



ARM Executive Forum

Advanced Recycling
The Reality and the Challenges

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March 21, 2023

Overview

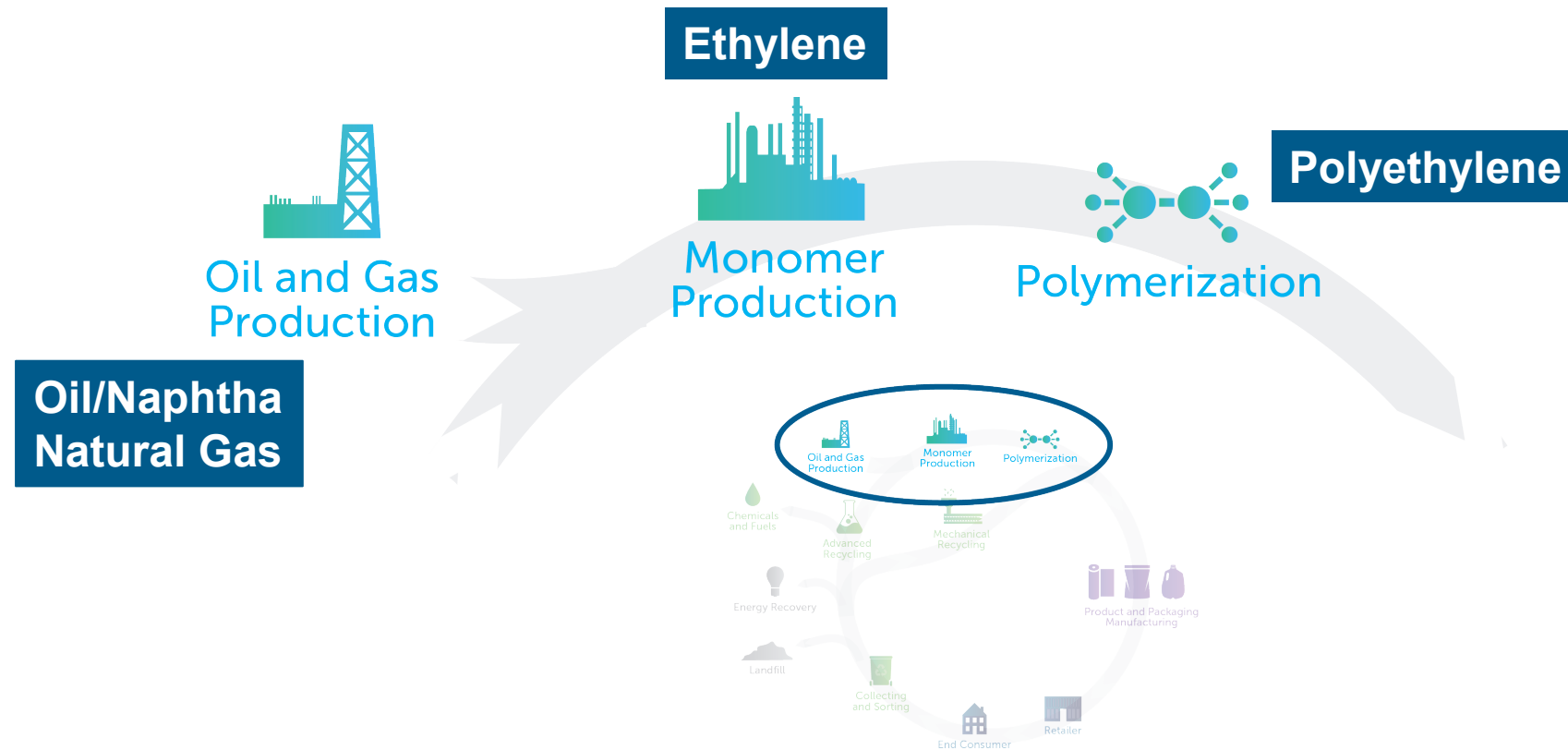
- Meeting Purpose: Provide an overview on Advanced Recycling (AR)
- Topics
 - Circularity of Plastics
 - Protect the Environment for Future Generations
 - What is Advanced Recycling?
 - Supplement to mechanical recycling
 - The processes
 - The challenges
 - What is the current status of AR?
 - Facilities, volumes, timelines
 - What is the industry doing?
 - Where do we go from here?



The Plastics Life Cycle



The Plastics Life Cycle



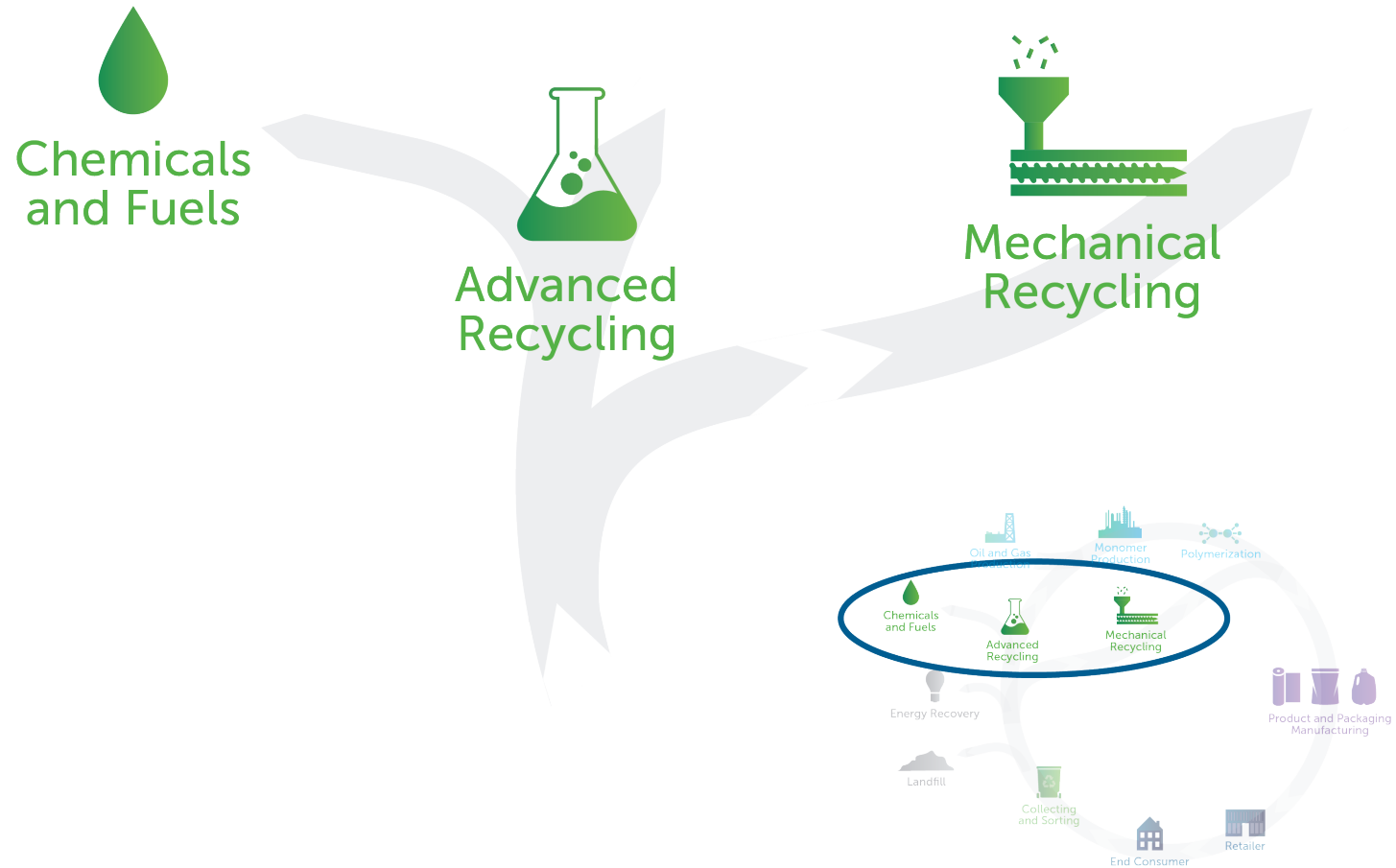
The Plastics Life Cycle



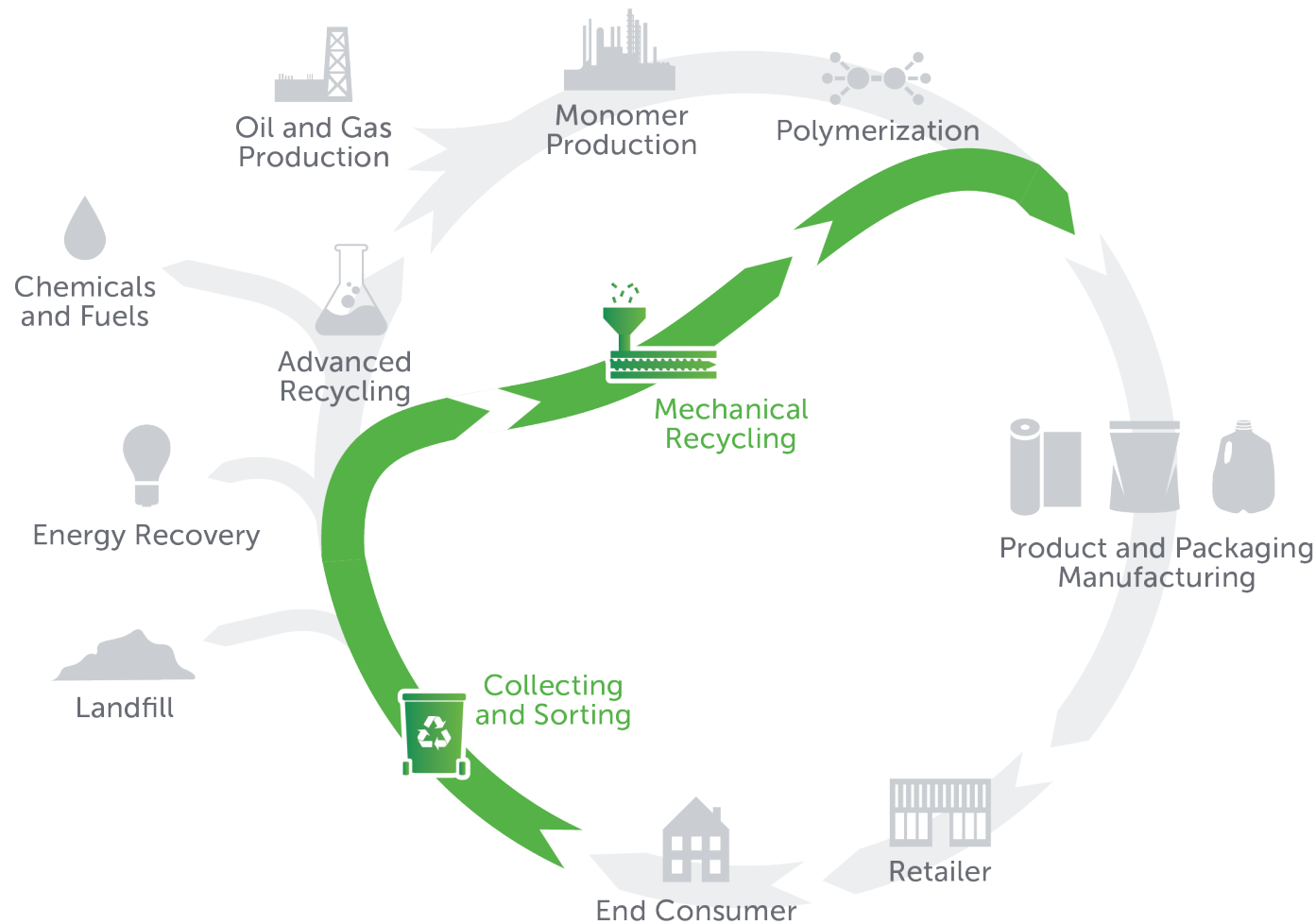
The Plastics Life Cycle



The Plastics Life Cycle



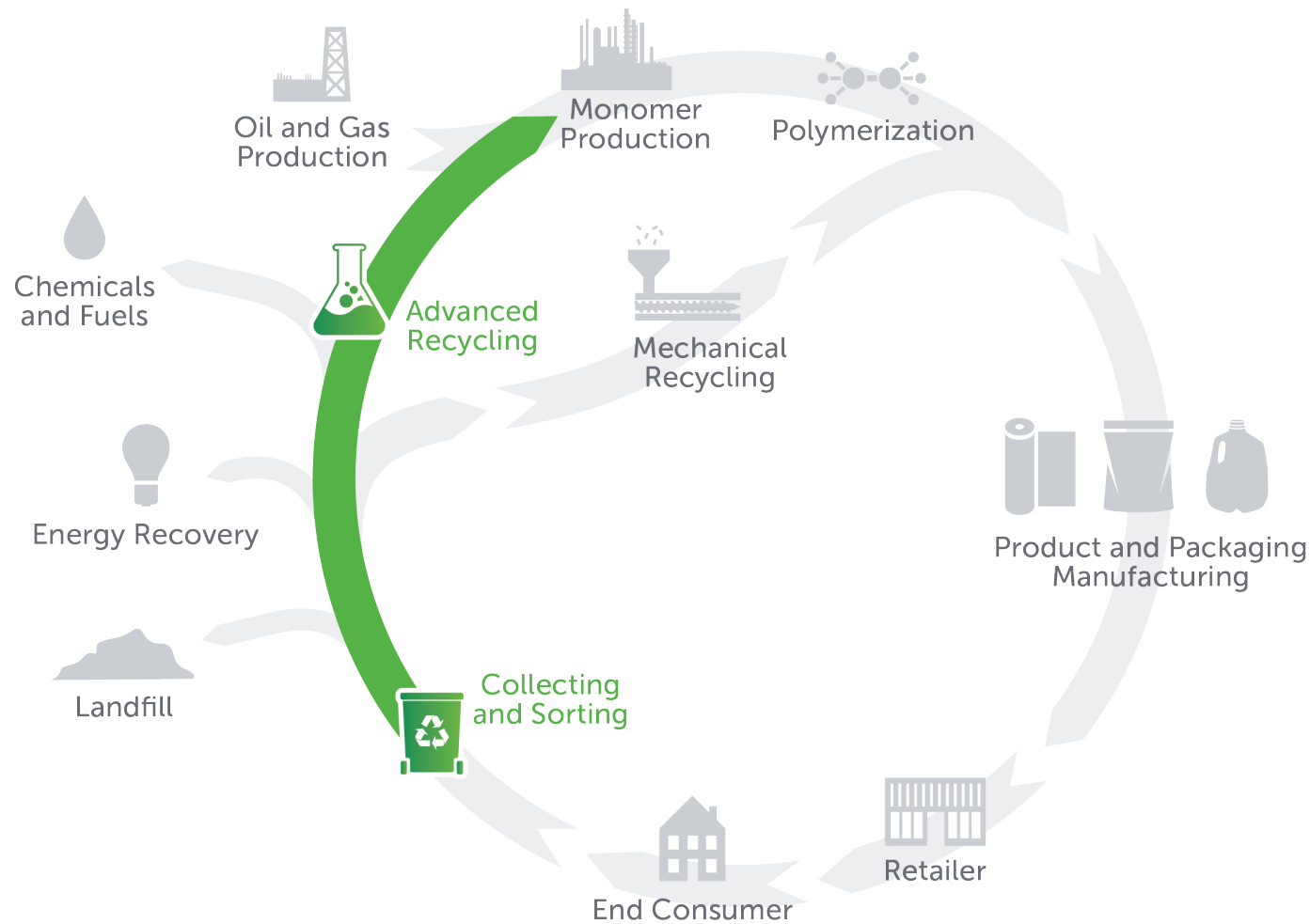
Mechanical Recycling



Mechanical recycling is the most mature recycling route and is the only one at scale today

- Process: physically processes plastic waste back into resins, leaving the polymer chain intact
- Challenges:
 - Material downcycling
 - Contamination
 - Availability of sorted feedstock at scale

Advanced Recycling (AR)

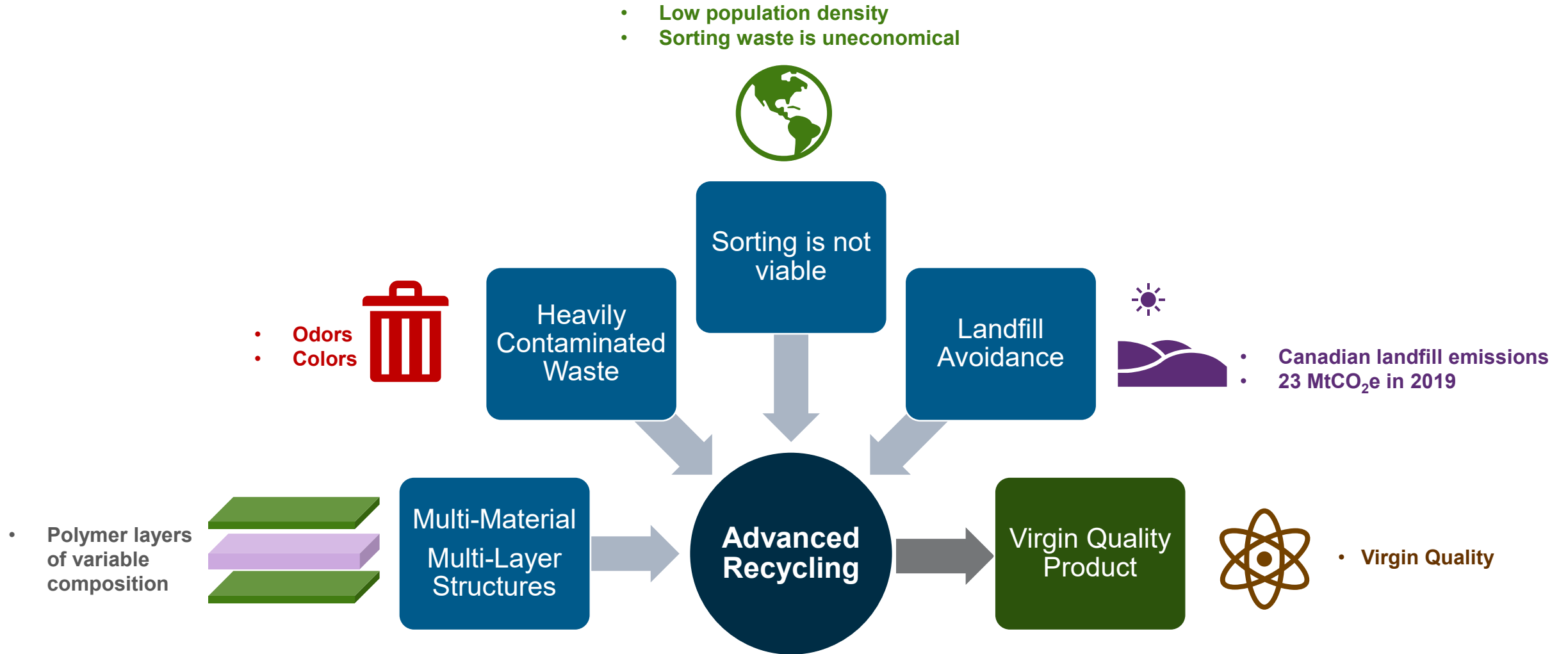


Advanced recycling addresses the hard to recycle segments of plastic waste

- Process: chemically breaks down polymer chains into monomers or pyrolysis oil
- Challenges:
 - Process intensive
 - Capital investments in pyrolysis units and other cleanup/processing equipment,
 - Ability to scale-up
 - Access to inexpensive mixed plastic waste feedstock

Source: ACC

When to Use Advanced Recycling

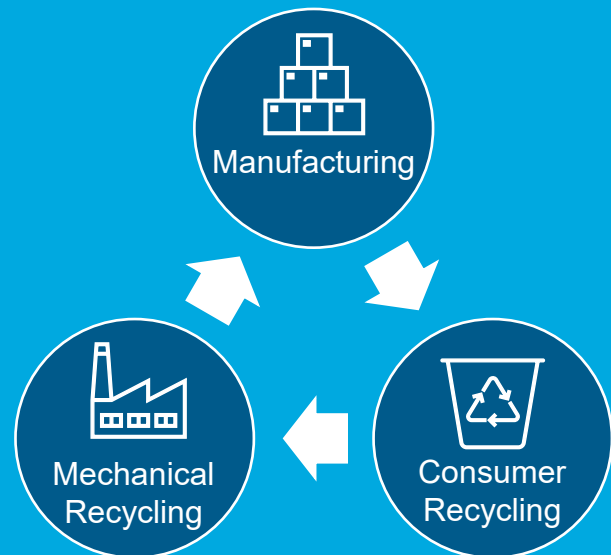


Recycling Options for Plastic Waste

Mechanical

Pelletization

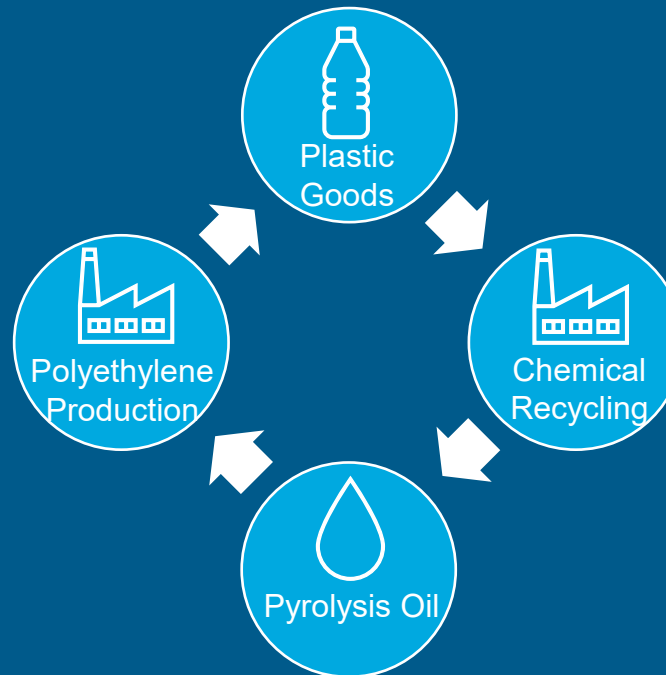
Extruding and pelletizing sorted plastic waste back into pellets



Advanced

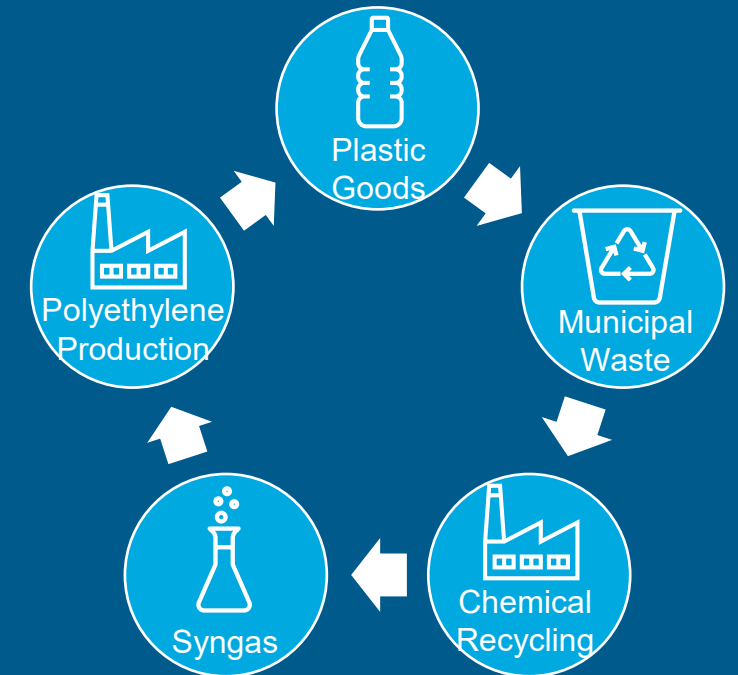
Pyrolysis

Converting **plastic waste** to liquid feedstock for virgin quality plastic



Gasification

Converting **municipal solid waste** to gaseous feedstock for virgin quality plastics



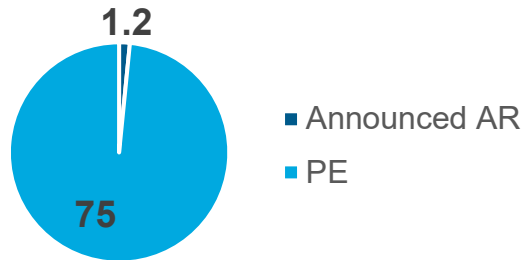
NOVA Chemicals is evaluating recycled feedstock supply via commercially available technology such as gasification (through our Joint Development Agreement with Enerkem)

Scale-up Challenge – Waste Plastic Feedstock Volumes

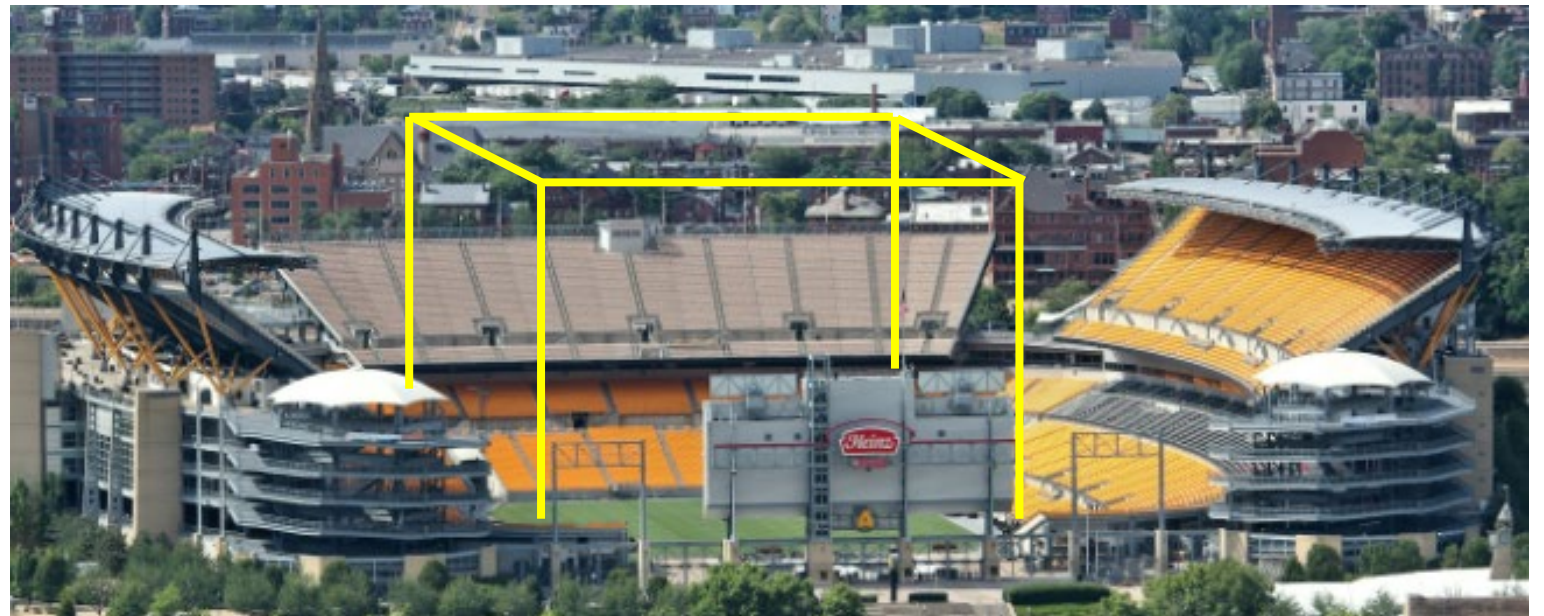
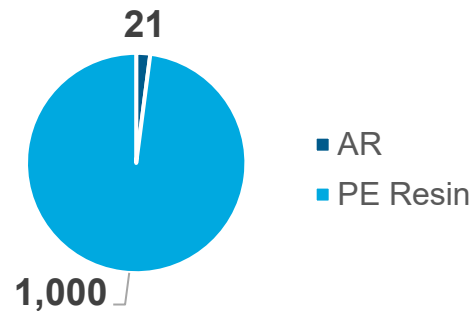
A world scale pyrolysis plant = 200 kTa (440 MM lbs)

What does ~220 MM lbs of compacted waste plastic look like?

NAM Capacity (B lbs)



Facility Capacity (MM lbs)



Logistical challenges:

- Sourcing
- Transporting
- Sorting
- Storing

AR Supply and Demand Outlook

Supply:

- Industry activated – capital investments
- Improved efficiencies across total value chain

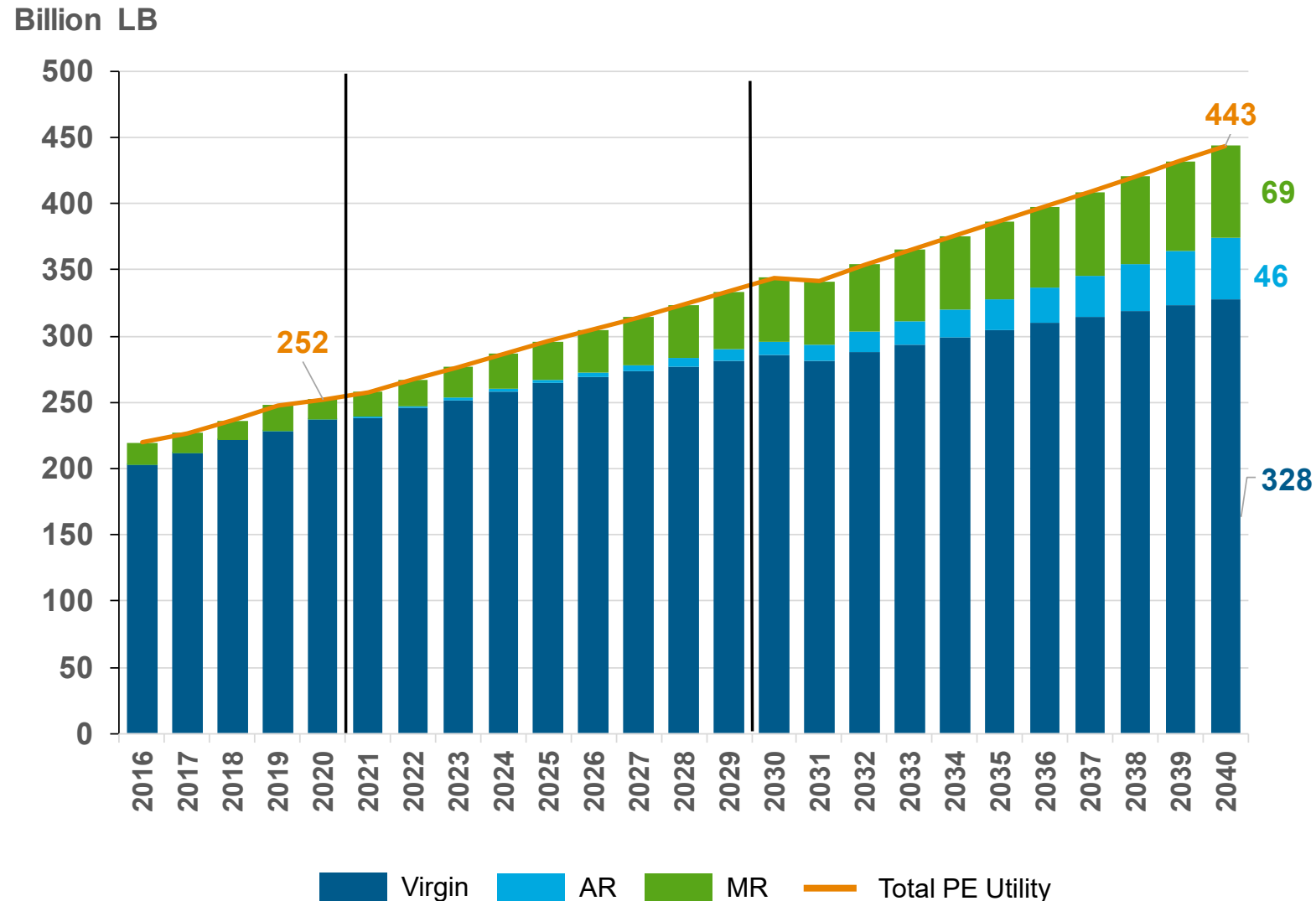
Global Demand:

- Total PE Utility - 2.9%
- Virgin (incl. AR) - 2.3%
- Mechanical recycling - 7.9%



- Mechanical – 3 grades + 1 Food Contact
- Advanced – Initiative w/ Enerkem

Global PE Demand: 2022 Outlook





Advanced Recycling Looking Ahead

- Call to Action
 - Support plastics circularity
 - Understand recycling opportunities
 - Support the industry



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