

Facts and Figures

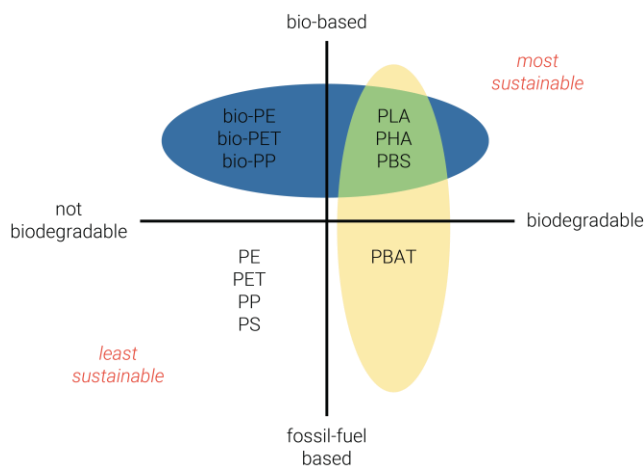
Defining Plastics



What Plastics Are Made Of And How They Do (And Don't) Go Away

Plastics are repeating chains (polymers) of carbon-based compounds (monomers) that, when linked together, form a stable, solid form that can easily be shaped or molded using heat and/or pressure. They are distinguishable from other materials in that they are lightweight with a high strength-to-weight ratio and are naturally water resistant.

Plastics can be categorized by their material source (i.e., what they're made of) and their end-of-life properties (i.e., how they do or do not degrade in the environment). To date, the vast majority of plastics are made of fossil fuels and do not biodegrade – meaning they persist in the environment indefinitely.



Material Source Key Terms

- **Fossil-fuel based** (bottom left quadrant) – This category encompasses nearly all existing plastics (e.g., PET, PE, PS, PP). These are derived from fossil-fuels and do not break down in the environment.
 - Ninety-nine percent of plastics are made from fossil-fuel derived materials (SOURCE: [CIEL](#)).
 - There is no scientific consensus on the environmental lifetime of any given plastic

product (SOURCE: [Proceedings of the National Academy of Sciences](#)).

- **Bio-based** (top left and right quadrants)– These plastics are made from plants or other renewable materials (e.g., agricultural waste, algae) instead of fossil fuels (SOURCE: [EPA](#)). Though they are made from renewable materials, some bio-based plastics (top left quadrant) are structurally identical to existing fossil fuel-based plastics and therefore are not biodegradable (SOURCE: [Nature Reviews Materials](#)).
 - **Biopolymer** – A type of bio-based plastic, these plastics are produced naturally by microorganisms like bacteria and can typically be broken down by a variety of microorganisms in the environment.

End-of-Life Properties Key Terms

- **Biodegradable** (right top and bottom quadrants) – Plastics can be considered biodegradable if they completely break down into compounds naturally found in the environment in which they are degrading within one year (SOURCE: [FTC](#)). Not all plastics labeled “biodegradable” can break down into natural compounds in *all* environments (e.g., soil, fresh water, and marine environments *in addition to compost*).
 - Global production capacity of biodegradable plastics in 2019 was 1.2 million metric tons, or 0.3% of the total plastic production capacity (SOURCE: [Plastics Europe](#)).
- **Compostable** – These plastics are biodegradable only under specific conditions (e.g., a compost pile). Many compostable materials require industrial composting conditions (higher heat, mixing) to break down (SOURCE: [EPA](#)).
 - The standard requirement to be labeled compostable allows for plastics to break down over 180 days (six months); however, most industrial compost facilities cannot keep

materials in store for that long, resulting in compostable plastics not completely breaking down (SOURCE: [European Bioplastics](#)).

- Only 3% of the U.S. has access to municipally run curbside composting programs that allow compostable packaging (SOURCE: [GreenBlue](#)).
- **Oxo-degradable or oxo-biodegradable** – These plastics include additives (typically heavy metals or other catalysts) designed to help the plastic break down. There is compelling evidence that these plastics fragment into smaller pieces and contribute to microplastic pollution rather than biodegrading into compounds naturally found in the environment. This classification is not well regulated or defined (SOURCE: [Closed Loop Partners](#)) and is increasingly seen as incompatible with a circular economy (SOURCE: [EMF](#)).

Examples of Nontraditional Plastics

- **Bio-based and biodegradable** (top right quadrant) – This category represents plastics that are made from renewable resources and can break down naturally across *most* environments.
 - PLA (polylactic acid) and PBS (polybutylene succinate) represent 29.5% and 5.4% of the global biodegradable plastic production respectively (SOURCE: [European Bioplastics](#)). Both plastics are compostable in industrial conditions *but do not biodegrade in the ocean*.
 - PHA (polyhydroxyalkanoate) is a biopolymer produced by bacteria that breaks down across all environments. It currently only accounts for 2.8% of global biodegradable plastics (SOURCE: [European Bioplastics](#)).
 - Studies show a PHA bottle takes 1.5-3.5 years to break up in the ocean (SOURCE: [Marine Pollution Bulletin](#)).
- **Bio-based and not biodegradable** (top left quadrant)– This category represents bio-based materials that are structurally identical to existing plastics and therefore do not break down naturally. However, these materials can have a lower GHG footprint and can be recycled like traditional plastics.
 - Examples: bio-PE, bio-PET, bio-PP which account for 26.5%, 17.3%, and 5.3% respectively of the global bio-based, non-biodegradable plastic production (SOURCE: [European Bioplastics](#)).

- **Fossil-fuel based and biodegradable** (bottom right quadrant) – This category represents materials that are made from fossil fuels like traditional plastics but that are biodegradable without the use of special additives.
 - Example: PBAT (polybutylene adipate terephthalate) represents 29.9% of the global biodegradable plastic production (SOURCE: [European Bioplastics](#)).

All inappropriately discarded plastics – regardless of material source or end-of-life properties – pose risk of injury or entanglement to freshwater and ocean wildlife.

Regulations And Certifications

- The American Society for Testing and Materials (now known as ASTM International) establishes voluntary consensus technical definitions and standards for testing biodegradability, compostability, and bio-based materials (SOURCE: [ASTM](#)).
- The Federal Trade Commission (FTC) issues guidance on environmental marketing claims through their “[Green Guides](#)” and is responsible for enforcement against false or deceptive product labeling (e.g., [issuing warnings](#) against oxo-degradable plastics).
 - The guide advises marketers “not to make an unqualified degradable claim for a solid waste product unless they can prove that the entire product or package will completely break down and return to nature within one year after customary disposal.”
- There are a number of additional certifications for compostability (e.g., [BPI](#)) and bio-based materials (e.g., [USDA Biobased](#)).
- Despite existing certifications and testing, the National Academies of Sciences, Engineering, and Medicine recognized the need for increased standards and enforcement of these terms to prevent confusion (SOURCE: [NASEM](#)).