…)**	**Final site**	**Method of treatment**	**Waste treatment hierarchy**
ALDFG	Veolia industrial Sorting Center La Millière, Marseille	Sauvage méditerranée, 13090 Aix-en-Provence (FR)	Up-cycling	2
Glass		O-I France, 34500 Beziers (FR)	Recycling	3
Inerts		Veolia Bronzo, 13720 Belcodène (FR)	Disposal	5
Metals (without WEEE)		Derichebourg, 13700 Marignane (FR)	Recycling	3
Plastics mix		Pronatur, 08040 Barcelona (SP)	SRF (Solid Recovered Fuels)	3
Textiles		Lafarge La Malle, 13320 Bouc-Bel-Air (FR)	SRF (Solid Recovered Fuels)	3
Tires		Lafarge La Malle, 13320 Bouc-Bel-Air (FR)	SRF (Solid Recovered Fuels)	3
WEEE		Veolia Triade, 13790 Rousset (FR)	Recycling	3

Table 2. Solutions in France

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Others solutions for ALDFG, plastic mix and tires -major marine lithers on demo sites- are presented in Annex 2.

3.4. Solutions in Spain

In Tarragona, litters issues identified are :

Marine litters or items category	Site for material preparation (sorting, baling / crushing…)	Final site	Method of treatment	Waste treatment hierarchy
ALDFG	Ecoparc or transfer station, Tarragona (SP)	Popsicace , Barcelona (SP) / Sea2see, Barcelona (SP)	Up-cycling	2
Glass		LoveSeaGlass, Alicente (SP)	Up-cycling	2
Inerts	Planta de reciclatge de Tarragona (SP)	Valorisation plant for RCD (Residuos de Construcción y Demolición), Tarragona (SP)	Recycling	3
Metals (without WEEE)	Ecoparc or transfer station, Tarragona (SP)	Tarragonesa de Metalls, Tarragona (SP) / Scrap Point, Tarragona (SP)	Recycling	3
Plastics mix		PlasticPeople, Reus (SP) / Birkle recycling, Tarragona (SP)	Recycling	3
Textiles		Incineradora de Tarragona (SP)	Energy Recovery	4
Tires		Aimplas, Valencia (SP)	Recycling	3
WEEE		A3 aprofitament assessorament ambienta, Granollers (SP	Recycling	3

Table 3. Solutions in Spain

Others solutions for ALDFG, plastic mix and tires -major marine lithers on demo sites- are presented in Annex 2.

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4. Emerging solutions

Recent advances in marine and municipal waste management have generated several promising technologies aimed at addressing plastic pollution and complex waste streams. Not many of these approaches have reached industrial-scale deployment due to numerous limitations.

4.1. Emerging recycling technologies

For each type of major marine litter, we identified highlighting recent innovations and promising trends.

ALDFG

- Pyrolysis : conversion of nets into synthetic oil or gas (e.g., the “Fishing for Litter” project).
- Chemical recycling: depolymerization to recover monomers (e.g., “Carbios” technology for polyester).
- Composite material recovery : reuse in sustainable products (e.g., street furniture by *Bureo*).

Glass

- Cold recycling : fine grinding for reuse in cement or asphalt mixes (e.g., “Glassphalt”).
- Vitrification of hazardous waste : immobilization of heavy metals in a glassy matrix (e.g., plasma arc technology).
- Cellular glass : transformation into thermal insulation (e.g., “Foamglas”).

Inert materials

- Accelerated carbonation : capture of CO_2 in mineral waste (e.g., “CarbonCure”).
- Geopolymers : alternative binders to cement (e.g., “Hoffmann Green Cement”).

Metals (excluding WEEE)

- Advanced hydrometallurgy**: Selective extraction using solvents (e.g., *Solvay*).
- Electrochemistry**: Recovery of precious metals via electrolysis (e.g., *Redwood Materials*).
- Bio-leaching**: Use of bacteria to extract metals (e.g., *BioSigma*).

Plastics (mix)

- Enzymatic recycling : degradation of PET by enzymes (e.g., “Carbios”).
- Catalytic pyrolysis : conversion into naphtha or syngas (e.g., “Plastic Energy”).
- Selective dissolution : separation of polymers by solvents (e.g., “APK AG”).
- Algae-based plastics : biodegradable alternatives (e.g., “Notpla”).

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Textiles

- Chemical recycling : regeneration of cellulose (e.g., “Infinited Fiber”).
- Bioremediation : degradation by fungi (e.g., “MycoWorks”).

Tires

- Devulcanization : rubber recovery (e.g., “Tyromer”).
- Pyrolysis : production of carbon black and oil (e.g., “Scandinavian Enviro Systems”).
- Aggregates for sports surfaces : reuse in synthetic turf (e.g., “EcoSafe”).

WEEE

- Rare earth hydrometallurgy : recovery via ionic liquids (e.g., Solvay).
- Biometallurgy : extraction using microorganisms (e.g., BioIntelliPro).
- Urban mining : mapping of metal deposits (e.g., Redwood Materials).
- Li-ion Battery Recycling: recovery of cobalt and lithium (e.g., Northvolt).

4.2. Focus on two promising technologies

This part will delve into two solutions that were identified in the literature, explain their relevancy for the subject and why scalability and adaptability to our waste stream is difficult.

4.2.1. Enzymatic degradation of Polymers

Enzymatic degradation is a biocatalysed process, where enzymes produced by microorganisms break-down large polymer chains in order to produce oligomers, dimers and monomers. The enzyme adsorbs to the polymer surface, then cleaves susceptible bonds, producing smaller fragments that microbes can assimilate producing CO_2, H_2O or CH_4. Enzymatic degradation is very relevant for marine waste composed of plastics as microorganisms could operate in an ocean environment if conditions are met.

The process is quite promising however it presents many challenges, including the slow degradation rate for plastics with highly stable C-C bonds, the sensitivity of enzymes and microorganisms to numerous parameters such as pH and temperature. Furthermore enzyme production is very costly, it limits the industrial application of these processes. Last but not least, enzymatic processes are polymer-specific.

The degradation of PET is for example done by PETase and MEHTase enzymes, this process is one of the only scaled-up enzymatic degradation of polymers. A demonstration plan was made in 2021 by Carbios on a Michelin site in Clermont-Ferrand. It recycles all types of PET waste (bottles, clothes…) and breaks down PET into its monomers and produces 100% recycled and 100% recyclable PET products, without loss of quality.

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4.2.2. Hydrothermal Carbonization

Hydrothermal processes take place in a water medium at high temperatures and under high pressures. It can handle a variety of feedstock, from low to high-water content. It is therefore quite relevant for marine plastic as they could have a high-water and high-salt content.

Hydrothermal carbonization is a chemical process that is a subcategory of hydrothermal processes. It can treat a feedstock of plastic waste. The process takes place in a high temperature (100–250 ◦C) and high-pressure water (30 bar). During the process polymers are decomposed into oligomers and monomer units and produce hydrochar which is defined as a carbon-rich material with coal-like properties. The product can be used in various items such as tyres, solid fuel and additives in cement.

As seen above, the process is a promising process for converting plastic waste into valuable products. Nevertheless, several key challenges continue to constrain the broader application to marine plastics. Indeed, studies seem to have been done on controlled waste streams and may not be representative of the response in case of marine plastics, heterogeneity and contamination of the feedstock may be costly from a pre-treatment aspect.

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Conclusions

For most of the major marine litters, **existing EPR systems** (cf Appendix 1) in Croatia, France and Spain. However, it should be noted :

- For glass, metals and plastics, usually **only packaging is concerned.**
- ALDFG's EPR is newly implemented (2025) in all three countries, following EU SUP Directive.
- Inerts (construction waste) generally do not have EPR systems in EU countries.

Whether or not there is an EPR scheme**, in all cases marine litter must be directed to sorting/transfer centers** after collection. This step is essential for the preparation of materials and massification before sending them to the processing units.

For re-processing, small quantities of waste, particularly plastics (ALDFG, plastics mix, rubbers), can be taken to up-cycling units. However, these units are not capable of handling large volumes.

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Appendix

1. EPR schemes

Waste Type	Croatia	France	Spain
ALDFG	**EPR**: ✔ (since 2025) **Organizations**: System in deployment, managed through Croatian Environmental Agency (CAEN) - no dedicated collective scheme yet established	**EPR**: ✔ (since 2025) **Organizations**: ADEPALE (in deployment)	**EPR**: ✔ (since 2025) **Organizations**: System in development, no dedicated collective scheme yet established
Glass	**EPR**: ✔ **Organizations**: Zelena Točka, EKO-OZRA	**EPR**: ✔ **Organizations**: Citéo, Adelphe, Léko	**EPR**: ✔ **Organizations**: Ecovidrio (glass packaging), Ecoembes (mixed packaging)
Inerts	**EPR**: ✘ **Organizations**: No EPR system - managed through waste management permits and licensed operators	**EPR**: ✘ **Organizations**: No EPR system - managed through construction waste regulations and licensed operators	**EPR**: ✘ **Organizations**: No EPR system - managed through construction waste regulations and authorized facilities
Metals (without WEEE)	**EPR**: ✔ Yes (for metal packaging) **Organizations**: - Zelena Točka- EKO-OZRA	**EPR**: ✔ Yes (for metal packaging) **Organizations**: - Citeo- Adelphe- Léko	**EPR**: ✔ Yes (for metal packaging) **Organizations**: - Ecoembes- Ecoembalia
Plastics mix	**EPR**: ✔ Yes (for plastic packaging) **Organizations**: - Zelena Točka- EKO-OZRA	**EPR**: ✔ Yes (for plastic packaging) **Organizations**: - Citeo- Adelphe- Léko	**EPR**: ✔ Yes (for plastic packaging) **Organizations**: - Ecoembes- Ecoembalia
Textiles	**EPR**: In development **Organizations**: System being established - collection infrastructure in deployment phase	**EPR**: ✔ Yes **Organizations**: - Refashion (formerly Eco TLC)	**EPR**: ✔ Yes (since 2020 **Organizations**: - Multiple schemes in development- Coordination with social

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			economy entities (Cáritas, Cruz Roja, Humana, etc.)
Tires	**EPR**: ✔ Yes **Organizations**: - CIAK (Centar za Istraživanje i Analizu Kvalitete)	**EPR**: ✔ **Organizations**: - Aliapur- GIE France Recyclage Pneumatiques	**EPR**: ✔ Yes **Organizations**: - SIGNUS Ecovalor- TNU (Tratamiento Neumáticos Usados)
WEEE	**EPR**: ✔ Yes **Organizations**: - EE-FOND-ELEKTRO-EKO	**EPR**: ✔ Yes **Organizations**: - Ecologic- Ecosystem- PV Cycle (solar panels)	**EPR**: ✔ Yes **Organizations**: - Ecoasimelec- Ecolec- Ecofimatica- Ecotic- ERP España- Fundación Ecolum- Ambilamp- Ecoraee's

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2. Others recycling solutions

ALDFG

Demo site	Company	Target
Marseille	NAME : Fil&Fab LOCATION : Brest (1280 km from Marseille)	DESCRIPTION : Fil&fab is a French company based in Brest, Brittany, that specializes in recycling fishing nets into plastic pellets and yarn. They transform fishing nets primarily made of polyamide/nylon. RECOVERED MATERIAL : PA6 (Nylon)
Marseille	NAME : Filae LOCATION : Marseille	DESCRIPTION : Collects and repairs end-of-life fishing nets into structural supports for urban structures. RECOVERED MATERIAL : Fishing nets
Marseille	NAME : SAO LOCATION : Bessan (214 Km from Marseille)	DESCRIPTION : French initiative focused on recycling fishing nets into eco-responsible textile. RECOVERED MATERIAL : PA6 (Nylon) - HDPE
Marseille & Tarragona	NAME : Sea2see LOCATION : Barcelona (97,6 km from Tarragona)- La Ciotat (38,3 km from Marseille)	DESCRIPTION : Sea2See is a Barcelona-based company that produces glasses from recycled marine plastic waste, particularly from fishing nets and ropes. They work with fishing communities near Spanish/French ports that collect the ML (Tarragona-La Ciotat) RECOVERED MATERIAL : PA6 (Nylon)-PE-PET
Tarragona	NAME : Bracenet LOCATION : Hamburg/Porto	DESCRIPTION : Bracenet is a company that creates bracelets from discarded fishing nets (ghost nets) recovered from the oceans. These ghost nets are cleaned, processed, and transformed into colorful, sustainable bracelets. RECOVERED MATERIAL : HDPE trawl nets - PA6 (Nylon)
Tarragona	NAME : Ecoalf LOCATION : Madrid (548 Km from Tarragona)	DESCRIPTION : ECOALF is a Spanish sustainable fashion brand founded in 2009,It is known for creating clothing and accessories from recycled materials, including plastic bottles, discarded fishing nets. RECOVERED MATERIAL : PA6 (Nylon)
Tarragona	NAME : The gravity wave LOCATION : Calpe (390 Km from Tarragona)	DESCRIPTION : Gravity Wave is a Spanish-based social enterprise , we work with fishermen and companies to remove plastics from the sea and ports, giving them a second life as panels and products. RECOVERED MATERIAL : PA6 (Nylon) - HDPE

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Tarragona	NAME : Popsicace LOCATION : Barcelona (97,6 km from Tarragona)	LOCATION : Barcelona (97,6 km from Tarragona) DESCRIPTION : Popsicase is a brand of eco-friendly phone cases that feature a unique pop-out handle design resembling a popsicle stick. They are made from recycled fishing nets (ghost nets) recovered from the ocean RECOVERED MATERIAL : PA6 (Nylon)

Plastic mix

Demo site	Company	Target
Mechanical recycling		
Dubrovnik	NAME : Hamburger recycling LOCATION : Zagreb (606 km from Dubrovnik)	DESCRIPTION : Large firm specialising in collection and treatment of paper and non-hazardous plastics and have advanced sorting/processing lines for light plastic packaging. RECOVERED MATERIAL :
Marseille	NAME : CarbonBlue LOCATION : Géménos (26 km from Marseille)	DESCRIPTION : CarbonBlue is a company that uses modular and connected local micro-factories to transform plastic waste into pellets or semi-finished products, thereby eliminating transport costs and CO2 emissions. RECOVERED MATERIAL : PET-HDPE
Marseille	NAME : Les Toiles du Large LOCATION : Marseille	DESCRIPTION : 'Les Toiles du Large' is a french initiative that recycles old boat sails into unique, handcrafted bags and accessories. RECOVERED MATERIAL : PE-PA6 (Nylon)-Mylar-Kevlar
Marseille	NAME : Vaïba LOCATION : Marseille	DESCRIPTION : Vaïba is a brand of waterproof bags & pouches made in Marseille, from recycled plastic waste collected in the sea and on coastlines. RECOVERED MATERIAL : PE-PET
Marseille	NAME : Atelier poupe LOCATION : Marseille	DESCRIPTION : Atelier POUPE is a Marseille-based brand that creates eco-responsible lighting fixtures from marine floats and fenders. RECOVERED MATERIAL : PVC
Marseille	NAME : CMR LOCATION : La Brillanne (92,9 km	DESCRIPTION : CMR Recyclage located in Alpes-de-Haute-Provence works on collection, recycling and shredding of plastics and serves regions including Marseille.

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	from Marseille)	More geared to general plastics (industrial/household) than marine litter specifically RECOVERED MATERIAL : PE-PET
Tarragona	NAME : NexCopolimer LOCATION : Tarragona	DESCRIPTION : Local polymer distributor / recycler with an office in Tarragona; could be useful for local logistics, small-scale sorting. RECOVERED MATERIAL : ABS-HDPE-PP-PS-PVC-PET
Tarragona	NAME : TER Plastic Recycling LOCATION : Vic-Manlleu (168 km from Tarragona)	DESCRIPTION : Catalan company that recover and recycle plastics from post-industrial waste into polymer pellets. It could be interesting to have their feedbacks RECOVERED MATERIAL : PS-PP-PET-PE
Tarragona	NAME : Nuga recytech LOCATION : Karlovac (559 km from Dubrovnik)	DESCRIPTION : NUGA recytech offers end-to-end solutions for the mechanical recycling of plastics. Covering every stage from size reduction to material preparation for extrusion. RECOVERED MATERIAL : PET-HDPE-LDPE-PE-PP-PVC
Tarragona	NAME : Ecoalf LOCATION : Madrid (548 Km from Tarragona)	DESCRIPTION : ECOALF is a Spanish sustainable fashion brand founded in 2009. It is known for creating clothing and accessories from recycled materials, including plastic bottles, discarded fishing nets. RECOVERED MATERIAL : PET-HDPE-LDPE-PE-PP
Chemical recycling of plastic		
Dubrovnik	NAME : mi-plast LOCATION : Rijeka (608 km from Dubrovnik)	DESCRIPTION : Mi-plast is a family company. Its core business is production, distribution and recycling of polyethylene packaging used in household, construction, agriculture, tourism etc. They are part of lifeECOMETHYLAL project that works on technologies that can potentially valorize non-recyclable plastic waste using such as gasification or pyrolysis for chemicals and energy production. RECOVERED MATERIAL : PE
Marseille	NAME : Ineos lavera LOCATION : Martigues (42 km from Marseille)	DESCRIPTION : The INEOS cracker in Lavera, France, has received the first deliveries of pyrolysis oil made from recycled plastic waste that it will use to make virgin-quality polymers. Ineos does not disclose publicly the exact origin, polymer type, or supplier of the pyrolysis oil feedstock delivered to Lavéra.

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		RECOVERED MATERIAL : PE-PP
Tarragona	NAME : Greenertis LOCATION : Barcelona (94 km from Tarragona) and in 2025 Tarragona	DESCRIPTION : Greenertis converts complex plastic waste into Circular-Oil®, a crucial resource for the petrochemical industry in the production of new, high-quality recycled plastics. By the second half of 2025 it will inaugurate its first plastic waste recycling facility in Tarragona RECOVERED MATERIAL : PE-PP
Tarragona	NAME : BluePlasma Power LOCATION : Castellón (199 km from Tarragona)	DESCRIPTION : Blueplasma Power has a patented technology to convert into CO2-free Hydrogen and Circular Carbonates, the very difficult waste to valorize (mixed plastics, textiles, foams, paper, …) that nowadays are going to landfills or incineration. RECOVERED MATERIAL :
Tarragona	NAME : Repsol LOCATION : El Morell (Tarragona)	DESCRIPTION : Repsol has been developing the Ecoplanta Molecular Recycling Solution, This project will become the first plant in Spain for non-recyclable municipal waste recovery into methanol, which will be used to manufacture new materials and advanced biofuels. RECOVERED MATERIAL : PE-PP

Tires

Demo site	Company	Target
Marseille	NAME : AER LOCATION : Vendenheim (815 km from Marseille)	DESCRIPTION : A company specialised in the recycling of elastomer/rubber wastes using a developed thermomechanical devulcanization process. They have a partnership with Plymouth, it must be studied if they will accept rubbers from marine litter. RECOVERED MATERIAL : Rubber bands, wiper blade rubber, small fragments of rubbers
Marseille	NAME : Plymouth LOCATION : Feyzin (305 km from Marseille)	DESCRIPTION : It specialises in the transformation of rubber and plastics into fine sheets, elastics, bands, etc. It has expanded into recycling/regeneration of rubber wastes in recent years using a devulcanization process. RECOVERED MATERIAL : Rubber bands, wiper blade rubber, small fragments of rubbers
Tarragona	NAME : GMN	DESCRIPTION : GMN handles end-of-life tyres (ELTs) and

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	LOCATION : Maials (119 km from Tarragona)	focus on material recovery (rubber + steel), they serve as a mechanical recycling solution. They don't handle tires taken from marine litter. RECOVERED MATERIAL : Tyres
Tarragona	NAME : Aimplas LOCATION : Valencia (258 km from Tarragona)	DESCRIPTION : They are a technology centre working on plastics/rubber recycling, they are focused on advanced rubber recycling (devulcanization…) RECOVERED MATERIAL : Tyres
Tarragona	NAME : Greenval Technologies LOCATION : Zaragoza (233 km from Tarragona)	DESCRIPTION : Greenval offers a pyrolysis technology that provides a final solution to end-of-life tyres (ELT), valorising them into various materials for the industry. RECOVERED MATERIAL : Tyres
Tarragona	NAME : Elastocinca LOCATION : Fraga (108 km from Tarragona)	DESCRIPTION : Elastocinca is a company with a technology that allows the devulcanization of all type of rubbers. RECOVERED MATERIAL : Tyres
Tarragona	NAME : Ecoalf LOCATION : Madrid (548 Km from Tarragona)	DESCRIPTION : ECOALF is a Spanish sustainable fashion brand founded in 2009. It is known for creating clothing and accessories from recycled materials, including plastic bottles, discarded fishing nets. RECOVERED MATERIAL : Tyres

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