



# BIO-UPTAKE

## Impact on the Environment

Use of ecotoxicological tools

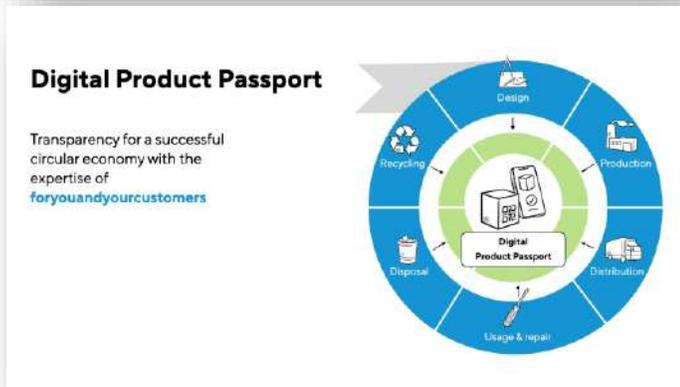
Isabel Lopes

University of Aveiro

09/02/2026



# EU Strategies for climate-neutral, circular and resource-efficient economy



# Targets



- ❖ Safer materials for the environment and humans.
- ❖ Towards zero pollution for air, water and soil.
- ❖ Reduce pollution to levels no longer considered harmful to health and natural ecosystems, creating a toxic-free environment.

Assess safety and sustainability throughout the entire chemical and material innovation processes ← **Ecotoxicological tools**

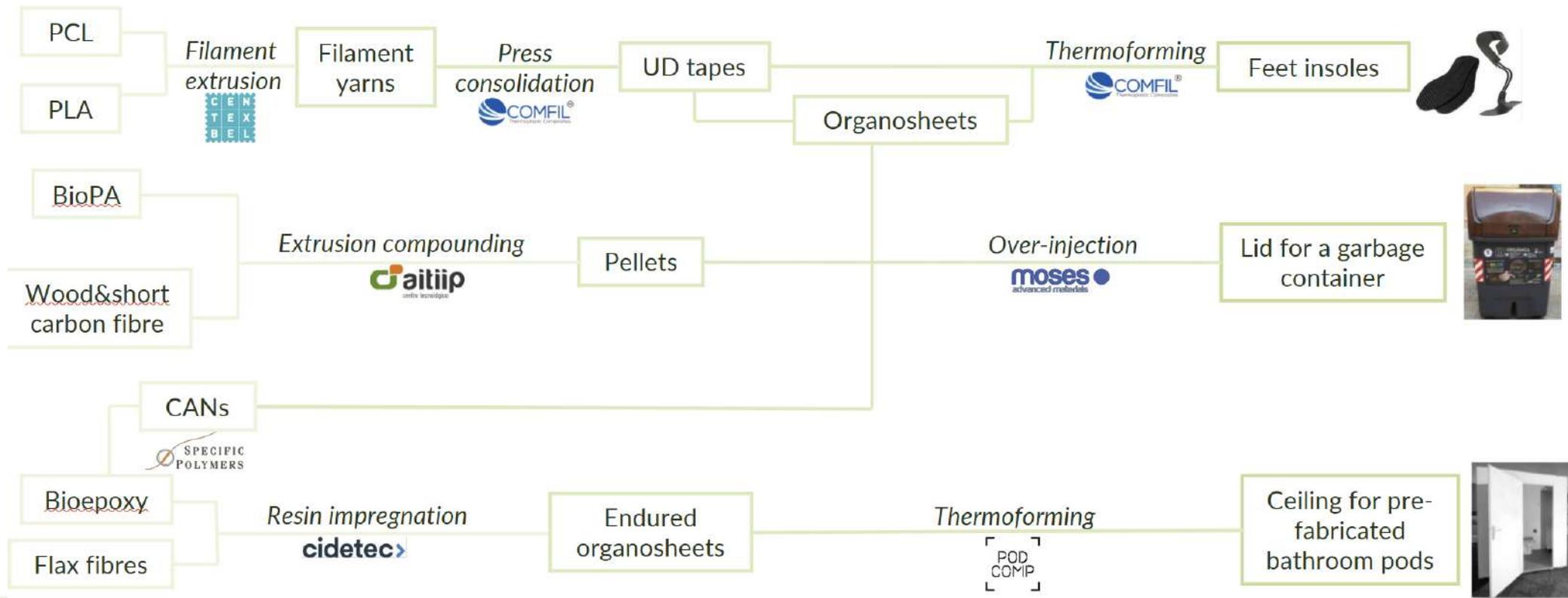
# Regulatory Landscape – EU Requirements

- ❖ **REACH Regulation:** generation and registration of (eco)toxicity data for composite constituents and leachates (Ecotoxicity classification mandated for >10 tonnes/year).
- ❖ **CLP:** uses these ecotoxicity data to classify mixtures as ‘hazardous to the aquatic environment’, triggering labels, pictograms and downstream legal duties.
- ❖ **EU Eco-Design Directive:** requires to document and assess environmental impacts, which may include ecotoxicity where relevant.

Ecotoxicity data supports market access and regulatory compliance



# Biouptake: Substances | Materials



	BADGE	PLAL175				HTPLA-PLA 50216 1.2 mm
Wood fibers	PHTE	PLA130	PA10-10	PA10 5% wood	BUP-PRP 05	HTPLA-PLA L175_Lx930 1mm
Carbon fibers	DGEVA	PLALX930	PCL6800	PA10 5% carbon	BUP-PRP 04	HTPLA-PLA L175_Lx930 5mm
	Cystamin	PLA6060				HTPLA-PLA L175-6060D 5mm
						HTPLA-PLA L130-6060D 3mm

# Freshwater ecotoxicological characterization

Bio-epoxy  
resins



E.g.:  
Bisphenol-free  
diglycidyl ether of  
valillyl alcohol  
  
Phloroglucinol  
triglycidyl ether

Bio-based  
fibers



E.g.:  
Carbon fibers  
  
Wood fibers



Bio-based  
pellets



E.g.:  
Polylactic acid  
  
Polycaprolactone



Bio-based  
intermediate formats



E.g.:  
Flax fibers  
  
Thermoplastic materials  
with carbon and/or  
wood reinforcement



# Ecotoxicity testing

## Need different approaches:

- ❖ **Bio-resins:** directly dissolved in the test media
- ❖ **Materials (wood and carbon fibers, pellets):**  
Leachates are produced following standard DIN 38414-4 (10:1 ratio; filtration with 0.45  $\mu\text{m}$  membrane filters)
- ❖ **Materials (intermediate formats):**  
Leachates following standard CEN/TS15863: 8  $\text{cm}^3 \text{cm}^{-2}$



# Freshwater ecotoxicological characterization:

## Samples preparation

Bio-epoxy  
resins

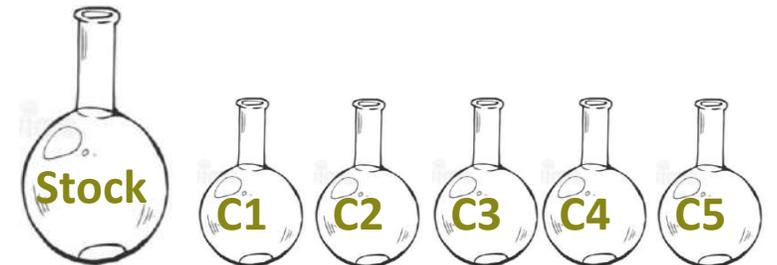
Prepare under argon  
environment



Need to use an organic  
solvent.



Directly dissolved in the  
test media.



# Freshwater ecotoxicological characterization:

## Samples preparation

Bio-based fibers  
Bio-based pellets

Elutriate,  $H_2O_{\text{dist}}$ :  
standard DIN  
38414-4  
(10:1, V:W ratio)

Stirring for 24 h  
at room  
temperature

Filtration with  
 $0.22 \mu\text{m}$   
membrane filters

Dilute  
in the  
test media



# Freshwater ecotoxicological characterization:

## Samples preparation

Bio-based  
intermediate formats

Leachates, H<sub>2</sub>O<sub>dist</sub>:  
standard CEN/TS15863  
(8 cm<sup>3</sup> cm<sup>-2</sup>)

Stirring for 24 h, 32 d  
and 64 d  
at room temperature

Filtration with  
0.22 μm  
membrane filters

Dilute  
in the  
test media.



# Freshwater ecotoxicological characterization:

## Ecotoxicity assays

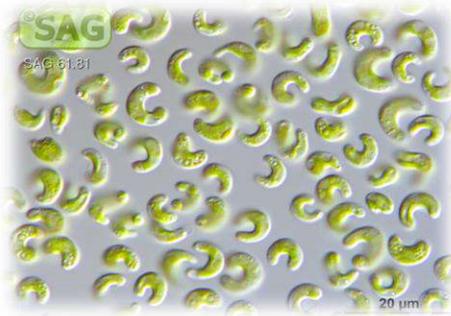
*Raphidocelis  
subcapitata*

*Lemna  
minor*

*Daphnia  
magna*

*Brachionus  
calyciflorus*

*Danio  
rerio*



OECD 201, 2004

OECD 221, 2006

OECD 202, 2004

Rotokit F<sup>®</sup>

OECD 236, 2013

Growth inhibition

Growth inhibition

Immobilisation

Immobilisation

Embryo acute

**Primary  
producers**

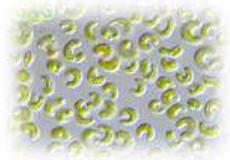
**Primary  
consumers**

**Secondary  
consumers**

# Freshwater ecotoxicological characterization:

## Resins

*R. subcapitata*



*L. minor*



*B. calyciflorus*



*D. magna*



*D. rerio*



**BADGE**

LC<sub>50,72h</sub>  
> 100 mg/L

LC<sub>50,7d</sub>  
4.15 mg/L

LC<sub>50,24d</sub>  
17.85 mg/L

LC<sub>50,48h</sub>  
3.75 mg/L

LC<sub>50,96h</sub>  
2.84 mg/L

**DGEVA**

LC<sub>50,72h</sub>  
> 100 mg/L

n.a.

LC<sub>50,24h</sub>  
73.83 mg/L

LC<sub>50,48h</sub>  
> 50 mg/L

**NO MORTALITY**

**PHTE**

LC<sub>50,72h</sub>  
24.82 mg/L

n.a.

LC<sub>50,24h</sub>  
2.28 mg/L

LC<sub>50,48h</sub>  
26.75 mg/L

LC<sub>50,96h</sub>  
12.5 to 25 mg/L

**Cystamine**

LC<sub>50,72h</sub>  
63.84 mg/L

LC<sub>50,7d</sub>  
6.91 mg/L

LC<sub>50,24h</sub>  
15.99 mg/L

LC<sub>50,48h</sub>  
6.18 mg/L

**NO MORTALITY**

**DGEVA least toxic.**

# Freshwater ecotoxicological characterization

## Fibers

*R. subcapitata*



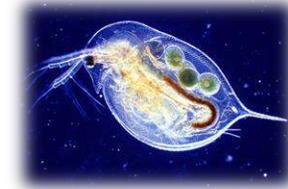
*L. minor*



*B. calyciflorus*



*D. magna*



*D. rerio*



**Carbon  
fiber**

LD<sub>50,72h</sub>  
N.C.  
(Yield)

LD<sub>50,7d</sub>  
34.1 %  
(Yield)

LD<sub>50,24d</sub>  
26.5 %  
(Mortality)

LD<sub>50,48h</sub>  
89.8 %  
(Mortality)

LD<sub>50,96h</sub>  
76.2 %  
(Mortality)

**Wood  
fiber**

LD<sub>50,72h</sub>  
27.9 %  
(Growth rate)

LD<sub>50,7d</sub>  
30.6 %  
(Yield)

LD<sub>50,24h</sub>  
12.0 %  
(Mortality)

LD<sub>50,48h</sub>  
37.2 %  
(Mortality)

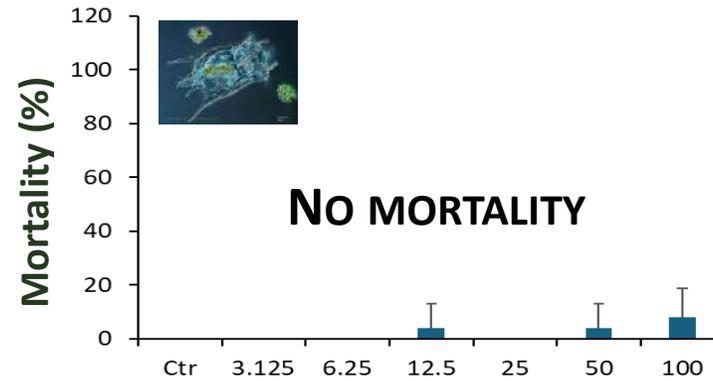
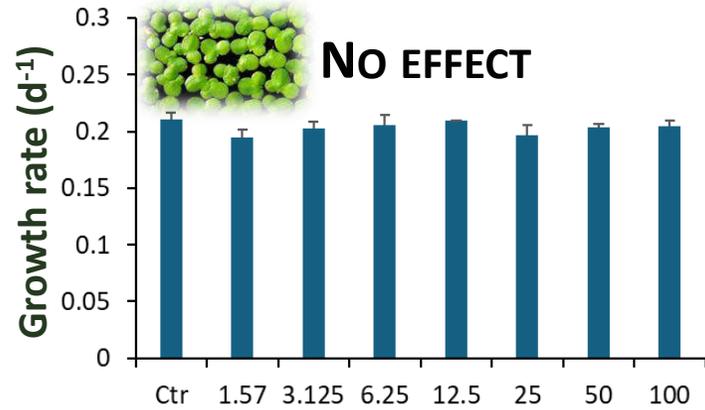
LD<sub>50,96h</sub>  
13.6 %  
(Mortality)

**Carbon fibers least toxic.**

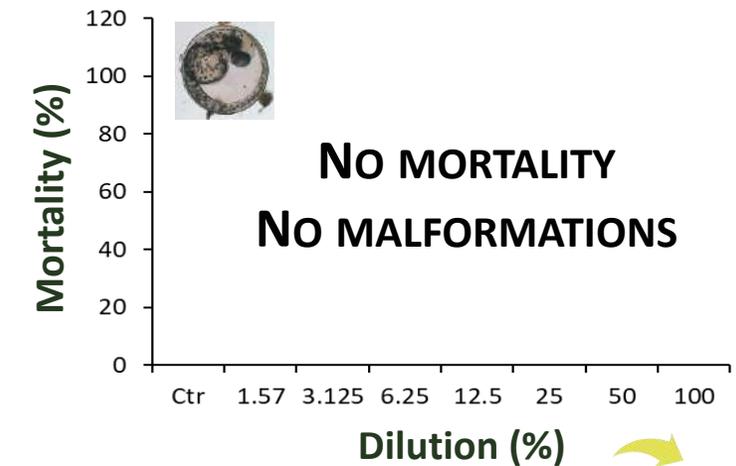
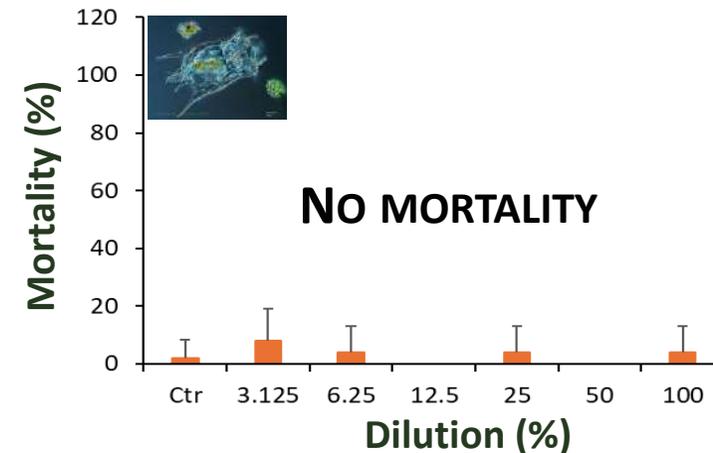
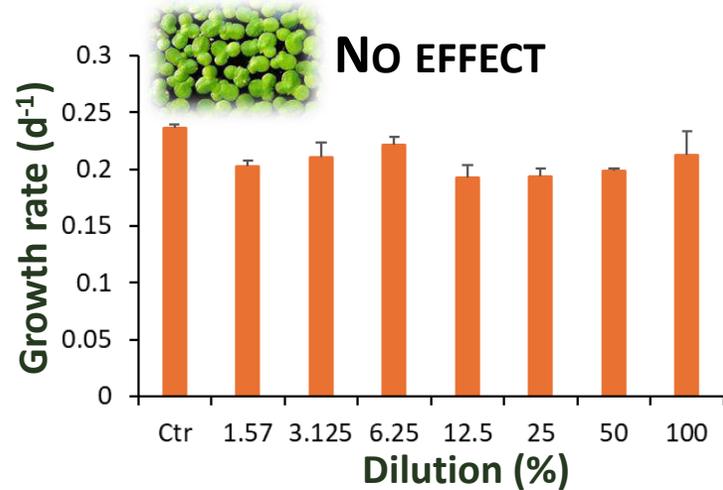
# Freshwater ecotoxicological characterization

## Intermediate formats: PA 5% wood or carbon fibres

PA 5%  
Wood fibres



PA 5%  
Carbon fibres

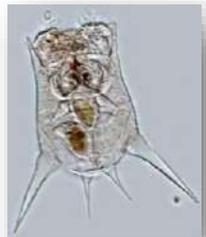
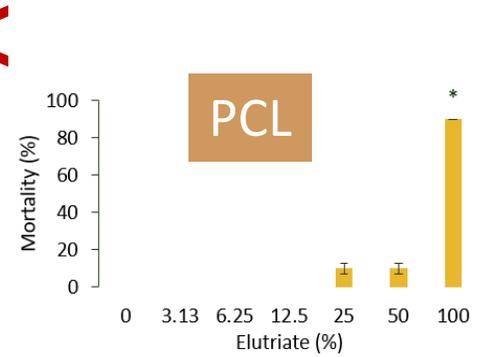
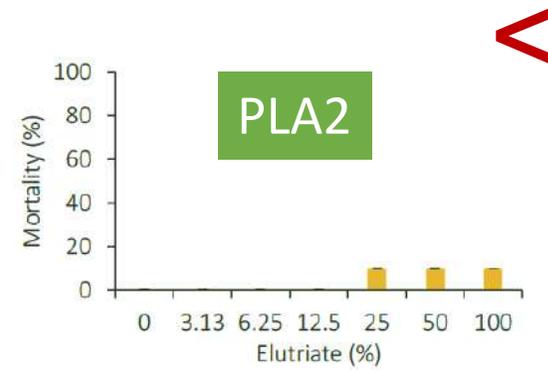
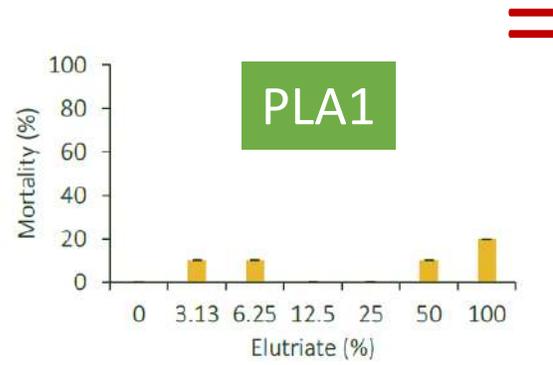
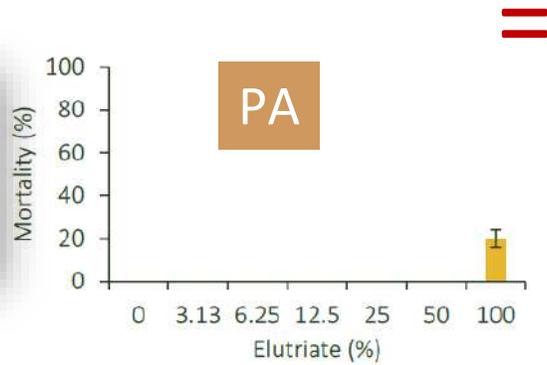


# Freshwater ecotoxicological characterization

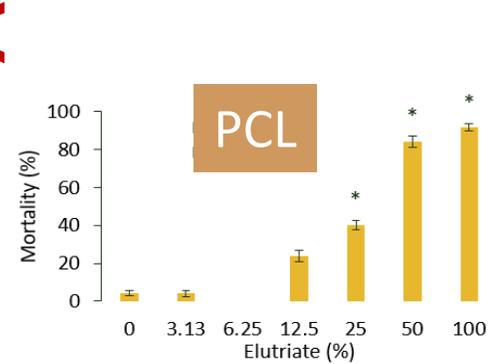
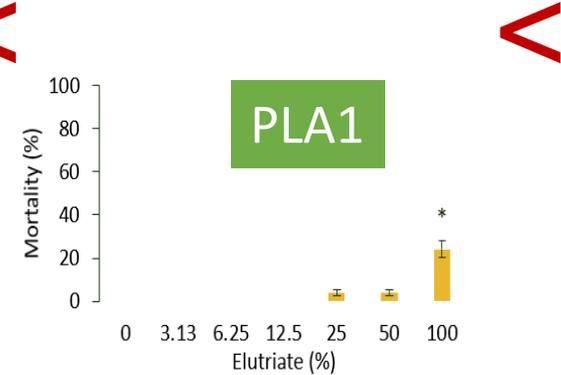
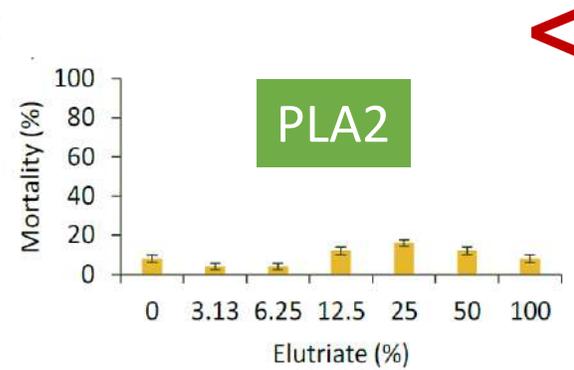
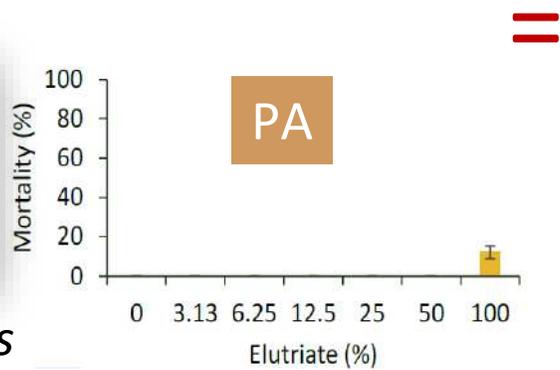
## Polymers



*Danio rerio*



*B. calyciflorus*



# Highlights & lessons learnt

- ❖ Bio-resin, developed within Biouptake, considered safer for the environment than fossil based ones.
- ❖ Fibers incorporated into intermediate formats, developed within Biouptake, did not induced toxicity to aquatic organisms.
- ❖ Bio-based polymers, in general, were not toxic to freshwater organisms, contrarily to PCL (fossil based).

The logo features the text "BIO-UPTAKE" in a bold, white, sans-serif font. The text is centered within a white rounded rectangular border. Two white curved arrows are positioned around the text: one above and one below, both pointing to the right, suggesting a cycle or process.

# BIO-UPTAKE

## **LCA as a tool for the measurement of environmental Impact**

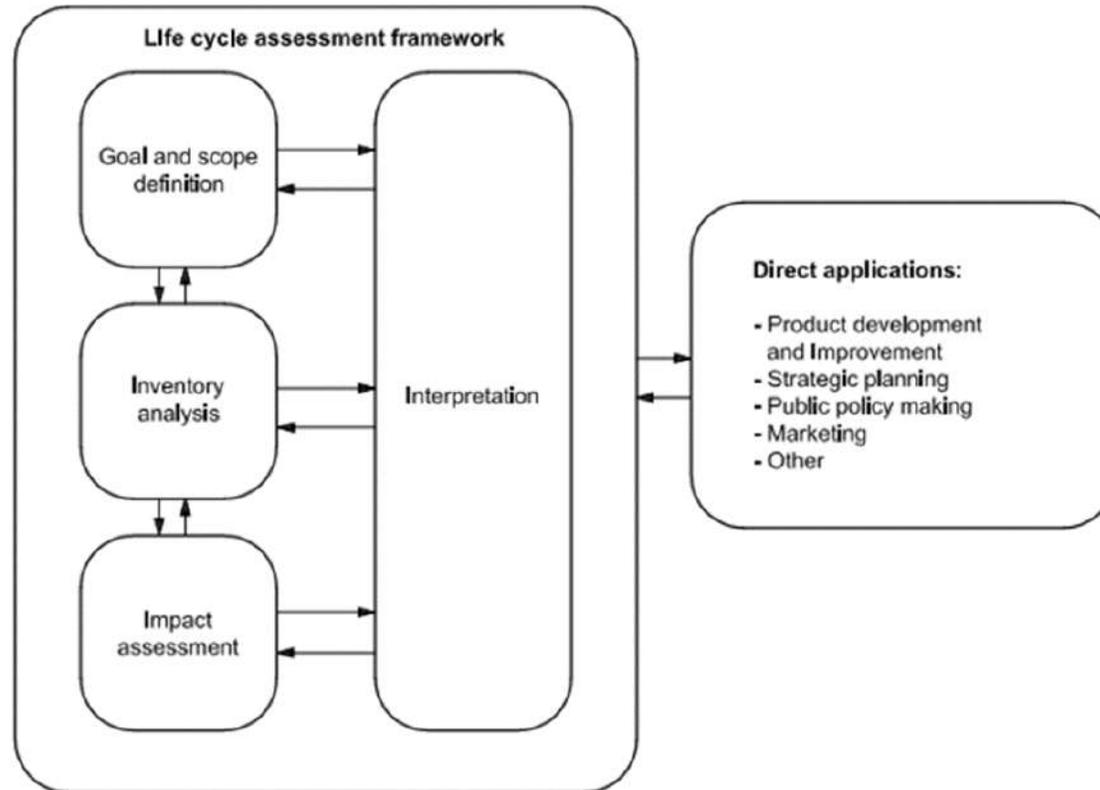
Dr Anne Beaucamp Mc Loughlin, University of Limerick

# What is a life cycle assessment?



- Measures the impacts on the environment associated with the life cycle of a product, process, or service.
- Every part of a product's life cycle can have an impact on the environment in many ways.
- LCA results help to improve the product development, marketing, strategic planning...
- Quantitative evaluation of inputs, outputs and potential environmental impacts of a production system throughout its life cycle.
- We measure the impact of a given process/product (defined by the functional unit) on an environmental category (e.g. GWP, eutrophication, water use, energy use, etc)

# Stages of an LCA



As per the *ISO 14040:2006*

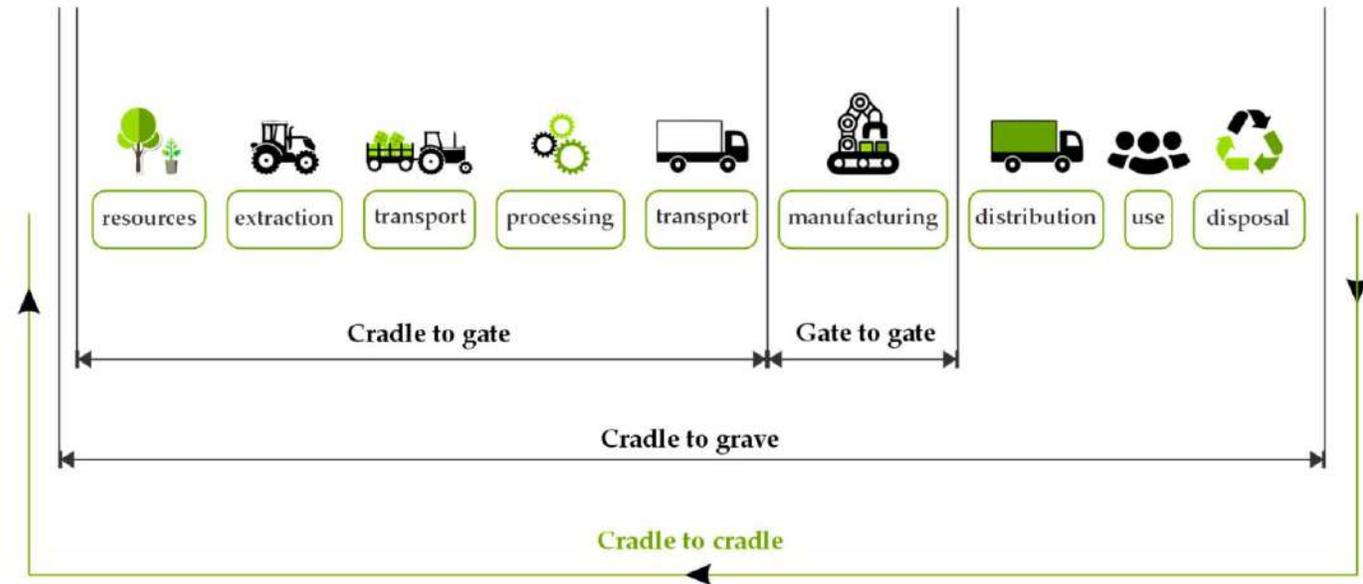
There are four stages:

- *Goal and Scope* – Definition of the functional unit, the system boundaries and methodology.
- *Inventory* – Gathering of the inputs and outputs for processes within system boundaries
- *Impact Assessment* - characterise inputs and outputs according to damage potentials or impacts
- *Interpretation* - Normalisation, weighting, contribution analyses, sensitivity analyses

# Stages of an LCA – Goal and Scope

**Functional Unit** is a quantified description of the function of a product that serves as the reference basis for all calculations regarding impact assessment.

**System Boundaries** - The system boundaries indicate the limits of the system being investigated using the LCA method: The system boundaries define what is included in the system and is therefore analyzed. At the same time, the system boundaries describe what is outside the system and therefore not included in the study.



Bodoga, A.;  
*Sustainability* **2024**, <https://doi.org/10.3390/su16146094>

# How is data collected for the inventory?

Data is shared by the partners through the establishment of questionnaires.

The questionnaires help establishing the functional unit of the study and the input and outputs.

All the data shared by the partners is used. Any gaps are filled by searches in databases (E.G. Ecoinvent).

# Impact Categories (Environmental Footprint (EF) v3.1 method)



CLIMATE CHANGE



WATER USE



LAND USE



ACIDIFICATION



OZONE DEPLETION



HUMAN TOXICITY  
NON-CANCER



EUTROPHICATION  
MARINE



ECOTOXICITY  
FRESHWATER



RESOURCE USE  
MINERALS AND  
METALS



HUMAN TOXICITY  
CANCER



EUTROPHICATION  
TERRESTRIAL



IONISING  
RADIATION



RESOURCE USE  
FOSSILS



PARTICULATE  
MATTER



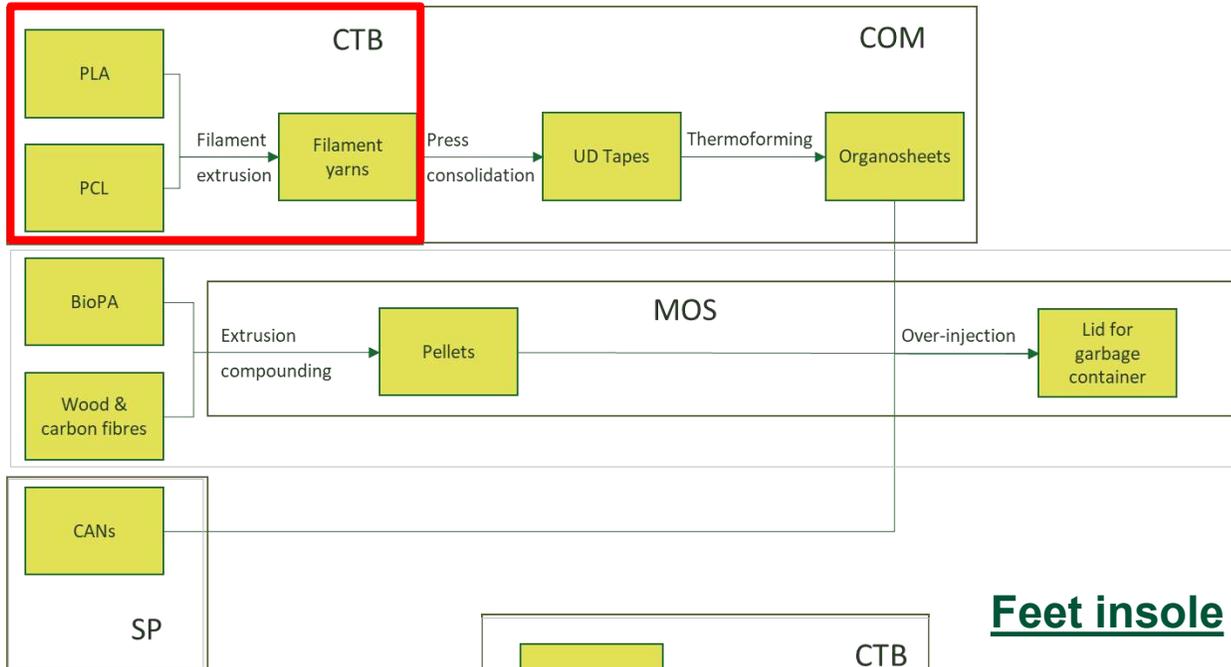
EUTROPHICATION  
FRESHWATER



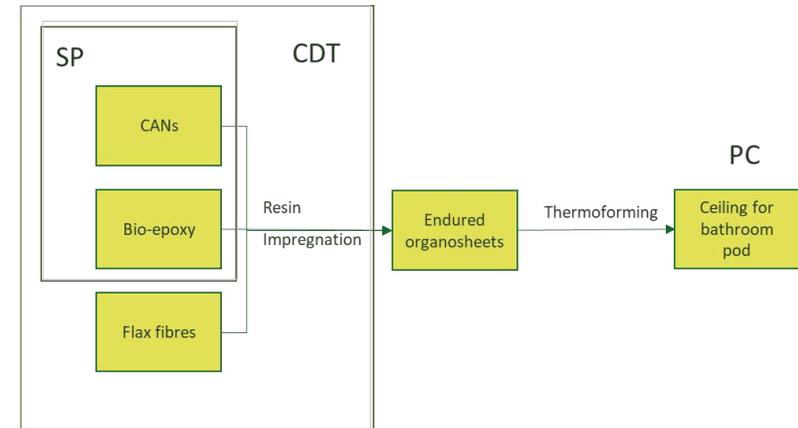
PHOTOCHEMICAL  
OZONE FORMATION

# Bio-Uptake systems

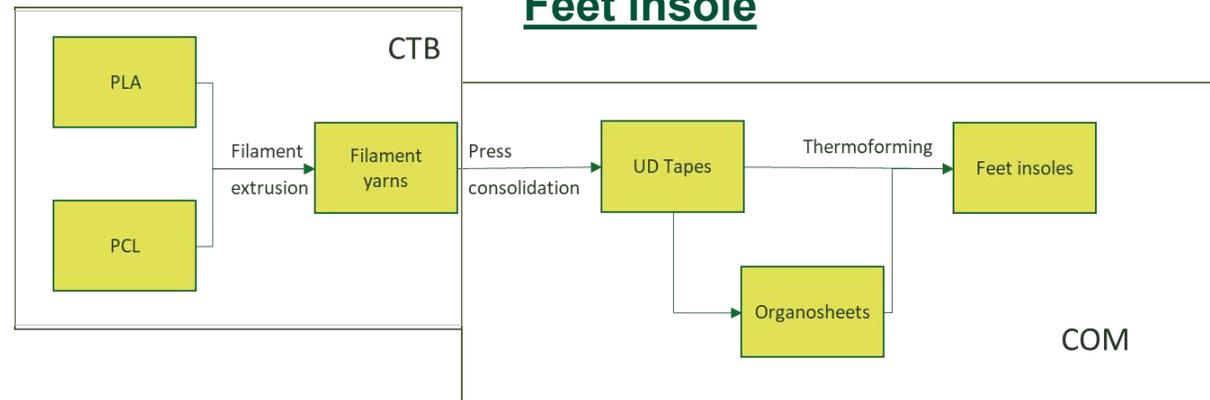
- Bin lid



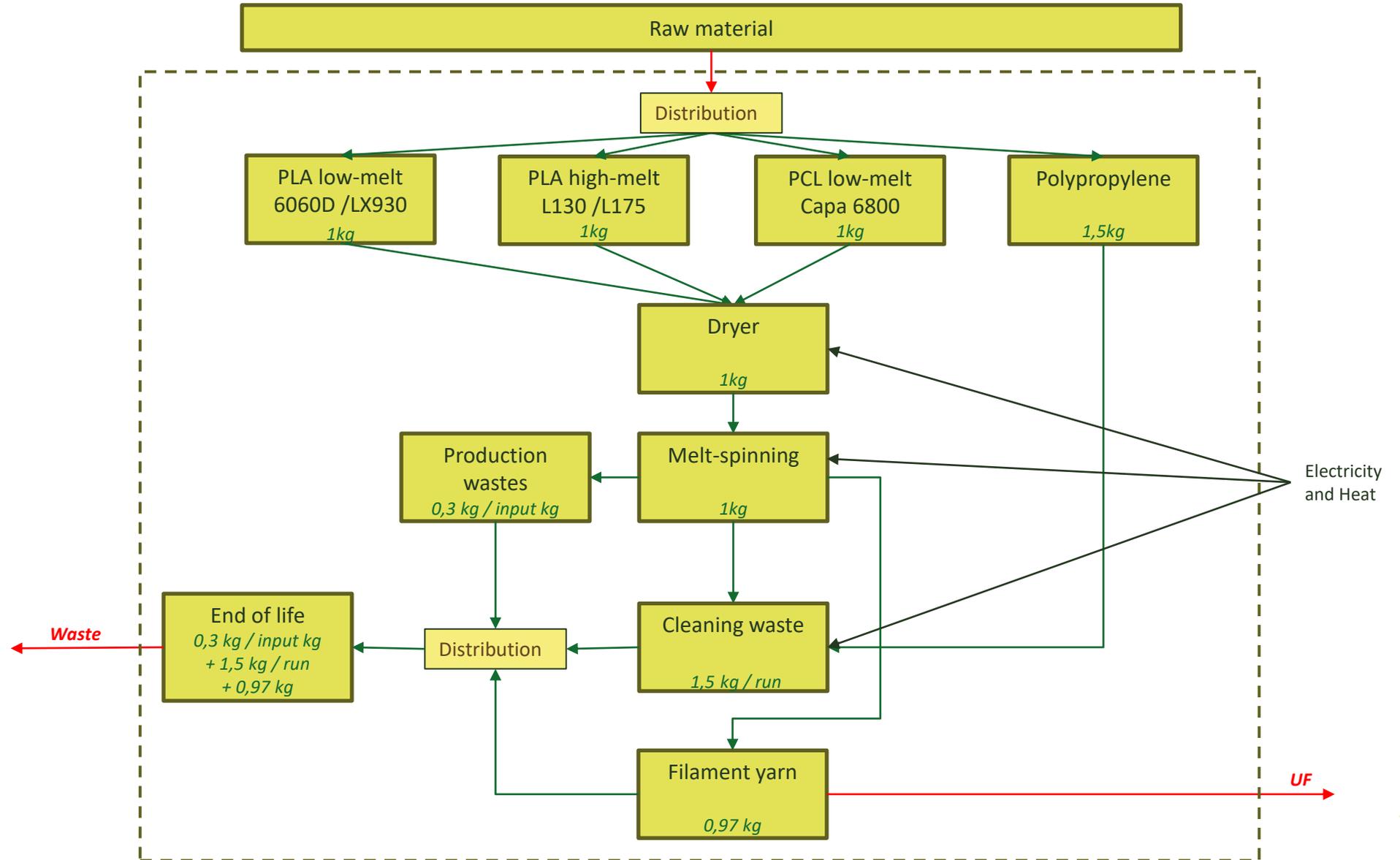
## Ceiling pod



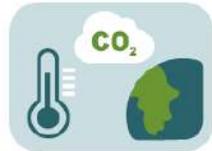
## Feet insole



# Centexbel system model



# Impact Categories (Environmental Footprint (EF) v3.1 method)



**CLIMATE CHANGE**



**WATER USE**



**LAND USE**



**ACIDIFICATION**



**OZONE DEPLETION**



**HUMAN TOXICITY  
NON-CANCER**



**EUTROPHICATION  
MARINE**



**ECOTOXICITY  
FRESHWATER**



**RESOURCE USE  
MINERALS AND  
METALS**



**HUMAN TOXICITY  
CANCER**



**EUTROPHICATION  
TERRESTRIAL**



**IONISING  
RADIATION**



**RESOURCE USE  
FOSSILS**



**PARTICULATE  
MATTER**

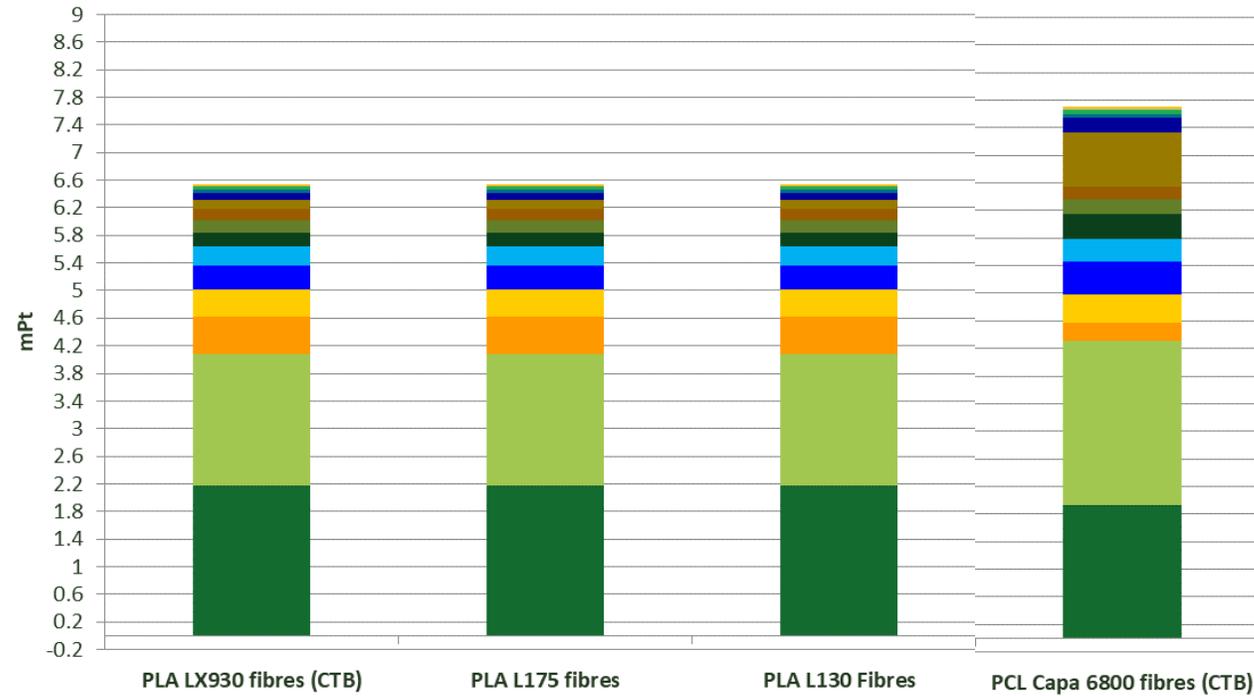


**EUTROPHICATION  
FRESHWATER**



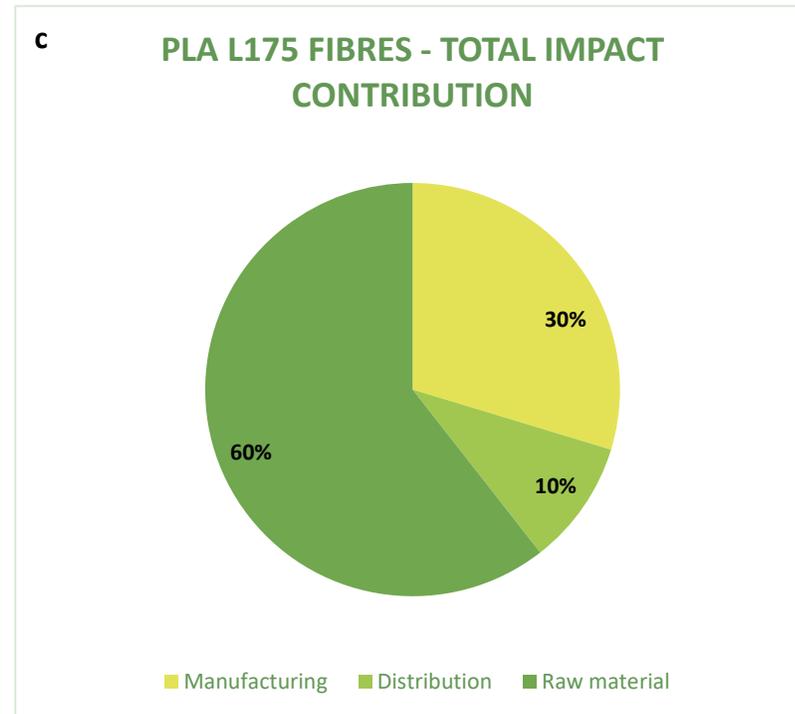
**PHOTOCHEMICAL  
OZONE FORMATION**

# Results Representation

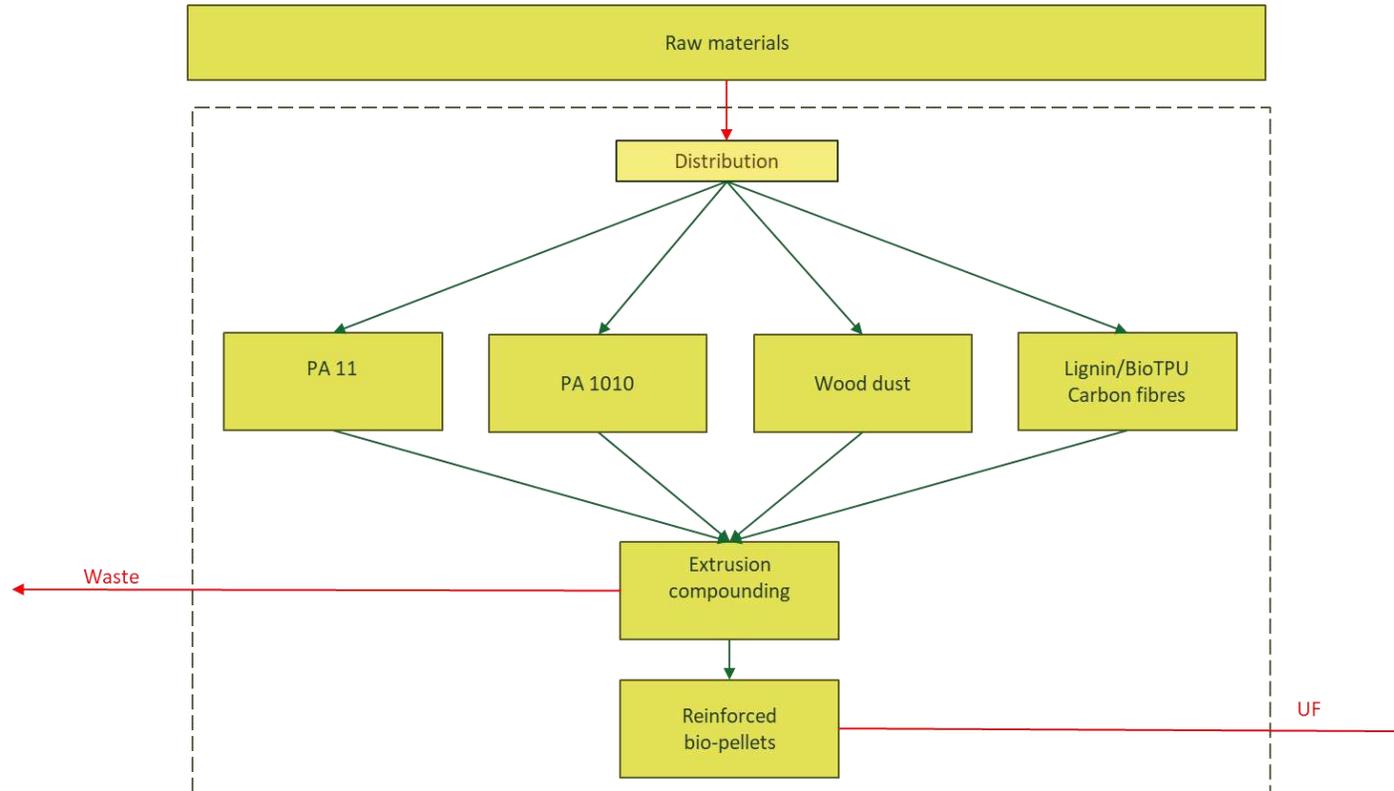


- Climate change
- Resource use, fossils
- Eutrophication, freshwater
- Photochemical ozone formation
- Acidification
- Ionising radiation
- Water use
- Eutrophication, terrestrial
- Eutrophication, marine
- Particulate matter
- Ecotoxicity, freshwater
- Land use
- Human toxicity, non-cancer
- Resource use, minerals and metals
- Human toxicity, cancer
- Ozone depletion

# Further Analysis

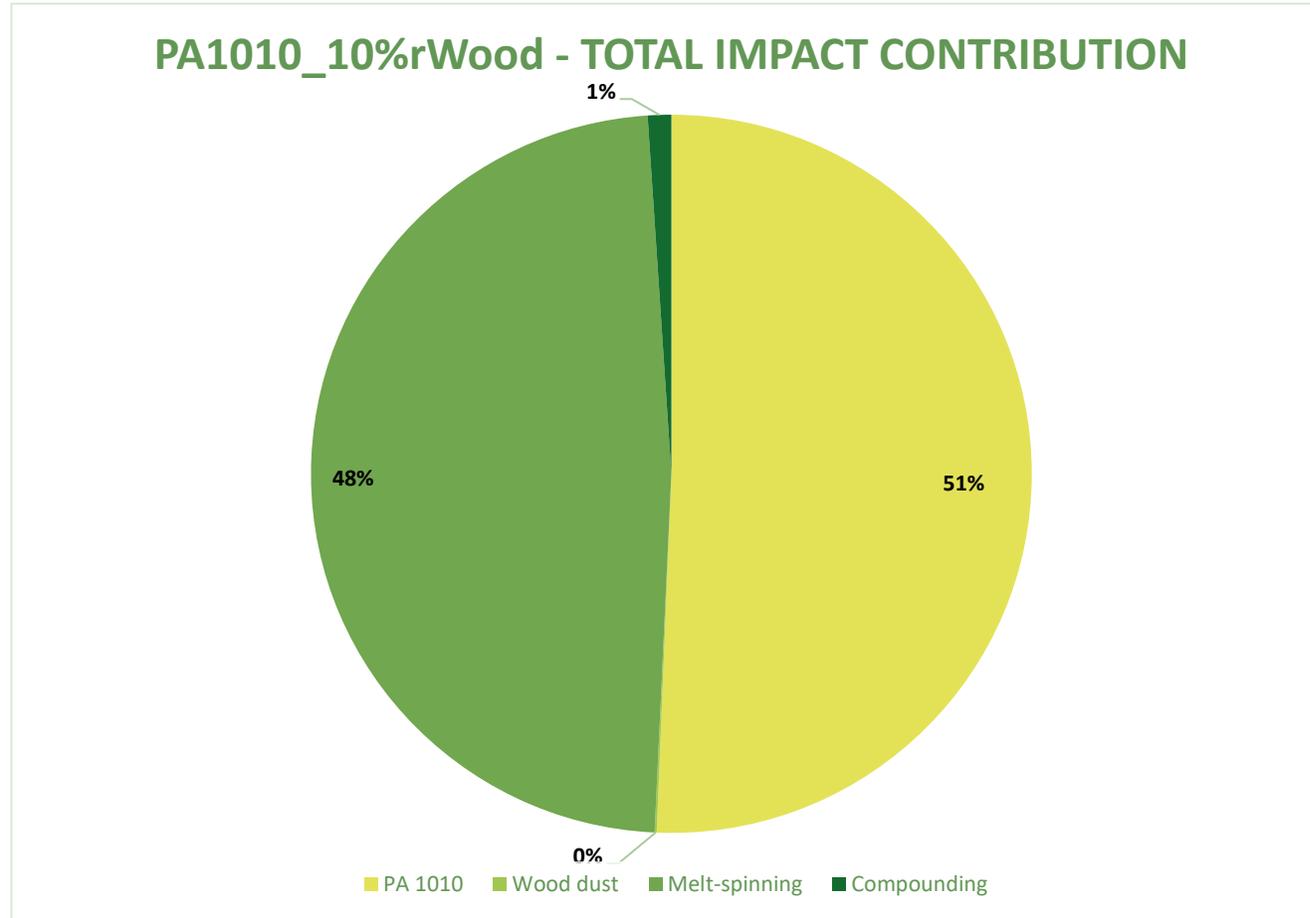


# MOSES Model





# Further analysis



# Current Work

Assembling of the products model

Going beyond Cradle to gate:

Evaluation of Use phase Impact based on the data shared with the partners;

Establishment and modelling of the end-of life Processes;

Comparison with the benchmarks

# Take Home Message

- LCA is a standardized, systematic, and quantitative method which allows to evaluate the environmental impacts of a product, process, or service throughout its entire life cycle;
- The LCA allows to make informed decision on the design of the product early in its conception and production processes;
- LCA also highlights hot-spots in the production of the material, allowing for early remediation where possible.

A white circular arrow icon consisting of two curved arrows forming a circle, positioned to the left of the main text.

# BIO-UP TAKE

## **Sustainability - FAQ**

Dr Anne Beaucamp Mc Loughlin, University of Limerick

09/02/2026



# BIO-UPTAKE

**Thank you!**

**Funded by the European Union under GA 101057049.** Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. The European Union cannot be held responsible for them.



Funded by  
the European Union

