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a circular
multilayer plastic approach
for value retention of end-of-life
multilayer films

A circular multilayer plastic approach for value retention of end-life multilayer films

Innovation Forum4Plastics

TIRME, October the 13th 2022, Céline Chevallier (IPC)

CIMPA project, Grant Agreement N° 101003864

“Our goal is to turn multimaterial films waste into valuable and circular resources through cutting-edge technology and contribute to Europe’s Green Deal agenda

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CIMPA AT A GLANCE

Grant agreement ID: 101003864

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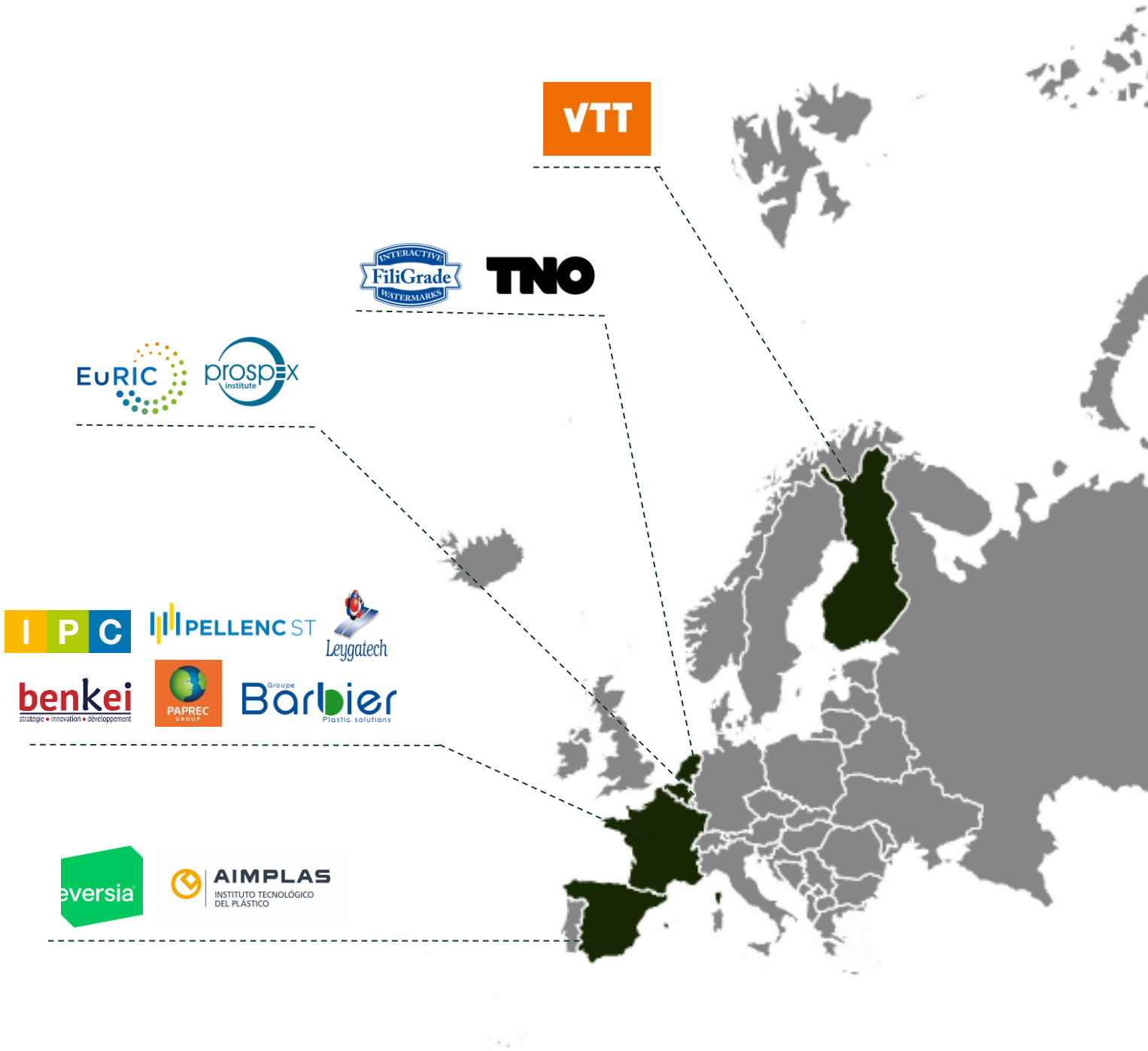
Overall budget: € 4 984 396,25

EU contribution: € 4 984 396,25

Coordinated by:

CENTRE TECHNIQUE INDUSTRIEL DE LA PLASTURGIE ET DES COMPOSITES, France



EXAMPLE OF FOOD PACKAGING

Recyclable

Non Recyclable

PET bottles

PET punnets

3.6 Mt

HDPE, PP bottles
PE, PP punnets & pots

2.5 Mt

HDPE and LDPE flexible films

1.2 Mt

PS, XPS pots and tubs

1.2 Mt

Complex packaging (mainly multilayers and mutimaterials)

2.1 Mt

20 %t

PVC packaging

0.3 Mt

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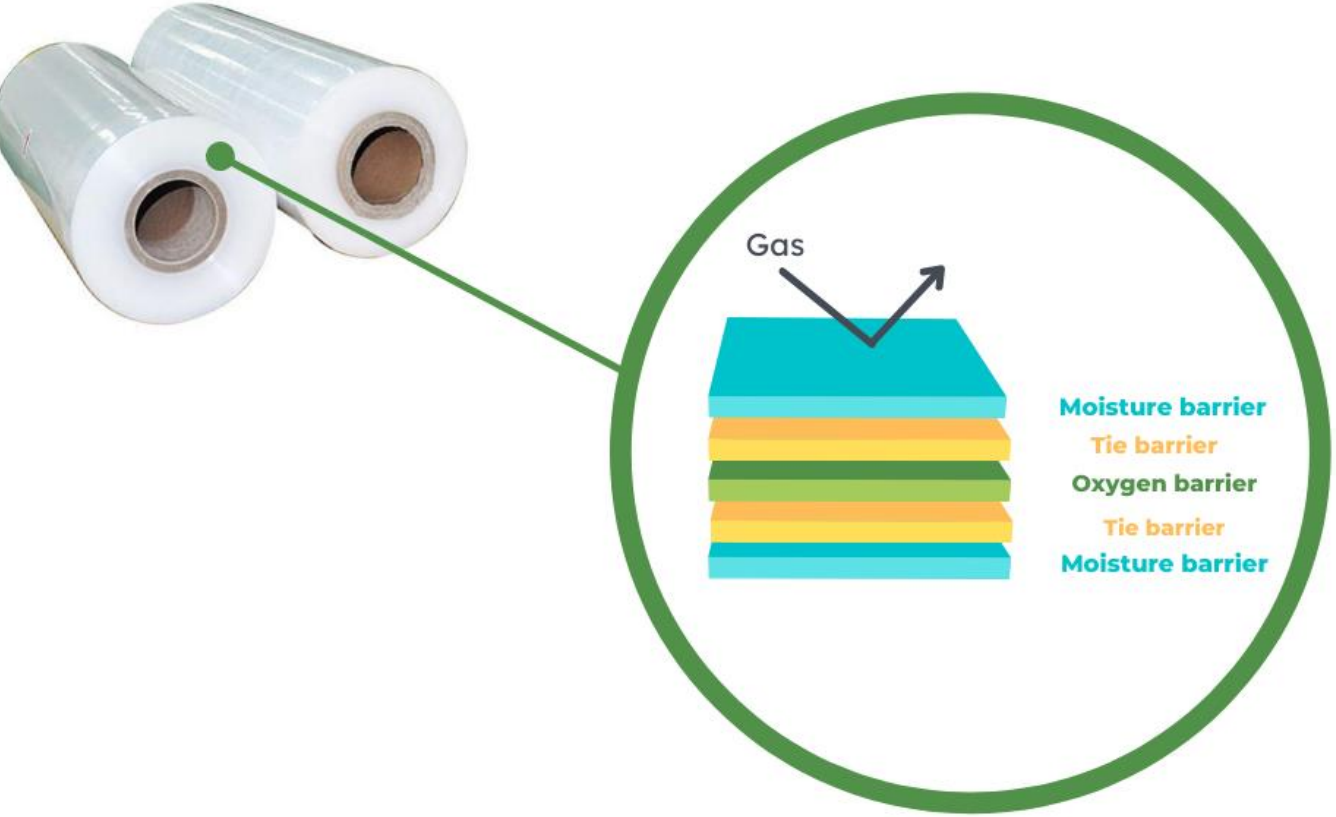
EU estimations based on CITEO data

Multilayer and multimaterial films characteristics



- Exceptional mechanical resistance
- Impermeable to oxygen and UV protection
- Moisture protection and water conservation
- It is lightweight, makes transportation easy → reduces shipping costs and emissions
- Ensures food safety and crop protections → reduce food waste

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Multilayer films applications

Multimaterial plastic films are used as packaging for the protection of food (2Mt/year) and agriculture for crops (0.6Mt/year)

Food

PA/PE
Vaccum packaging

PET/PE
Cheese, cooked food

BOPPmet/BOPP
Snacks, candies

PET/Alu/PE
Crips, pet food

PE/EVOH/PE
Stand up pouches

PE/EVOH/PA/PE
Fresh meat, cooked meat

PP/PA/EVOH/PA/PE
Snacks, baby, frozen food

PET/PVDC/PA/PP
Coffee

Agri.

PE/PA/PE *Barrier fumigation film*

PE/EVOH/PE *Barrier fumigation film, cover silage film*

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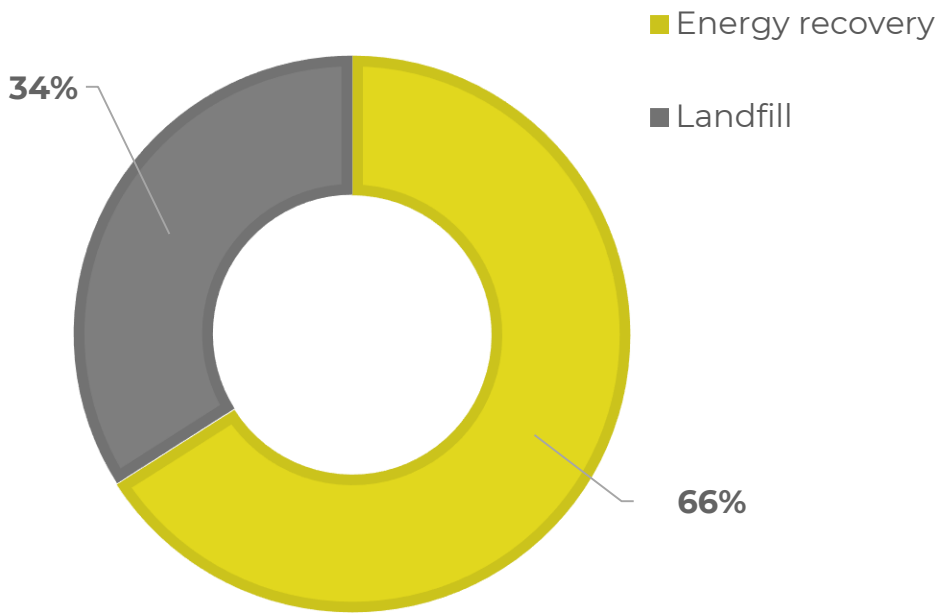
An environmental and economic issue

In the last decades, development has focused on the improvement of multi-layer materials properties (barrier, mechanical resistance etc) rather than their recyclability

- Due to current lack of sorting and recycling technologies, multilayer films are mostly incinerated or worse landfilled

- As a consequence, each year, the equivalent of 650M€ to 950M€ economic value is not recovered for the EU economy.



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Closed loop vs. Open loop

"[M]aterials, components and products [...] circulating in **closed loops**, where **nothing is wasted** but instead channelled to different processes depending on [...] [the] remaining properties and characteristics [of the materials, components and products]."[1]

Recycling convert a material into something roughly of **the same value** as the original

An "**Open loop** recycling refers to **recycling a product into a different product**. For example, often plastic water bottles are recycled into sleeping bags or fleece jackets. There's still a loop, with the plastic bottle going from manufacturing, to use, to recycling collection to recycling. [...] So rather than completely avoiding the trash, the plastic in that original bottle is just **delayed on its way to going into the trash**."[2]

Downcycling converts a discarded material into something of **less value** than it originally was.

CIMPA aims to create closed loops with the food packaging and agricultural multilayer multimaterial films .

1, Eleni Iacovidou et al.: A pathway to circular economy: Developing a conceptual framework for complex value assessment of resources recovered from waste, Journal of Cleaner Production, Volume 168, 1 December 2017, Pages 1279-1288.
2, https://www.grangerwasteservices.com/closed-open-recycling/

CIMPA CONCEPT

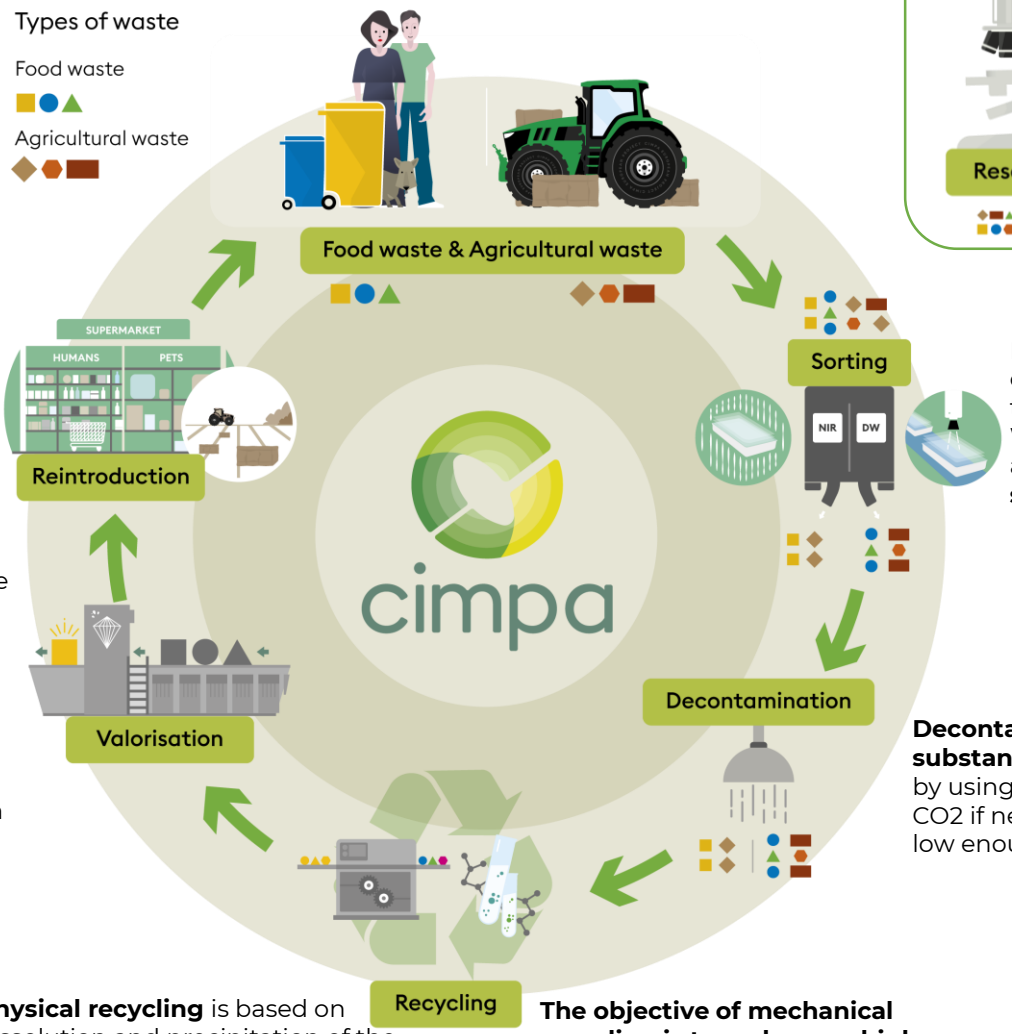
CIMPA will develop the **first recycling value chain** for multilayer multimaterial films retaining up based on a synergetic approach combining innovative **compositional sorting**, **mechanical and physical** (dissolution) **recycling**, and **upgrading solutions** (decontamination, properties improvement, in-line adaptive process control).

The project aims to demonstrate that multilayer multimaterial films can be circular in two large volume segments: **food and agriculture.**

CIMPA Value Chain

To create a value chain for multilayers recycling and reuse in the food and agriculture packaging markets, in a systemic way, considering all aspects of the value chain

The recycling processes will be developed according to current European legislation. **Modification of such legislation and standards could be proposed** to increase multilayer films recyclability.



New designs will be proposed including :
Multilayer structures more recyclable
Multilayer compositions including recycled materials

NIR identification relies on inner characteristics of the multilayer films: Composition, transparency, number and thickness of layers... When a combination of NIR, metal detection and Digital Watermarking is used, **up to 99% of sorting efficiency can be expected.**

Decontamination will remove toxic and hazardous substances, but also more than 80% reduction of VOCs, by using conventional stripping agents and supercritical CO2 if necessary. The Overall Migration Limit should be low enough to return to food contact applications.

A novel pilot recycling line with in-line adaptive melt rheology control and additivation will be used **to stabilize and upgrade targetted properties of recycled stream**, such as melt flow properties (targetting e.g. less than ±15% variance in melt flow index for recycled feedstock).

Physical recycling is based on dissolution and precipitation of the polyolefin contained **in the *Multilayer films that cannot be mechanically recycled***. The process uses a low boiling point solvent, and up to 90% recovery of the PO present should be reached.

The objective of mechanical recycling is to make new high gas barrier films. 2 innovative processes will be used : continuous extensional flow mixing and multinanolayering extrusion. Bi-axial stretching can also improve the barrier properties if needed.

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CIMPA IMPACT

- Moving from ~ 2% of ML recycling to a projected **recycling rate** between **12%** (short-term worst-case scenario) **up to 72%** (in a high impact scenario including return to food contact)

- **Reduction of virgin material use** by to 1.17M ton / year

- **Reduction of waste incinerated or landfilled** by up to 2.34M ton / year

- **Reductions of CO_2 emissions** by 2 to 4Mt/y

- **Average value retentions in EU** (= economic value saved in a circular vision) between 0.3B€ / y up to 2.2B€ /y

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Do you have any questions?
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