



***Recent advances in improving
circularity of PLA bioplastics:***

***Keeping biobased carbon in
the loop :***

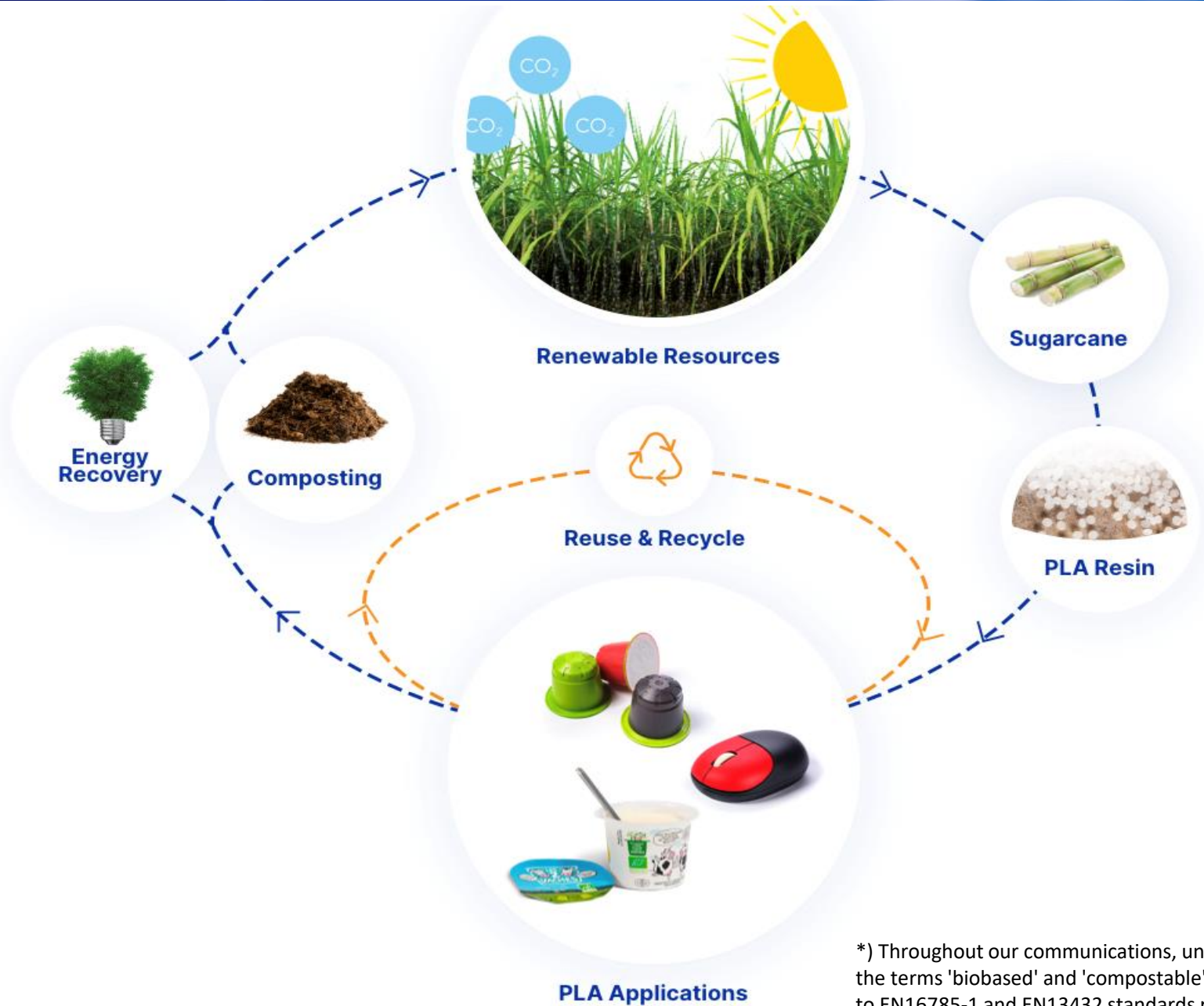
again and

again and

again and ...

François de Bie

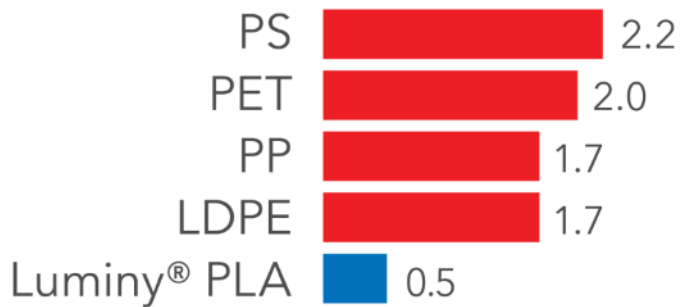
The biobased carbon loop with Luminy® PLA



*) Throughout our communications, unless otherwise specified, the terms 'biobased' and 'compostable' or 'biodegradable' refer to EN16785-1 and EN13432 standards respectively.

PLA carbon footprint

Carbon Footprint Emissions from production of common polymers* (kg CO₂ eq per kg polymer)



Sources: www.lca.plasticseurope.org and Int. Journal Life Cycle Assessment, 'LCA of the manufacture of lactide and PLA...' 3 Aug 2010.

Growth of bioplastics market confirmed by research reports

*Global Biodegradable Plastics Market is expected to grow at approximately **12.25% CAGR** during the forecast and reach **USD 29.75 Billion by 2030.***

Market Research Future

*“The Italian market for biodegradable products experienced **30% growth** from 2020 to 2021”*

Plastic Consult 2021

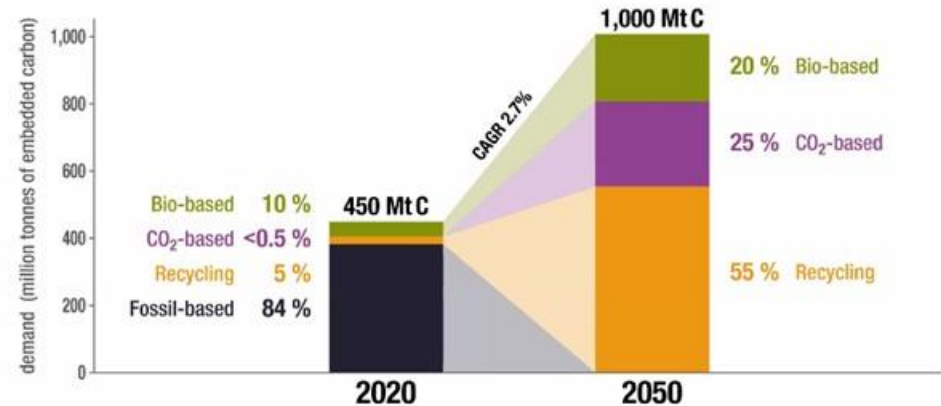
“The bioplastics market is driven by ... government regulations in Europe, green procurement policies, and shift in consumer preference toward eco-friendly and biodegradable plastic products. High potential in India and China and multi-functionalities of PLA ... ”

Research and Markets

*The **CAGR for bioplastics is 8%** , significantly higher than the overall growth of polymers (3-4%) – this is expected to continue until 2025.”*

Nova institute

Global Carbon Demand for Chemicals and Derived Materials
in 2020 and Scenario for 2050 (in million tonnes of embedded carbon)



NOVA Institute 2022

*“The **PLA market** was valued at \$0.7 billion in 2020, and is projected to reach \$4.0 billion by 2030, growing at a **CAGR of 17.2% from 2021 to 2030.**”*

MG Research and Markets

The (draft) Packaging & Packaging Waste Legislation

The proposed revision of the EU legislation on Packaging and Packaging Waste has three main objectives:

1. prevent the generation of packaging waste: reduce it in quantity, **restrict unnecessary packaging** and **promote reusable and refillable packaging solutions**.
2. boost high quality ('closed loop') recycling: make **all packaging on the EU market recyclable** in an economically viable way by 2030.
3. reduce the need for primary natural resources and create a well-functioning market for secondary raw materials, **increasing the use of recycled plastics** in packaging through mandatory targets.

The headline target is to **reduce packaging waste by 15%** by 2040 per Member State per capita, compared to 2018. It will happen through **both reuse and recycling**.

Many measures aim to make packaging **fully recyclable by 2030**.

There will also be **mandatory rates of recycled content that producers have to include in new plastic packaging**.

The recycling targets in the PPW Legislation

Recycled content target for 2030:

- 30 % for contact sensitive packaging made from polyethylene terephthalate (PET) as the major component;
- **10 % for contact sensitive packaging, except single use plastic beverage bottles, made from plastic materials other than PET;**
- **30 % for single use plastic beverage bottles;**
- **35 % for other packaging**

Recycle content amounts for 2040:

- 50 % for contact sensitive packaging made from polyethylene terephthalate (PET) as the major component;
- 65 % for single use plastic beverage bottles;
- 65 % for other packaging

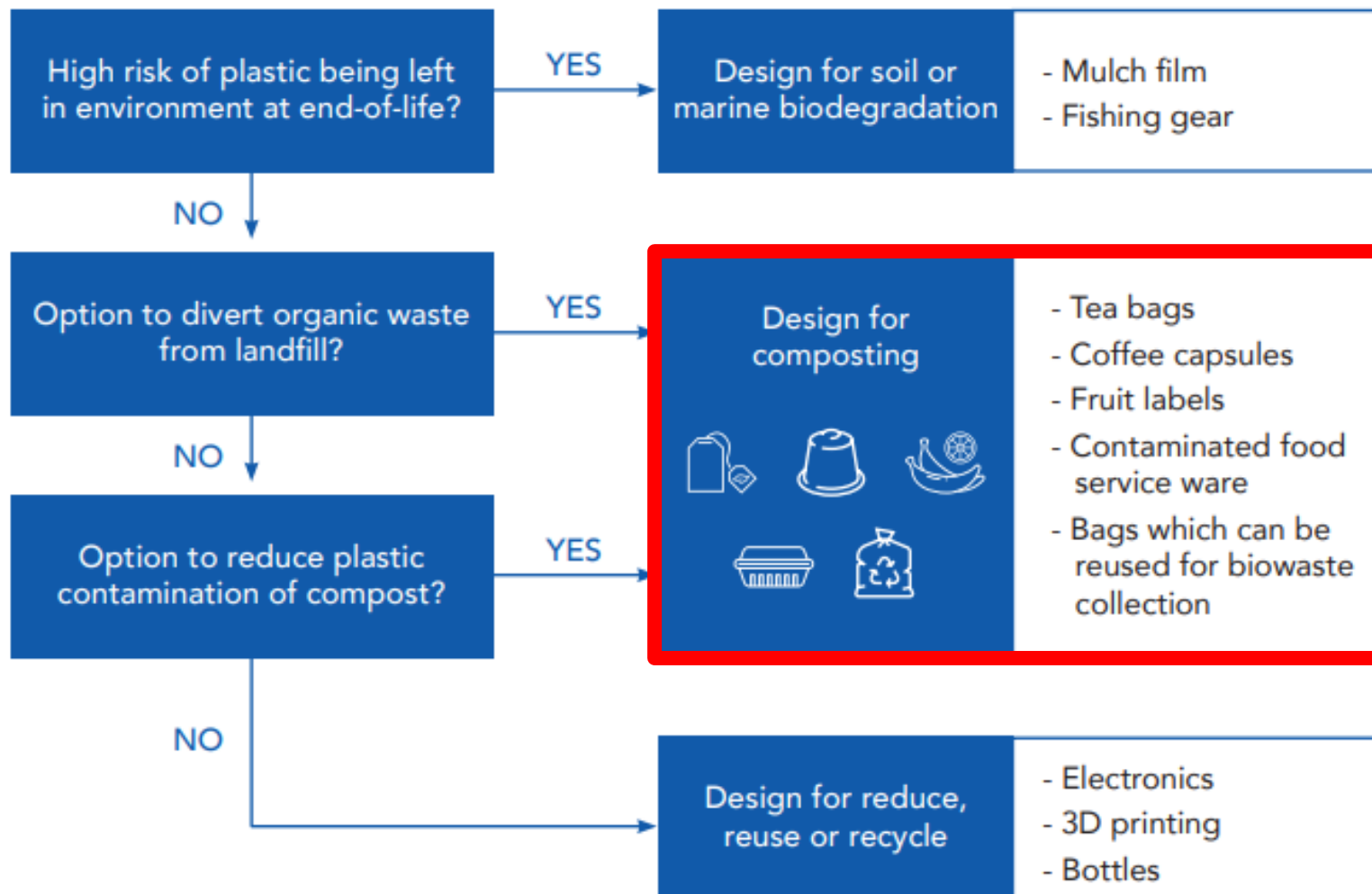
The targets does not apply to compostable plastics (going to composting).



Preferred end of use solutions for Luminy® PLA

1. *Industrial Composting*
2. *Recycling*

Decision Tree for PLA End of Life



Composting benefits

Composting organic waste and PLA produces high quality compost...



Free from persistent microplastics pollution



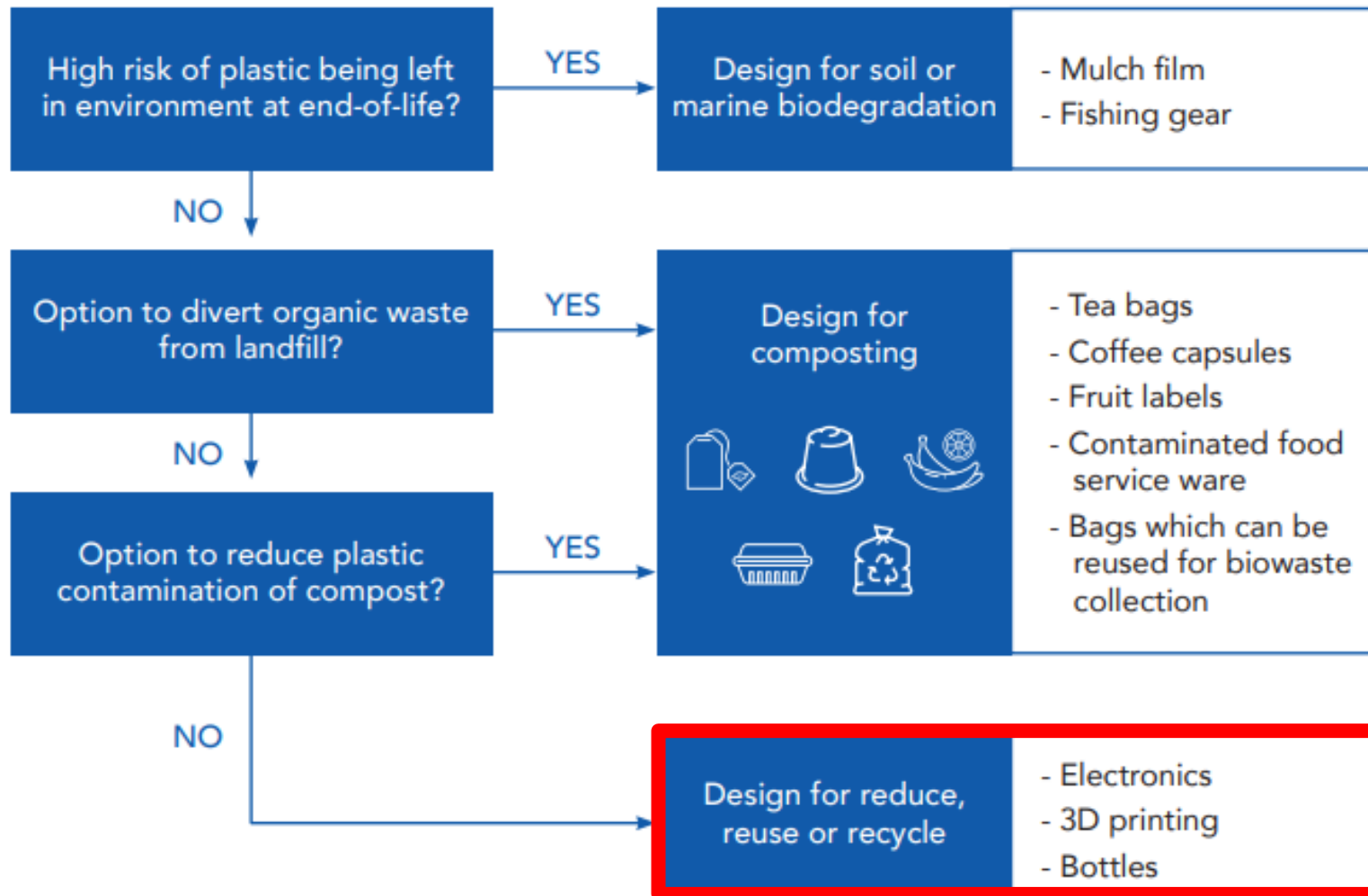
Reducing the use of chemical fertilizers



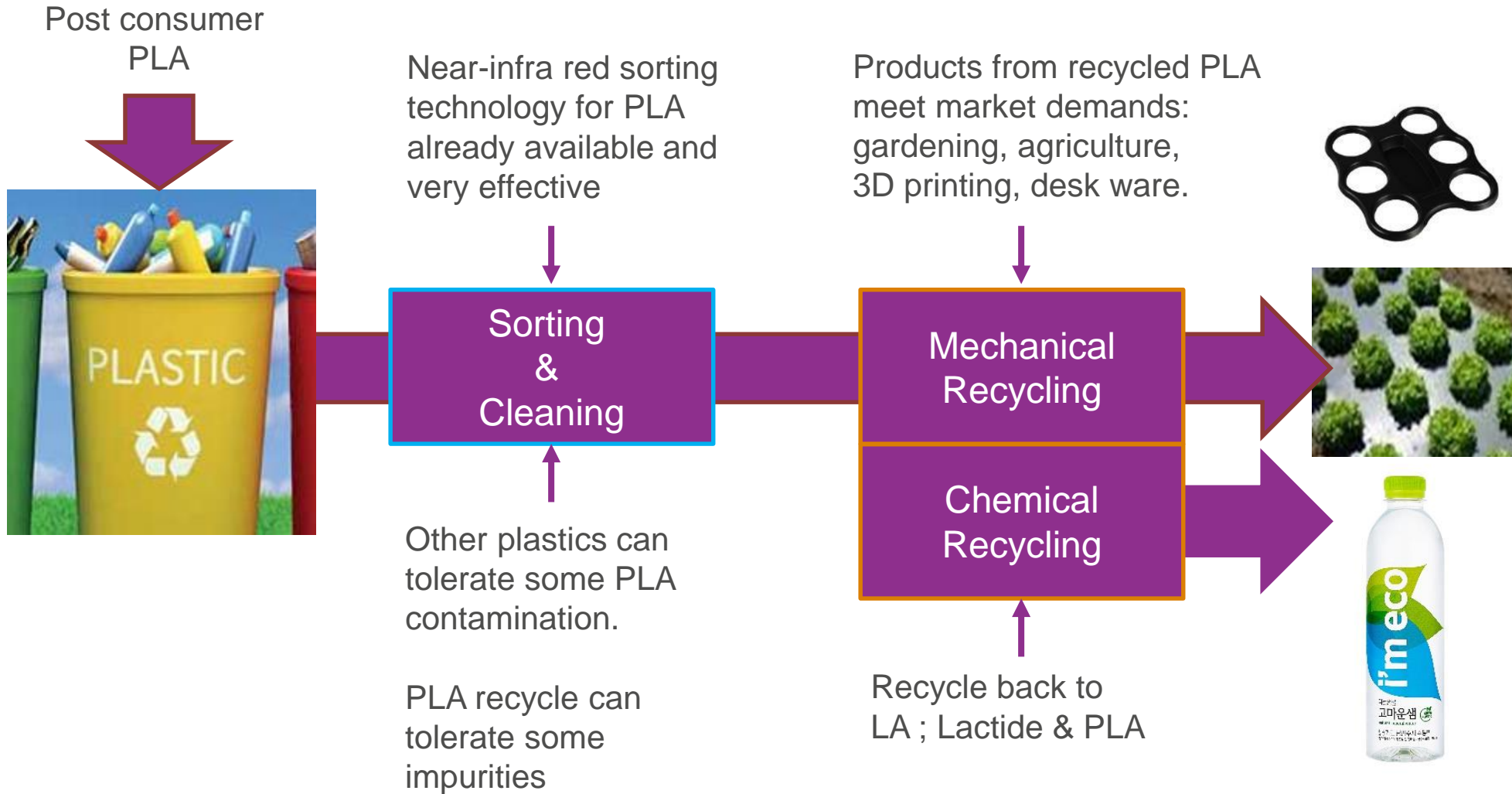
Bringing back carbon to the soil and providing soil nutrients

BACK TO EARTH

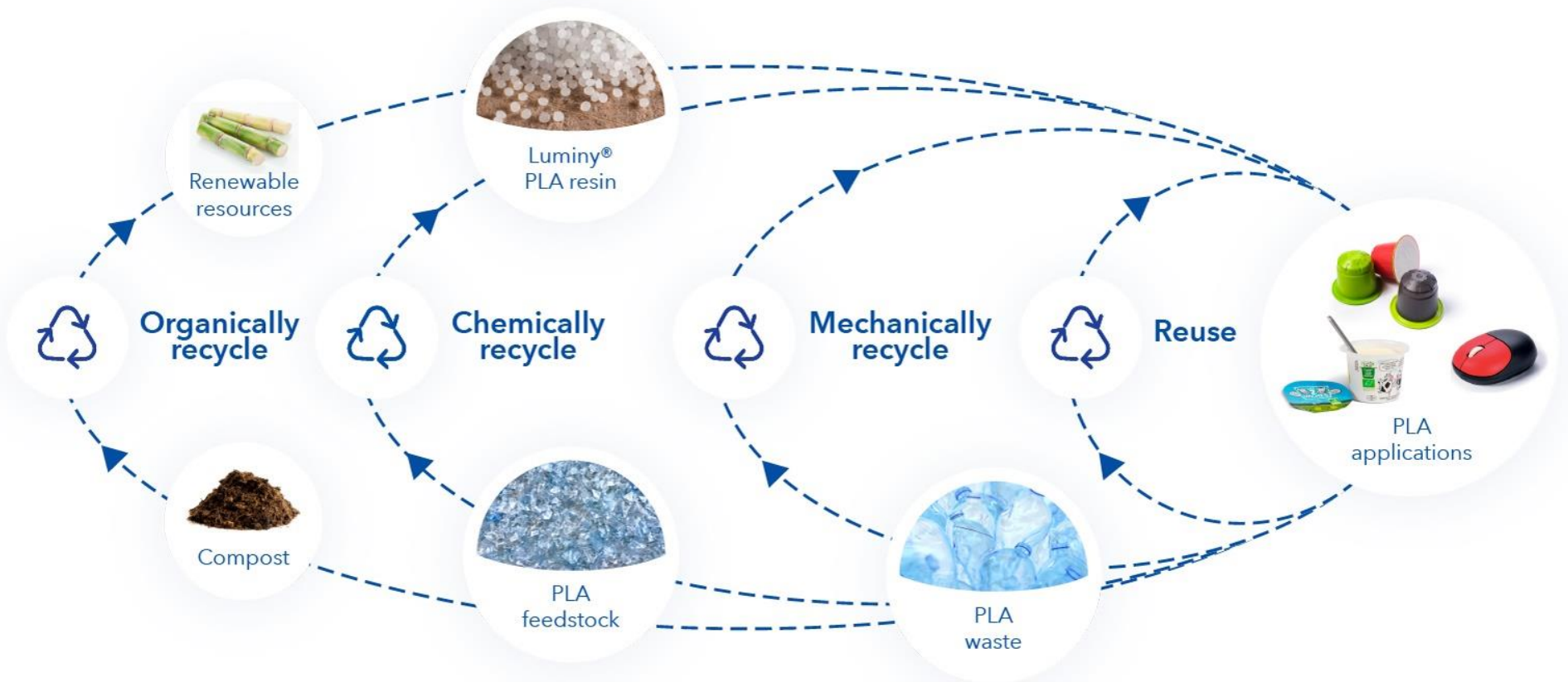
Decision Tree for PLA End of Life



PLA can be mechanically or chemically recycling



Closing the loop with Luminy® PLA



***Keeping biobased carbon in the loop : again and
again and
again and
again ... !***

Case Study: Luminy® RMB grades – 20% recycle content

Partnership on bottle-to-bottle PLA recycling with Korean customer Sansu



Luminy® PLA made from chemically recycled feedstock now commercially available

Total Corbion PLA has launched the world's first commercially available chemically recycled bioplastics product. The Luminy® recycled PLA grades boast the same properties, characteristics and regulatory approvals as virgin Luminy® PLA, but are partially made from post-industrial and post-consumer PLA waste. Total Corbion PLA is already receiving and depolymerizing reprocessed PLA waste, which is then purified and polymerized back into commercially available Luminy® rPLA.



Photo 1: The closed-loop end-of-life solutions enabled when using Luminy® PLA now also include chemical recycling.

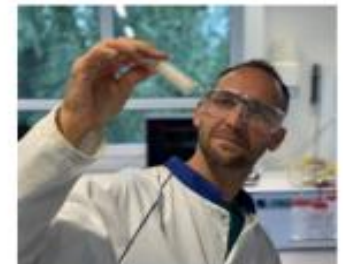


Photo 2: Geoff Gobius du Sart, Corporate Scientist at Total Corbion PLA, inspects the first batch of chemically recycled Luminy® rPLA pellets.

PLA advanced recycling value chain

The purified LA is used again as feed at the start of our polymerization process to make Luminy® PLA

Recycled content is allocated using mass balance approach. Currently we offer a rPLA with 20% recycle content.

PLA feed is used by our plant in Thailand as a raw material: The PLA feed will be hydrolized back to the LA building blocks.

Specialized companies collect, sort, clean & pelletize the 'PLA waste' and supply TotalEnergies Corbion with PLA feed

Customers can use Luminy® PLA with or without recycled content

Post-industrial and post-consumer PLA waste



Collaboration with:



Existing NIR equipment can be used to sort PLA



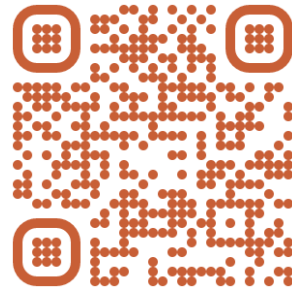
Sorting trials done at Tomra PLA trays sorted from mixed municipal plastic waste (1)



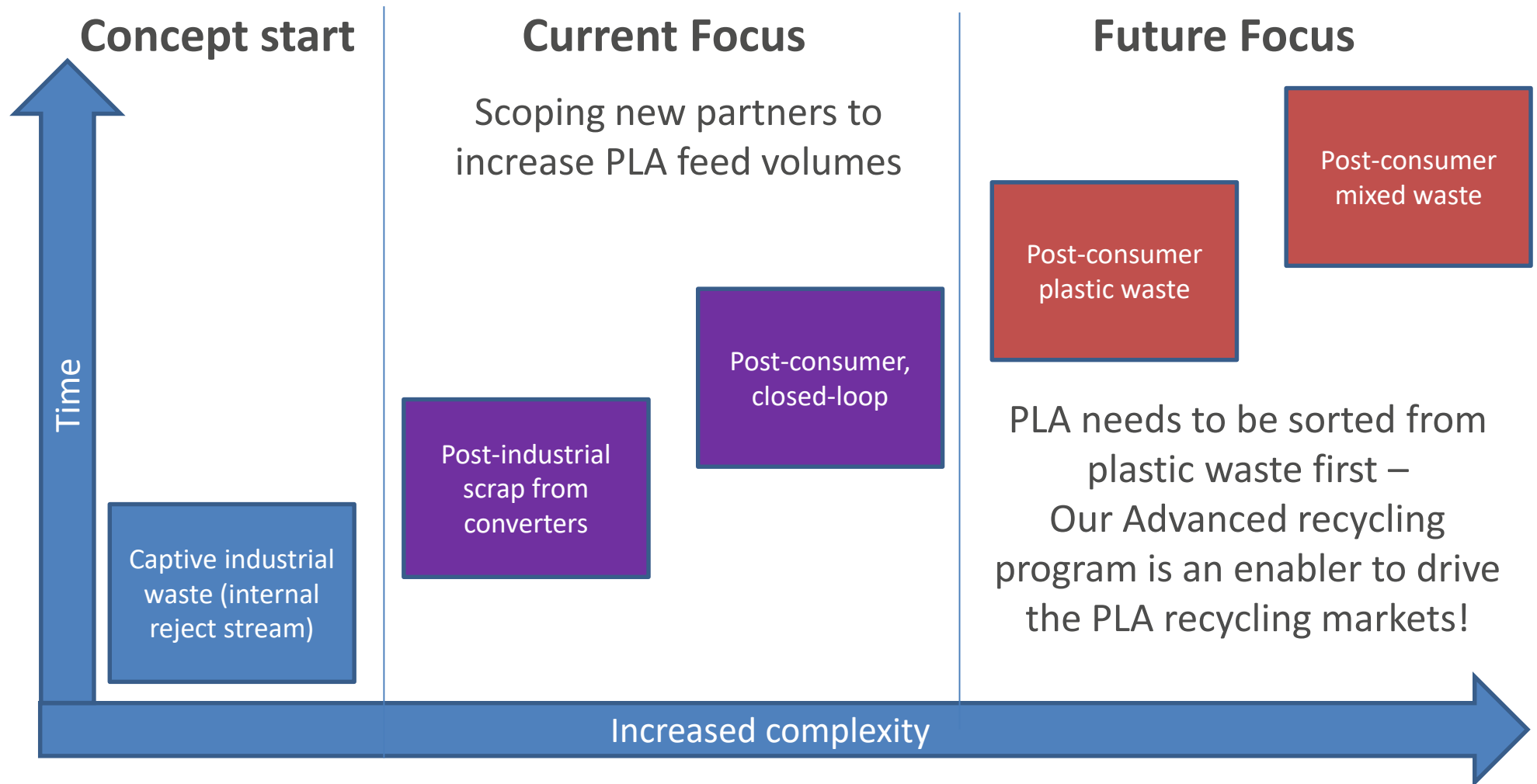
Sorting trials done at Tomra PLA trays sorted from mixed municipal plastic waste (2)



Please see our video on YouTube with the results of these sorting trials.



Recycling of PLA – our roadmap & commitment



**Call for action: if you have good quality PLA scrap, waste, recycle
→ let us know as we will make you an offer !**

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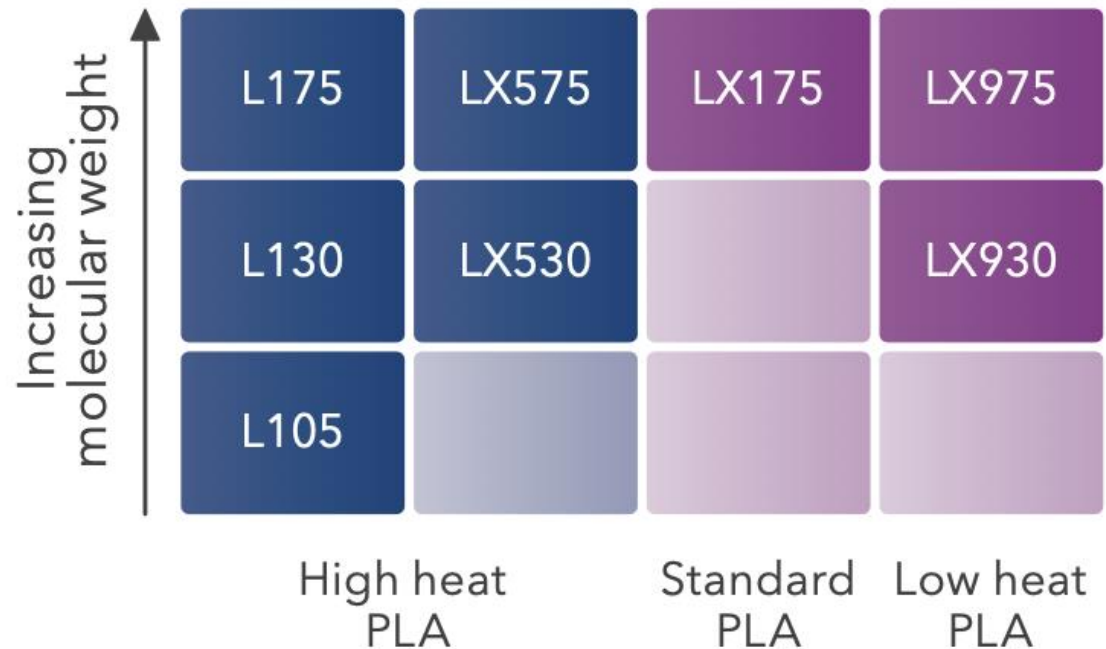
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Recycling of PLA – our commercially available grades



20% RECYCLED CONTENT
POST-CONSUMER/PRE-CONSUMER
MASS BALANCE ALLOCATION



Luminy rPLA RMB20 portfolio has been 3rd party certified.

Example:

Luminy LX175 RMB20: has been certified to contain 20%



Recycling of PLA – our “Stay in the cycle” campaign

Stay in the cycle

Rethinking recycling with PLA bioplastics



Advantages of Luminy® PLA bioplastics

Performing and sustainable polymer solution

- Made from sustainably grown raw materials
- Favorable CO₂ footprint (~75% less CO₂ emission vs oil-based alternatives)
- Comparable mechanical and physical performance to PS/PET/PP/PE
- High heat performance
- Biodegradable/Compostable EN13432
- **Mechanically Recyclable**
- **Easy to sort from mixed municipal plastic waste using NIR technology**
- **Chemically Recyclable – 20% recycle content grades are commercially available!**





Throughout our communications, unless otherwise specified, the terms 'biobased' and 'compostable' or 'biodegradable' refer to EN16785-1 and EN13432 standards respectively. It is the responsibility of the article producer to ensure that claims on final products are substantiated by testing against the relevant standards. Check your locally available end-of-life infrastructure to ensure that legitimate end-of-life claims are made on the final product.

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PLA to substitute PS, PE, ABS and PET

Functionalities

- Biobased EN16785-1
- Biodegradable and compostable EN13432
- Reduced CO₂ footprint
- High mechanical strength
- Reduced littering
- Good gloss / printability
- EU legislation to support bio shopping bags
- Styrene free
- PLA can be processed on existing PS/PET production lines

Markets & Applications



Dairy packaging



Food Serviceware
Clam shells



Shopping bags



3D printing



PLA mulch film



Non wovens
Face masks

High heat PLA to substitute ABS, PP and engineering plastics

Functionalities

- Biobased EN16785-1
- Reduced CO₂ footprint
- Eco-labels in consumer electronics
- Biodegradable (under the right conditions)
- High heat resistance (140°C)
- High impact strength
- Good scratch resistance
- High gloss

Markets & Applications



Consumer electronics



Auto Interior trim



Bank/gift cards



Coffee capsules



Cosmetic Packaging



3D printing

PLA for injection molded cosmetics packaging

Benefits:

- Biobased
- Quality feel
- Weight of the part
- Good processing economics
- Replacing Thermoset



PLA for injection molded re-usable lunch box

Benefits:

- Biobased
- Reduced CO2 footprint
- Food contact approved
- Bright colors
- Dishwasher safe
- BPA & Melamine free



boplast[®]

Acorn Artistic

PLA for 3D printing – Remote Control (RC) planes

High Heat – Low Weight compound:

- Compound based on Luminy L175 + PHA + other additives.
- The printed material is foamed to reduce weight and density
- Compound developed in close collaboration with colorFabb
- Compound made 'in-line' by colorFabb

Benefits:

- Reduced density – the total plane is ultra light weight
- Ease of printing of very thin sections
- High heat – can withstand the heat of the sun while in flight or on the runway
- Specifically developed for hobbyist that print remote control planes at home

color**Fabb**



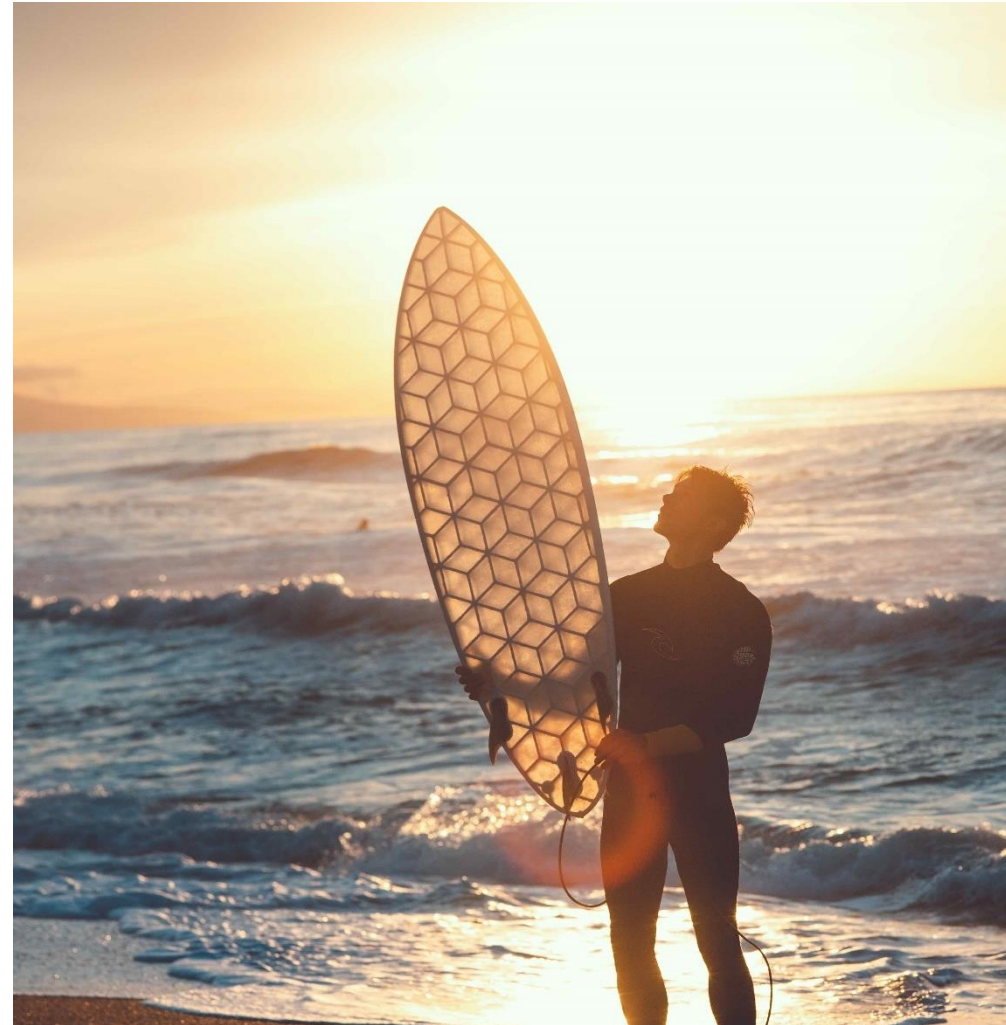
PLA for a 3D printed surfboard

3D printed surfboard:

- The core is a hexagonal, stiff and lightweight structure
- The core is 3D printed to allow for a wide range of different board designs
- Top layer is a fiberglass-epoxy laminate

Benefits:

- Design flexibility – many different board designs are possible.
- High strength & stiffness at low weight
- Innovative ‘look & feel’
- Biobased content reduces the environmental impact



PLA for tea bags & coffee pads

Benefits:

- Biobased
- Compostable
- High heat resistance: can withstand boiling water
- Aroma neutral
- Soft & silky touch
- Less contamination of organic waste with plastics
- Could become legislated in EU in the near future



PLA for high heat injection molded coffee capsules

Benefits:

- Biobased
- Compostable
- High heat resistance: can withstand boiling water
- Good barrier properties
- Good processing economics



PLA for injection molded root trainers for rubber trees

Benefits:

- Biobased
- Biodegradable
- Strength & stability
- Reduced accumulation of plastics in the environment



PLA for automotive industry

World's first biobased, circular car created using Luminy® from Total Corbion PLA

- Car chassis and all bodywork made from natural and biobased materials.
- No metal or traditional plastics were used for structural parts of the car.
- Designed by the TU/ecomotive team at Technical University of Eindhoven.

Benefits:

- Biobased
- Durable
- Recyclable
- Reduced carbon footprint
- Excellent surface appearance
- Good impact resistance

