Environmental Defense Fund

# GET THE REAL FACTS ABOUT "ADVANCED RECYCLING"

## So-called "advanced recycling" is neither advanced nor recycling.

So-called "advanced recycling" is neither advanced nor recycling. The "advanced recycling" process generates toxic air pollution, chemical waste, and dangerous byproducts while producing very little useable product. In addition to these toxic pollutants, the process also releases significant amounts of greenhouse gases, contributing to climate change. The high-heat nature of pyrolysis, along with the combustion of plastic feedstocks, leads to carbon dioxide ($CO_2$), methane, and other greenhouse gas emissions, which contribute to global warming.

The toxic pollution released from this process can include toxic chemicals such as dioxins, PFAS and dangerous metals such as mercury and arsenic. These toxic substances can lead to serious health effects to nearby residents, including higher risks of cancer, birth defects, harm to pregnant women, cardiovascular and respiratory impairment, neurological problems, and reproductive system damages. The plastics industry's efforts to sell "advanced recycling" as an environmental solution is greenwashing.

## Industry uses the term "advanced recycling" to refer to a process called pyrolysis.

### What is it?

Pyrolysis is the application of heat in low-oxygen or inert environments to degrade materials. It is typically carried out at moderate temperatures (300°–700° C, depending on the material to be degraded and the reactor type). There are a variety of pyrolysis processes and how effective they are at breaking down plastics will depend upon process conditions and the type and mix of materials pyrolyzed.

### Is it actually recycling?

Can pyrolysis of waste plastics be used to unzip polymers to form new monomers which can then be used to form new plastics and achieve true circularity?

## What are plastics?

- Plastics are made from combinations of polymers, such as polyvinyl chloride (PVC) and polystyrene (PS) and chemical additives that provide performance characteristics. Polymers are long chains of repeating chemical units called monomers. The chemical additives include pigments, plasticizers, flame retardants and stabilizers which give the plastics useful properties. Plastics may be further treated, e.g., by fluorination, after formation to improve functionality.

- The type and quantity of the chemical additive to the polymer will depend on the intended use of the plastic. There are hundreds of chemical additives used to make these different plastics. Thus, even within families of plastics, such as PVC or PS, there can be hundreds of different plastics with many hundreds of different chemical additives.

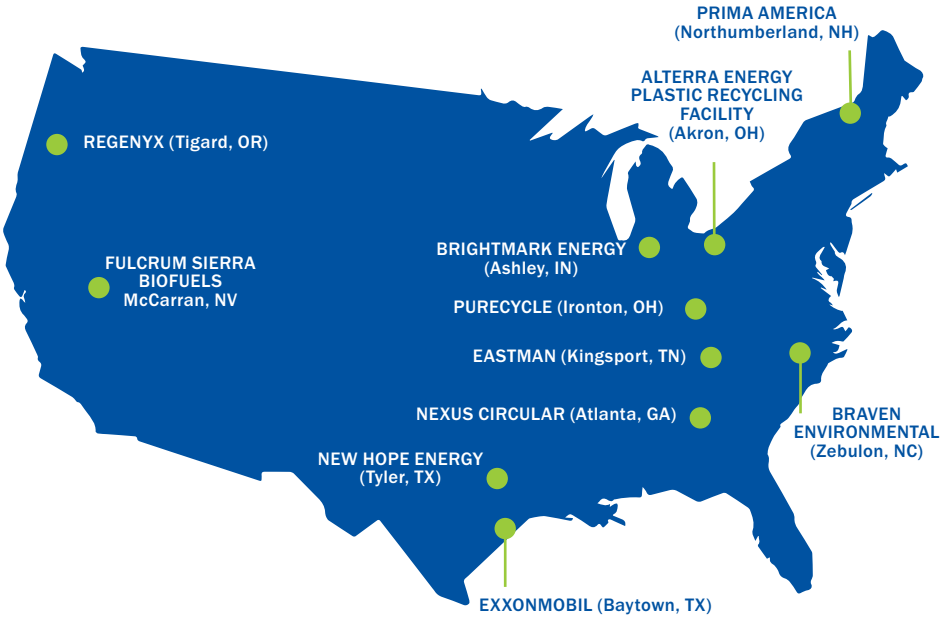
- Individual waste-plastic streams can contain hundreds of different types of plastics with up to a thousand different chemicals.

# "ADVANCED RECYCLING" BEING ADVERTISED AS A SOLUTION TO OUR PLASTICS PROBLEM IS WHOLLY MISLEADING.

**The plastics industry wants to weaken regulations and protections around these high-heat processes. "Advanced Recycling" is not a solution to our plastics problem but an enabler to continued environmental injustices and toxic releases into frontline communities.**

- Pyrolysis of waste plastics is not recycling. With very limited exceptions, it is not a way to regenerate the monomers that were originally used to make the polymer in the plastic.
- The pyrolysis of waste plastics typically results in complex mixtures of chemicals consisting of many toxic substances. Three factors contribute to the complexity and toxicity of the pyrolysis oil.
  - When high heat is applied to the polymers' chains of repeating units of monomers, such as during pyrolysis, these chains will break down at different points in the chain, giving a complex mix of chemicals. In addition, during the pyrolysis, the new chemicals formed can combine in multiple ways to produce other chemicals, many of which are carcinogenic, further adding to the complexity of the pyrolysis product.
  - Some polymers can form hazardous byproducts during pyrolysis. PVC is known to form dioxins when oxygen is present. This can occur even under the low oxygen environment of pyrolysis when mixed plastics are present because many will contain oxygen sources.
  - The waste plastics being pyrolyzed consists not only of the polymer but of the many chemicals added to make the plastics. Many of the additive chemicals used in plastics are toxic. During pyrolysis, only some of the chemicals will be destroyed or partially destroyed, while others will just be volatilized and released. Some such as PFAS are extremely difficult to destroy and will be emitted or will form other PFAS which are then emitted.
- In addition to contributing to the complexity of the mixture, the many chemical additives in the variety of waste plastics that make up a waste-plastic feedstocks will affect the efficiency and effectiveness of the pyrolysis and the amounts of hazardous substances produced and released.

## CHEMICAL RECYCLING PLANTS IN THE U.S.




Constructed U.S. "Chemical Recycling" Plants, as of September 2023 (Beyond Plastics and IPEN, 2023)

## Is it truly advanced?

Is the pyrolysis of waste plastics a cost-effective way to produce pyrolysis oils that can be used in steam crackers or as fuels?

- **No.** High quality waste plastics, particularly single stream plastics, are typically mechanically recycled because this is more cost effective.
- **Lower quality plastics are landfilled or incinerated.** These lower quality plastics are often the type of feedstocks used in waste-plastic pyrolysis.
- Given the **inability of many companies to manage the chemical complexity of the waste-plastic input streams**, the low efficiency of producing useable pyrolysis oils, and the hazardous constituents produced, the pyrolysis of waste plastics is economically viable only with significant external financial supports. It is not a way to effectively produce new plastics. Rather, it is incineration by another name.