Enabling world-scale advanced circular recycling of plastics with ISCC PLUS

Jason Pierce
Group Leader, Circular Economy & LCA
Eastman

ISCC Technical Stakeholder Meeting |Circular and Bioeconomy | June 4, 2020
Enhancing the quality of life in a material way

Making life safer

Making life easier

Making life better
Plastics improve the quality of life . . .

HYDRATE

2.2B people globally still do not have access to clean drinking water.

FEED

Advanced packaging technologies can prevent 72k tons of landfilled food, preventing 329k tons GHG emissions annually in the U.S.*

CARE

Plastics improve sterility, patient safety, and comfort in therapies.

. . . BUT what about end of life?

*Source: refed.com

C. Jason Pierce cpierce@eastman.com

Eastman Chemical Company @EastmanChemCo

Eastman.eco
The world has a plastic waste problem.
Opportunities going to waste

300 million metric tons of plastics are produced globally

260 million metric tons of plastics are disposed

Eastman Advanced Circular Recycling technologies are applicable to these types of waste

- 40% Landfilled
- 25% Incinerated
- 19% Unmanaged dumps or leaked into environment
- 12% Actually gets mechanically recycled
- 16% Collected for mechanical recycling

“Inspiring a generation to rethink, redesign, and build a positive future through the framework of a circular economy”
Committed to at least 25% recycled content by 2025

These commitments are impossible with mechanical recycling alone.

Chemical recycling with certified mass balance is a critical enabler.
Mechanical recycling is not enough to solve the plastic waste problem.

<table>
<thead>
<tr>
<th>Common uses</th>
<th>Share of plastic waste generated</th>
<th>Mechanically recycled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottles</td>
<td>14%</td>
<td>Yes (clear) ~ 30% recycle rate</td>
</tr>
<tr>
<td>Films, forms, other</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Textiles</td>
<td>N/A</td>
<td>Very little</td>
</tr>
<tr>
<td>Carpet</td>
<td>N/A</td>
<td>Very little</td>
</tr>
<tr>
<td>Polyethylene terephthalate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-density polyethylene</td>
<td>17%</td>
<td>Yes ~ 9% recycle rate (natural HDPE ~ 31%)</td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td>3%</td>
<td>X</td>
</tr>
<tr>
<td>Low-density polyethylene</td>
<td>23%</td>
<td>Very little</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>23%</td>
<td>Very little</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>7%</td>
<td>X</td>
</tr>
<tr>
<td>Other (acrylic, polycarbonate, PETG, mixed plastics)</td>
<td>13%</td>
<td>Very little Diversity of materials risks contamination.</td>
</tr>
</tbody>
</table>

Most mechanical recycling results in **downcycling** into lower-value products that eventually are landfilled.

Generated share and recycled share of material sent to U.S. Municipal Solid Waste in 2017 reported as recycled by U.S. EPA. "Combusted" materials not considered recycled. Total of 32,120,000 MT discarded. Recyclability from OurWorldInData.org.
<table>
<thead>
<tr>
<th>MECHANICAL RECYCLING</th>
<th>VS. AND</th>
<th>CHEMICAL RECYCLING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal GHG footprint</td>
<td>Improved GHG footprint</td>
<td></td>
</tr>
<tr>
<td>Limited to clean sources</td>
<td>Enable use of broad range of waste</td>
<td></td>
</tr>
<tr>
<td>Degradation in performance properties</td>
<td>Indistinguishable performance</td>
<td></td>
</tr>
<tr>
<td>Finite processing</td>
<td>Infinite processing</td>
<td></td>
</tr>
</tbody>
</table>

Best choice if applications allow

Required where mechanical cannot work
A material
REVOLUTION
in the making
Vision for a sustainable future

Transforming our product portfolio to participate in the circular economy via **three loops**

Mechanical recycle stream technology
- Operational today

Carbon renewal technology
- REFORMING
- Operational today

Polyester renewal technology
- GLYCOLYSIS
- Operational today
- METHANOLYSIS
- Operational by 2022

Eastman’s Advanced Circular Recycling technologies

International Sustainability & Carbon Certification (ISCC)
EASTMAN ADVANCED CIRCULAR RECYCLING TECHNOLOGIES

**Carbon renewal technology (CRT)**
- MIXED PLASTIC WASTE
- Reforming (NOW)
- C, O, H₂ (syngas)
- Cellulosic plastics (20%–100% recycled content allocated by mass balance)
- 20%–50% LOWER GHG (intermediates)

**Polyester renewal technology (PRT)**
- PET PLASTIC WASTE
- Glycolysis (NOW)
- Methanolysis (2022)
- Recycled DMT, recycled EG
- Copolyester specialty plastics
- 20%–30% LOWER GHG (intermediates)
Eastman Advanced Circular Recycling technologies
Carbon renewal and polyester renewal can process up to 23 million kilograms of waste. Right. Now.

3 processing sites certified under ISCC PLUS
## Mechanical recycling is not enough to solve the plastic waste problem.

<table>
<thead>
<tr>
<th>Plastic type</th>
<th>Common uses</th>
<th>Share of plastic waste generated</th>
<th>Mechanical recycling?</th>
<th>Eastman Advanced Circular Recycling?</th>
<th>PRT</th>
<th>CRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene terephthalate</td>
<td>Bottles</td>
<td>14%</td>
<td>Yes (clear) ~ 30% recycle rate</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Films, forms, other</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Textiles</td>
<td>N/A</td>
<td>Very little</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Carpet</td>
<td>N/A</td>
<td>Very little</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>High-density polyethylene</td>
<td></td>
<td>17%</td>
<td>Yes ~ 9% recycle rate (natural HDPE ~ 31%)</td>
<td></td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td></td>
<td>3%</td>
<td></td>
<td></td>
<td>×</td>
<td>Not yet (2nd generation)</td>
</tr>
<tr>
<td>Low density polyethylene</td>
<td></td>
<td>23%</td>
<td>Very little</td>
<td></td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Polypropylene</td>
<td></td>
<td>23%</td>
<td>Very little</td>
<td></td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Polystyrene</td>
<td></td>
<td>7%</td>
<td></td>
<td></td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Other (acrylic, nylon, polyurethane, polycarbonate, PETG)</td>
<td></td>
<td>13%</td>
<td>Very little</td>
<td>Diversity of materials risks contamination.</td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

Generated share and recycled share of material sent to U.S. Municipal Solid Waste in 2017 reported as recycled by U.S. EPA. "Combusted" materials not considered recycled. Total of 32,120,000 MT discarded. Recyclability from OurWorldinData.org.
MASS BALANCE ENABLES CHEMICAL RECYCLING AT WORLD-SCALE

- Is an accounting system that enables chemical recycling to happen at massive scale
- Tracks recycle materials co-processed together with virgin in existing assets
- Guarantees the recycle content allocated to products balances with inputs
- Enables linkage of recycle capability to market demand
Eastman view on ISCC PLUS challenges for circular economy

- Standardized claims for percent recycled content based on mass balance allocation
- Mass balance methodology to accommodate more complex products, operations, and ERP systems
- Licensing option needed for brand owners
- Regional credit transfer needs for processing & storage
- Streamlined certification structures for complex value chains
ISCC PLUS is the front-runner and has tremendous opportunity for global adoption as “the” certification for advanced plastic recycling.