The advantages of compostable bioplastics for the circular economy

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Context

The perception of plastic packaging has changed significantly in recent years. As industry, governments, and users understand better the environmental costs, they want solutions with more sustainable end-of-life options.

Building a circular plastic economy is crucial for the sustainability of our societies. Only 9% of plastics have ever been recycled[1]. Estimates suggest that, if current production and waste management trends continue, roughly 12,000 million tonnes of plastic waste[1] will be in landfills or the natural environment by 2050.

Brand owners and manufacturers are aware of their environmental responsibilities when using plastics. The industry has evolved plastic technology to meet environmental concerns while addressing the versatile characteristics of plastics, with bioplastic offering a viable solution for a variety of applications, from medical products to hygienic food packaging.

The innovative bioplastic products, particularly those made from Polylactic Acid (PLA), a biobased and compostable polymer made from renewable resources, retain their advantages as a material. At the same time, their environmental impact is mitigated by their biobased nature and their compostability, offering new viable end-of-life options.

This whitepaper examines the compostability of PLA bioplastic and where it can be designed for use in everyday applications. Most importantly, we will highlight the role and advantages of industrial composting of biowaste and PLA.

Summary of compostable bioplastics benefits

- Recycle plastic products that are not usually recycled due to contamination with organic waste
- Increase the quality of compost by reducing its contamination with traditional plastics
- Avoid the use of fertilizers
- Increase the amount of biowaste separately collected and treated in a circular way
- Reduce carbon footprint by storing carbon in soils, reducing fertilizer production and reducing methane from landfills
- Decrease landfill and the related Green House Gas (GHG) emissions from biowaste
- Lower incineration and related GHG emissions
- Cut back the levels of persistent microplastics accumulated in the soil and the water

What is industrial composting?

Industrial composting is when biowaste is degraded in industrial composting plants. In these plants, controlled conditions for temperature (50-60 °C), humidity and aeration are maintained. This provides the right environment for microbial activity, such as bacteria or fungi and their enzymes, to "digest" the chain structure of biowaste and compostable polymers as a source of nutrition. Not only do the higher temperatures speed up the biodegradation process, they are also required to make sure there are no pathogens left in the organic waste[12].

During these processes the following conversion takes place:
$C_6H_{12}O_6$ (carbohydrates) + 6 O_2 → 6 CO_2 + 6 H_2O and the resulting end products are water, carbon dioxide (CO_2) and biomass, otherwise known as compost.

Industrial composting is recycling

Recycling of waste is defined in the Waste Framework Directive as any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. Industrial composting allows for full degradation of biowaste and compostable materials, producing a high-quality compost that saves resources. This conversion of waste into a valuable product, bringing back carbon to soils, is known as organic recycling and offers many benefits compared to mechanical recycling. Where fossil-based plastics cannot be economically recycled when contaminated with food residue, compostable plastics can be composted alongside food waste, reducing organic waste ending up in landfills or incineration and conventional plastic contamination of compost and soils.

"Biological recycling of biodegradable plastics through industrial composting is an efficient and low-cost solution for the treatment of plastic waste."

Emmanuelle Gastaldi, Associated Professor at the University of Montpellier, France

Biochemist with expertise in biopolymers, biodegradable plastics, and their end-of-life and environmental fate

The benefits of compostable plastics

Compostable plastics have a wide range of benefits which will be multiplied by their increasing adoption for packaging solutions.

Around the world, composting increases overall recycling rates[7]:

- It recycles 83 million tonnes of biowaste every year.
- It reduces greenhouse gas emissions by 9 million tonnes of carbon dioxide equivalents a year by storing carbon in soil and offsetting fertilizer use.
- It recycles 1 million tonnes of plant macronutrients, equivalent to USD 807 million a year.

Plastics contaminated by organic waste are usually not recycled for technical and economic reasons. They end up in landfills or incinerated, contributing to climate change and environmental pollution. Using compostable plastic packaging for applications containing food waste allows the consumer to throw the biowaste with its packaging. Consequently, the plastic packaging and the biowaste content will be recycled.

Using compostable bioplastic products in applications that have contact with food allows a higher separate collection of food waste - a typical example is biowaste collection bags.

Using compostable plastics and organically recycling them with food waste reduces landfill GHG emissions from organic waste. In fact, organic waste in landfills will anaerobically biodegrade producing carbon dioxide and methane contributing to global warming potential. It also mitigates climate change by storing carbon in soils and avoiding fertilizer production emissions.

"With the clock ticking on climate change, it's worth celebrating the growing momentum behind composting as a solution and the role that compostable packaging plays in diverting food scraps from landfills."

Olga Kachook, Director, Bioeconomy & Reuse Initiatives GreenBlue, and working for the Sustainable Packaging Coalition, USA

Conventional plastics are found in high quantities in compost, contributing to soil pollution. Replacing conventional plastics in applications typically found in biowaste streams with compostable bioplastics reduces this contamination and increases the quality of soils by providing carbon and nutrients such as nitrogen, phosphorus and potassium.

The organic recycling potential

The potential to organically recycle biowaste is 12-fold[8,9,10] if the world's waste output is collected separately and composted.

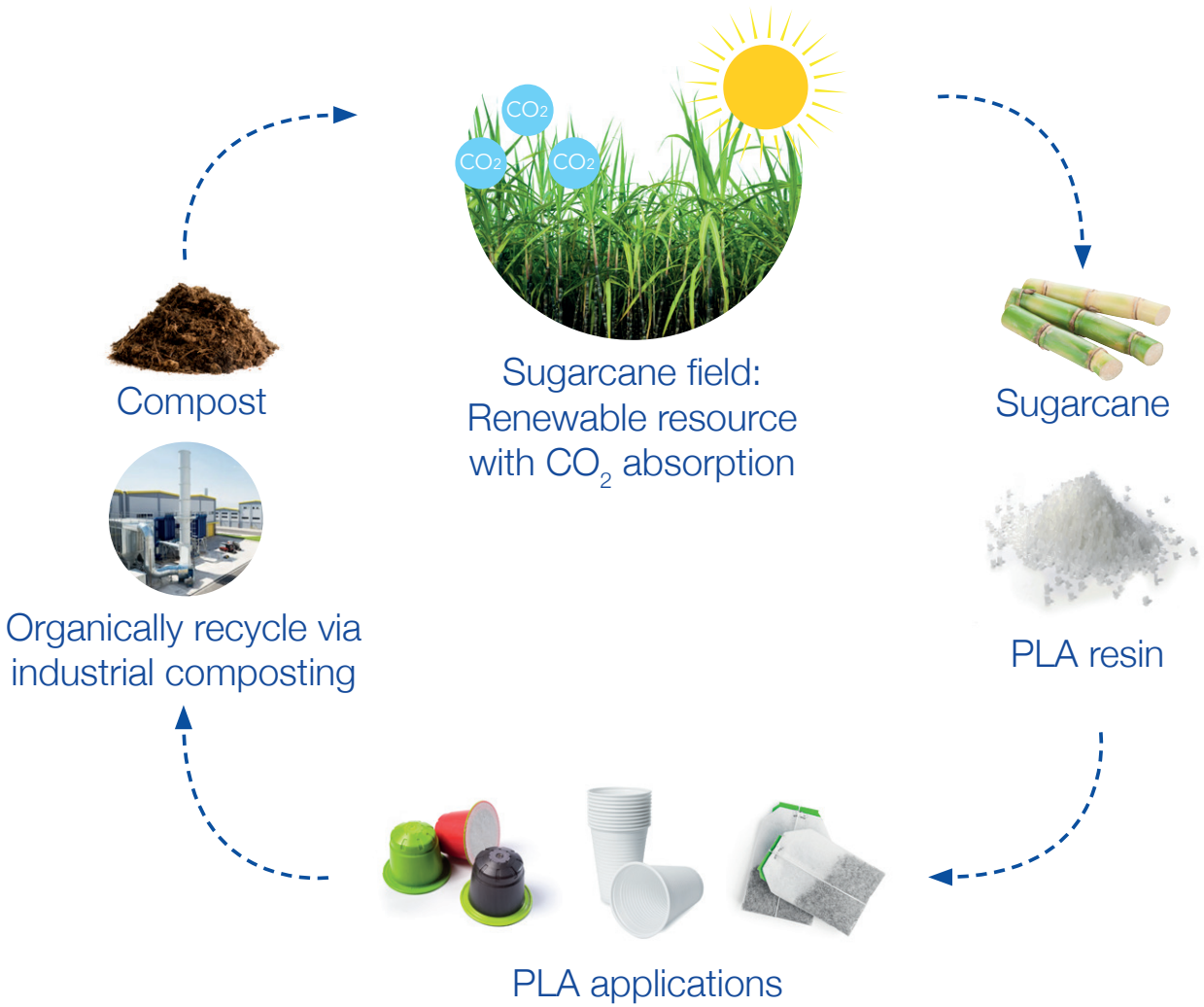
In the EU27+, the current capture of food waste is 9.5 million tonnes per year, just 16% of the theoretical potential, estimated at 59.9 million tonnes[8,9,10]. The absence of collection and treatment for biowaste means organic waste ends up in landfill or being incinerated, releasing greenhouse gases.

Offering new end-of-life solutions for bioplastics with composting will help reach the EU goals of 70% of packaging recycling by 2030 and specifically 55% of plastic packaging recycling by 2030[11].

It all adds up for PLA bioplastic

Bioplastics are plastics that are biobased, biodegradable, or both. PLA is a bioplastic that is both compostable and biobased - offering a reduced carbon footprint compared to traditional plastics and the potential to vastly increase its positive impact as it becomes more widely adopted.

TotalEnergies Corbion is at the forefront of this move towards greater use of PLA bioplastics and is constantly working to encourage learning, understanding and use of PLA bioplastic by consumers and companies alike.



The potential of biobased and compostable PLA bioplastics

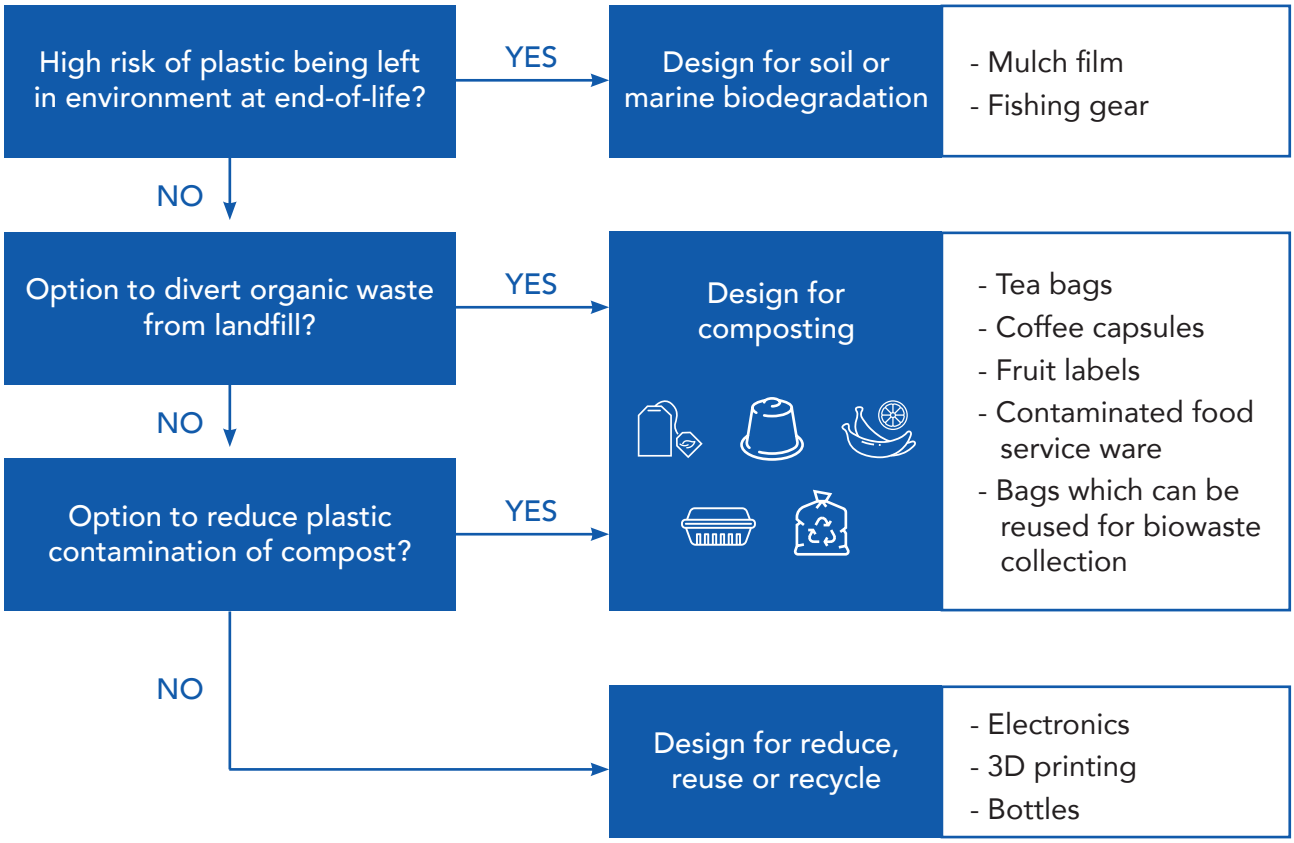
Using biobased and compostable PLA bioplastics helps 'close the cycle', increasing resource efficiency and contributing to a more circular economy. The process starts with using renewable, sustainable plant-based resources to make biobased plastic products. At the end of the product life cycle, they can then be mechanically or chemically recycled as well as organically recycled via industrial composting, creating valuable biomass, which, in turn, facilitates plant growth and closes the cycle.

Making the best use of compostable packaging

Compostable packaging has a clear advantage when plastic items are contaminated with food waste – as is often the case with food packaging and foodservice ware. Normally when this happens, mechanical recycling of either food waste or packaging is not viable. However, using compostable plastics means you can organically recycle both the packaging and the food waste content. Biowaste is diverted from other waste streams to be organically recycled, and non-biodegradable plastic contamination is reduced. In addition, many existing examples of plastic packaging cannot be redesigned to make them reusable. In contrast, the same design can be made with compostable plastics that can be efficiently composted.

Prime products for PLA designed for organic recycling

When designing a product, TotalEnergies Corbion[12] believes we should consider end-of-life and the specific conditions for composting. For example, when designing food packaging which is likely to be contaminated at the end of its life, can a biobased compostable plastic be used for the application? And will the material be suitable for industrial composting and is there a potential to reduce persistent plastic contamination in the compost?



A lot of the disposable items for serving food used in closed-loop environments, such as festivals or fast-food restaurants, will be contaminated with organic waste. Replacing them with compostable items such as PLA would allow combined food waste and packaging collection while remaining hygienic and convenient for consumers. This makes the collection process easier and more efficient, organically recycling everything together and avoiding landfill or incineration.

Certified compostable

There are stringent rules to establish what materials can be classified as compostable plastics.

The EN 13432[13] European standard specifies requirements and procedures to determine the compostability of packaging. It addresses biodegradability, disintegration, the effect on the biological treatment process and the quality of the resulting compost.

ASTM D6400[14] is the American standard specification for solid material biodegradation by composting. This is required for the labelling of plastics designed to be aerobically composted in municipal or industrial facilities.

Luminy® PLA is certified EN 13432 and ASTM D6400.
A number of scientific studies[2,3,4,5,6] proved certified compostable bioplastics disintegrate in standard industrial composting methods found in existing facilities. Read our summary of these studies to learn how these materials have no negative impact on compost quality and reduce conventional plastic contamination.
Find it here: https://www.totalenergies-corbion.com/about-pla/compostable/

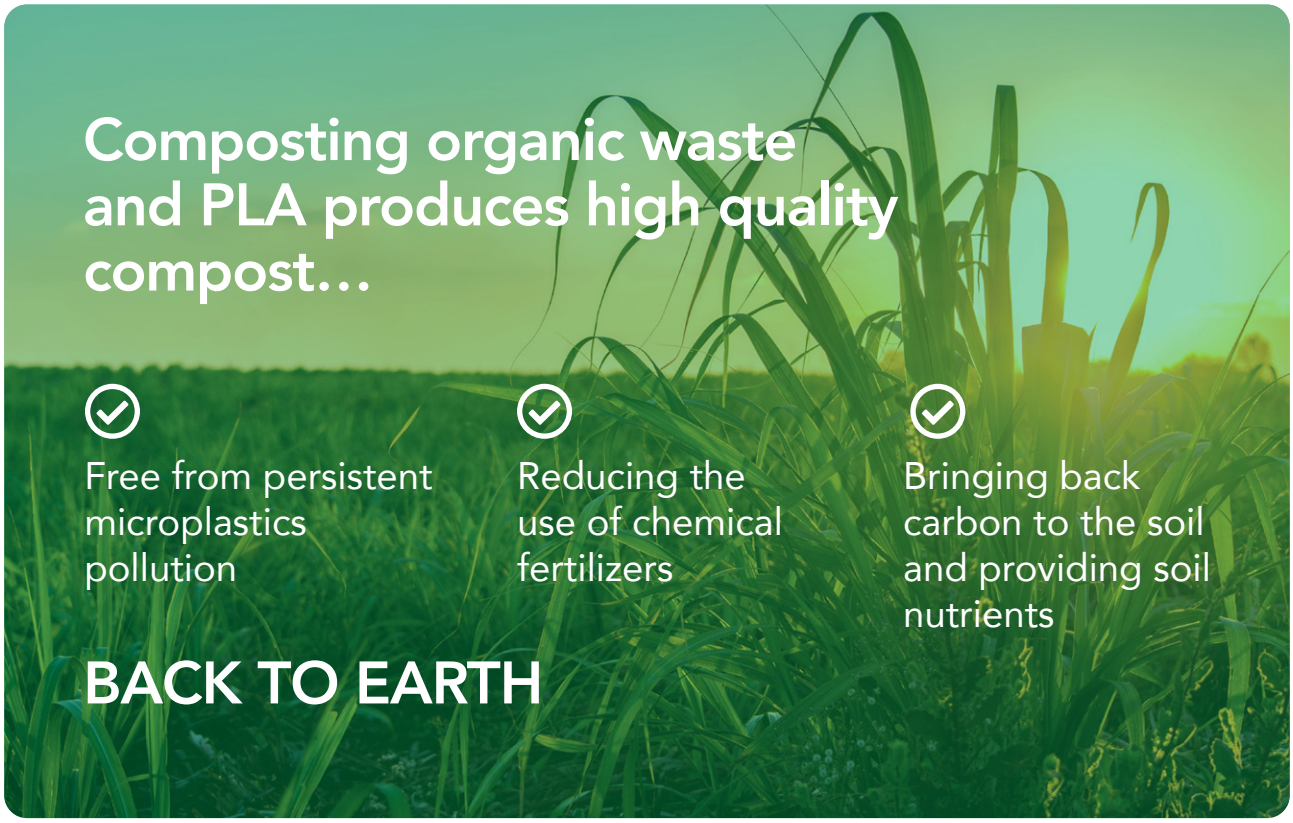
Conclusion

PLA compostable bioplastic is a sustainable solution for the circular economy bringing benefits at every step of bioplastic life cycle.

It is produced sustainably from annually renewable plants. PLA is versatile and can be used in the same way as conventional plastic for a wide variety of applications.

When collected with biowaste at its end-of-life, PLA becomes a fundamental part of the industrial composting process. Using PLA compostable bioplastic presents an opportunity to collect more biowaste therefore recovering waste that would end up in landfill. Furthermore, it reduces contamination in the industrial composting process, producing high-quality compost used in agriculture to improve soil quality.

Its increased adoption and use by brands worldwide will help meet recycling and climate targets, reduce plastic waste mismanagement, and help cut the carbon footprint of plastic packaging.



Definitions

Bioplastics
Plastics which are biobased, biodegradable or both.

Biobased plastics
Plastics wholly or partly derived from biomass used for bioplastics stems from e.g. corn, sugarcane, or cellulose according to the standard EN 16785-1.

Biodegradable plastics
Plastics that can decompose through biodegradation producing water, carbon dioxide, methane and biomass. The property of biodegradation does not depend on the resource basis of a material but is rather linked to its chemical structure. In other words, 100 percent biobased plastics may be non-biodegradable, and 100 percent fossil-based plastics can biodegrade.

Biodegradation
Biodegradation is a chemical process during which microorganisms that are available in the environment convert materials into natural substances such as water, carbon dioxide and compost (artificial additives are not needed). The process of biodegradation depends on the surrounding environmental conditions (e.g., location or temperature), on the material and on the application.

Compostable plastics
Plastics with biodegradable properties intended to decompose in an industrial composting plant and that comply with EN 13432 and/or ASTM D6400.

European Standard EN 13432
Requirements for packaging recoverable through composting and biodegradation requires at least 90% disintegration after 3 months, 90% biodegradation in six months, and includes tests on ecotoxicity and heavy metal content.

References

1. Roland Geyer, Jenna R. Jambeck, Kara Lavender Law (2017) *Production, use, and fate of all plastics ever made*. Science Advances, e1700782, Volume 3, Issue 7, doi:10.1126/sciadv.1700782. Available at: https://www.science.org/doi/abs/10.1126/sciadv.1700782 [Accessed: 19 May 2022].
2. Maarten van der Zee, Karin Molenveld Institute (2020) *The fate of (compostable) plastic products in a full scale industrial organic waste treatment facility.* Wageningen Food & Biobased Research. Available at: The fate of (compostable) plastic products in a full scale industrial organic waste treatment facility – Projects — Research@WUR [Accessed: 19 May 2022].
3. Carlos Edo, Francisca Fernández-Piñas, Roberto Rosal (2022) *Microplastics identification and quantification in the composted.* Organic Fraction of Municipal Solid Waste ,Science of The Total Environment, Volume 813, doi: 10.1016/j.scitotenv.2021.151902. Available at: https://www.sciencedirect.com/science/article/pii/S0048969721069783 [Accessed: 19 May 2022].
4. Dr. Michael Kern, Falk Neumann, Hans-Jörg Siepenkothen, Thomas Turk Witzenhausen-Institut für Abfall and Dr. Martin Löder, Universität Bayreuth (2020) *Plastics in compost: Practical tests to determine the polymer affiliation.* Available at: https://muellundabfall.de/ce/kunststoffe-im-kompost/detail.html [Accessed: 19 May 2022].
5. Optimization of organic waste recycling (2019-2020) *Summary of the results of the CIC - COREPLA monitoring program (2019-2020) CIC.* Consorzio Italiano Compostatori.
6. TotalEnergies Corbion (2022) *A Comprehensive Look at Compostable Plastics.* Available at: https://www.totalenergies-corbion.com/downloads/ [Accessed: 25 May 2022].
7. Compost Research and Education Foundation (CREF) (2021) *Compost Overview ICAW 2021.*
8. European Bioplastics (2019) *Criteria for switching products to certified compostable plastics.* Available at: https://docs.european-bioplastics.org/publications/EUBP_discussion_paper_criteria-for-compostable-plastics_products.pdf [Accessed: 19 May2022].
9. Biobased Industries Consortium & Zero Waste Europe (2020) *Bio-waste generation in the EU: Current capture levels and future potential.* Available at: https://biconsortium.eu/downloads/bio-waste [Accessed: 19 May 2022].
10. United States Environmental Protection Agency (Last updated February 2022) *Reducing the Impact of Wasted Food by Feeding the Soil and Composting.* Available at: https://www.epa.gov/sustainable-management-food/reducing-impact-wasted-food-feeding-soil-and-composting [Accessed: 14 February 2022].
11. European Commission (2018) *EU plastic strategy.* Available at: https://ec.europa.eu/environment/strategy/plastics-strategy_en [Accessed: 19 May 2022].
12. TotalEnergies Corbion (2020) E*nd-of-life options for bioplastics-Clarifying end-of-life options for bioplastics and the role of PLA in the circular economy.* Version 1.0. Available at: https://www.totalenergies-corbion.com/downloads/ [Accessed: 19 May 2022].
13. European Standards, DIN EN 13432 *Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging; English version of DIN EN 13432.* Available at: https://www.en-standard.eu/din-en-13432-requirements-for-packaging-recoverable-through-composting-and-biodegradation-test-scheme-and-evaluation-criteria-for-the-final-acceptance-of-packaging-english-version-of-din-en-13432/ [Accessed: 19 May 2022].
14. ASTM INTERANTIONAL, ASTM D6400-21-*Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities.* Available at: https://www.astm.org/d6400-21.html [Accessed: 19 May 2022].

MAKING PLA PART OF THE PROCESS

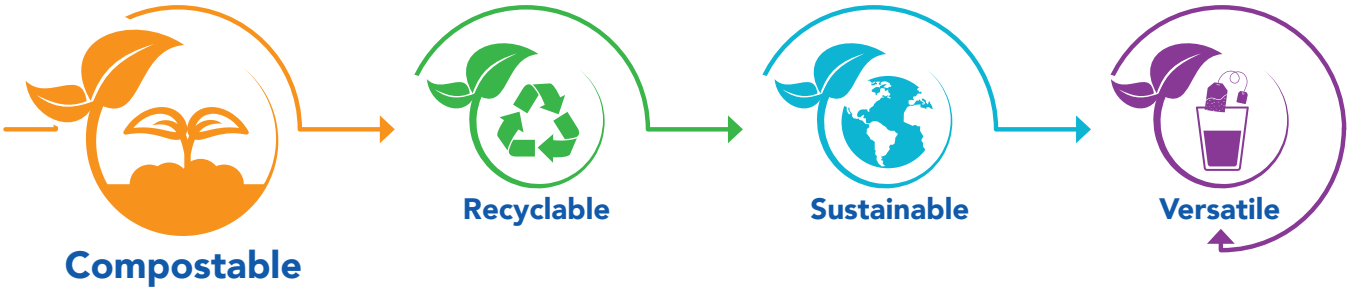
To find out more about TotalEnergies Corbion Luminy® PLA range and how it can help create a more sustainable future, visit:
www.totalenergies-corbion.com/about-pla/compostable/

Back to earth

Facts about biobased compostable plastic

Luminy® PLA

Beyond conventional plastic



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