# PLA Bioplastics

for a brighter future

## Jornades EIC

**Biopolimers, una solució sostenible per la circularitat**

TotalEnergies Corbion

# TotalEnergies Corbion in BioPlastics

*Bioplastics general overview*

# European Bioplastics definition of bioplastics

## BIOPLASTICS

**are**

**biobased**
**e.g. bio-PE**

**biodegradable**
**e.g. PBAT**

**or both**
**e.g. PLA**

*Oxo-degradable polymers – NOT to be considered as bioplastics*

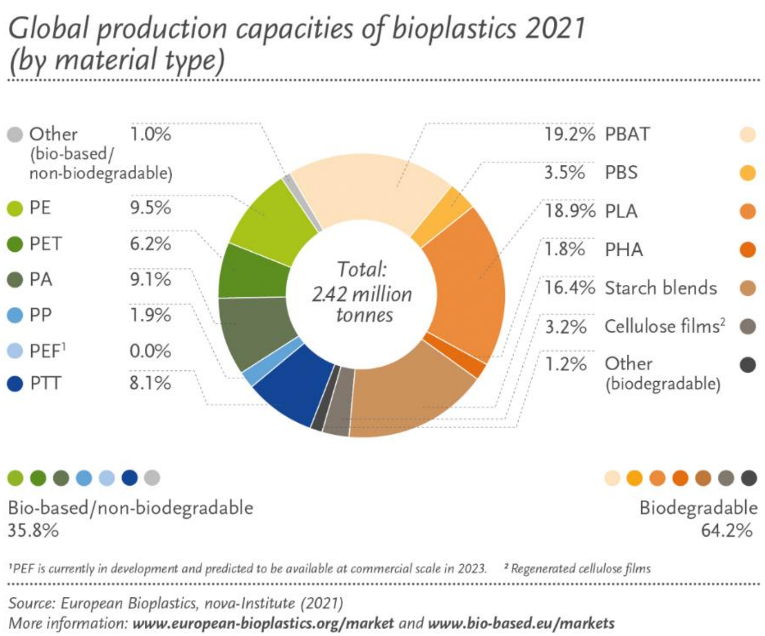
- Polymers made from fossil fuels that fragment into micro plastic pieces which will not further degrade (= worse for the environment than traditional plastics)

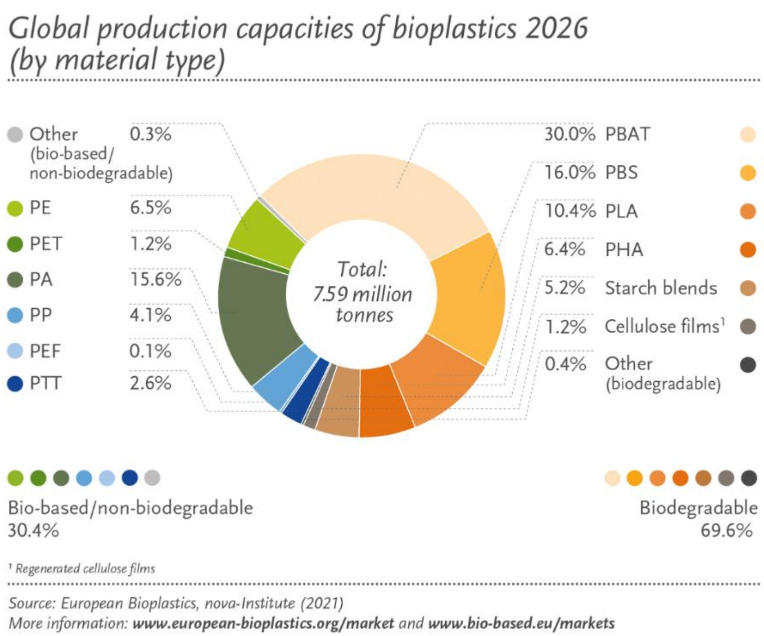
# Bio-based & compostable plastics market 2021 vs 2026

## Fast growing enabler of the circular economy

### *Material development and diversification*

*Bioplastic alternatives exist for almost every conventional plastic material and corresponding application. Due to a strong development of polymers, such as PBAT (polybutylene adipate terephthalate) but also PBS (polybutylene succinate) and PAs (polyamides) as well as a steady growth of polylactic acids (PLAs), the production capacities will continue to increase significantly and diversify within the next 5 years.*




Source: European Bioplastics

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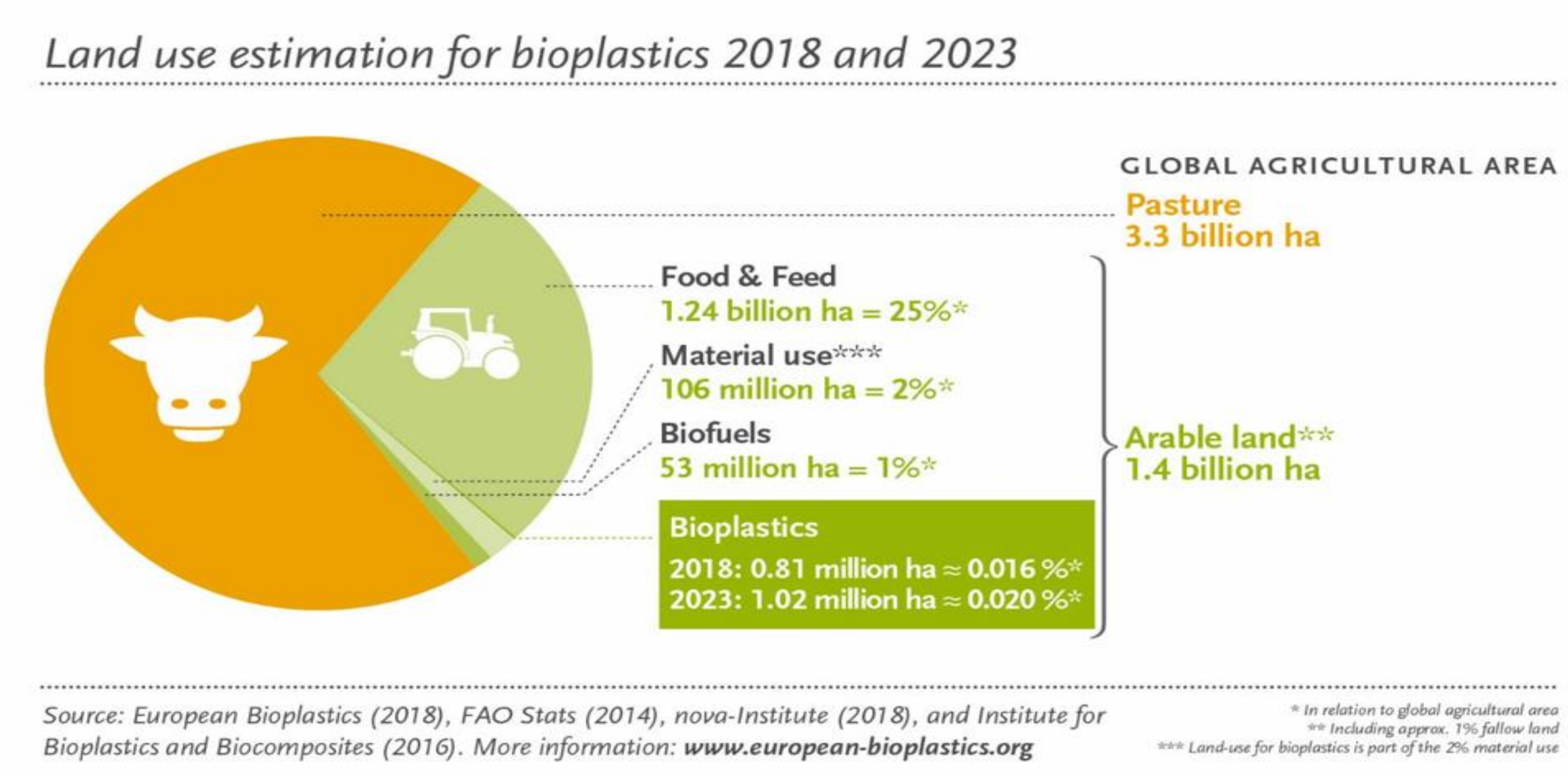
# Land use for bioplastics 2018 and 2023

*Bioplastics are nowhere near to competing with food and feed*



# Introducing TotalEnergies Corbion

*Bio-based products, powered by nature, designed by science, & delivered through our dedication*

# Two parent companies with complementary strengths

| | TotalEnergies | Corbion |
|---|---|---|
| **Position** | World's 4th largest oil & gas company | World's largest lactic acid producer |
| **Headquarters** | Courbevoie, France | Amsterdam, the Netherlands |
| **Revenue** | $ 209 B | $ 1 B |
| **Employees** | 100,000 | 2,040 |
| **Main businesses** | Oil & Gas, Solar & Bioenergy, Commodity & Specialty Chemicals | Food Ingredients, Biochemicals, Bioplastics, Biomedical |

**Source:** 2018 annual report Corbion / 2018 numbers TotalEnergiesEnergies.

# TotalEnergies Corbion

50/50 joint venture to become a major player in PLA – bio-based, recyclable and biodegradable, with low carbon footprint & high feedstock efficiency - launched on 2 March 2017.

TotalEnergies

General manufacturing process technology

Product & application technology

A global sales network

**Consistent with TotalEnergies's ambition of expanding in biofuels and bioplastics**

## Joint Venture

TotalEnergies Corbion

1 kT PLA pilot plant

100 kT lactide plant

75 kT PLA plant

**R&D, Production, Sales/Marketing**

Corbion

Lactic Acid

Lactide & PLA polymerization technology

PLA product & application know how

**At the core of Corbion's strategy built around advancing sustainability**



TotalEnergies Corbion

# Total Corbion PLA - our first PLA plant is located in Thailand

- 50/50 Joint Venture between Total and Corbion
- World scale & brand new 75kTpa PLA polymerization plant in Rayong, Thailand.
- Sugar to PLA on integrated bio-refinery site
- Lactic acid supplied to the JV by Corbion, utilizing Thai sugarcane


TotalEnergies Corbion

# Total Corbion PLA - our second plant will be in France

- Located in Grandpuits, France on an existing TotalEnergies site
- Ramping up to 100kTpa
- Lactic acid supplied by Corbion, initially from Spain and Thailand
- Green hub:
  Co-located with a chemical recycling, a biofuel and a solar panel farm

TotalEnergies Corbion

# From Sugar to PLA

*Polymerization*



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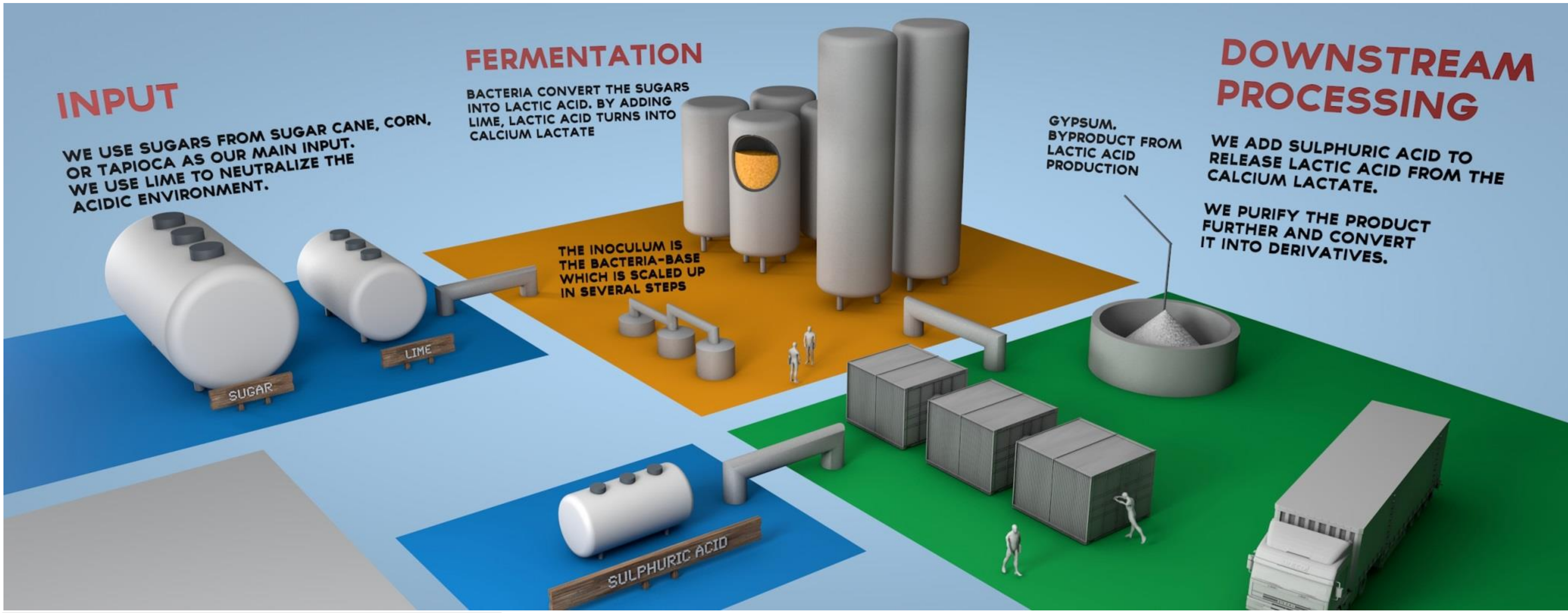
# Fermentation – Corbion's core technology

Fermentation is a metabolic process converting sugars to acids, gases and/or alcohol using yeast or bacteria. Corbion has been fermenting sugars into organic acids, more specifically lactic acid, for more than 80 years. Corbion has a 60% world market share in Lactic Acid.




### Biomass

sugars from corn/cane/tapioca and C5/C6 sugars from biomass

### Other organic acids

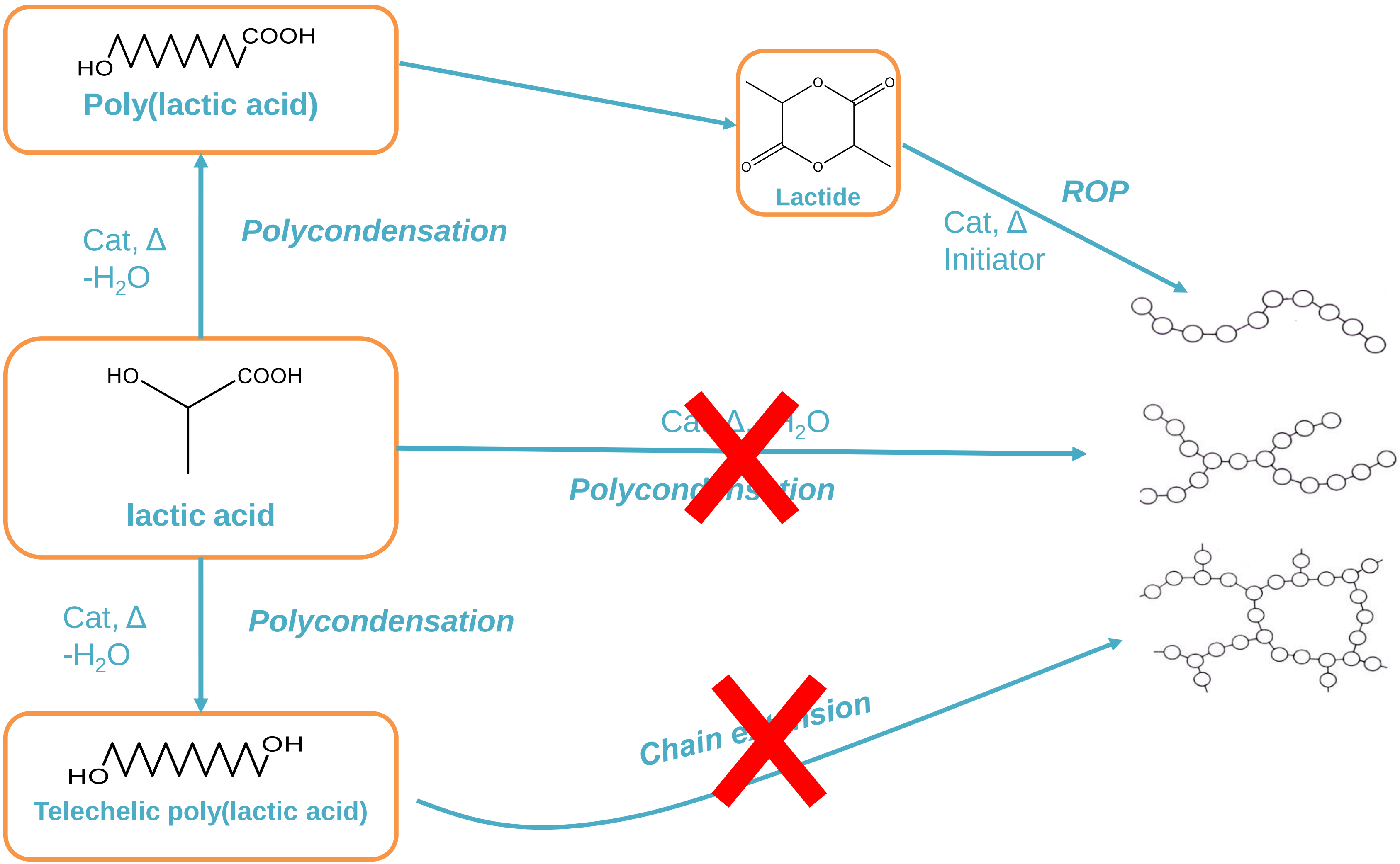
Our fermentation processes can also produce other organic acids besides lactic acid (e.g. succinic acid)

### Gypsum free

Our new lactic plants will no longer produce any unwanted gypsum and won't need lime or Sulphuric acid

# Polymerizations routes

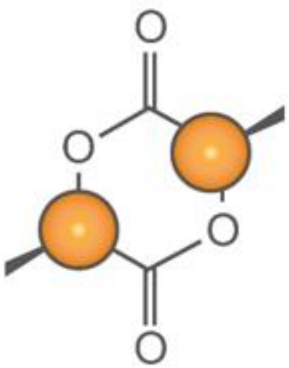
more than one way to skin a cat



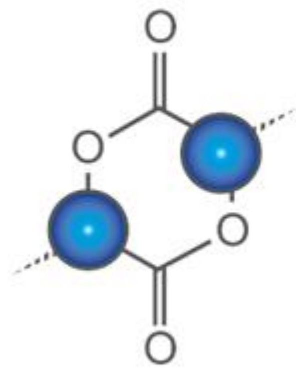
# Start with the best building blocks

*Stereochemically pure monomers make the difference*

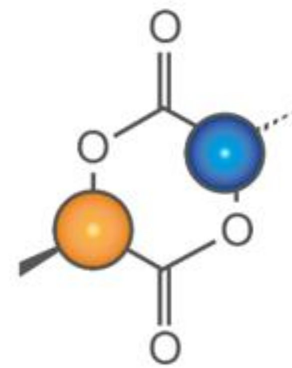
L-lactic acid → L-lactide
D-lactic acid → D-lactide



(R,R)- lactide
or D-lactide



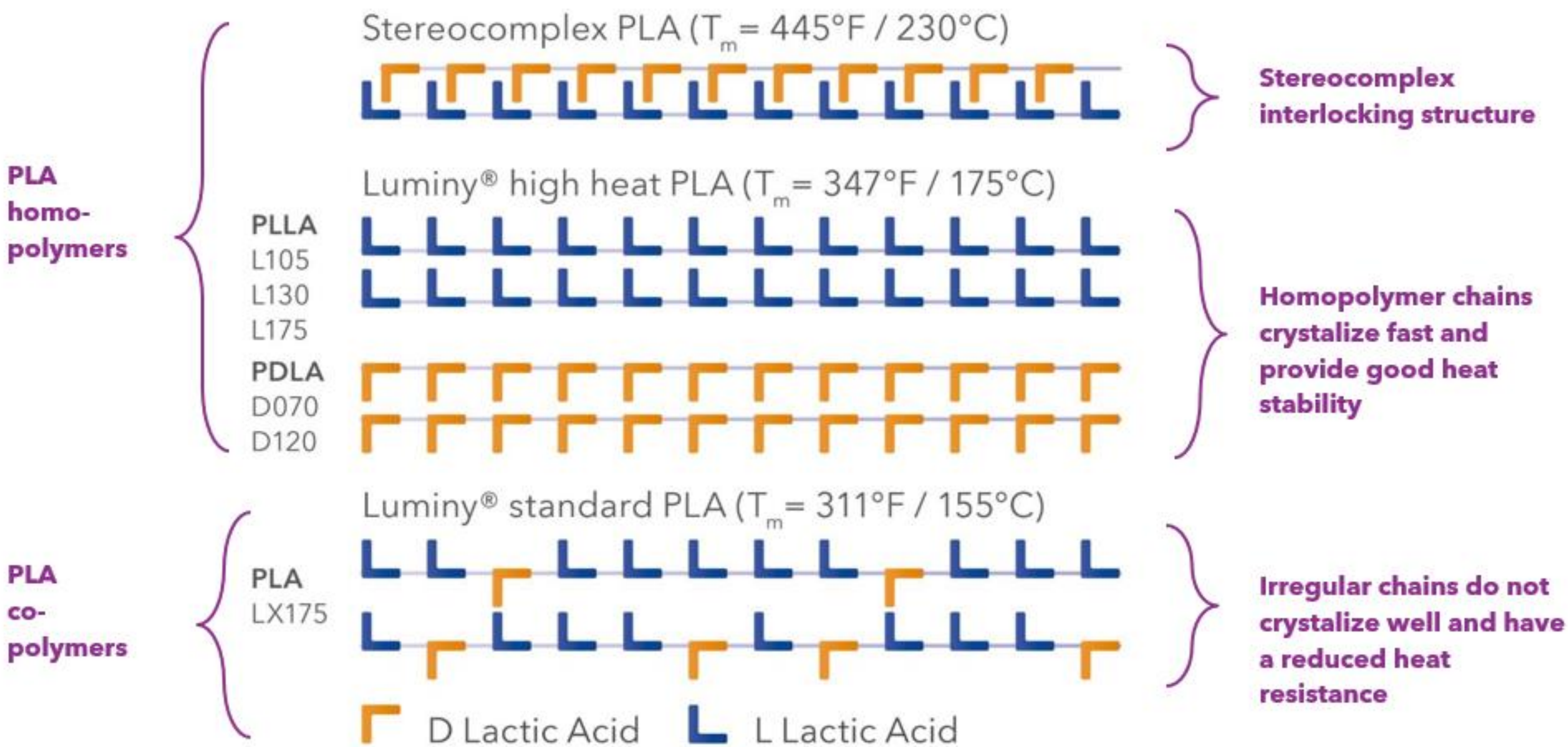
(S,S)- lactide
or L-lactide



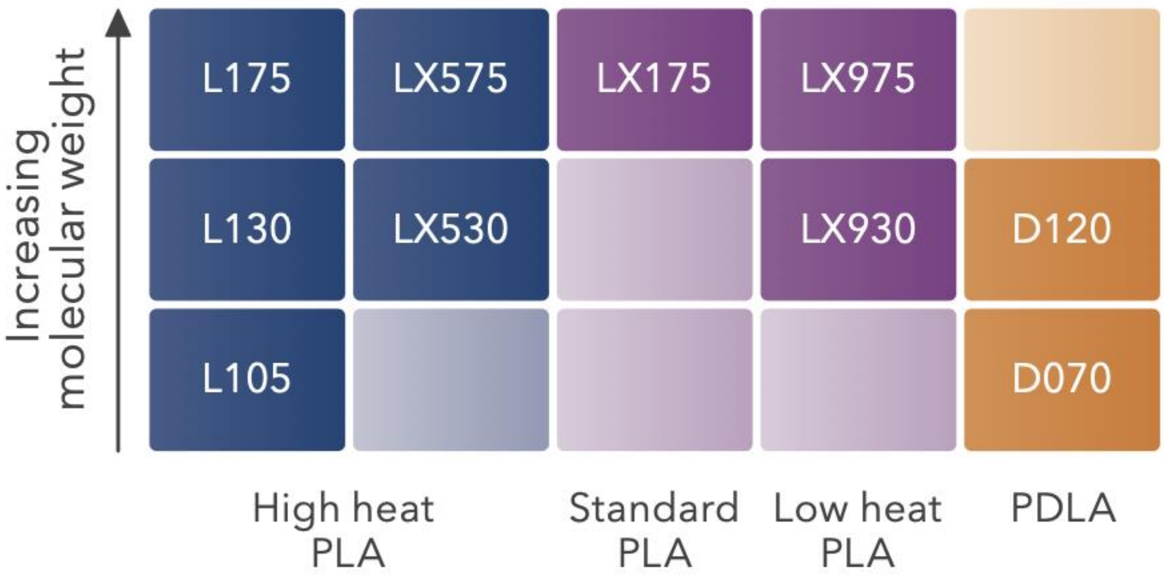
(R,S)- lactide
or meso-lactide

Stereochemically pure lactide monomers:
building blocks used to make
Luminy® PDLA & PLLA homopolymers

# Homopolymers: driving performance



# Luminy® PLA portfolio




biobased %
DIC-00001

7W2030
compostable

**PLA L175, L130, L105**

High heat PLA used in opaque applications where heat resistance/durability are of key importance

**PLA LX575, LX530**

High heat PLA, typically used in transparent films or fibers

**PLA LX175**

Standard PLA for transparent sheet, film or thermoformed applications. Also often used in compounds for film blowing.

**PLA LX930, LX975**

Low heat PLA often used as heat seal layer or in bi-component fibers.

**PDLA D120, D070**

Typically used in combination with high heat PLA to reduce cycle times and/or to create stereocomplex PLA.

**Food contact approved** in Europe, USA & China

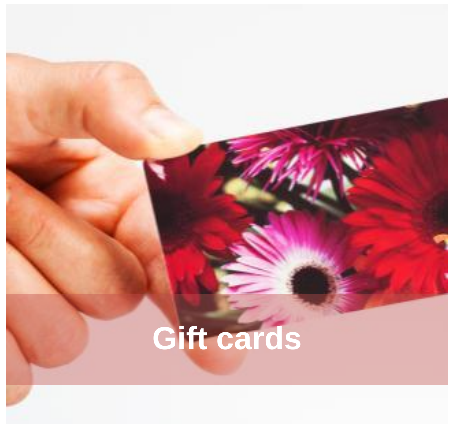
**Certified** compostable and 100% biobased

# TotalEnergies Corbion in BioPlastics

*Applications*

# PLA (Poly Lactic Acid) in commercial applications today


Cups & lids

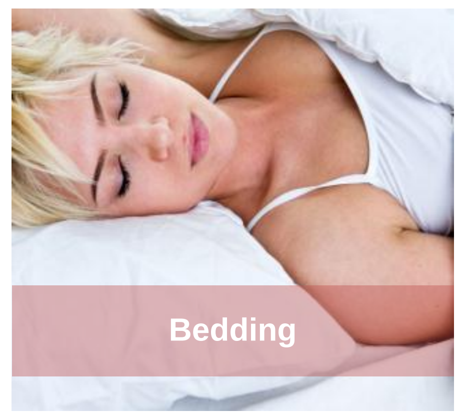

Gift cards

Coffee capsules


Packaging films & labels


Consumer goods packaging


Food packaging containers


Bedding


Apparel

# PLA for high heat thermoformed coffee cups

**Benefits:**

- Bio-based
- High heat resistance: can withstand boiling water
- Recyclable
- Good processing economics
- Can be processed on existing PS lines

# PLA for high heat injection molded coffee capsules


**Benefits:**

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


la COPPA

Peeze bewust genieten

Advanced Technology Innovations

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# PLA for nonwoven tea bags & coffee pads

**Benefits:**

- Bio-based
- Compostable
- High heat resistance: can withstand
  boiling water
- Aroma neutral
- Soft & silky touch



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# PLA for injection molded cosmetics packaging

**Benefits:**

- Bio-based
- Stone/wood look & feel
- Weight of the part
- Good processing economics

# PLA for automotive industry

**Benefits:**

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

# TotalEnergies Corbion in BioPlastics

*End of life options for PLA*

# PLA's end of life options: a complementary approach

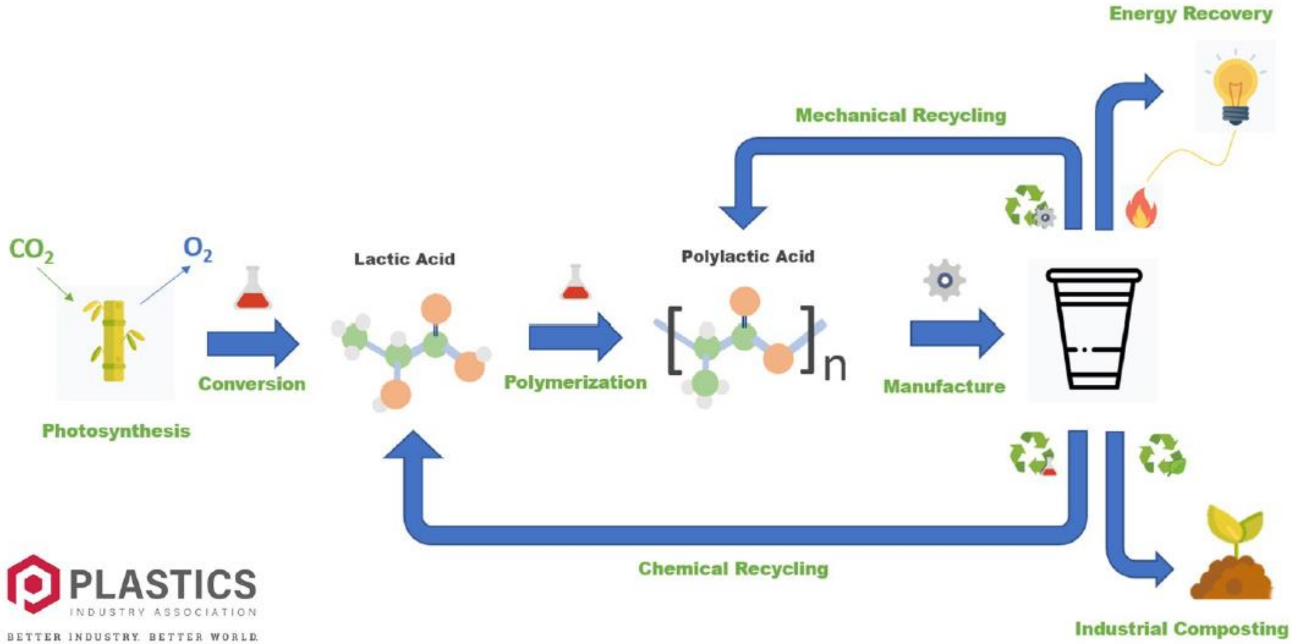
Composting and Recycling as two possible complimentary end-of-life for PLA

- Food contaminated plastics, if compostable could be organically recycled
- Food contaminated plastics, if compostable could reduce discarded plastics from recycling stream

**Composting of PLA**

- PLA is mechanically & chemically recyclable
- For applications where there is no co-benefit in composting (no food waste contamination), recycling is the proper end of life treatment

**Recycling of PLA**

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# Circular Economy*

Key applications for compostable plastics

**Applications with a co-benefit if made with compostable plastics:**

- Bio-waste bag
- Very thin plastic bags / fruit and vegetable bags
- Tea bags
- Coffee capsule, coffee pads, coffee filters
- Fruit stickers
- Cling-film (and / in combination with) stickers / labels for fresh produce
- Catering items such as cups, trays, plates, cutlery (esp. closed loop events)
- Multi-material flexible packaging for perishable food


*European Bioplastics, "*Criteria for switching products to certified compostable plastics*", September 2019.

# Facts about biobased compostable plastic


## Did you know?

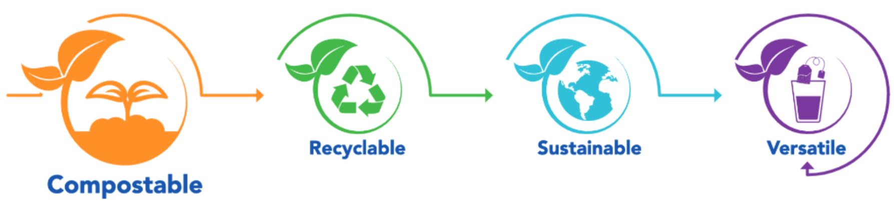
Biobased compostable plastics such as PLA degrade in industrial composting facilities and disintegrate faster than orange peels and paper.

University research study[2]

**11** PLA plant pot fully disintegrated after 11 days

**22** PLA teabags fully disintegrated after 22 days

**22** But orange peel and banana skins were still present after 22 days




Luminy® PLA is certified EN 13432 / ASTM D6400 in an industrial composter

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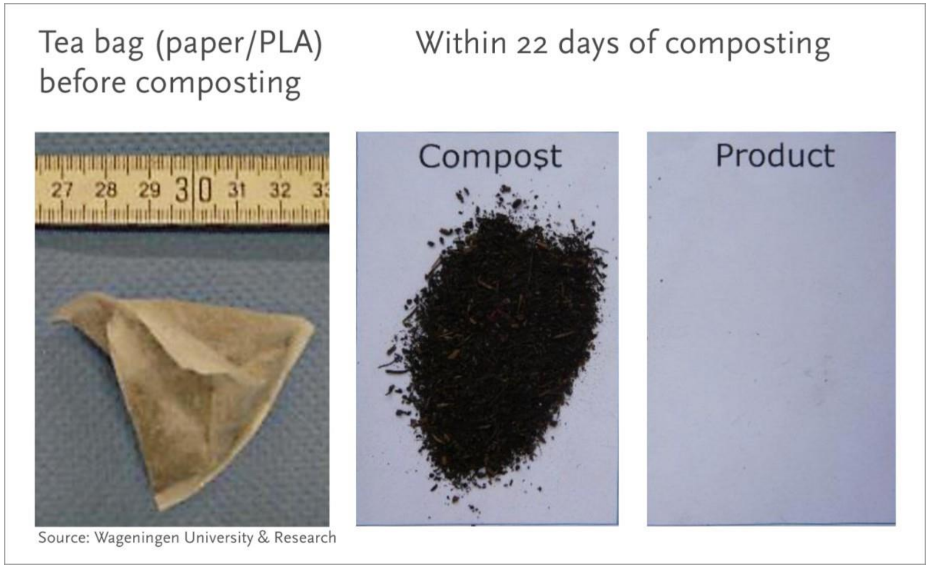
# PLA breaks down very fast in industrial composting facilities

PLA in real application and a real composing plant breaks down:

- Faster than in the EN13432 lab environment
- Faster than orange peels and wood !

*Source:*

*WUR study for Dutch Environmental Ministry, published February 2020.*




**Industrial Composting test: Luminy® PLA 10x10 cm sheet**


Start | 2 weeks | 4 weeks | 6 weeks | 8 weeks | 12 weeks

# 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

# PLA can be mechanically or chemically recycling

Post consumer PLA


Near-infra red sorting technology for PLA already available and very effective

Sorting & Cleaning

Other plastics can tolerate  to 5% PLA contamination.

PLA recycle can tolerate up to 5% impurities

Products from recycled PLA meet market demands: gardening, agriculture, 3D printing, deskware.

Mechanical Recycling

Chemical Recycling

Recycle back to PLA, Lactide or Lactic Acid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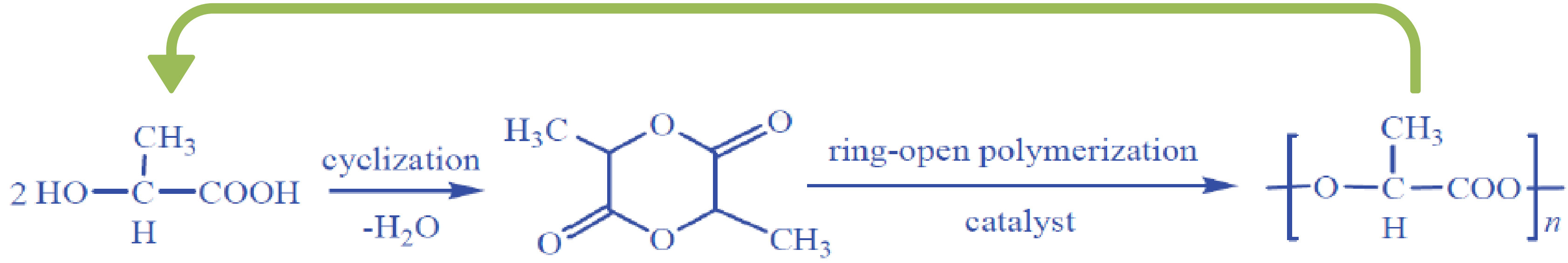
# What is Chemical recycling of PLA ?

**Chemical recycling:**
breaking PLA back into its “building blocks” + re-using those “building blocks”.




**Lactic Acid** **Lactide** **PLA**

Applications:
- Lactide
- Textile industry
- Leather industry
- Cleaning products

Applications:
- PLA
- Sealants & adhesives
- Coatings

Applications:
- Same as virgin PLA

Corbion



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# Chemical Recycled PLA is very energy efficient
## Pyrolysis of traditional polymers uses much more energy

### PLA Advanced/Chemical Recycling

**HYDROLYSIS**

- For hydrolysis of PLA only water and a temperature of ~100C are needed. The resulting product is lactic acid.
- PLA hydrolysis reactor is already included in the plant we operate in Thailand and is an “integrated part” of our plant.
- Retention of food contact for rPLA.

### Traditional polymers Chemical Recycling

**PYROLYSIS**

- A pyrolysis unit produces pyrolysis oil at 450C – 700C which is blended into the feed, which might be naphtha or gas oil, which is then fed into a conventional steam pyrolysis unit that operates at about 850C.
- A pyrolysis unit is typically a “stand alone” unit requiring 100-200mm$ of investment.

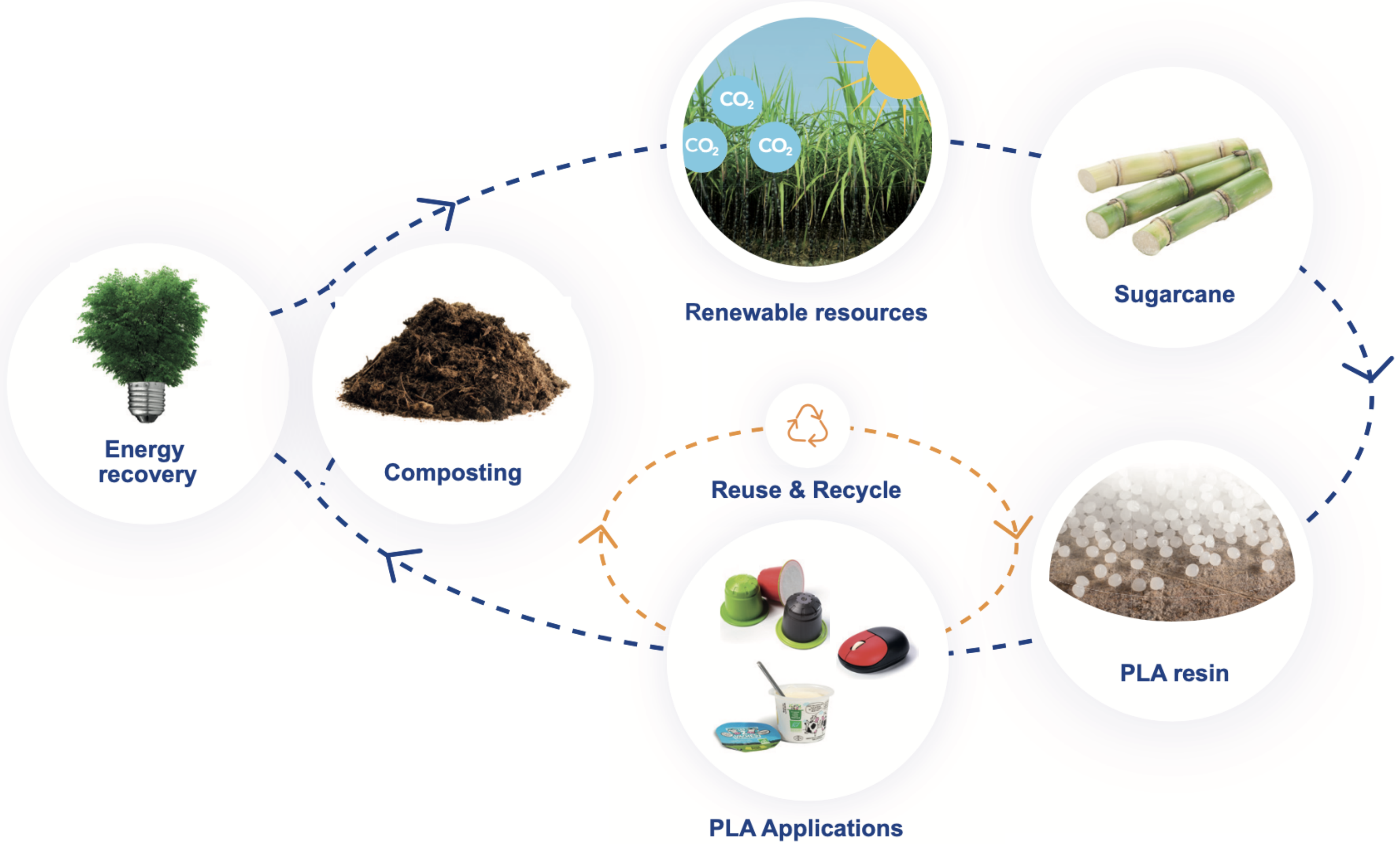
**TotalEnergies Corbion offers commercial grades of chemically recycled PLA (rPLA).**

**PLA chemical recycling = Hydrolysis = Minimal use of “energy” and “plant investments”**

## TotalEnergies Corbion in BioPlastics

*Carbon footprint emissions – Carbohydrate usage*

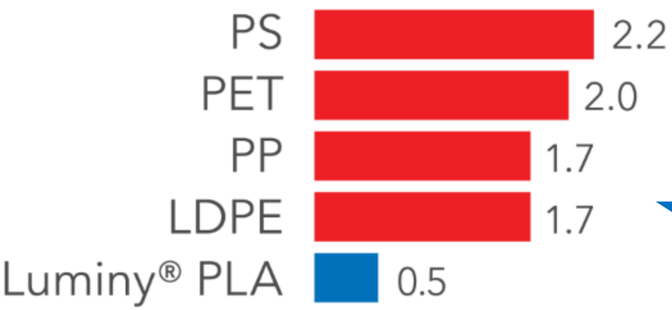
# Luminy PLA – a cradle-to-cradle polymer



# PLA carbon footprint & feedstock efficiency

**Carbon Footprint Emissions from production of common polymers***

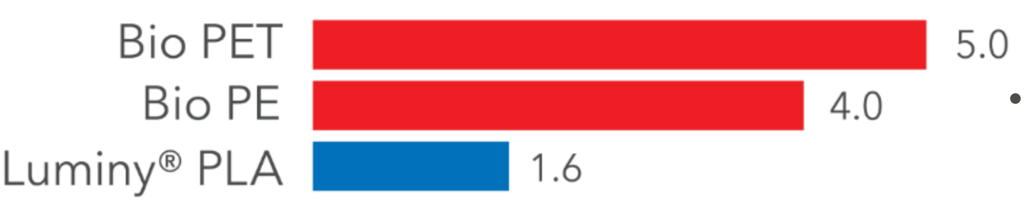
(kg $CO_2$ eq per kg polymer)




**~ 75% carbon footprint reduction with Luminy® PLA !**

**Carbohydrate Usage of Bioplastics**

(kg sugar per kg plastic)




- **Peer reviewed Life Cycle Assessment. Confirms Low carbon footprint of Luminy® PLA**
- **From a cradle-to-gate the Global Warming Potential (GWP) of PLA is 0.5kg CO2/kg of PLA**

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

## Get in touch:

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