



Thinking Differently: Driving change through collaboration



Greenhouse
Gases



Plant
Sugar



Lactic
Acid



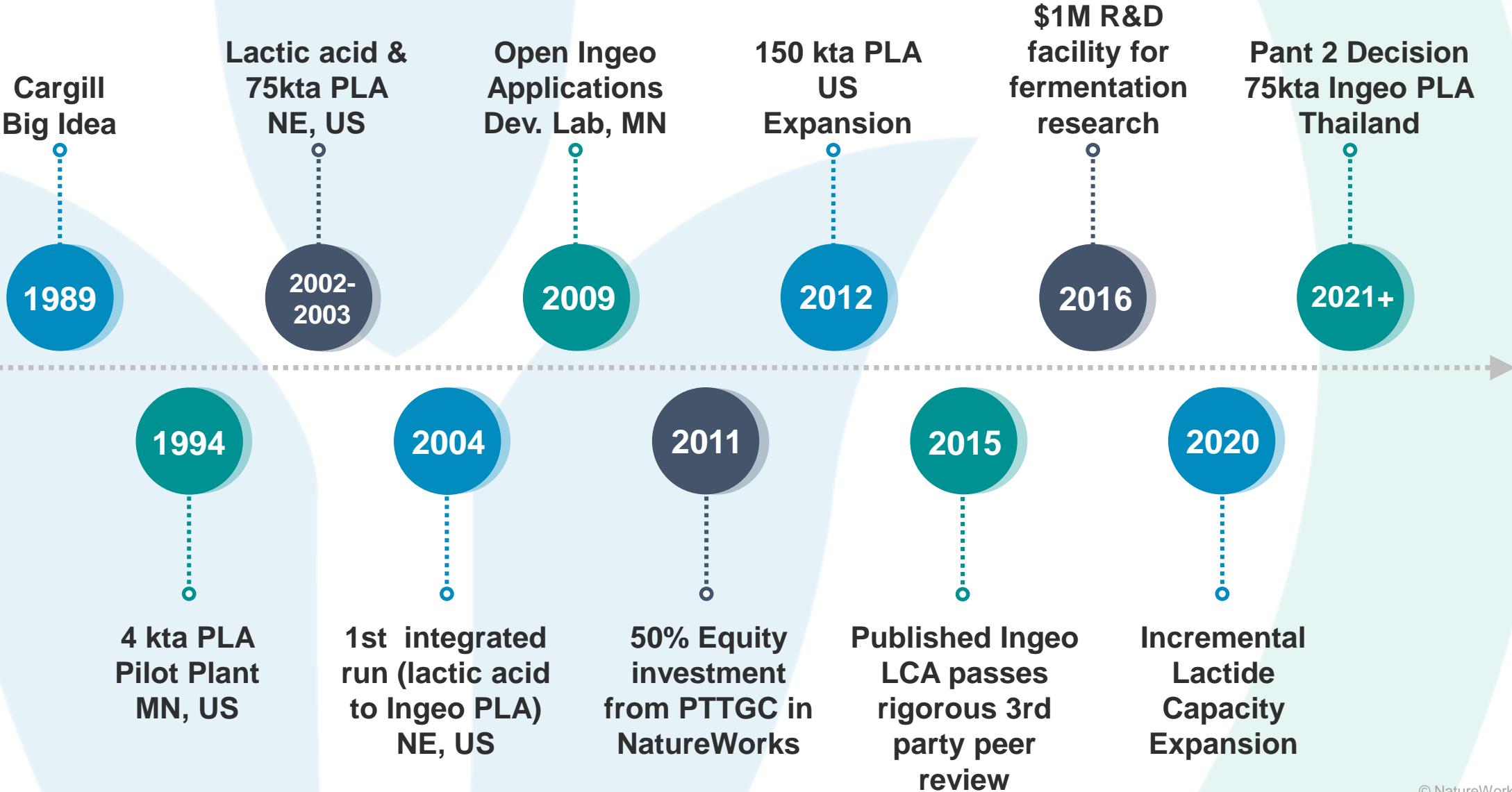
Lactide



Ingeo
polylactide

Mark Vergauwen
April 13th, 2023

We've been in the GHG Conversion Business for >> 20 years...



2024: New Fully Integrated Ingeo Manufacturing Plant in Thailand



Rendering of the constructed fully integrated 75kta Ingeo PLA manufacturing facility in Thailand

- **75,000 tons per year**
- **Dedicated Ingeo manufacturing with integrated lactic acid, lactide, and polymer manufacturing sites**



Pre-construction site of the new Ingeo PLA manufacturing facility

- **Located in the Nakhon Sawan Biocomplex in Nakhon Sawan Province, Thailand**
- **Opening in 2024**

Performance Materials From Greenhouse Gases

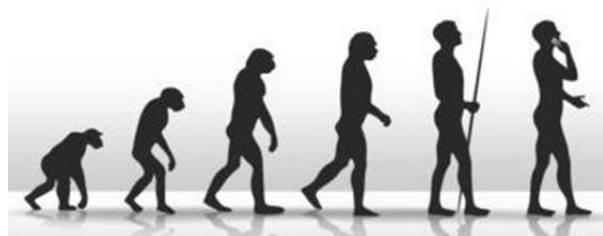
Polylactic acid is a biobased thermoplastic derived from renewable resources that can be transformed into packaging and products via traditional plastics and fibers manufacturing processes.



Why does Nature itself has no waste problem?

It is producing billions of tons of material each year?

And doing this for millions of years.....



✓ Bio-based
✓ Biodegradable
✓ Circular



✓ Fossil-based
✓ Persistent
✓ Linear

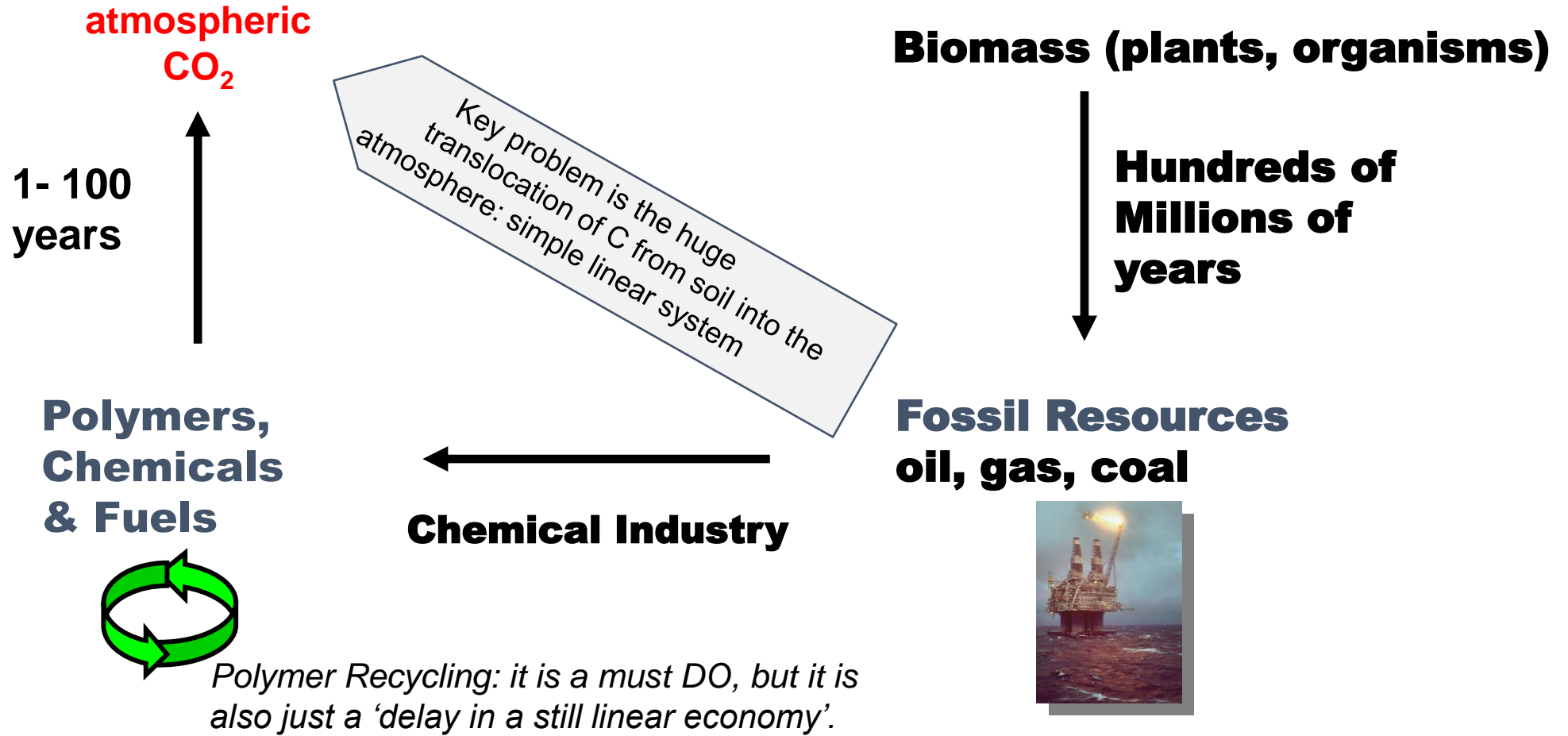


- Climate Change
- Plastic pollution
- Persistent substances
- Biodiversity loss
- Cocktail of chemicals in our environment
- etc.....

“It’s time to blend into natural cycles again”

Fossil-based versus Bio-based or a Linear versus a Circular system. The Use of Carbon in Materials

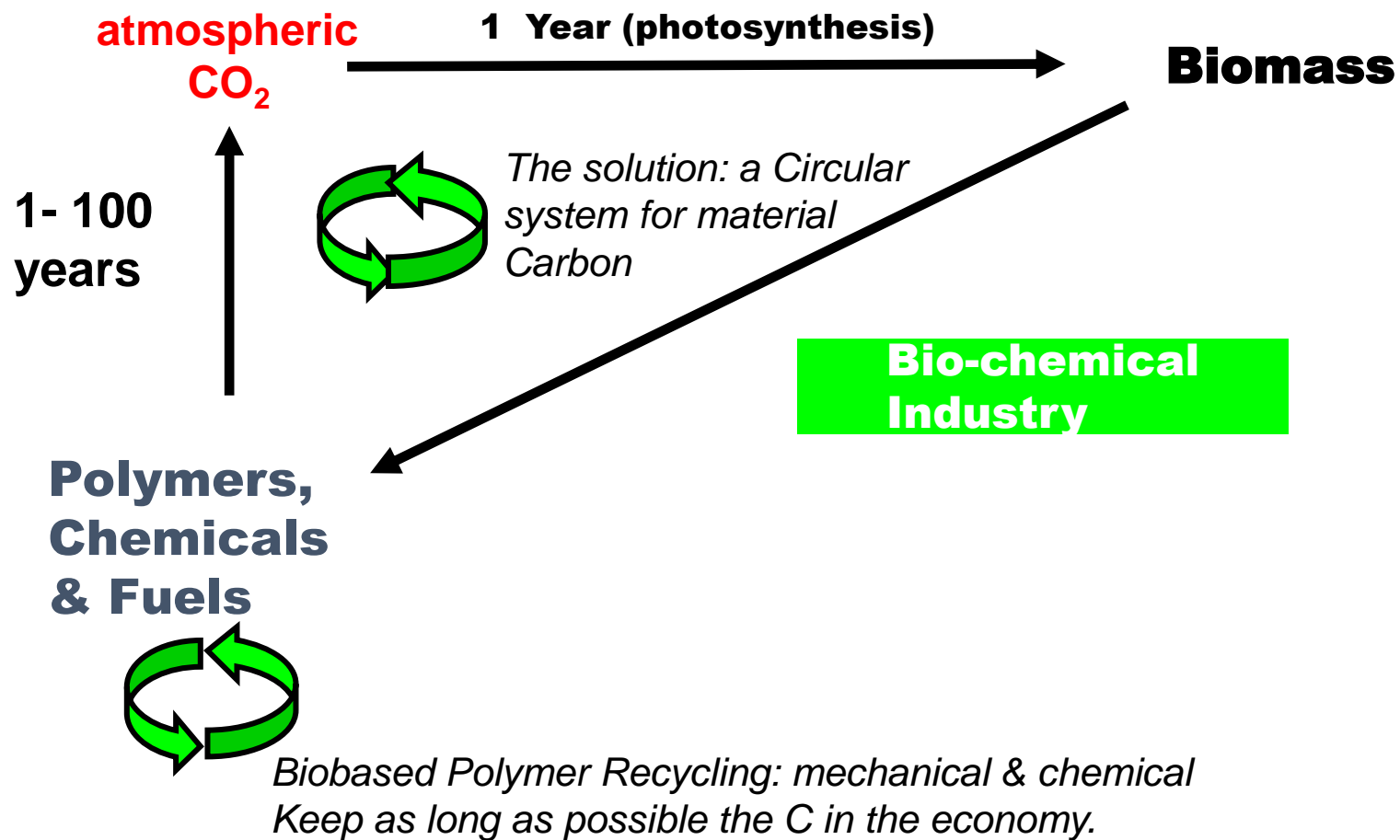
The Fossil Case.



*'You cannot recycle yourself out of a linear economy'
'One needs to look for alternative C sources'*

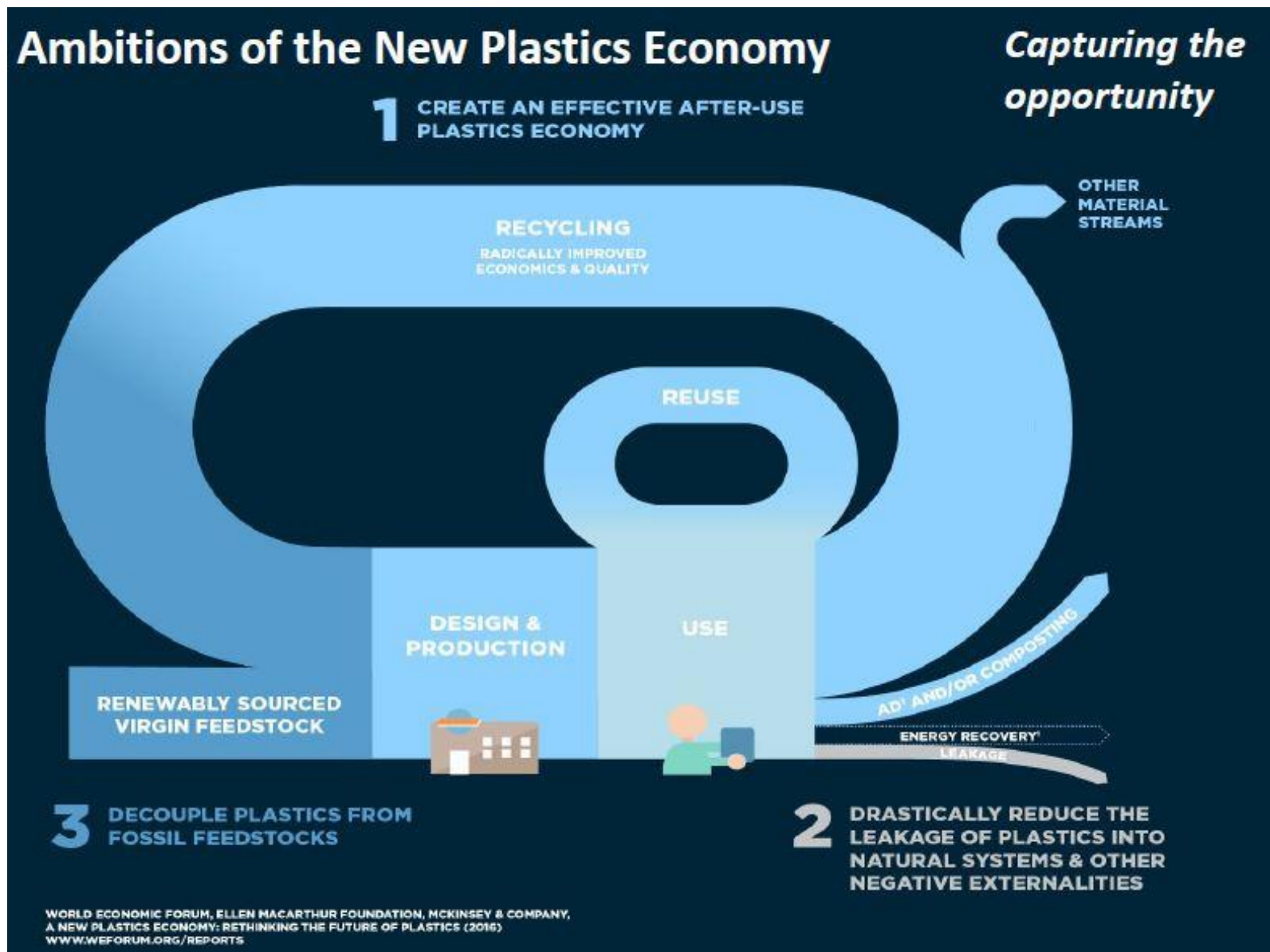
Fossil-based versus Bio-based or a Linear versus a Circular system. The Use of Carbon in Materials

The Biomass Case.



The New Plastic Economy – Circular Model

THE NEW PLASTICS ECONOMY RETHINKING THE FUTURE OF PLASTICS, EMF, 2016

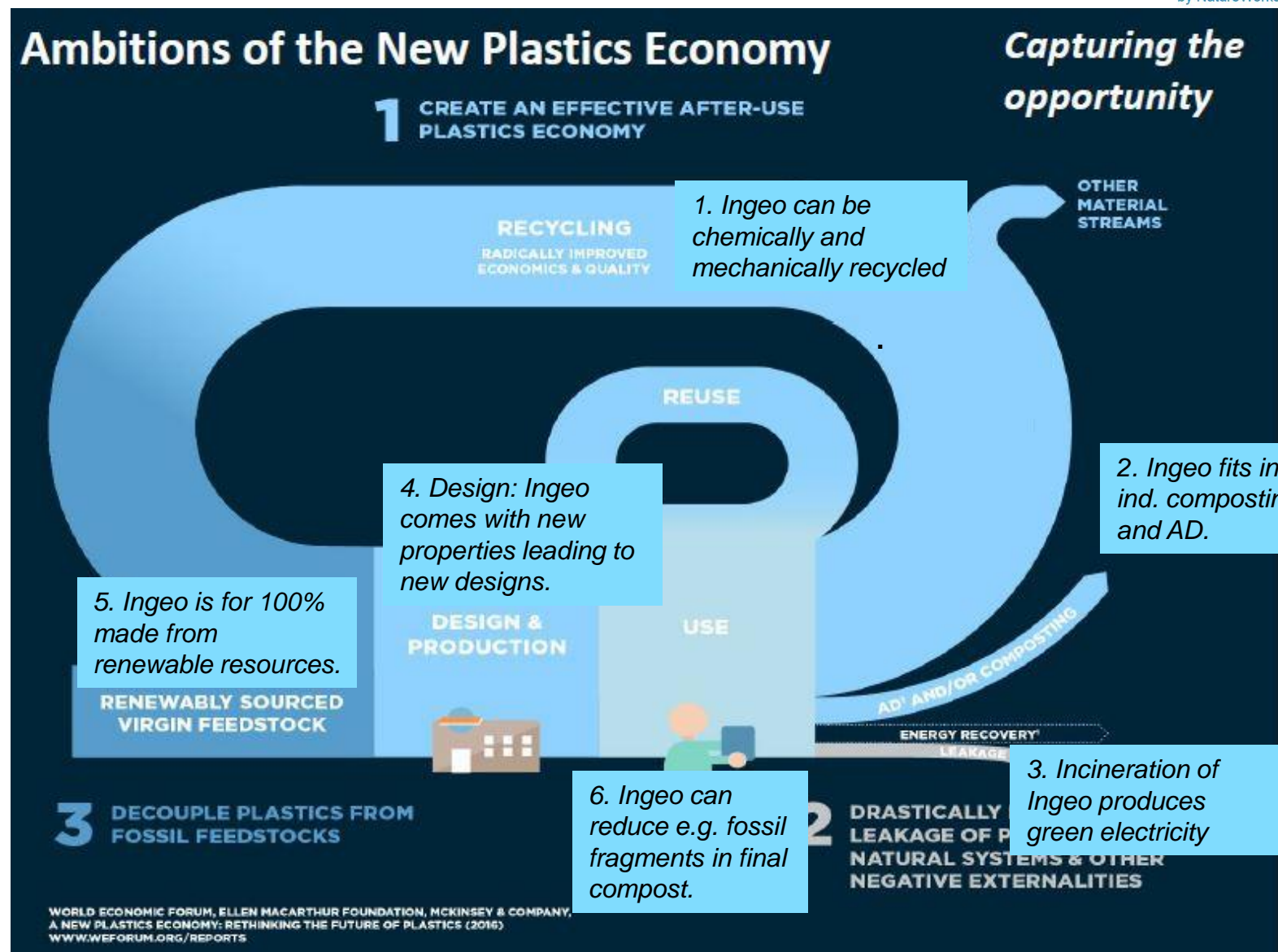


While everyone seeks circularity through Recycling, many overlook the use of Bio-based carbon as the primary pillar

The New Plastic Economy – Circular Model

Where does Ingeo fit in?

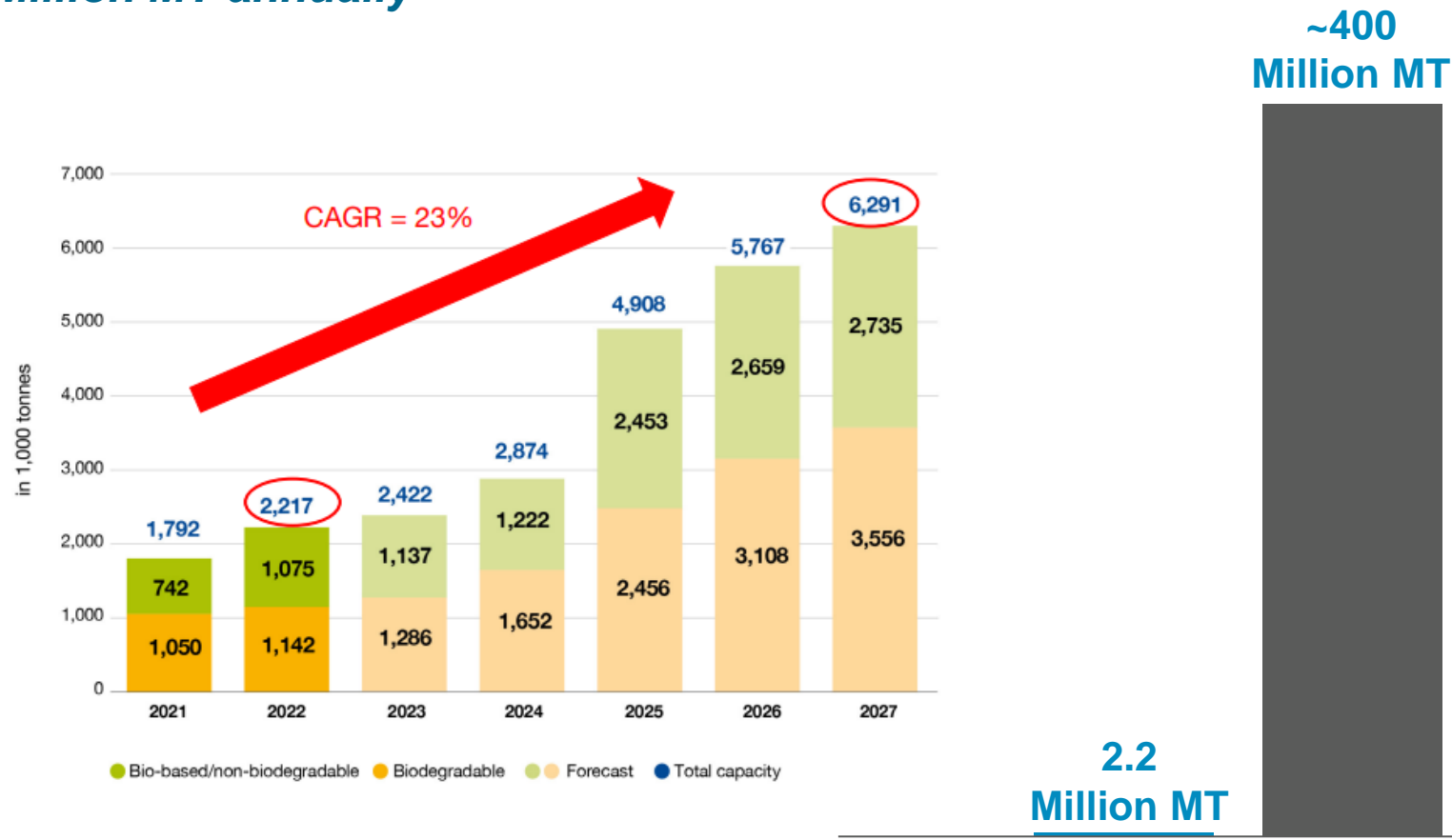
*Decoupling from fossil resources
More recovery options*



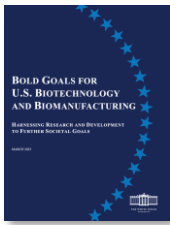
Biopolymer capacity is growing, but still undersized compared to petrochemical plastics

Over the past decade, plastics experienced a 3.9% CAGR that is expected to continue at greater than **10.9 Million MT annually**

Global production capacities of bioplastics 2022 – 2027



Source: European Bioplastics, nova-Institute (2022)



Biotechnology and Biomufacturing R&D to Further Climate Change Solutions

Goal 2.1 Develop Low-Carbon-Intensity Chemicals and Materials

In 5 years, produce >20 commercially viable bioproducts with >70% reduced lifecycle GHG emissions over current production practices.

Goal 2.2: Spur a Circular Economy for Materials

In 20 years, demonstrate and deploy cost-effective and sustainable routes to **convert bio-based feedstocks into recyclable-by-design polymers that can displace >90% of today's plastics and other commercial polymers at scale.**

Goal 4.1: Develop Landscape-Scale Biotechnology Solutions

In 10 years, develop technologies to expand implementation of landscape-scale soil carbon sequestration and management techniques on tens of millions of acres, increasing soil health and drought resilience and supporting U.S. climate targets.



Bold Goals for U.S. Biotechnology and Biomufacturing

Harnessing Research and Development to Further Sustainable Goals

Plastics Recycling Coverage PAGES 8-14

POLYMER POINTS WITH FRANK ESPOSITO PAGE 20



March 27, 2023 | PlasticsNews.com 55

The White

Plastics News

U.S.



Biden sets US goal to replace 90% of plastics with biomaterials



Biden bioplastics goal seen as major signal

By Steve Tolokon
Plastics News Staff

President Joe Biden's administration is setting a goal of replacing 90 percent of fossil fuel-based plastics with bio-based alternatives over the next two decades. In a report released March 22, the White House Office of Science and Technology Policy (OSTP) outlined what it called bold goals for helping the U.S. to be a leader in bioeconomy technology, produce low-carbon-intensity chemicals to fight climate change and shore up domestic supply chains. "In 20 years, (the U.S. should)

Accordingly, an urgent global need exists to rapidly enable a more circular economy for today's fossil carbon-based polymers production and to source chemical building blocks for tomorrow's recyclable-by-design plastics from bio-based and waste sources."

White House Office of Science and Technology Policy demonstrate and deploy cost-effective and sustainable routes to convert bio-based feedstocks into recyclable-by-design polymers that can displace more than 90 percent of today's plastics and other commercial polymers at scale," the report said. According to the report, See [Biden](#), Page 13

By Frank Esposito
and Steve Tolokon
Plastics News Staff

The White House's ambitious bioplastics goals announced March 22 face many hurdles but some in that nascent industry see it as a clear sign that President Joe Biden's administration wants to support more climate-friendly manufacturing. The White House Office of Science and Technology Policy's new bioeconomy road map calls for replacing 90 percent of traditional plastics with bio-based materials in 20 years. Industry analysts noted many challenges, from huge See [Bioplastics](#), Page 15



© 2023 by Crain Communications, Inc. All rights reserved.



And in the meantime ...

2020-2022



2022 ...




*Switching to Biobased Carbon feedstock
Is more relevant than ever*

... And easier that you think


Market Pressures: Global brand owner pledges for plastics change remain strong



Make 100% of our packaging recyclable globally by 2025. Use at least 50% recycled material in our packaging by 2030.




By 2025, halve use of virgin plastic, by reducing absolute use of plastic packaging by more than 100,000 tons and accelerating use of recycled plastic.



Every piece of packaging, from bottle caps to yogurt cups, will be reusable, recyclable, or compostable by 2025.



100% of our packaging is recyclable or reusable by 2025.




Reduce global use of virgin petroleum plastic in their packaging by 50% by 2030.



100% of their plastic packaging will be reusable, recyclable or compostable by 2025.



Design 100% of packaging to be recyclable, compostable, or biodegradable by 2025.



100% recyclable or compostable packaging material by 2025.

Yet actual new biomaterial adoption decisions by these same Brands increasingly depend on requirements for new product functionality

Additionally, retailers have their own goals, and have powerful influence with brand owners ...



We aim to reach 100% Recyclable, reusable, or Industrially Compostable private-brand packaging by 2025

**Product
Differentiation
Opportunity**

**Channel
(Re)engagement
Opportunity**



“Through radical collaboration, we can accept the risks that come with interdependence on other entities with different agendas, while also recognizing that diverse resources lead to innovation”

**“The business of Radical Collaboration
Emily Bancroft, Forbes**



co·op·e·ti·tion

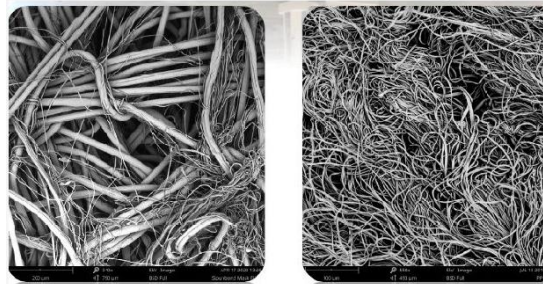
/kō ˌɑpəˈtiʃ(ə)n/

noun

collaboration between business competitors, in the hope of mutually beneficial results.

We're thinking differently

Radical Collaboration & Coopetition:



Collaborating to expand and apply our Ingeo Resin Product Design “Toolbox”

Designing for processability, functionality and end-of-life

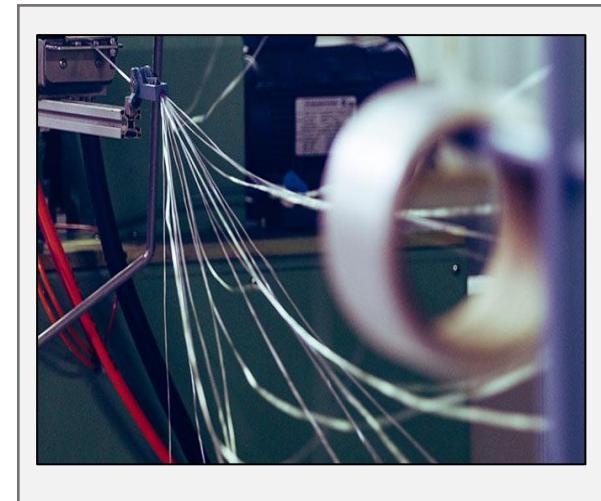
Chemical:

- Additive Content (e.g., prodegradant, enzyme, etc.)
- Polymer Chain Length (Molecular weight)
- Comonomer content
- Chain “end group” chemistry & reactivity
- Polymer Blends (PBS, PBSA, PCL, PBAT, PHA, etc.)
- Copolymers, block, random

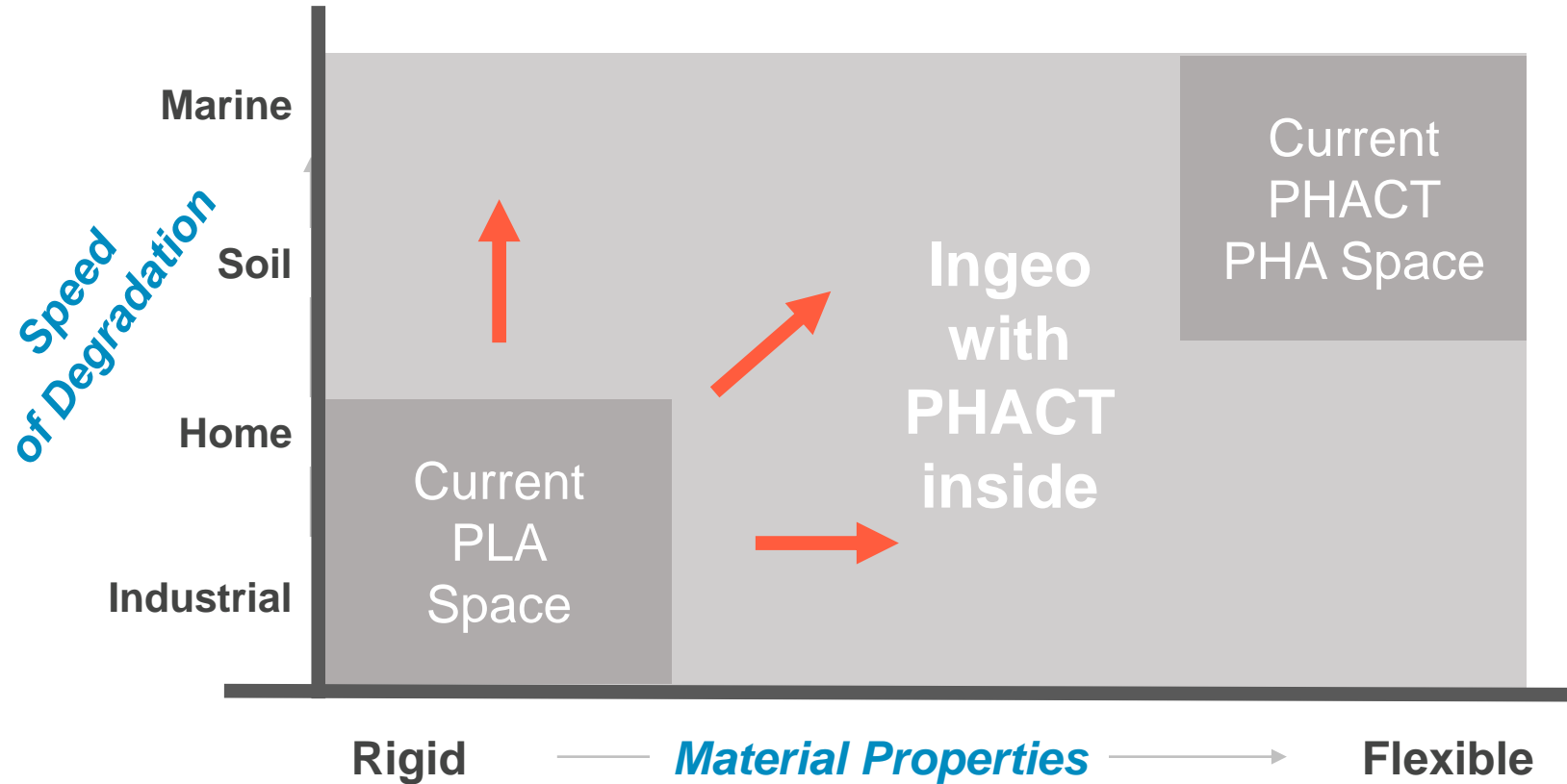


Physical:

- Thickness of the part
 - For films or sheet (gauge)
 - For fiber: (denier)
 - For nonwoven fabric: (gsm)
- Surface Area, Morphology



PLA and PHACT present a natural materials synergy

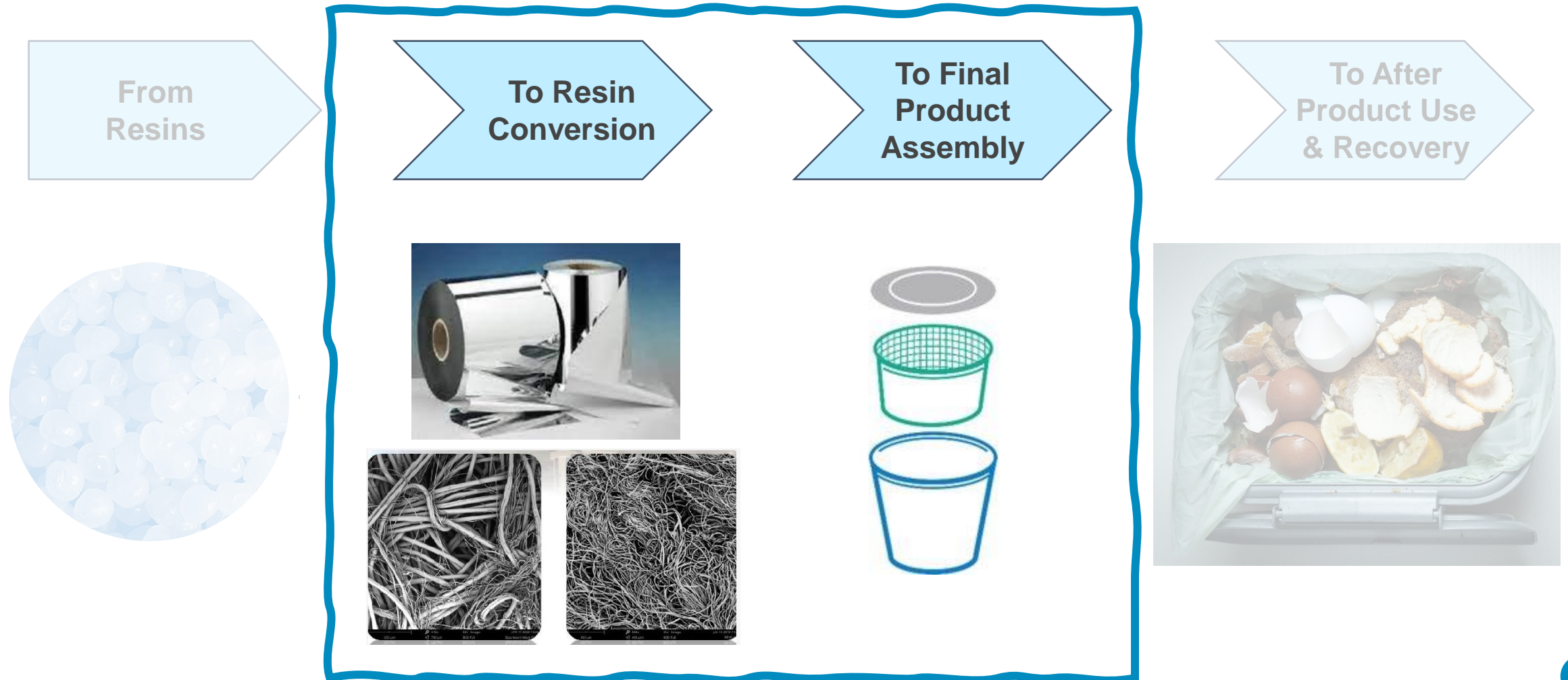


Materials like amorphous PHA provide us a further tool in our Ingeo materials design toolbox

Product design spanning a broad range of physical properties, and degradability

Radical Collaboration & Coopetition

Some NatureWorks Case Study Examples



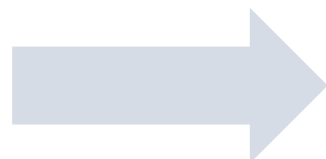
Value chain partnerships are key to delivering high performance, compostable coffee capsules to the market in North America & Europe



90%
of a brewed pod is coffee, valuable organics mostly **lost** to landfills due to a complicated recycling process from packaging



Compostable capsules simplify the recovery of organics for composting

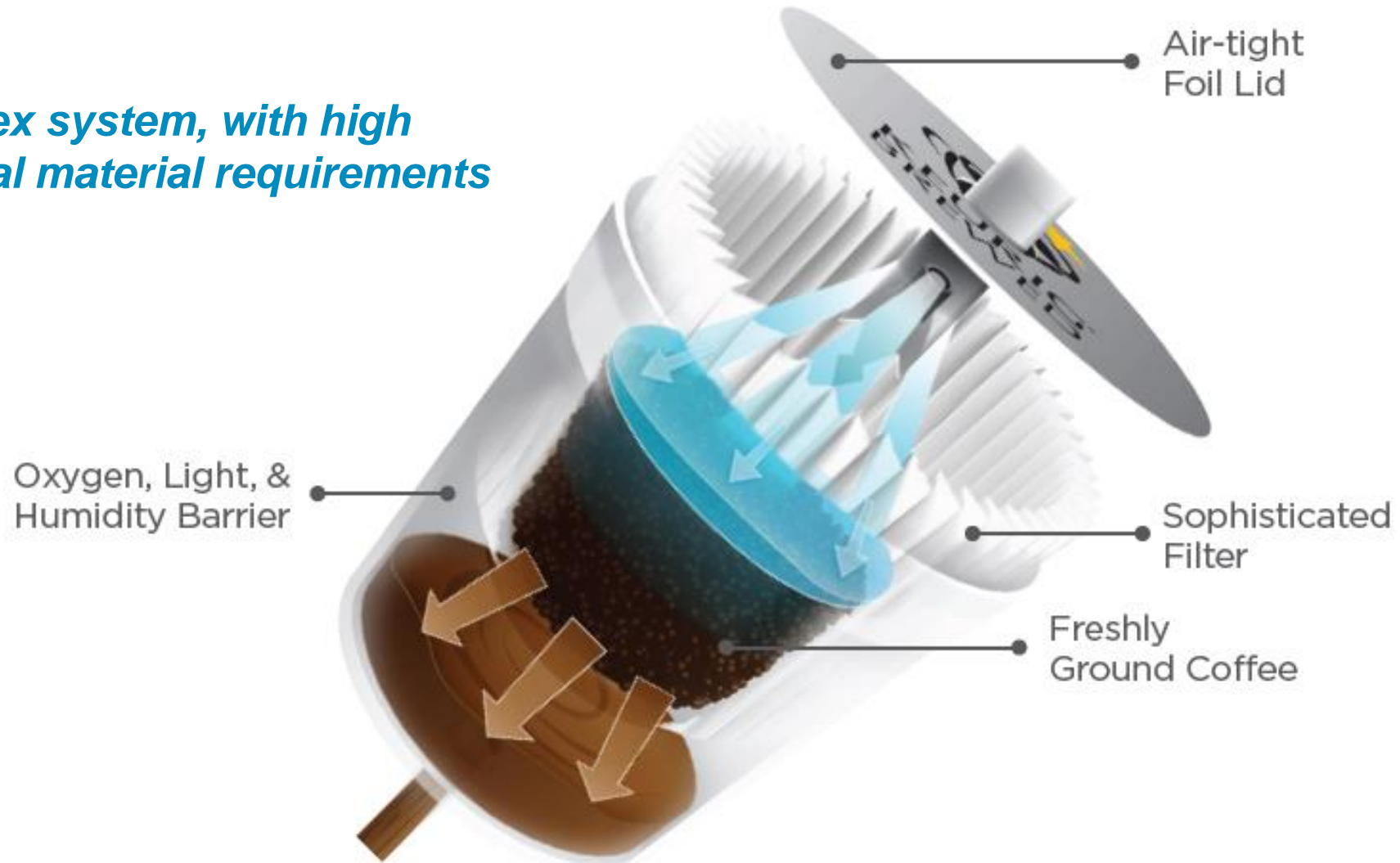


Heat & pressure resistance, barrier, and other properties need to come together to brew an excellent tasting cup of coffee



Radical Collaboration to support North American coffee capsule market

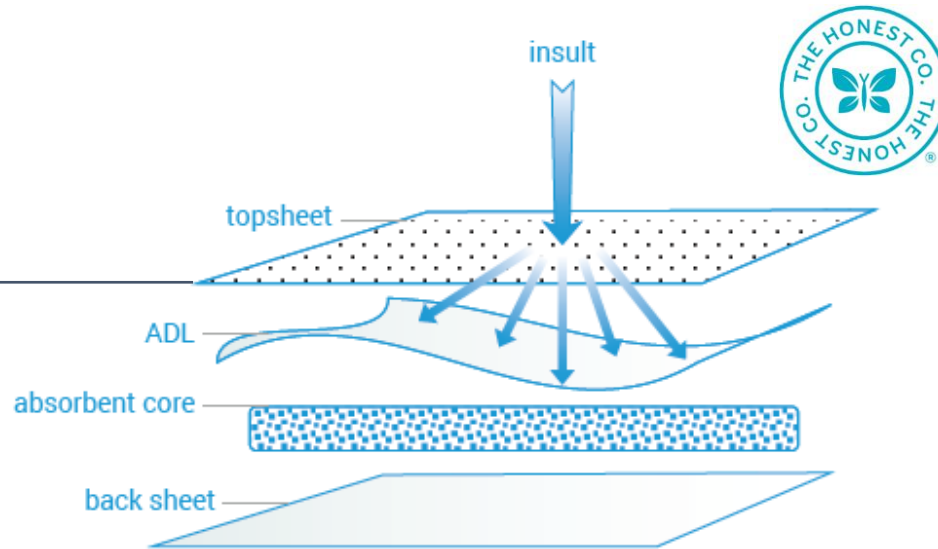
A complex system, with high functional material requirements



ENGINEERED SYSTEMS

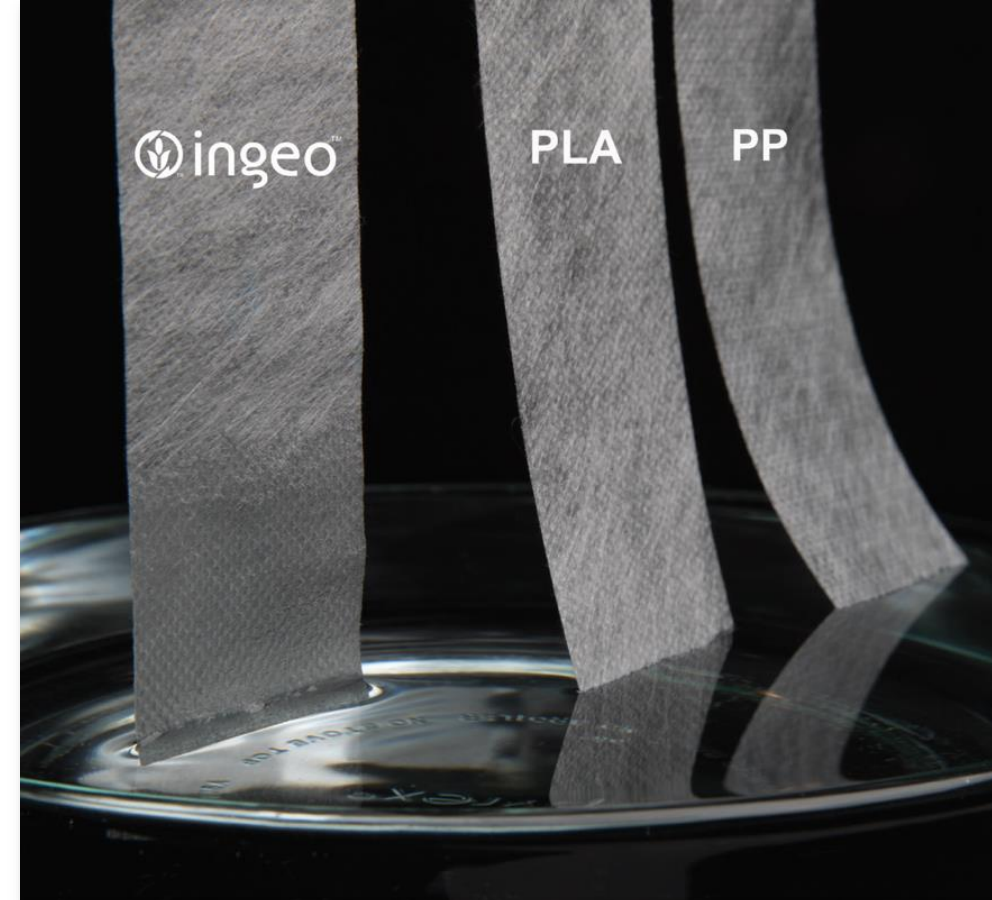
Ingeo Nonwovens Offer Fluid Management Superior to Polypropylene for Hygiene Applications

Improved strike-through, re-wet, and run-off



| PERFORMANCE | INGEO ¹ | TYPICAL PP ² |
|---|--------------------|-------------------------|
| Finish-on yarn [%FOY] | 0.3 wt. % | 0.6 wt. % |
| Strike-through [over 3 results] | 1.3 - 1.9 sec. | 1.8 - 2.3 sec. |
| Run-off [%] | 0 | 0.4% |
| Re-wet [grams] | 0.10 / 0.08 g | 0.21 / 0.25 g |
| Wash-off / Surface tension reduction [0.9 wt. % NaCl = 73.1 dynes/cm] | 70.8 dynes/cm | 47.8 dynes/cm |

1. 18 gsm spunbond modified with Goulston Lurol PL-15231-25
 2. 14 gsm spunbond modified with Goulston Lurol PP-15163



Switching the PP topsheet in a diaper to one made with Ingeo, can maintain absorption efficiency while reducing SAP content by 30%.

Combining biobased materials, paper + Ingeo bioplastic, to create better food serviceware options



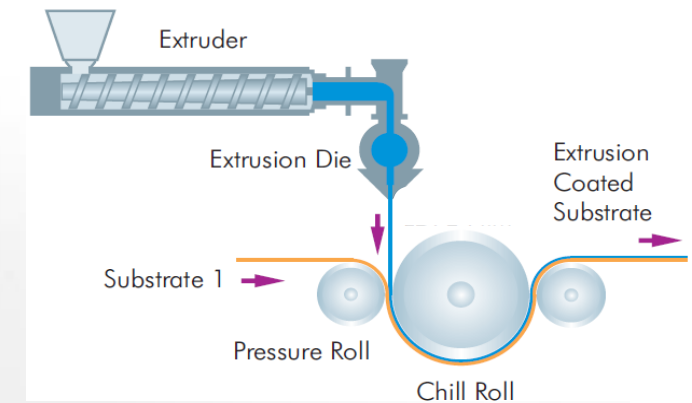
Safe Serviceware

- FDA compliant
- No taste or odor impact
- Approach 100% biobased
- Certified GreenScreen Platinum as **free of PFAS and other chemicals of concern**



Manufacturing at Scale

- Modeled the process of coating paper to recommend **optimizations that increase output and line speeds by 150-200%**
- Stable web for faster line speeds, lower coating weights, less scrap

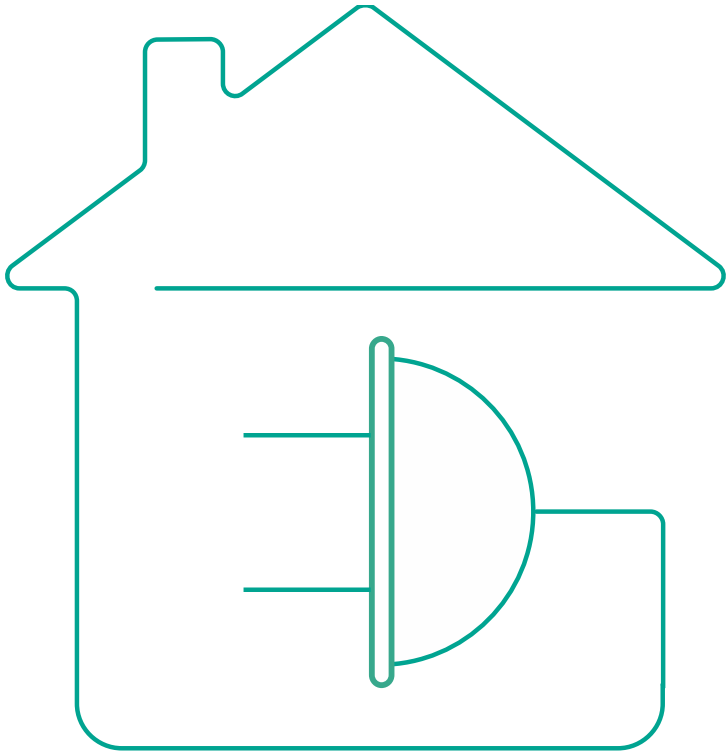


Circular

- Certified **compostable, repulpable, & recyclable** to flexibly fit with available infrastructure



Reducing energy consumption by 7% to 13% annually over the life of a refrigerator



Electrolux

Over its lifetime, using a refrigerator with an Ingeo liner saves energy equal to running your refrigerator for 2 years.



The Telegraph

PG tips switches to plastic-free tea bags after 200,000 sign gardener's petition

February 28, 2018

STORM IN A TEACUP

BRITAIN'S TEA HABIT HAS A PLASTIC PROBLEM

February 19, 2018 | qz.com

THE TIMES

Solved: Why your teabags won't disappear from the compost heap

Green campaigners take on tea manufacturers after the revelation that their bags are not fully biodegradable

December 17, 2017



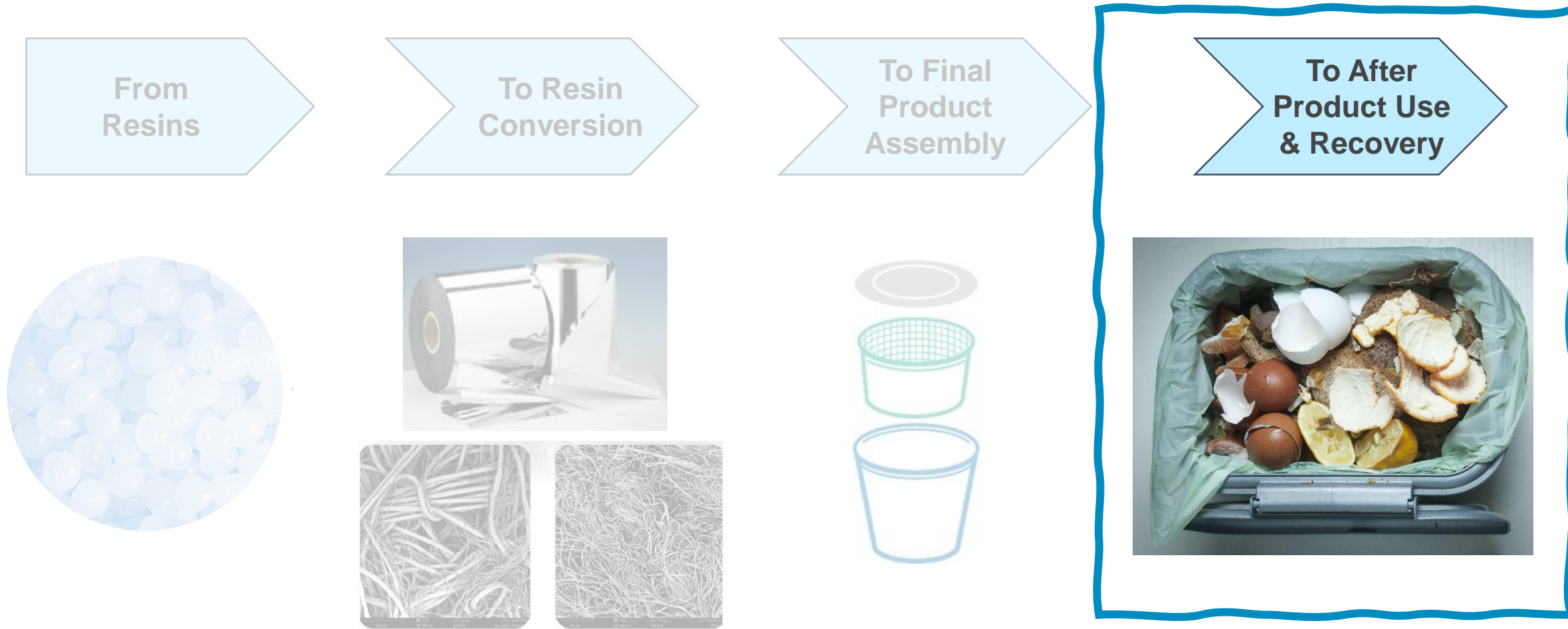
RETHINK PACKAGING  PLASTICS COMPOSTING 

PG Tips from Unilever Compostable tea bags

PG Tips are switching to a plant-based, compostable material derived from corn starch for their tea bags. This enables both the **packaging and the tea leaves to be composted together**. The brand has also started the removal of the plastic overwrap from the box.

Radical Collaboration & Coopetition

Some NatureWorks Case Study Examples



***Collaboration with the sports industry
to drive societal change***



GREEN
SPORTS
ALLIANCE

X

 NatureWorks

Compostable by Design Platform

Our Vision

Compostable by Design Platform- Guidance, guidelines and evaluation protocols to drive innovation and clear communication

Create a cross-value chain holistic approach similar to that of CEFLEX or 4evergreen, supported by science-based approach that will improve the circularity of packaging material focusing on types with low performance in material recycling, and select the right application in order to reduce contamination of inputs, increase the quantity of food waste collected in the EU, and increase the quantity and quality of the compost produced.



It's a clear ask of our industry...

Kimberly-Clark

Addressing the Global Plastic Crisis through Radical Collaboration

Lori Shaffer
Vice President, Global Nonwovens

“Coopetition” - How can we expand industry collaboration to enable unique business solutions at speed?

- We have one planet, and responsibility to protect it for the next generation.
- How can we work more collaboratively across the industry (Kimberly-Clark, Danimer Scientific, Dow, Berry, Fitesa, Indorama, State, Reicofil, etc.) to develop sustainable solutions faster?



We Need You...

ARE YOU IN?



Thank You ...