



# Challenges to Mechanical and Chemical Recycling of Textiles

NIST Conference 2021

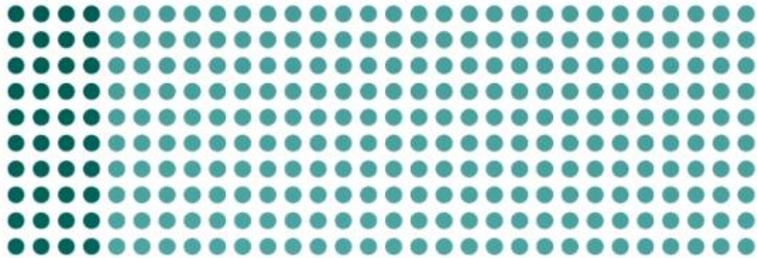
# A materials innovation company

- Celebrating more than **100 years** of vital innovations that enhance people's lives every day.
- A Fortune 500 company with approximately **14,500 employees** and approximately **8.5 billion USD** in revenue
- Dedicated to **enhancing the quality of life in a material way**
- Sustainability strategy commitment to **mitigating climate change, mainstreaming circularity** and **caring for people and society**

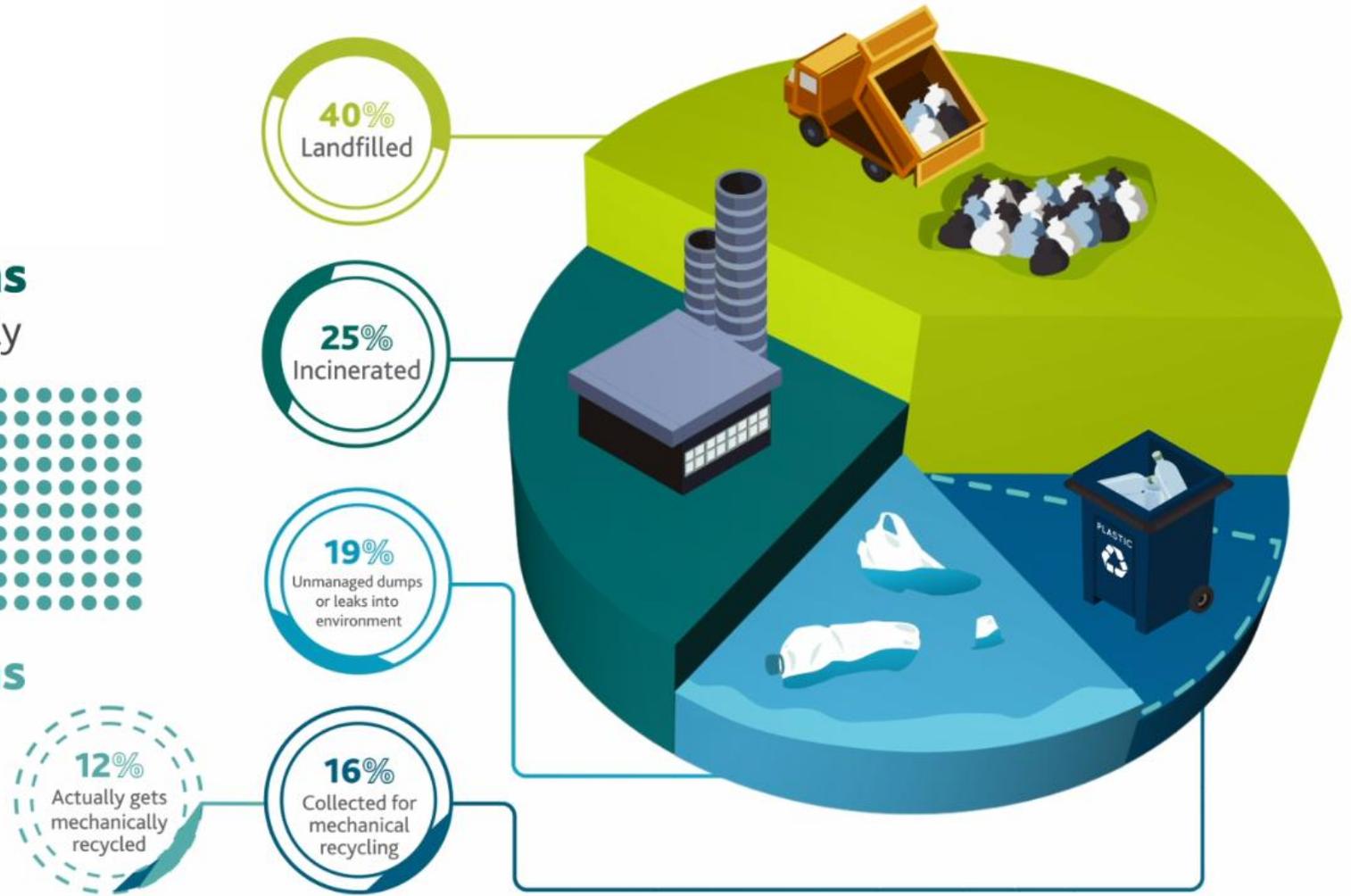


# Opportunities going to waste

**300 million metric tons**  
of plastics are produced globally



**260 million metric tons**  
of plastics are disposed



# Textile waste impact

## 2020 Global Textiles Production ~ 110 MMT

- Synthetics ~ 71 MMT
- Plant-based ~ 34 MMT
- MMCF ~ 7.5 MMT

## US 2018 MSW data (US EPA)

- 17 MMT generated
- 11 MMT went to landfill
- 2.5 MMT recycled
- 3.2 MMT combusted for energy recovery

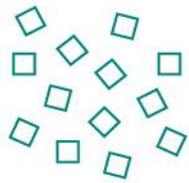


# MECHANICAL AND MOLECULAR RECYCLING

## MECHANICAL RECYCLING



PET BOTTLE



CHOPPED UP BOTTLE



REMELTED INTO NEW APPLICATIONS



Extends useful life of material but eventually must be downcycled or landfilled



LANDFILL

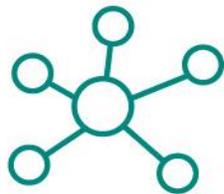


PRODUCT DEGRADES WITH EACH CYCLE

## MOLECULAR RECYCLING



MIXED WASTE PLASTIC



BROKEN DOWN TO MOLECULAR LEVEL



MADE INTO NEW PRODUCTS USING EXISTING PROCESSES



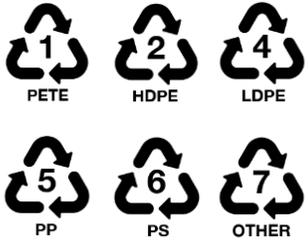
Equal or better end-use applications



INFINITE CYCLES

# EASTMAN'S ADVANCED CIRCULAR RECYCLING TECHNOLOGIES

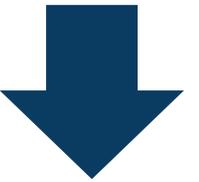
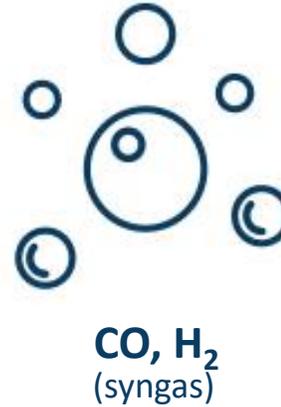
## Carbon renewal technology (CRT)



## MIXED PLASTIC WASTE



## MOLECULES



20-50%  
LOWER  
GHG  
(syngas)

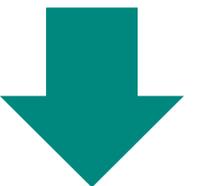
## Polyester renewal technology (PRT)



## PET PLASTIC WASTE



## MONOMERS



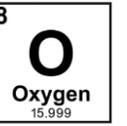
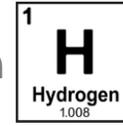
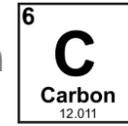
20-30%  
LOWER  
GHG  
(rDMT, rEG)

# Mechanical recycling is not enough to solve the plastic waste problem.

Plastic Type	Common Uses	Share of Plastic Waste Generated	Mechanical Recycling?	Eastman Advanced Circular Recycling?	
				PRT	CRT
 PETE	Bottles	14%	Yes (clear) ~ 30% recycle rate	✓	✓
	Films, Forms, Other		✗	✓	✓
	Textiles	N/A	Very Little	✓	✓
	Carpet	N/A	Very Little	✓	✓
 HDPE		17%	Yes ~ 9% recycle rate Natural HDPE ~ 31%	✗	✓
 PVC		3%	✗	✗	Not Yet (2 <sup>nd</sup> generation)
 LDPE		23%	Very Little	✗	✓
 PP		23%	Very Little	✗	✓
 PS		7%	✗	✗	✓
 OTHER	Other (acrylic, nylon, polyurethane, polycarbonate, PETG) 	13%	Very Little Diversity of materials risks contamination	✗	✓

# Chemical companies make materials/plastics used to make stuff

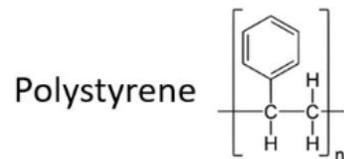
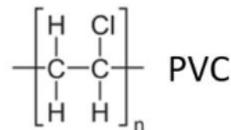
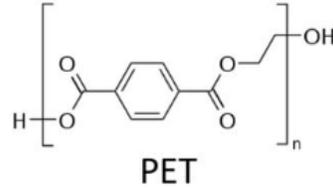
These materials/plastics are made mostly from carbon



**Plastic & Textile Waste**  
(Carbon, Hydrogen, and Oxygen)



Advanced or Chemical or Molecular Recycling



# MASS BALANCE accounting is necessary to achieve scale NOW

**Without mass balance**, duplicate infrastructure is required (plants, storage, logistics, etc.), essentially making it cost prohibitive to get to large scale by **dramatically increasing** timelines, costs, and carbon footprints.

With mass balance, existing assets can be modified to start **scaling waste plastic as feedstock quickly**.



To ensure acceptance it must be **credible, verified, and trusted**

We need to educate & advocate for a few critical points to **ensure credibility & flexibility**.



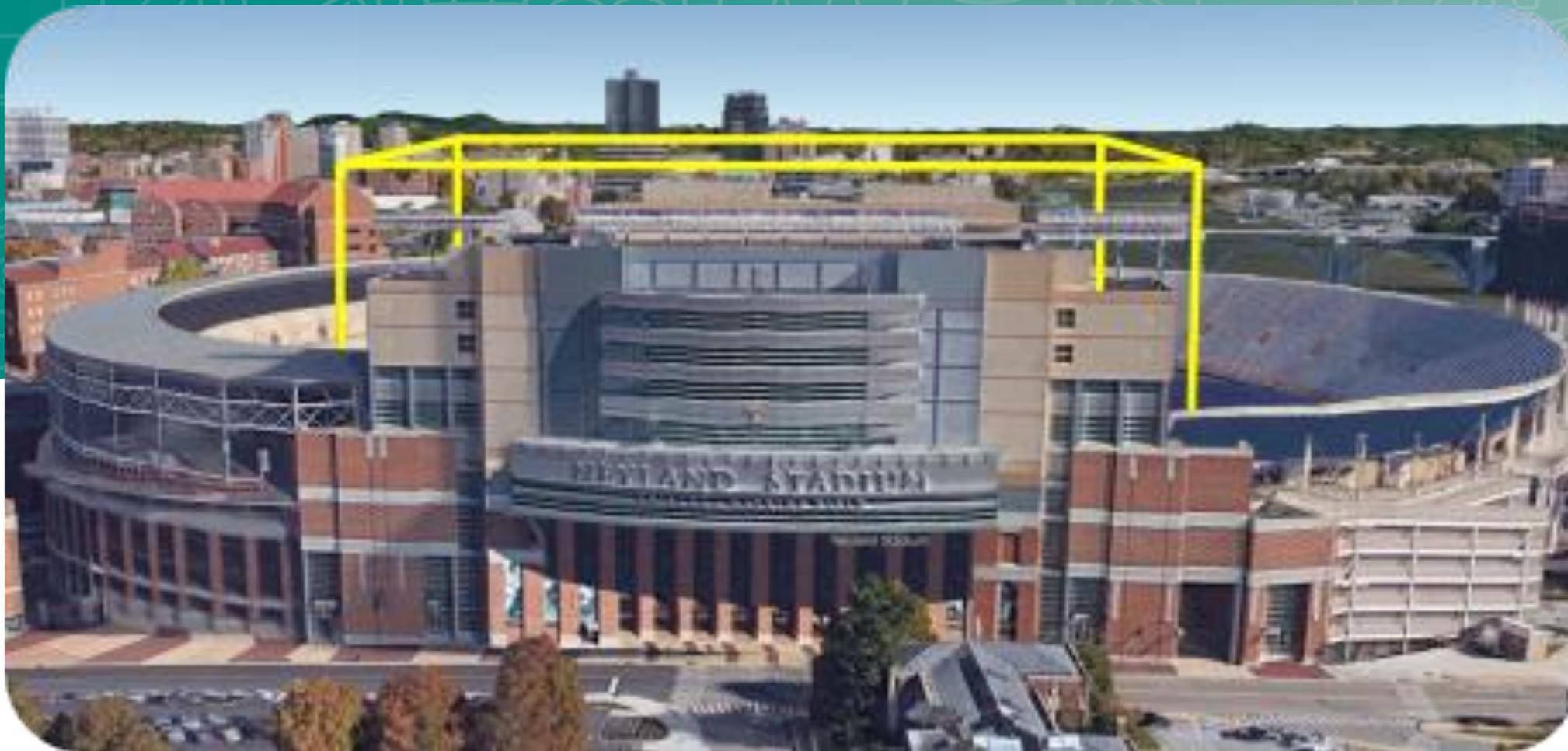
**It's not new.** Mass balance is trusted in other industries, i.e. FSC & renewable energy.



It needs a trusted, reliable, and credible certification body. **ISCC Plus is the leader.**



# **EASTMAN** What does 250,000,000 pounds of waste plastic look like?



250,000,000 pounds of waste plastic would fill this yellow box inside of Neyland Stadium.  
We will be processing this volume of plastic waste each year starting in 2023.



# Challenges of textile recycling

- Collecting the waste in tiny, mixed amounts
  - Post Industrial Waste (simpler compositions)
  - Post Consumer Waste
- Transporting the waste to a handling facility
- Sorting
- Cleaning
- Repackaging
- Transporting to market/buyer
- Mechanical recycling – typically single component textiles such as PET
- Chemical recycling – more complex textiles





**Welcome to the  
Renew world...**  
where circular solutions are made possible.



# Naia™ Renew drives circularity at scale.

Through Eastman's carbon renewal technology, we are helping to solve the global waste issue and reduce our carbon footprint. Naia™ Renew delivers "big circle" circularity.

## Consumer impact



**One T-shirt** made with 100% Naia™ Renew diverts the equivalent of **six water bottles** or **over 60 grams** of hard-to-recycle waste material from landfills.<sup>a</sup>

## Brand and mill impact

For every 100 metric tons of Naia™ Renew produced:

46 MT



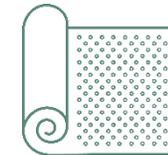
of waste material is diverted from landfill and used as raw material

Equivalent to



4.5 million water bottles<sup>b</sup>

OR



3.9 hectares of carpet

220 MT



reduction in GHG emissions<sup>c</sup>

<sup>a</sup>Typical men's T Shirts per PETRA (PET Resin Association). Naia™ Renew 40% recycled content is achieved by allocation of recycled waste material using an ISCC-certified mass balance process. <sup>b</sup>0.5-liter water bottles, <sup>c</sup>Compared to conventional Naia™ products

# The Naia™ brand portfolio gains traction as a sustainable fiber with fashion brand adoptions across the globe



Images & film supplied by H&M

Science

**THIS FABRIC IS PARTLY SOURCED FROM CERTIFIED WOOD FIBRES AND RECYCLED PLASTIC WASTE.**

Eastman Naia™ Renew cellulosic yarn is produced with an innovative and patented carbon removal technology. A process that recycles waste plastics and carpet fibers and captures value from hard-to-recycle materials that would otherwise be destined for the landfill.



- Numi
- uwilawarrior
- ALMOST THERE
- SHESSISS
- UOOYAA
- RESERVED
- orsay
- WEEKDAY
- GESTUZ
- STINE GOYA

# Key takeaways...

- Textile recycling represents a significant opportunity for the society today
- Collection and sorting infrastructures need to be established
- Molecular recycling can play an important role by complimenting traditional mechanical recycling.
- Eastman is investing in innovations and partnerships to catalyze the creation of a circular economy.



# Thank you! Questions?

Find more resources at  
[Eastman.com/circular](https://Eastman.com/circular)



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