

Anellotech

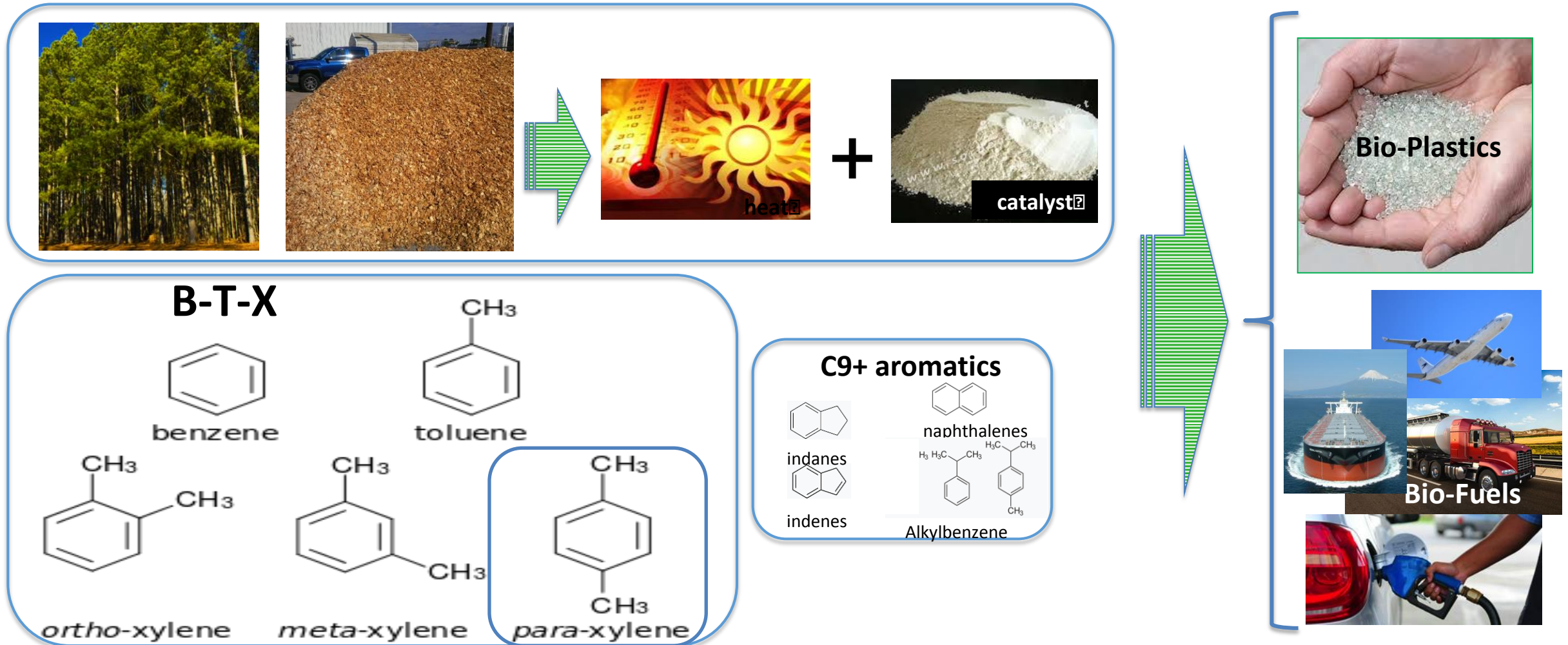


Renewably sourced chemicals for virgin bio-packaging

Plastics chemical recycling

Bio-sourced aromatics for virgin plastics

The Bio-TCat™ Process --- Thermal Catalytic Biomass Conversion



Developed with \$85 million cash and in-kind support from industrial R&D and brand owner partners

Anellotech

- ✓ Program Management
- ✓ Research & Development
- ✓ Pilot Plants



- ✓ Process Development
- ✓ Modeling & Hydrodynamics
- ✓ Scale-Up

SUNTORY
FOLLOW YOUR NATURE


Johnson Matthey
INTERCAT

- ✓ Catalyst Technologies
- ✓ Formulations
- ✓ Catalyst Supply

Axens
Powering integrated solutions

- ✓ Process & Plant Design
- ✓ Technology Licensing & Marketing
- ✓ Start-Up & Operations Support

 **TOYOTA TSUSHO**

TCat-8 Video

English Language Video: https://www.youtube.com/watch?v=27kzA_qk69E

Japanese Language Video: <https://www.youtube.com/watch?v=wC7QQT71AsY>

Anello tech



WWW.ANELLOTECH.COM



After 7500 hours of pilot plant testing, Bio-TCat commercial plant planning is underway

Bio-TCat: It's happening now



Georgia-grown loblolly pine



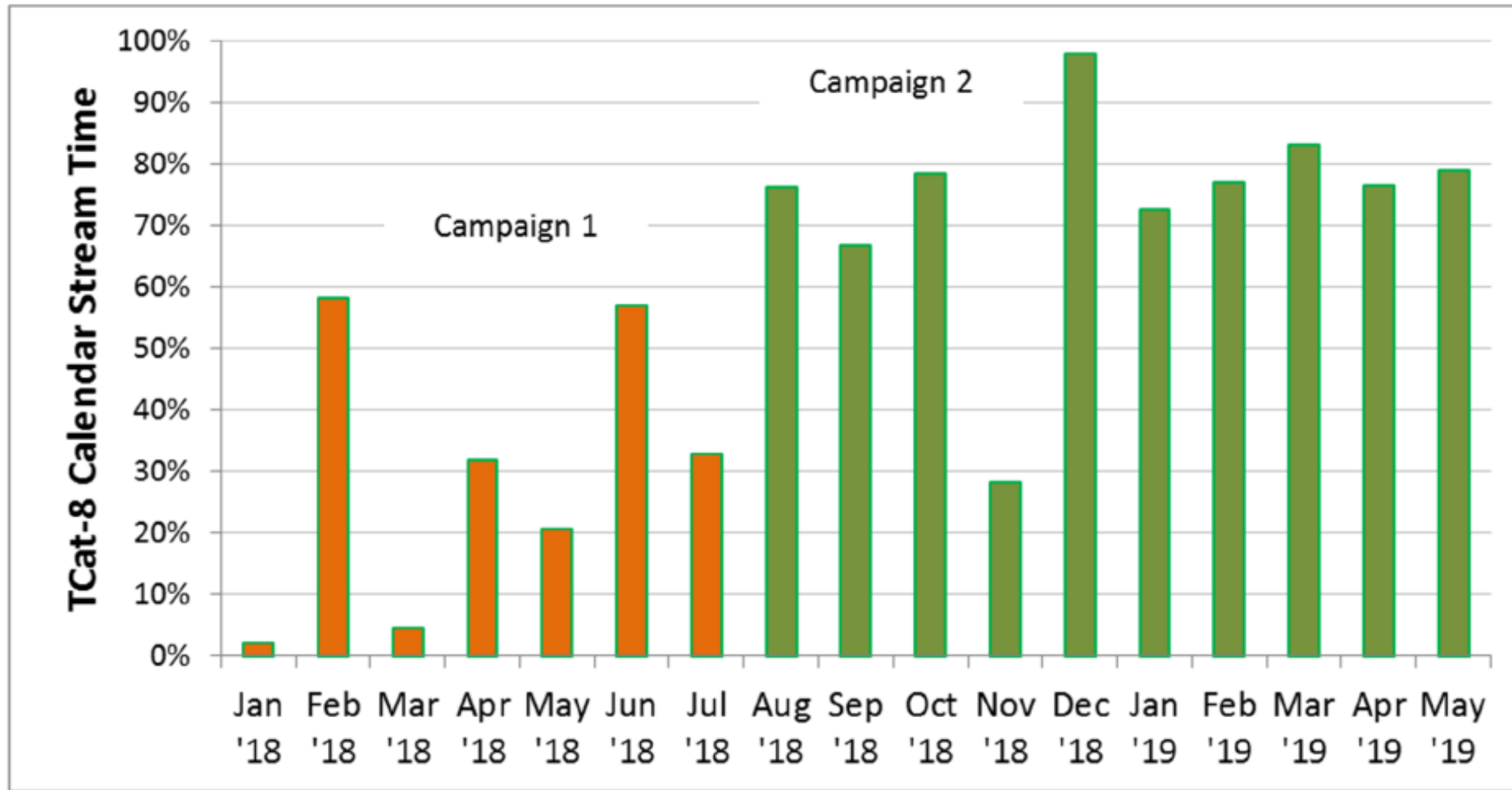
T-Cat 8 Pilot Unit



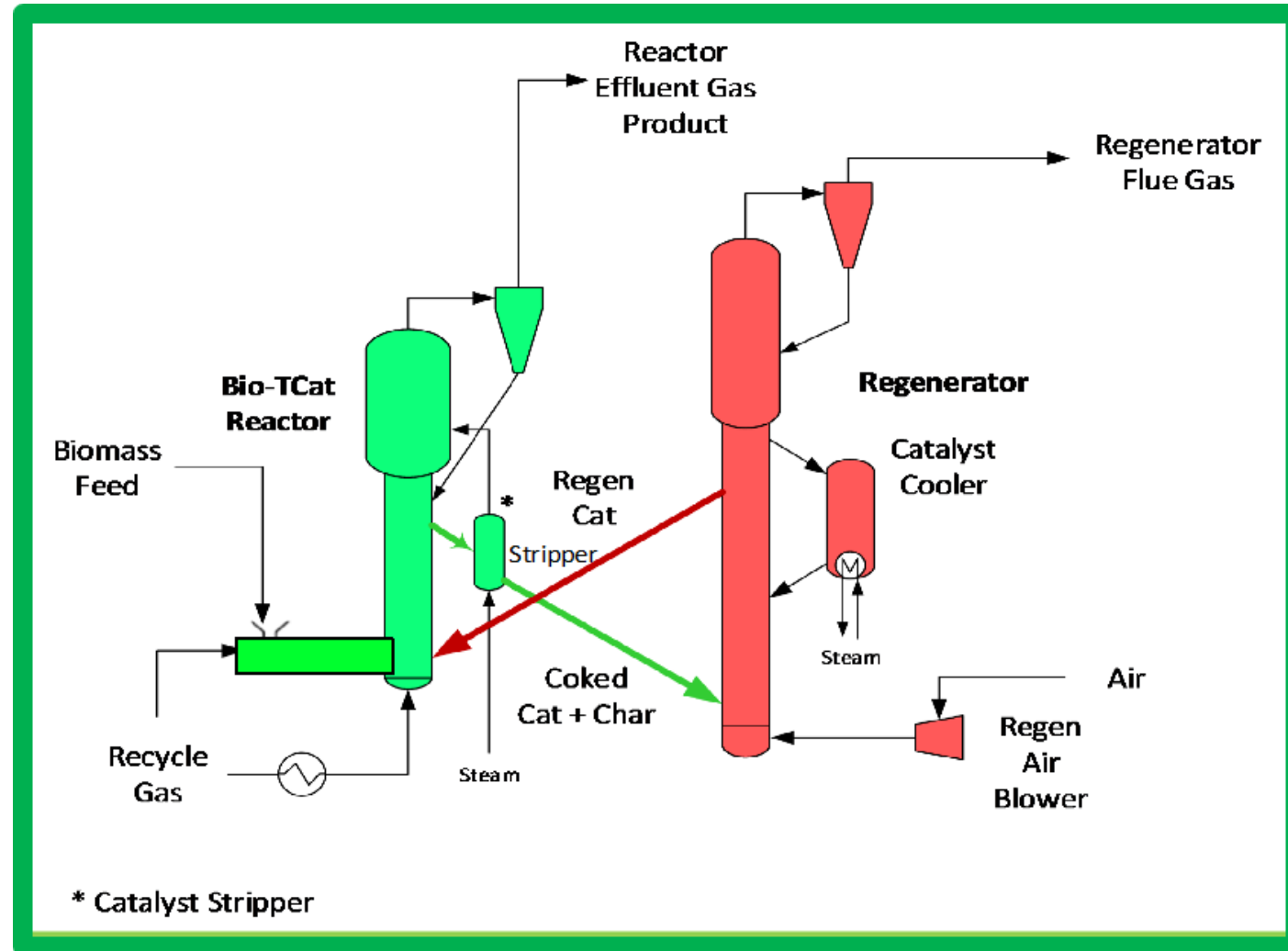
BTXN Product

- Commercial yield and catalyst life
- Regularly completing sustained 24/7 runs; 7,500+ hours on stream operations since Feb'18
- Demonstration of major continuous process operations, recycle loops
- Feedstock -- loblolly pine SE USA forests
- Operates inside OSHA PSM compliant commercial chemical facility

TCat-8 On-Stream Performance



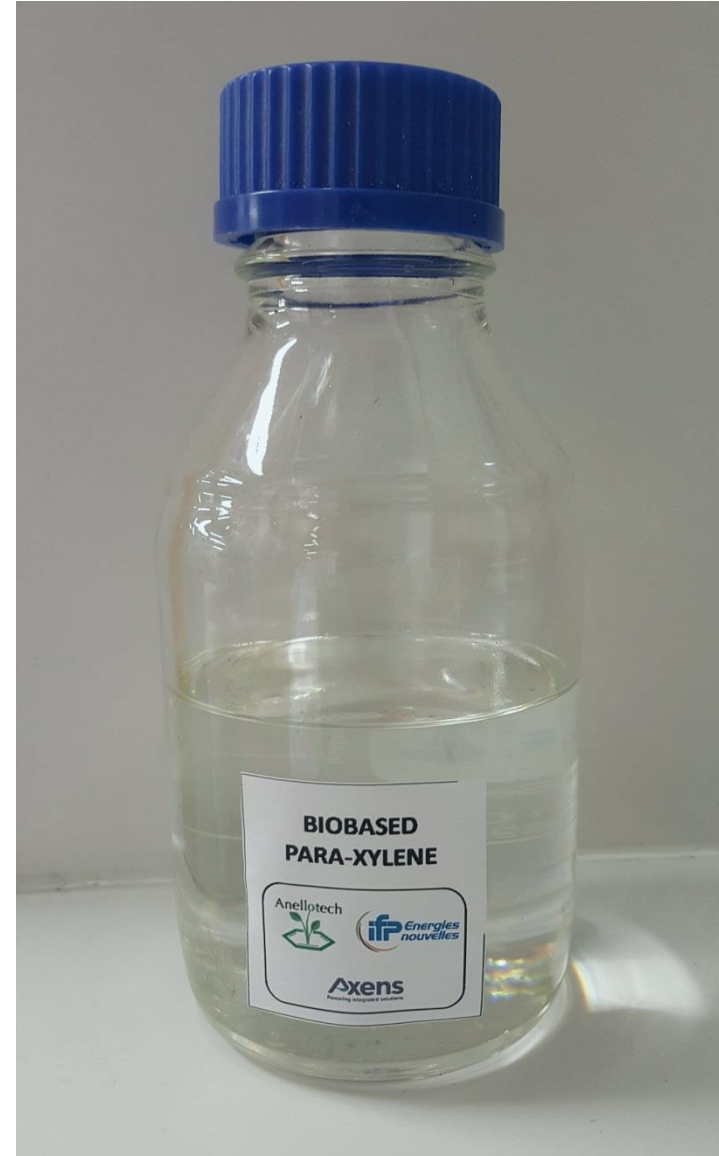
Bio-TCat uses industrial fluid bed reactor technology for large scale production



100% Bio PET Bottles

Objective:

Bio p-xylene from TCat-8[®] will be used to make renewable PET resin for prototype bottle manufacture and product testing.





Synthetic Rubber



Nylon



Polyurethane

Enabling a world of biobased BTX polymers



ABS Plastic Toys



Polyester Clothing & Shoes



Polystyrene



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Plas-TCat™

Plas-TCat will use Bio-TCat development infrastructure, including a large pilot/demo plant

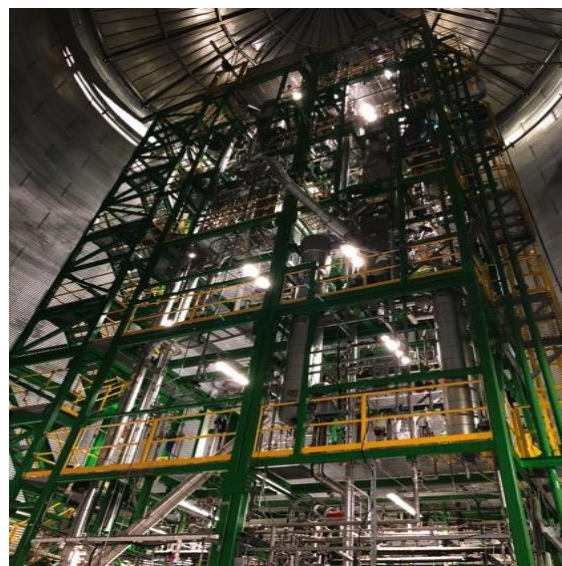
Laboratory Fluid Bed Reactors



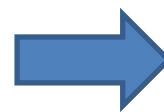
2019-2020



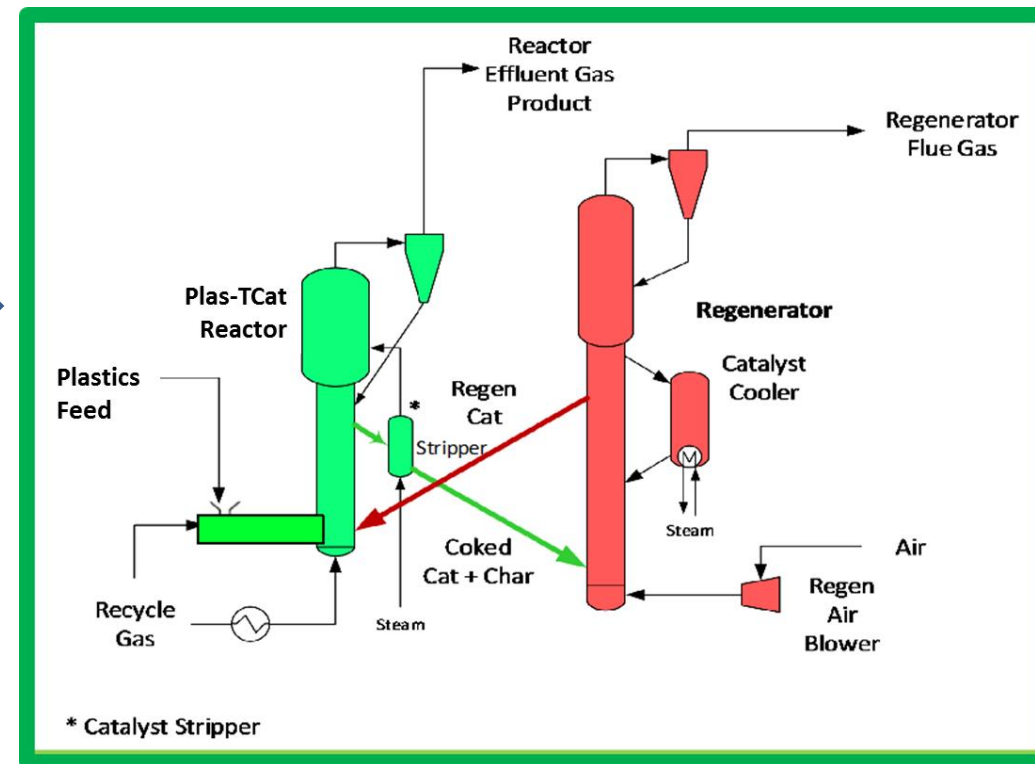
TCat-8 Pilot Plant
([VIDEO LINK](#))



2021



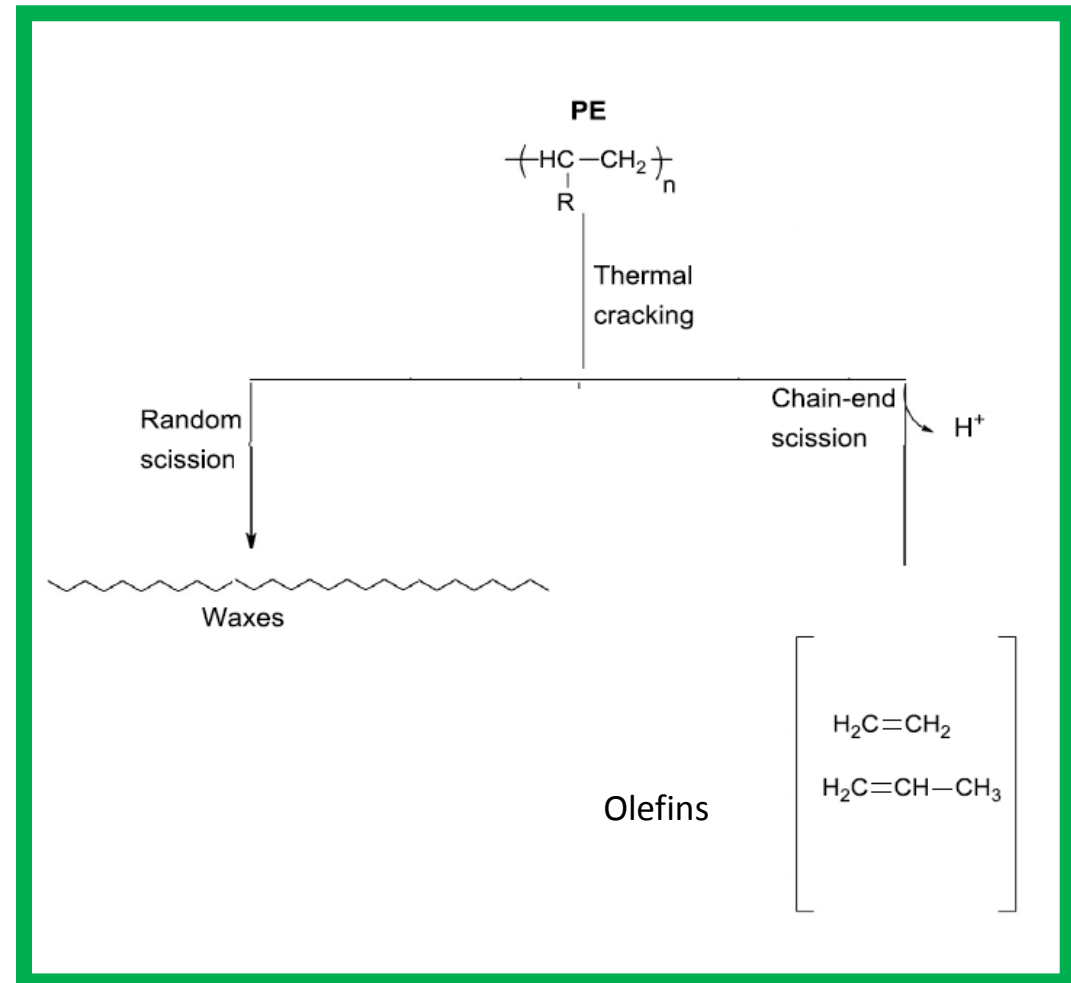
Future Commercial Plant



While Non-Catalytic Pyrolysis

of polyethylene produces a broad mix of waxes and olefins⁽¹⁾⁽²⁾

Requires upgrading in a steam cracker to yield upgraded valued product



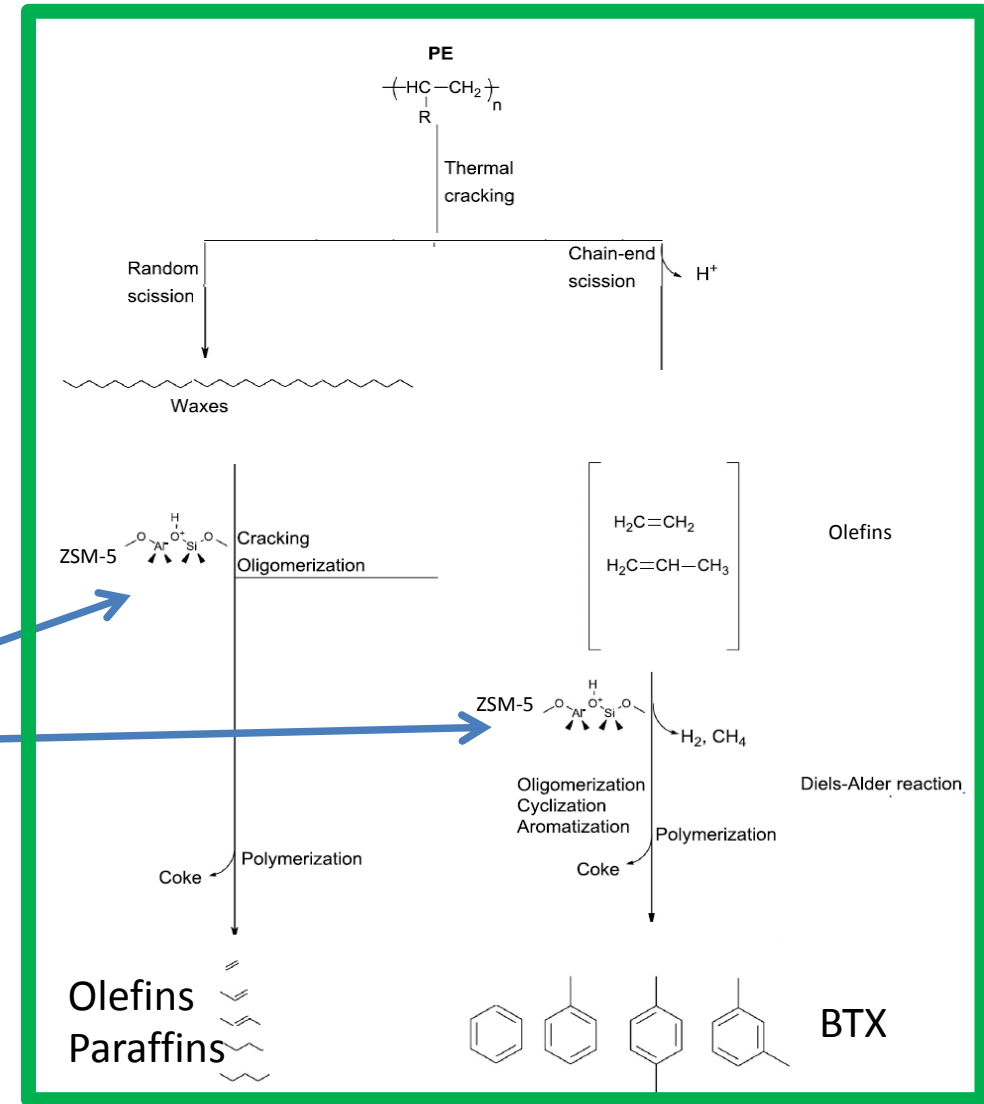
¹ Dongting Zhao, Xianhua Wang, James B Miller, George W Huber, "The chemistry and kinetics of polyethylene pyrolysis: A feedstock to produce fuels and chemicals.

² Xuesong Zang, Habwy Lei, Lei Zhu, Moriko Qian, Xiaolu Zhu, Joan Wu, Shulin Chen, "Enhancement of jet fuel range alkanes from co-feeding of lignocellulosic biomass with plastic via tandem catalytic conversion", *Applied Energy*, 173 (2016) 418-430

Plas-TCat Catalytic Pyrolysis yields mainly BTX, ethylene, propylene, paraffins **directly** in one reactor

Products ready for purification and use to make virgin plastics

ZSM-5 Catalyst

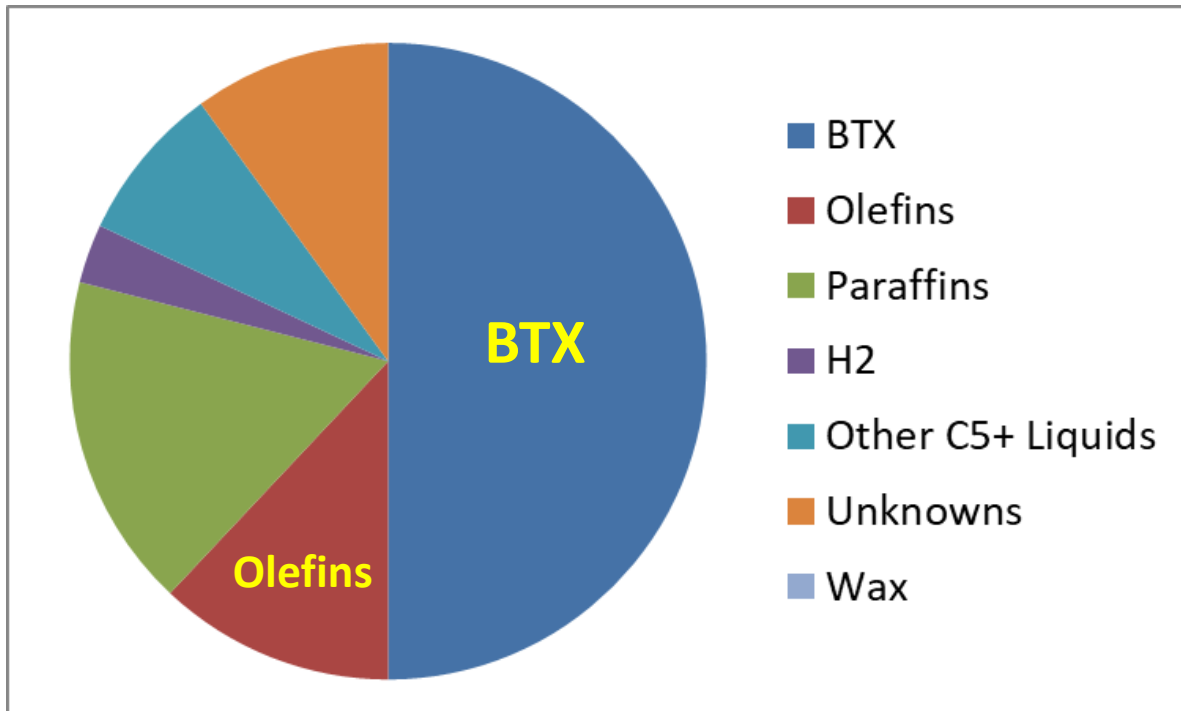


¹ Dongting Zhao, Xianhua Wang, James B Miller, George W Huber, "The chemistry and kinetics of polyethylene pyrolysis: A feedstock to produce fuels and chemicals."

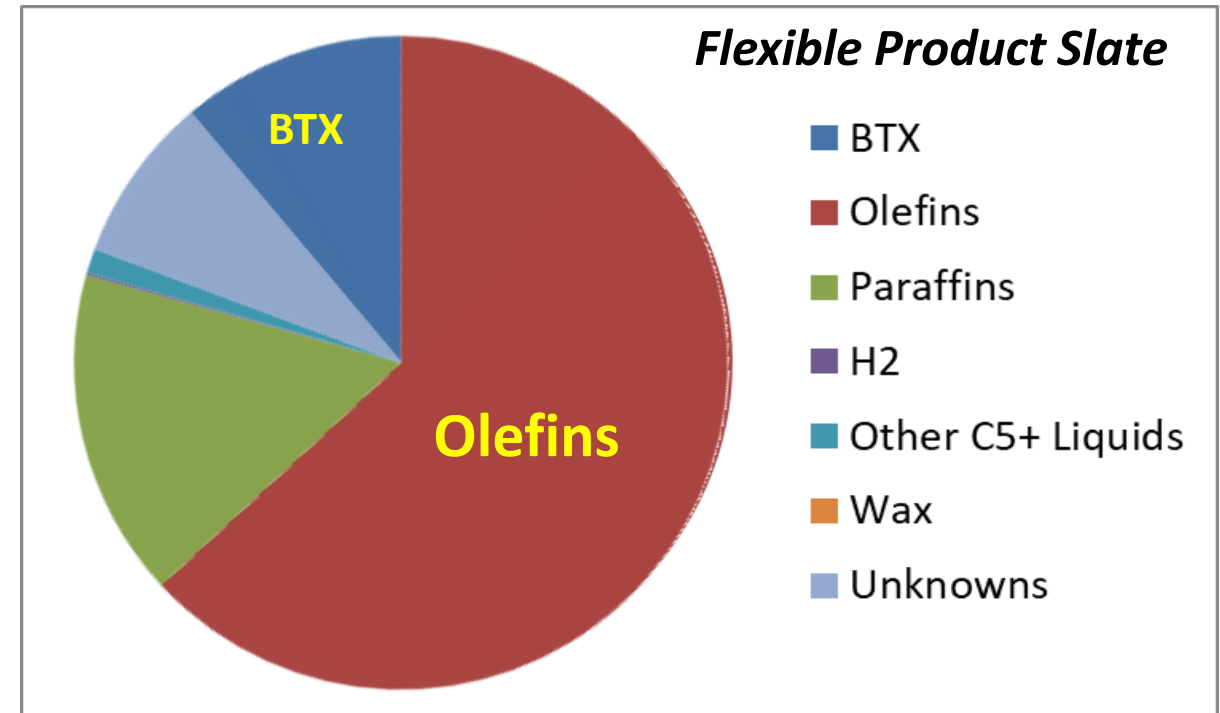
² Xuesong Zang, Habwy Lei, Lei Zhu, Moriko Qian, Xiaolu Zhu, Joan Wu, Shulin Chen, "Enhancement of jet fuel range alkanes from co-feeding of lignocellulosic biomass with plastic via tandem catalytic conversion", *Applied Energy*, 173 (2016) 418-430

Early data feeding polyethylene shows Plas-TCat output can be controlled to make either High Yield BTX *or* High Yield Olefins

Plas-TCat Hi-BTX



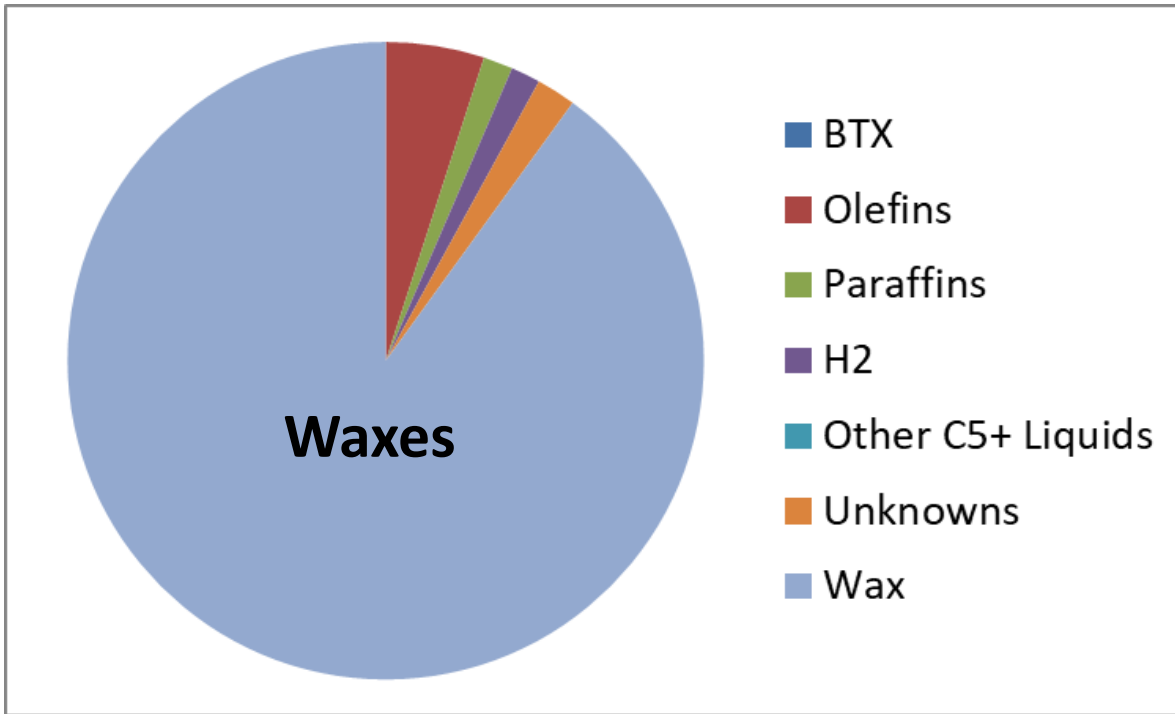
Plas-TCat Hi-Olefins



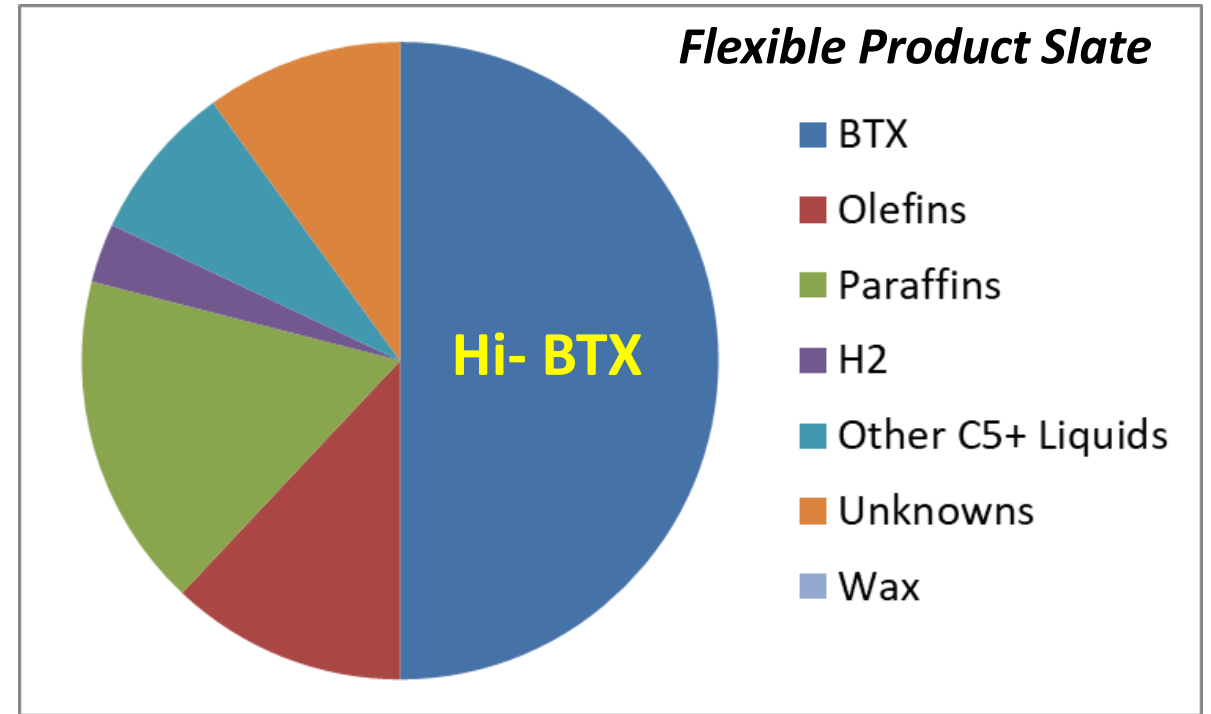
For illustrative, qualitative use only. These lab results are to be validated in long-duration studies in a fully integrated TCat-8 Pilot Plant. Detailed review of experimental conditions, catalyst and other factors can be shared to fully assess this data

Contrast this with non-catalytic pyrolysis, which produces predominantly waxes needing further upgrading

Non-Catalytic Pyrolysis

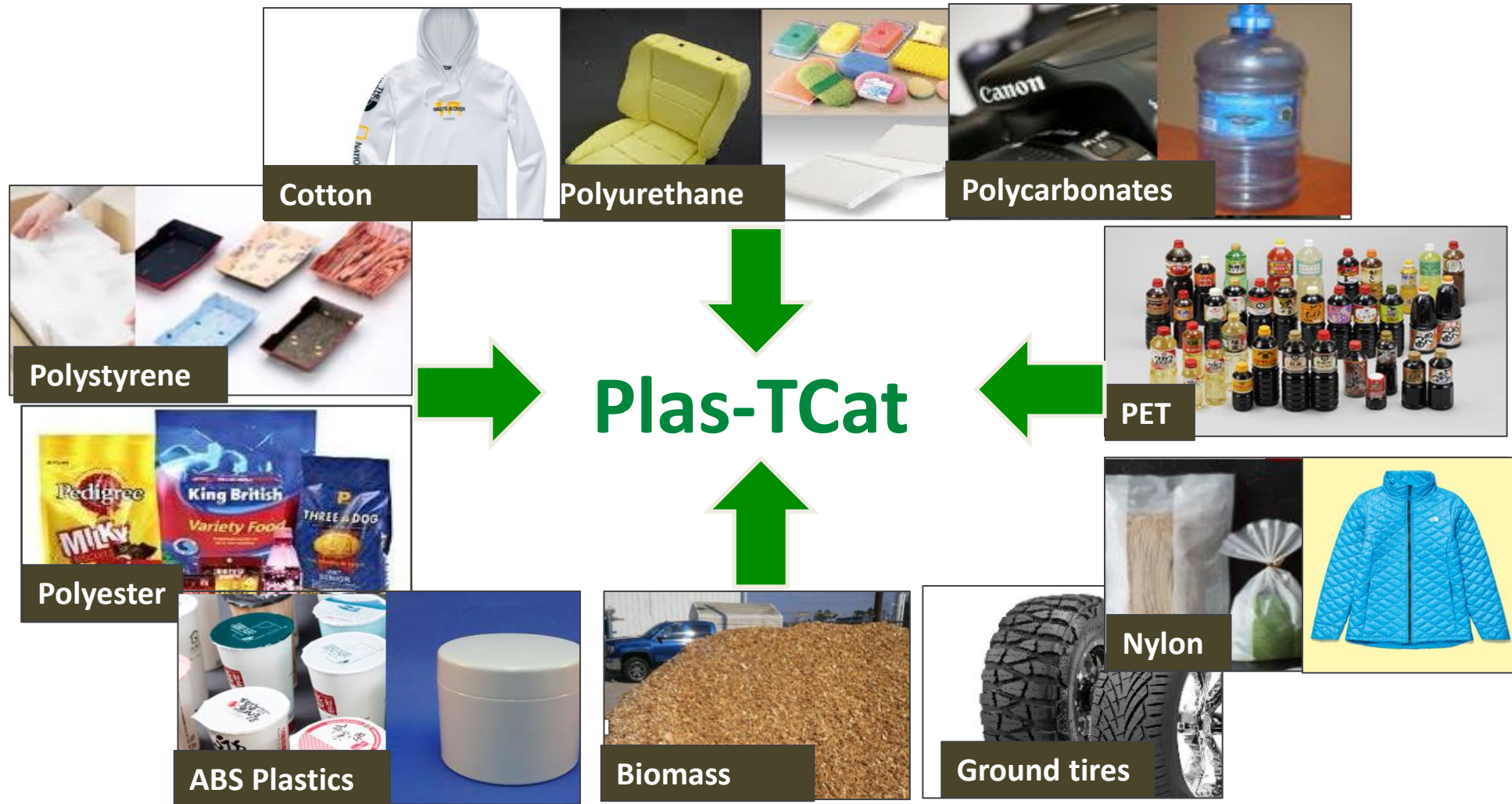


Plas-TCat Catalytic Process (Hi-BTX)



For illustrative, qualitative use only. These lab results are to be validated in long-duration studies in a fully integrated TCat-8 Pilot Plant. Detailed review of experimental conditions, catalyst and other factors can be shared to fully assess this data

Plas-TCat can convert a wide mix of plastics & natural materials... alone or as mixtures



Anellotech Plas-TCat unique competitive position

1



HIGH VALUE FINAL PRODUCTS

Plas-TCat will directly convert major plastics into the same aromatics and olefins used to make fuels or virgin polymers. These high value final products should drive competitive economics.

2



FEEDSTOCK FLEXIBILITY

Plas-TCat should convert a broad range of pure and composite plastics, as well as natural materials (paper labels, residual food) that may come with the feedstock.

3



SCALABILITY

Fluid bed reactor system (FCC) can be built at very large scale to make a significant impact

Anellotech

Plas-TCat™ Update

Now demonstrated with single-use packaging (potato chip bag)

rPET from non-PET plastic wastes

Goals for rPET for 2025 to 2030 will likely exceed supply

Major global brand owners across sectors announcing recycled content goals

Textiles
Carpeting
Cosmetics
Packaged Foods
Beverage bottlers

However, the only source of rPET today is from used beverage bottles...

Will enough beverage bottles be produced, collected and recycled to satisfy the global rPET demand for all of them?

Ban-the-bags movement gains traction

Some USA recyclers specifically reject single-use plastics bags & packaging

Single Stream Recycling

Programa de Reciclaje

Acceptable Items / Articulos Recyclables:



Magazines
Revistas



Junk Mail
Correspondencia no Solicitada



Office Paper
Papel de Oficina



Phone Books
Directorios de Telefono



Paper Bags
Bolsas de Papel



Newspapers
Periodicos



Plastics #1 - #7
Botellas de Plastico



Cardboard (Flatten)
Carton



Aluminum (Cans)
Latas de Aluminio
Papel Aluminio



Paperboard
Food/Milk/Juice Containers
Cartoncillos



Metal Cans/Containers
Latas de Metal



Glass Bottles & Jars
Botellas de Vidrio

Unacceptable Items / Articulos No Recyclables:

*****NO PLASTIC BAGS, PLEASE DO NOT BAG YOUR RECYCLABLES*****



Plastic Bags
Bolsas de Plasticas



Plastic Packaging
Envases de Plastico



Garbage
Basura

including snack bags like potato chips



Greenpeace & others support bans on single use plastics

Claim products falsely labeled as recyclable when no technology exists to do so!



The report "Circular Claims Fall Flat" states only PET #1 and HDPE #2 bottles and jugs are truly recyclable and accepted by MRFs

MRFs² cannot assure consumers they will be recycling items like takeout food ware and single-use plastic bags; these are therefore considered contaminants and companies cannot legitimately place recycle symbols on them

MRFs frequently send them to landfills or incinerators if buyers aren't available – these items have "**negligible-to-negative value**"

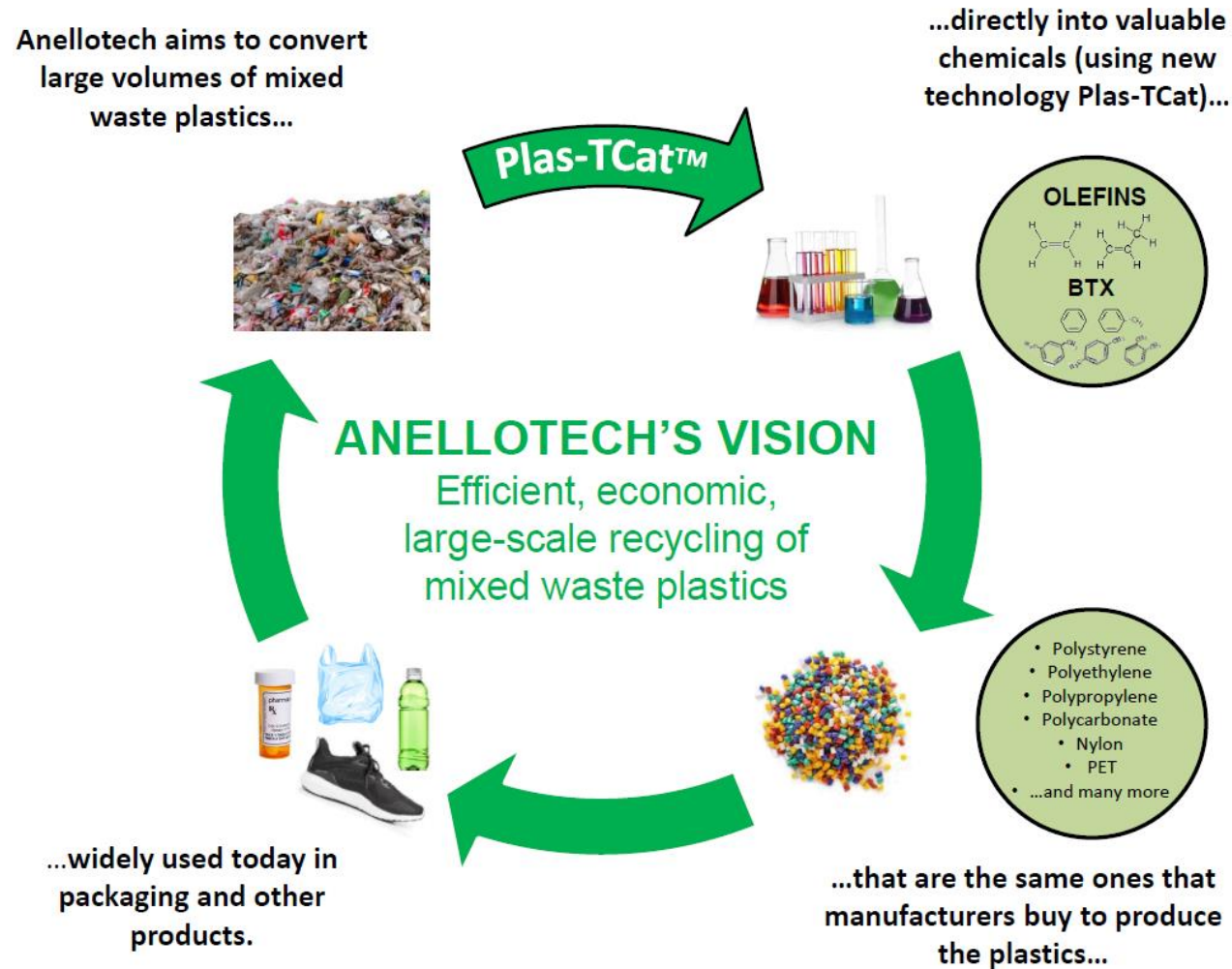
Indeed plastics #3-7s and non-bottle plastics #1-2s were common exports to China before the Jan 2018 import ban.

¹ <https://www.wastedive.com/news/greenpeace-report-recyclables-plastics-circular-economy/572293/>

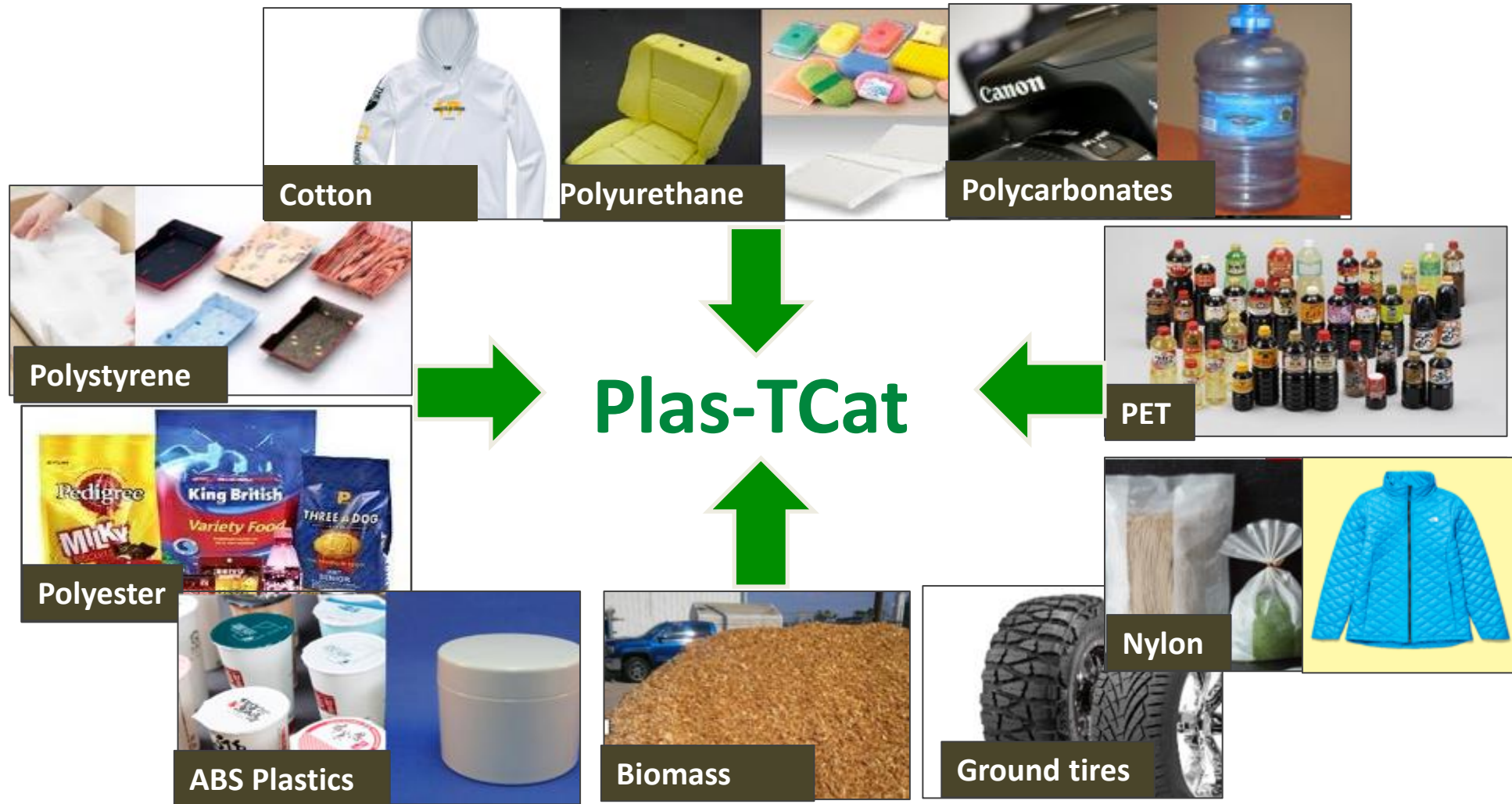
² Materials Recovery Facility, Materials Recycling Facility, or Multi Reuse facility

Anellotech can help solve both problems

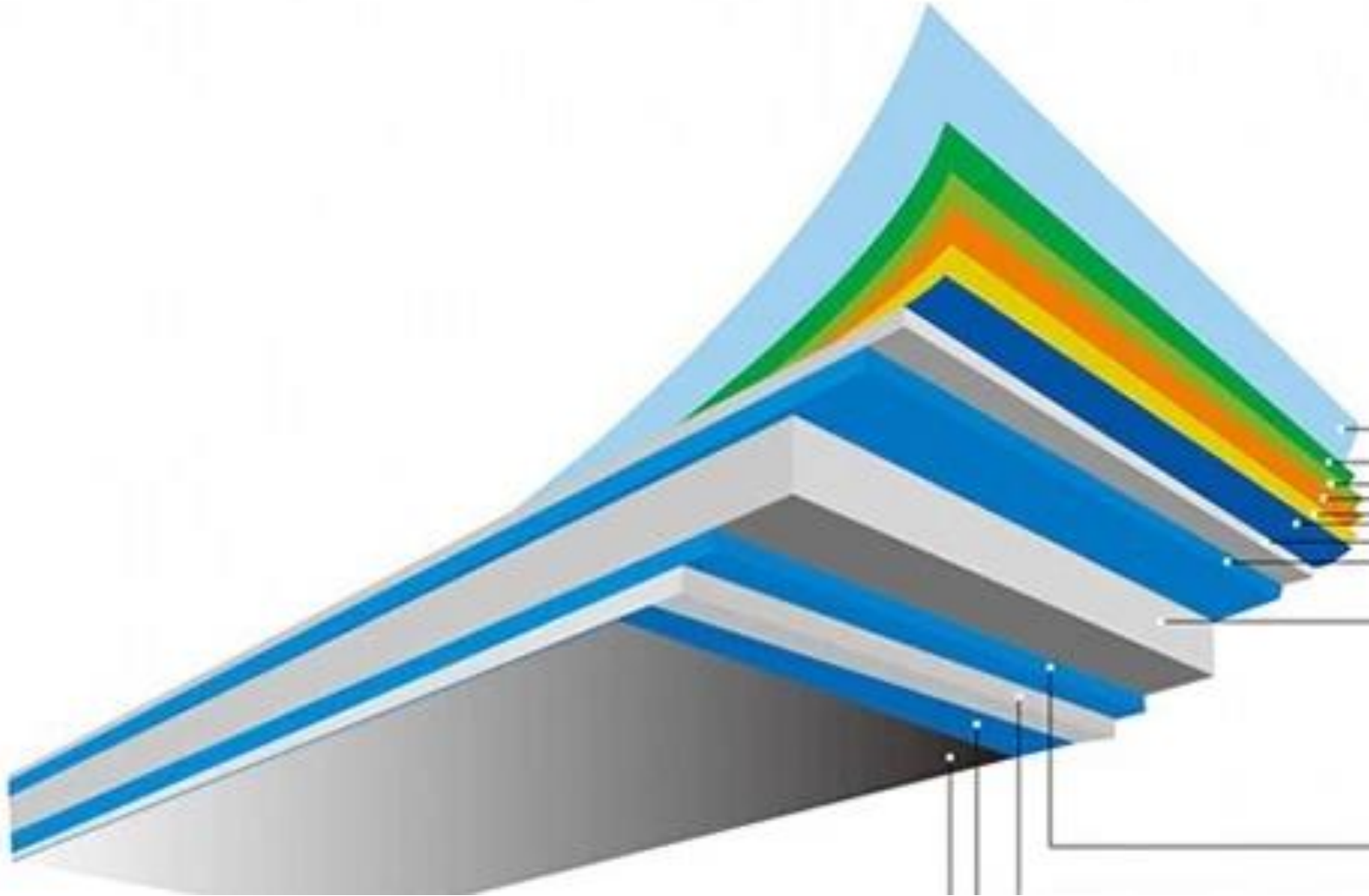
By making rPET from non-PET single-use packaging



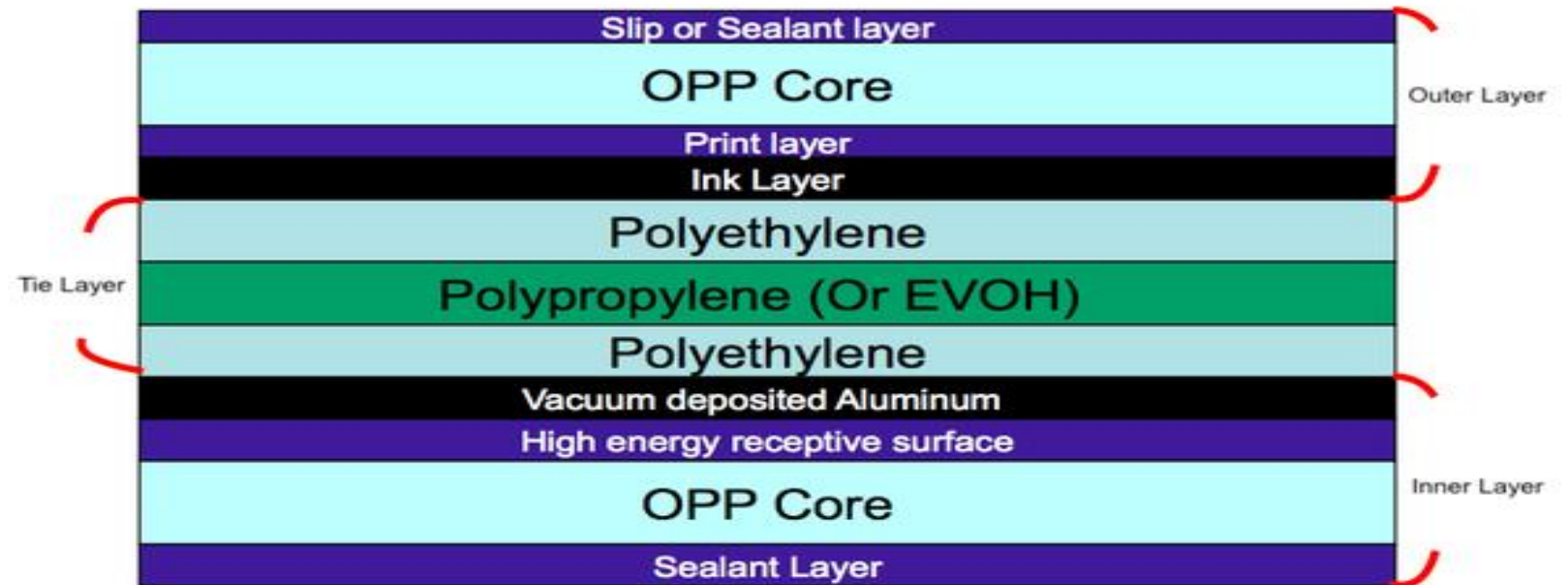
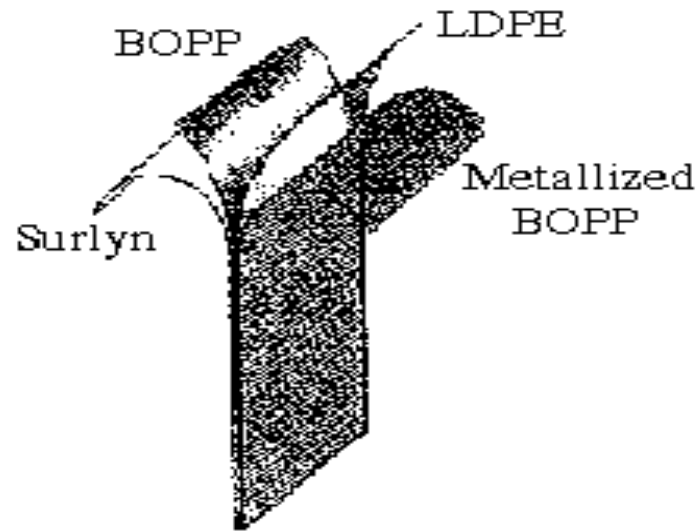
Plas-TCat can convert wide mix of plastics & natural materials... alone or as mixtures



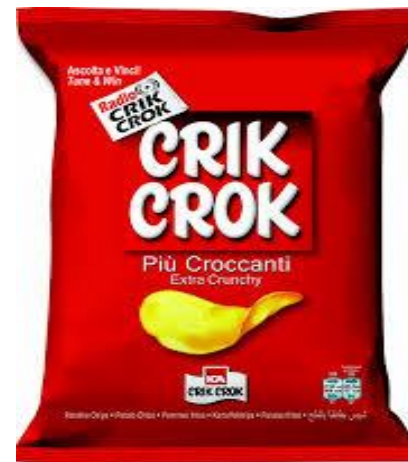
Including composite or multicomponent films



Used for packaging for potato chips and other snacks



In the USA, Japan and Europe

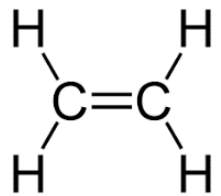


Into the primary chemicals used to make packaging

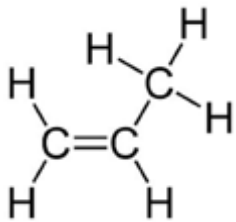


Plas-TCat™

Olefins

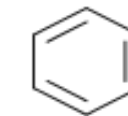


ethylene

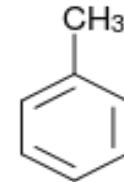


propylene

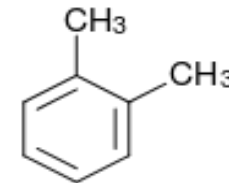
B-T-X



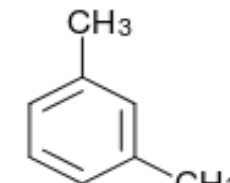
benzene



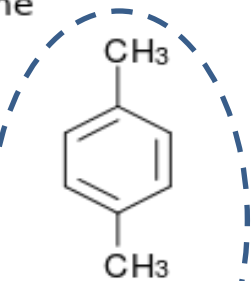
toluene



ortho-xylene



meta-xylene



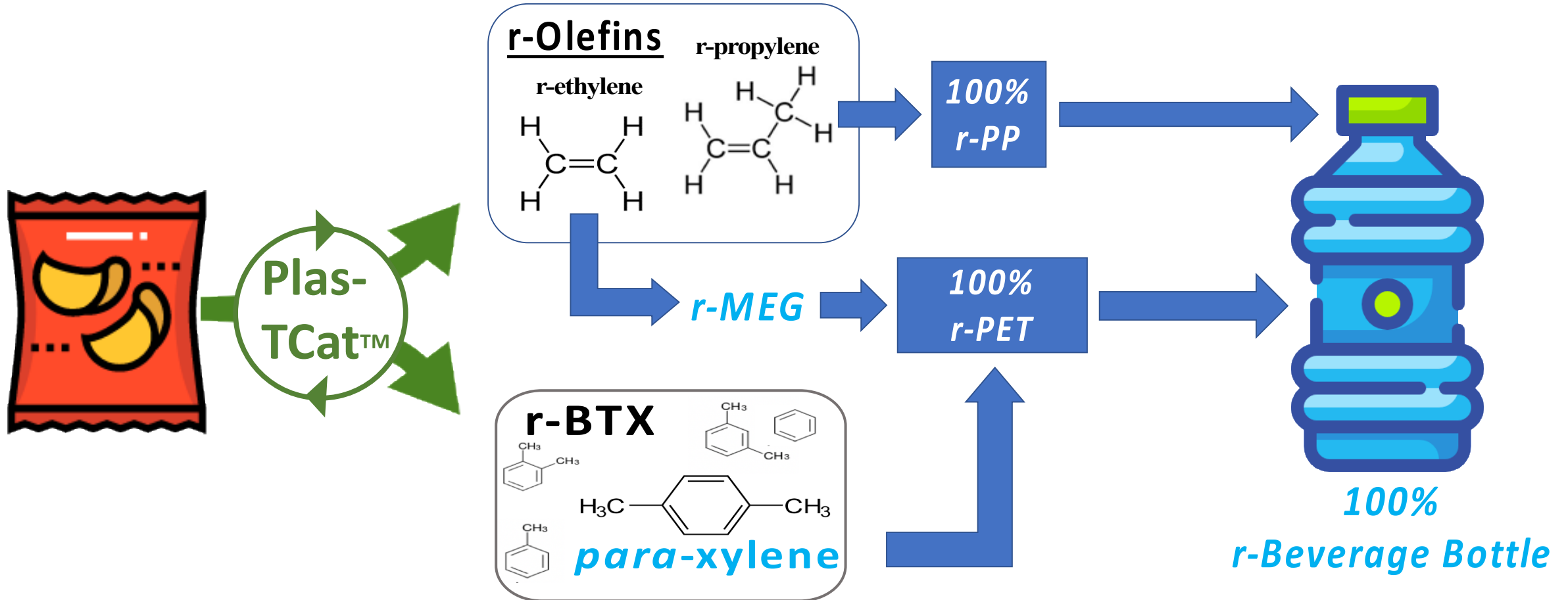
para-xylene

Plas-TCat paraxylene from snack bags and other single-use plastics helps brand owners meet rPET goals, while solving a major problem for food companies



Producing recycled PET and PP plastics from waste packaging

Anellotech Plas-TCat Technology helps brand owners meet recycled plastic content goals



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