Coatings Trends & Technologies SUMMIT

Powder Coating Resins from Recycled PET

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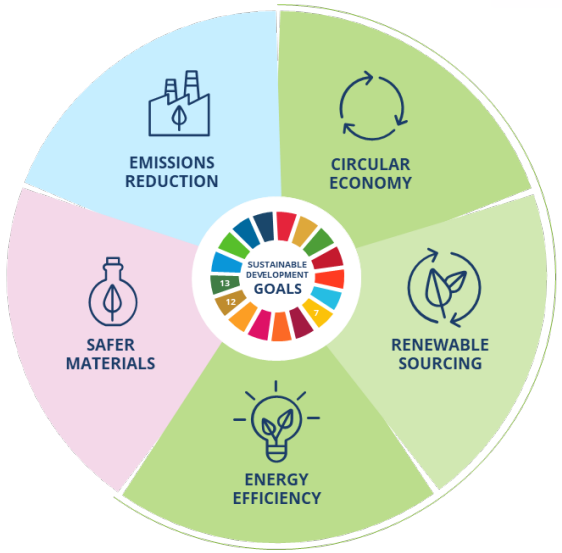
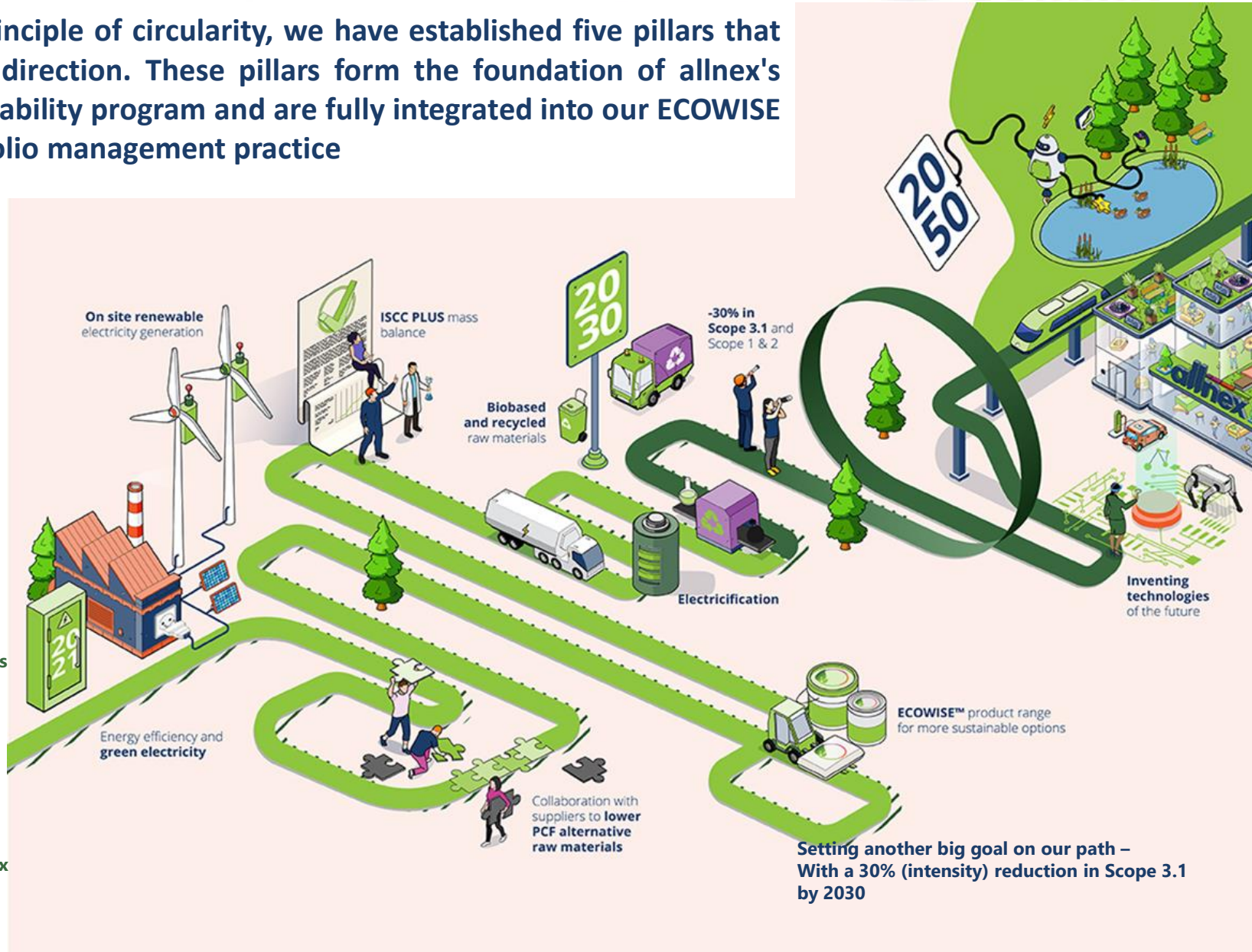
Agenda

- allnex Sustainability Program
- What is PET?
- Why interest in recycled PET (rPET)?
- PET Recycling Process
- Types of rPET
- rPET Powder Polyester Resins
- Coating performance of rPET resins
- Summary

The future we strive for: Our mid- and long-term goals



Guided by the principle of circularity, we have established five pillars that provide detailed direction. These pillars form the foundation of allnex's ambitious sustainability program and are fully integrated into our ECOWISE sustainable portfolio management practice



Achieve 30% (absolute) reduction in Scope 1&2 by 2030 and net zero by 2050

Achieve 30% (intensity) reduction in Scope 3.1. by 2030 and net zero by 2050

Achieve 85% renewable electricity use by 2030

Reach 50% total business for ECOWISE™ products by 2030

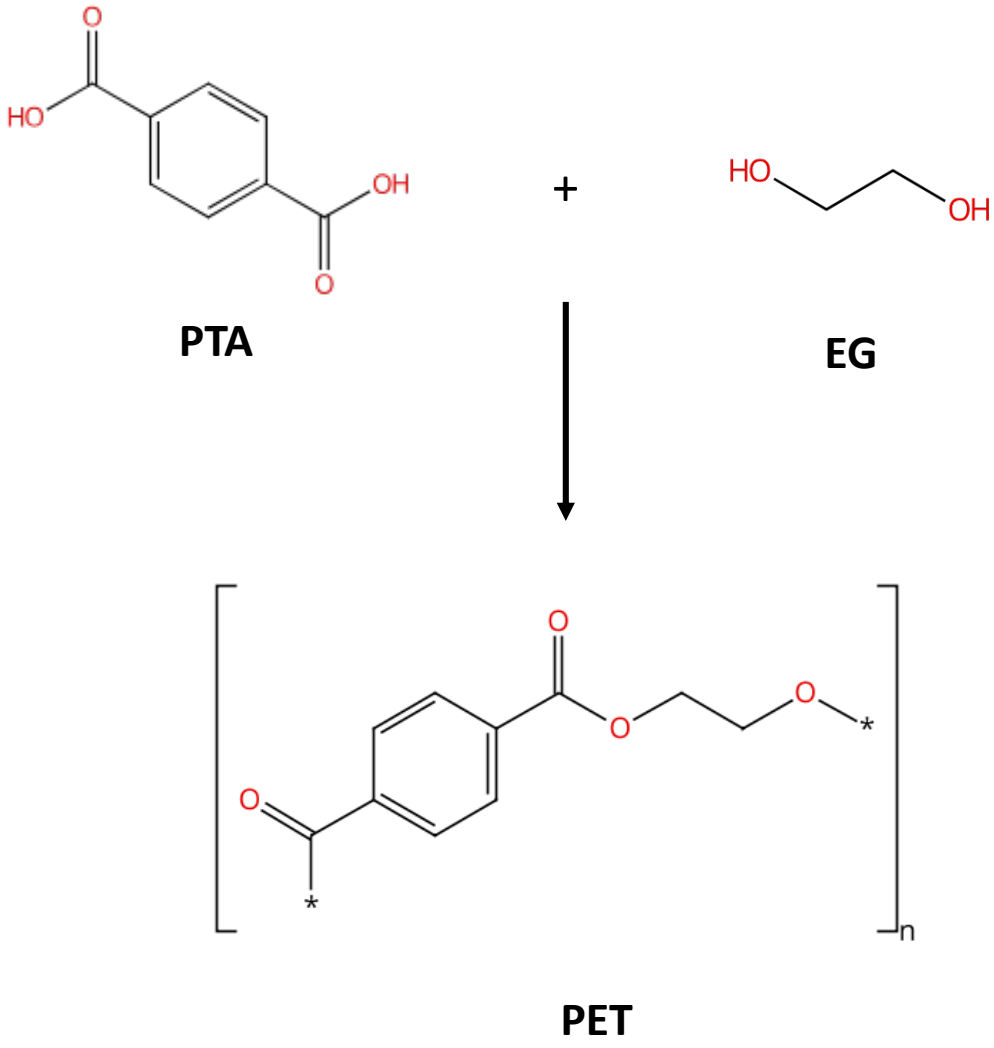
Increase the overall proportion of women in manufacturing at allnex to 16% by 2030

Increase the overall proportion of women in leadership roles at allnex to 35% by 2030

Setting another big goal on our path –
With a 30% (intensity) reduction in Scope 3.1 by 2030

What is PET?

- PET : polyethylene terephthalate
  - Polyester made from purified terephthalic acid (PTA) and ethylene glycol (EG)
- PET was discovered in 1940s.
  - Most successful polyester with widespread use and commercial success
- PET applications:
  - Fibers: polyesters (mostly PET) - 70% of al the synthetic fibers produced in the world.
  - Packaging - bottles and food packaging
  - Other- films, cam wheels, gear teeth and bearing
- PET Properties
  - Highly transparent and shatter proof – glass replacement
  - Good barrier for O_2, CO_2 and moisture – food and beverage
  - High strength to weight ratio – light weight packaging



Why interest in recycled PET (rPET)?

- Primary Driver: Reduce plastic waste in landfills and oceans
  - Huge global issue: “Planetary Crisis” – United Nations
  - In 2015 – 79% of global plastic waste ended up in landfills and natural environment!
- Secondary Driver: rPET can be an alternative to PET from virgin RMs.
  - PTA and EG derived from petroleum – ‘finite and diminishing resource’
  - Less energy demand and greenhouse gas emissions - LCA by National Association for PET Container Resources (NAPCOR)
    - 40% less process and transport energy
    - 75% lower total energy demand
    - 60% reduction in greenhouse gas emissions

Photo Source: Ocean plastic a 'planetary crisis' - UN (bbc.com)

R. Geyer et al., *SCIENCE ADVANCES,* vol. 3, no. 7, p. e1700782, 2017
"Life Cycle Analysis," NAPCOR, [Online]. https://napcor.com/sustainability/life-cycle-analysis/.

Challenges with rPET

- Effective separation of polymers during recycling
  - Even after separation of plastics, some polymeric impurities present in the segregated streams
    - Could result in phase separation of the resins
    - Leads to poor mechanical properties and surface imperfections
- Contaminants – Hydrolysis of rPET -reduce melt Vx
  - Acidic contaminants
    - PVC, Adhesives, ethylene vinyl acetate (EVA), and paper
  - Basic contaminants
    - NaOH, alkaline detergents (label removing and washing steps)
  - Water (washing step)
- Colored impurities and Yellowing
  - Colored plastics and labels – undesirable color effects
  - Yellowing – intramolecular crosslinking and oxidations reactions

Photo Source: Bales of PET bottles stacked - Plastic recycling - Wikipedia

PET Recycling Process

- Bulk of PET exist as fibers and is incinerated or goes to landfills.
- PET is also the most recycled plastic in the world!
- Much of the recyclable PET exist in the form of bottles or packaging.

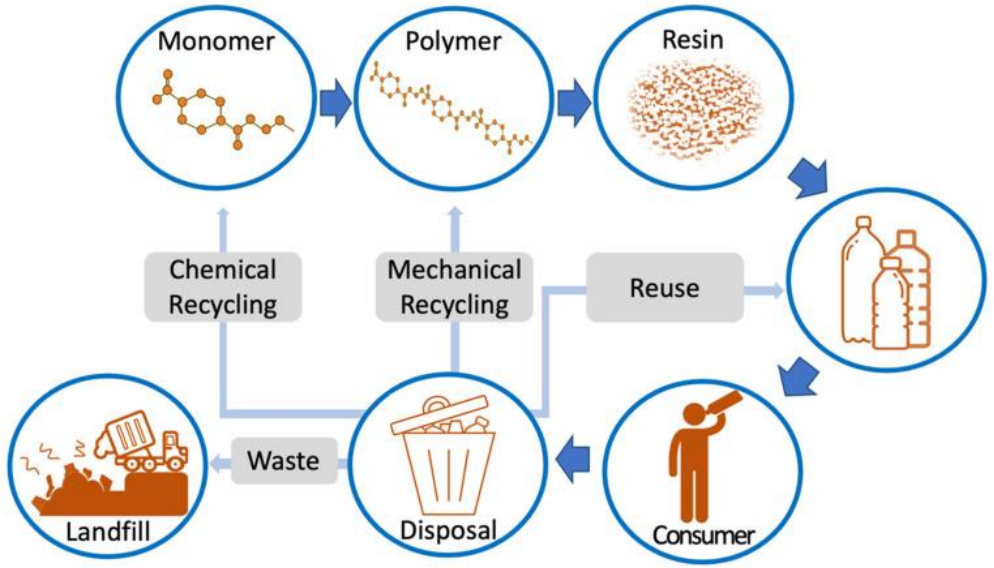
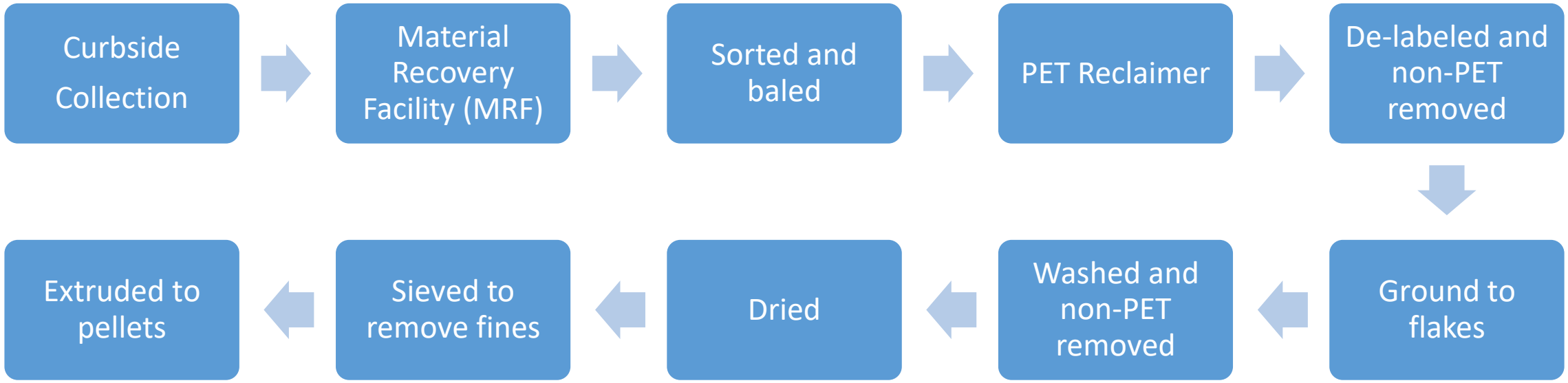
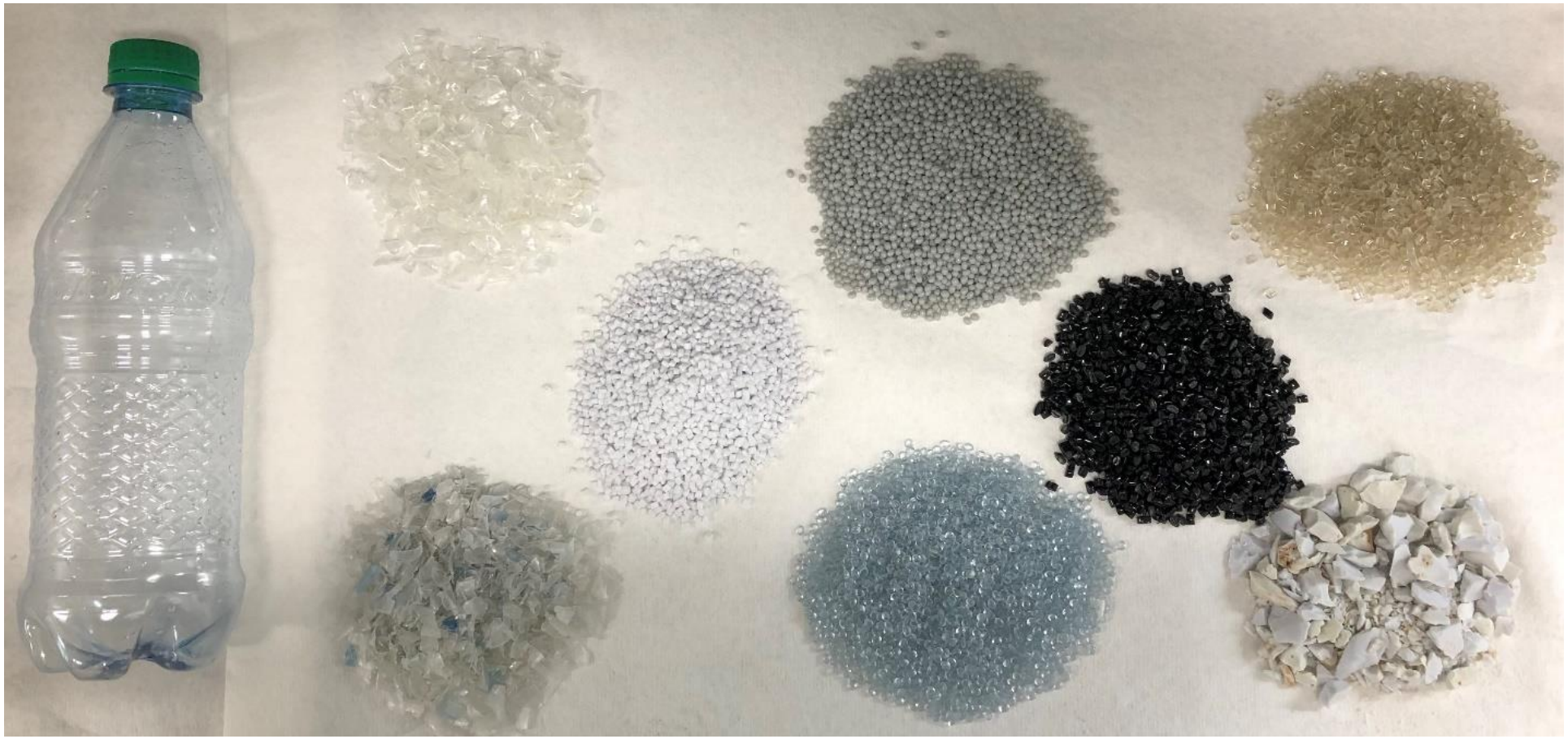


Image Source: Benyathiar, Patnarin *et al., Polymers* vol. 14,12 2366. 11 Jun. 2022, doi:10.3390/polym14122366

Mechanical Recycling steps of PET:



Types of rPET



various rPET types from multiple sources: Top row (L to R): clear bottle flakes , clear post-consumer rPET pellets, clear post-industrial rPET pellets , Middle row (L to R): white post-industrial rPET pellets, black post-industrial rPET pellets, Bottom row (L to R): clear bottle flakes, clear post-industrial rPET pellets, post-industrial rPET chunks.
Leftmost: a 500mL empty water bottle photographed for comparison.

rPET Powder Polyester Resins

No solvents

Water as a by-product

r-PET as a raw material

10-50%

Traditional Powder Polyester Resin

rPET Powder Polyester Resins

No solvents

No VOCs

Reclaim and Reuse

Powder Coatings

rPET Powder Polyester Resins

- Contains 5-50% rPET by weight. (@ 50% rPET→ 1MT of resin contains 50000 plastic bottles)
- Directly uses the rPET in the resin synthesis without going through a separate step to break down and purify the monomers.
- Up to 30% reduction in product carbon footprint (PCF) compared to a similar standard product.*
- A way of Recycling: Conversion of a used plastic bottle into a high-tech coating with a longer service life

*According to PCF (Cradle-to-Gate) calculations done following Together for Sustainability (TfS) guideline aligned with ISO 14067.

rPET Powder Polyester Resins – Examples

TGIC Resins

Resin	Ratio	Description
Resin 1	95/5	Standard Durable general-purpose resin
Resin 2	93/7	Architectural grade with good flow, flexibility and outdoor durability
Resin 3	93/7	Standard durable low cure option
Resin 4	93/7	Superdurable with balance of properties

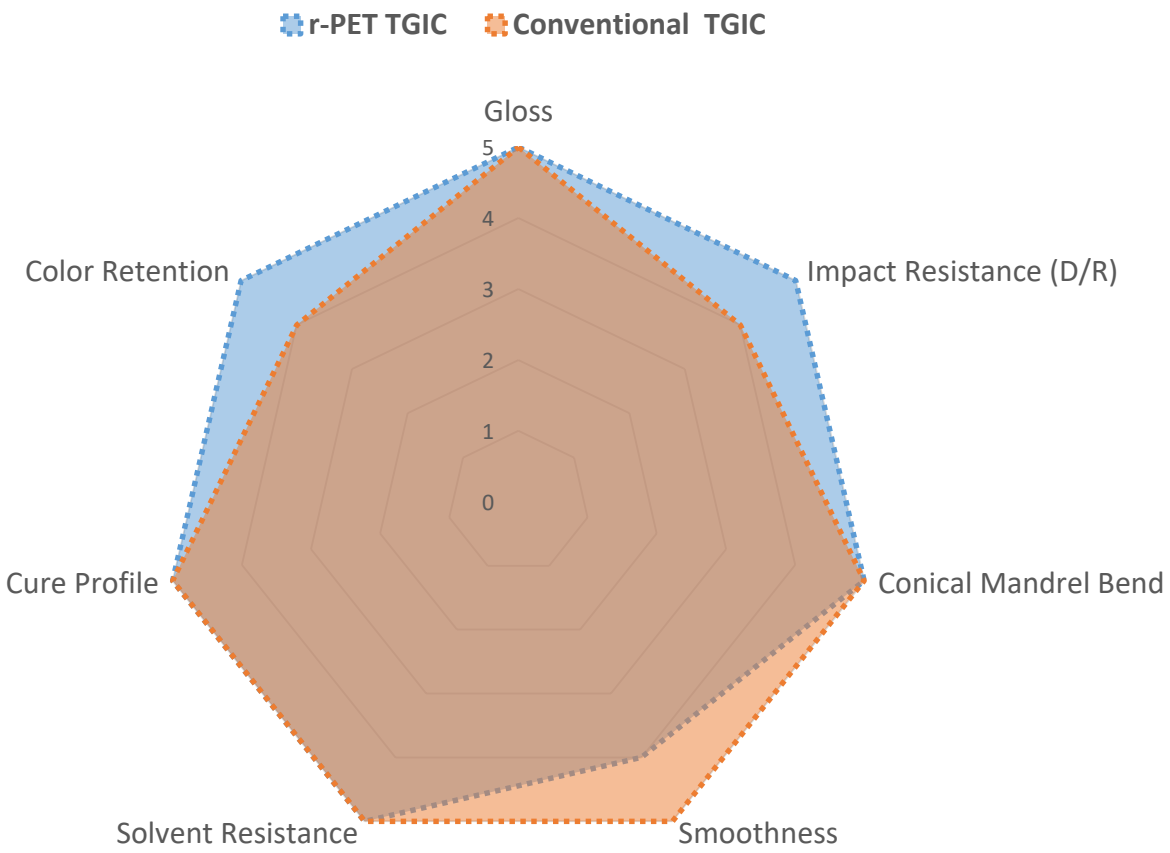
Hybrid Resins

Resin	Ratio	Description
Resin 5	50/50	Low cure option, good pigment wetting
Resin 6	60/40	High Tg with balance of properties
Resin 7	60/40	Low cure option
Resin 8	70/30	Balanced properties

Hydroxyalkyl amide (HAA) and Hydroxy versions are also available.

Coating Performance of rPET Resins

Performance versus conventional system



Performance Advantages:

- Excellent mechanical properties
- Excellent color retention
- Good solvent resistance
- Good balance of properties

Summary

- Huge quantities of plastic waste ends up in landfills and natural environment everyday and this is a major global issue.
- Recycling PET would significantly reduce;
  - the plastic waste end up in the environment.
  - the use of virgin raw materials originate from the diminishing petroleum resources.
  - the greenhouse gas and carbon emissions.
- We have successfully developed the capabilities and the know how to use rPET in powder coating resins.
- The use of rPET in powder coating resins converts a single use plastic container to a high-tech coating with a longer product lifetime.

Thank You for your Attention!

Questions?