Facts and Figures

Defining What Is and Is Not Plastics Recycling

Ocean Conservancy®

What Is Plastics Recycling?

The renowned "chasing arrows" recycling symbol represents, ideally, a closed-loop or circular economy for materials. For plastics, this means that plastic materials and products are collected, processed, and manufactured into new products *again and again*. This reduces waste, pollution, and the need for new/virgin plastics, 99% of which are derived from fossil fuels (SOURCE: CIEL).

Current plastics recycling technology, known as **mechanical recycling**, uses mechanical processes (e.g., washing, grinding, re-granulating) to recover plastic resins.

Unfortunately, scientists estimate that only 9% of all plastics ever made have been recycled; and only 10% of that has been recycled more than once (SOURCE: Science Advances).

What Is Not Plastics Recycling?

- **Landfilling** – Distinct from dumps, landfills are specially engineered and regulated facilities where solid waste is buried under ground. They require careful planning and control methods (e.g., piping) to collect and treat liquid and gas discharges and protect the surrounding environment from contaminants (SOURCE: EPA). No materials are recovered in the landfilling process.
    - In 2018, 75.5% of plastic waste in the U.S. was landfilled (SOURCE: EPA).
    - There are more than 2,600 landfills in the U.S.; about half are already at capacity (SOURCE: EPA).
- **Incineration** (also known as **waste-to-energy**) – Incinerators use controlled burning (combustion) of waste at very high temperatures (1100ºF to 1200ºF) to break down plastics from solids into gases (predominantly CO_2), heat, and residual ash (SOURCE: EPA). Like with coal and other fossil fuel technology, the heat, in turn, fuels turbines to produce electricity.
    - Incinerators have been used in the U.S. since 1885 (SOURCE: EPA).
    - In 2018, nearly twice as much plastic waste in the U.S. was incinerated (15.8%) as was recycled (8.7%) (SOURCE: EPA).
    - There are 73 municipal solid waste incinerators in the U.S. (SOURCE: Tishman Center), which made up 0.4% of total electricity generation in the U.S. in 2015 (SOURCE: EIA).
    - A recent study found that 79% of the incinerators in the U.S. are located in predominantly minority or low-income communities.
- **Chemical recycling** (also known as **advanced recycling** or **molecular recycling**) – This term includes a suite of technologies that use non-mechanical processes to break down plastics. Chemical recycling technologies can be roughly broken down into two categories: systems that use high heat and pressure (conversion) or systems that use chemicals (purification/decomposition) to break down plastics. Currently, neither of these categories of technologies recover plastic material and should therefore not be considered recycling.
    - **Conversion technologies** – These technologies use heat and pressure to break down chemical bonds in plastic to produce energy and/or small hydrocarbons such as synthesis gas ("syngas") and oils. These technologies have been available at scale for decades and are another form of **waste-to-energy**.
        - **Pyrolysis** – These systems use high heat (575ºF to 1650ºF) in the absence of oxygen to break down plastic waste into a synthetic

crude oil that can be refined for use in diesel fuels, gasoline, or heating oils (SOURCE: GAO).

- **Gasification** – These systems use very high temperatures (930°F to 2370°F) and a small amount of oxygen to break down plastic waste into syngas that can be combusted for electricity or converted into other fuels or chemicals (SOURCE: GAO).

- **Purification or decomposition technologies** – These technologies use chemicals rather than heat to break down plastics to produce monomers, polymer feedstocks, or polymers. These technologies are recent innovations and are largely not available at scale.

  - **Solvolysis** (also known as **solvent-based purification**) – These systems use chemical solvents and pressure to dissolve plastic waste without damaging the polymer. These systems often involve multiple steps to remove contaminants, filter, and then re-precipitate the polymer. This technology is not available at scale.

  - **Chemolysis** (also known as **depolymerization**) – These systems use various chemicals and catalysts (e.g., certain metals) to break down plastics into their basic building blocks (monomers), essentially reversing the polymerization process that made the plastics in the first place. This technology is only applicable for certain types of plastics based on how they were originally made.

    - This technology is currently in use for nylon, allowing for textile waste and fishing gear to be recycled back into nylon (SOURCE: GreenBiz).

  - **Enzymatic depolymerization** – While there has been a lot of research using microorganisms (e.g., bacteria, fungi) and their enzymes to break down plastics, this technology remains in a research stage (SOURCE: Frontiers in Microbiology).

Assessing Ocean Impacts

- **Climate impacts** – Recovering reusable plastic material from recycling (i.e., plastics-to-plastics) will yield the lowest lifecycle greenhouse gas impacts because of the emissions avoided by the production of new virgin plastics. Waste-to-fuel technologies, in addition to not recovering plastic material, are energy-intensive processes.

  - It is estimated that for one ton of mixed plastic waste:

    - Incineration emits 1777 kg CO_2-equivalent (SOURCE: BASF).

    - Pyrolysis emits 739 kg CO_2-equivalent (SOURCE: BASF).

    - Mechanical recycling emits 482 kg CO_2-equivalent (SOURCE: APR).

- **Toxic emissions** – Plastic products and packaging contain a variety toxins, from residual chemicals (monomers) used to make plastics (e.g., styrene or vinyl chloride) to flame retardants (e.g., HBCD) and other additives (e.g., phthalates). End-of-life management for plastic waste needs to ensure these toxic chemicals are not released to cause harm.

  - Toxics from plastics have been found in the products (e.g., oil), byproducts (e.g., char), and air emissions from chemical recycling like pyrolysis (SOURCE: GAIA).

  - Scientists have estimated that in 2015 seven of the most commonly polluted plastic items carried with them approximately 190 metric tons of 20 different chemicals additives into our ocean (SOURCE: Integrated Environmental Assessment & Management).

Ocean Conservancy's Position on Chemical Recycling

Ocean Conservancy does not presently support chemical recycling. In its current form, chemical recycling does not contribute to a circular plastics economy because it is not plastics-to-plastics recycling and creates environmental and social harms. At the same time, chemical recycling distracts from implementing much-needed systemic fixes to reduce our reliance on single-use plastics and improve waste management and recycling systems.