

GREEN FUTURE WITH HOSTAFORM® POM ECO-B

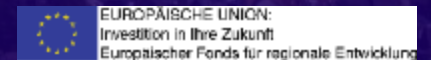
Dr. Klaus Kurz, Celanese
May 9, 2022



**Process⁴
Sustainability**

**Cluster for climate-neutral
process industries in Hesse**

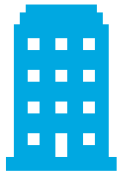
Supported by:



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- Introduction Celanese
 - Sustainability at Celanese
 - Engineered Materials – Sustainable Solutions:
 - ✓ Mass balance approach (ISCC+)
 - ✓ Lifecycle Analysis (LCA)
 - ✓ POM Eco-R, Eco-B, Eco-CC grades
 - Summary / Next steps

An overview of Celanese

Celanese Corporation is a global specialty materials leader in the production of differentiated chemistry solutions and specialty materials used in most major industries and consumer applications.



Based in
Dallas, Texas USA



Global network of
43 Manufacturing Sites



~7,700 Employees
worldwide



2018 Net Sales of
\$7.2 Billion

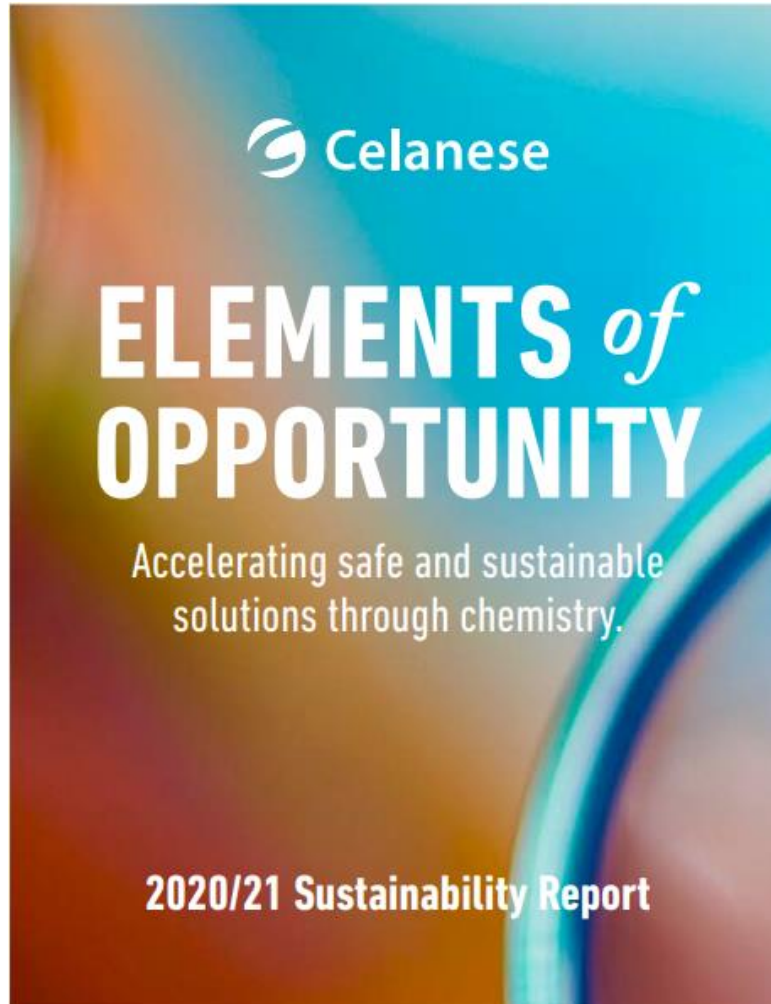
Our materials and chemicals products hold leading positions in the industries we serve worldwide and are complemented by a large, global production capacity, operating efficiencies, proprietary production technology and competitive cost structures.

Celanese is a company of world-class chemists, material & polymer scientists, engineers, operators and professionals across the globe.

Celanese is represented by diverse backgrounds, cultures, capabilities and expertise.

We engage with customers to help them address a problem, accelerate product development or deliver a new solution for their customers.

How We Think About Sustainability at Celanese



“For us, sustainability is not only the right path but the smart path, as we expand our portfolio to achieve more sustainable ways of living. In doing so, we meet growing customer demand and drive market innovation. We also attract and retain diverse talent, and we work to optimize our operations toward low-carbon goals.” - Lori J. Ryerkerk, Chairman of the Board and Chief Executive Officer

ELEMENTS of OPPORTUNITY

Accelerating safe and sustainable solutions through chemistry.

We are uniquely positioned to help improve the world through the power of chemistry.

As we embrace this opportunity, we demonstrate our deep sense of responsibility to keep people safe and help protect our planet.

We think of Sustainability as an unique opportunity for Celanese to accelerate safe and sustainable solutions through chemistry to drive value for our customers, investors, communities, and our people

01

Advancing Safe and Sustainable
CUSTOMER SOLUTIONS

Innovating the sustainable solutions our customers need today to protect our tomorrow

02

Investing in Our
PEOPLE AND COMMUNITIES

Empowering our people and communities to thrive in a changing world

03

Preserving the
ENVIRONMENT

Applying an actionable science-based approach to improve the sustainability of our operations

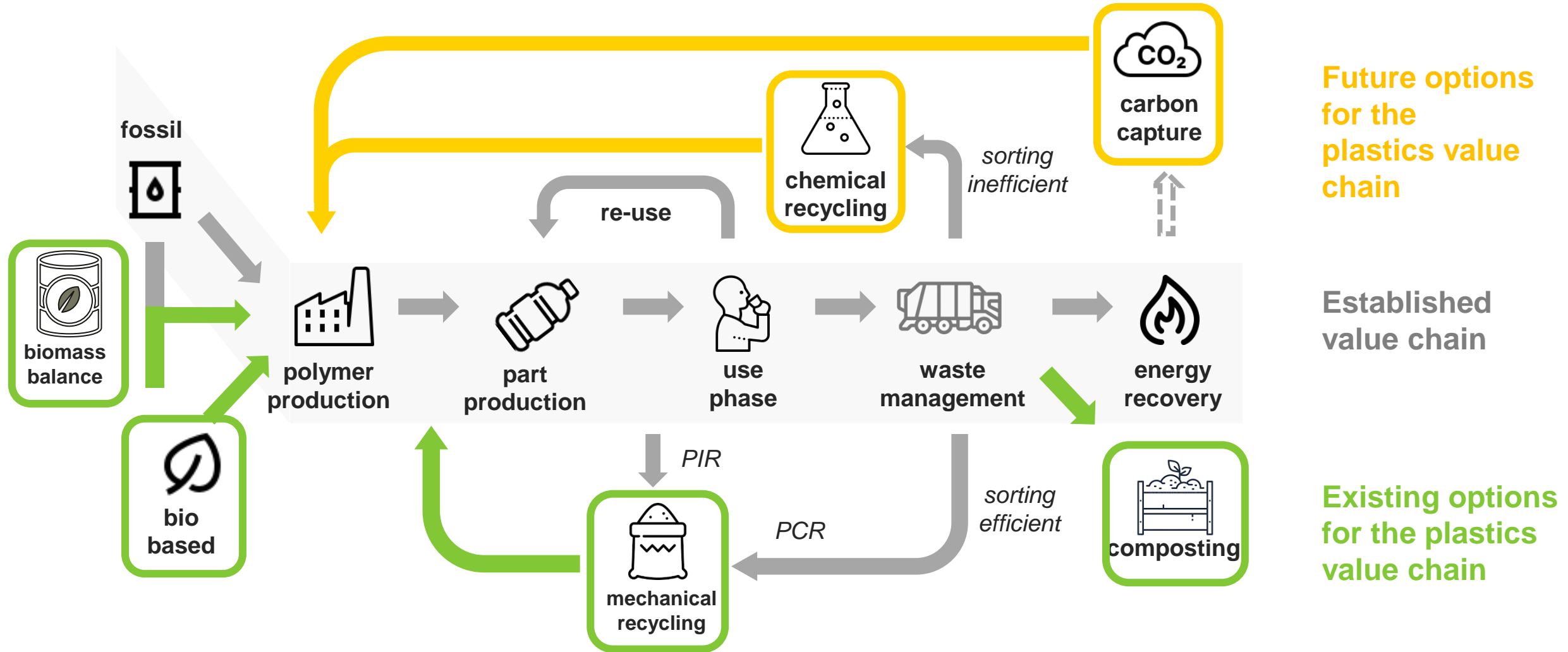
04

Operating with
INTEGRITY

Conduct business with high standards of integrity and ethical conduct

To learn more, view our sustainability site at: <https://www.celanese.com/sustainability/>

Circular economy in the plastics value chain





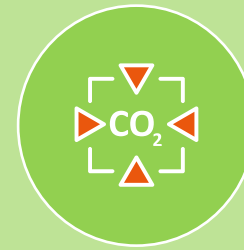
Recycled content ECO-R

Products that contain post-industrial or post-consumer recycled materials while still maintaining consistency, quality and performance



Bio-mass balance ECO-B

Products derived from biological feedstock like forestry and agricultural waste materials or renewable domestic waste using a mass balance approach



Carbon capture ECO-CC

Products based on CO₂ emissions converted into methanol as building block for downstream products



End-of-life

Products that are biodegradable and compatible with waste streams that go into composting





Raw materials

Long-term suppliers with proven history and robust systems to maximize quality, minimize variability and ensure traceability

Finished products

- ▶ Compensates performance drop from mechanical recycling step
- ▶ Product very close but not identical to prime (no drop in)
- ▶ Expanding offer beyond legacy unspecified recycled content to **ECO-R range with specified recycled content**

- ▶ **Post-Industrial Recycle (PIR):**
Derived from separated industrial waste streams
Generally higher quality due to more defined origin
- ▶ **Post-Consumer Recycle (PCR):**
Derived from separated consumer waste streams
Typically, higher variability and levels of contamination
- ▶ **Internal scraps:**
Derived from internal scraps incl compounded product
Generally, no longer recognized as recycling

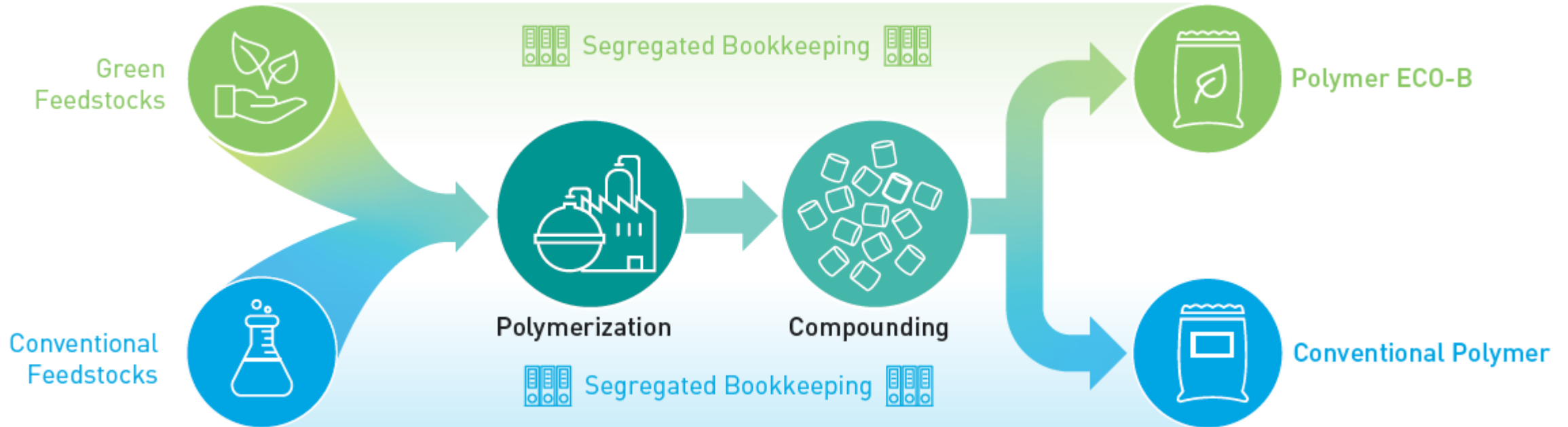
Material	Recycle Sources	Available	Product Brands
PA	PIR carpet, textile, industrial fiber	 now	Ecomid® PA ECO-R
PBT/PET	PCR beverage bottles, packaging scrap	 now	Impet® PET ECO-R, Celanex® PBT/PET ECO-R
PP	PIR textile fiber, non-woven	 2Q 22	Tecnoprene® PP ECO-R
TPV	PCR	 now	Santoprene® TPV ECO-R

ECO-B concept

- ▶ Bio-based feedstock using a **bio-mass balance** approach
- ▶ Independent **3rd party audited** mass balance certification (ISCC+, RedCert²)
- ▶ Significant increase in **renewable content** and reduction of **CO₂ footprint** vs standard fossil equivalents
- ▶ End products in identical quality and properties enable **drop-in replacement**

Material	Available	CO ₂ footprint reduction	Renewable content	Bio-Mass Balance feedstock
POM ECO-B	1Q 2021	up to 50%	up to 97%	Bio Methanol
Celanex [®] PBT ECO-B	2Q 2022	up to 45%	up to 40%	Bio BDO
GUR [®] UHMWPE ECO-B	3Q 2022	under evaluation	up to 99%	Bio Ethylene

ECO-B: Understanding Mass-Balance Approach



Feedstock:

Mass-balance approach means fossil- and bio-based or recycled feedstocks are mixed in production but accounted for separately

- Creates demand for non-fossil feedstocks
- Maintains efficiency and emissions benefits of large-scale production technologies

Bookkeeping:

Celanese system to accurately account and track the feedstocks used to produced equivalent amounts of product

- Accounting process and data certified by ISCC (International Sustainability and Carbon Certification), or RedCert, both leading and widely recognized certification institutes.











A multi-stakeholder initiative organized in an association with 144 members

ISCC is a well established and credible certification standard

- 25,000+ certificates, 4000+ system users
- System users in 100+ countries
- 32 certification bodies, 430+ ISCC trained auditors
- Several NGOs and research organizations are ISCC members (e.g. WWF, Deutsche Umwelthilfe etc.)
- ISCC cooperates with 32 certification bodies from 16 countries to conduct the audits for ISCC PLUS certification (e.g. TÜV, Dekra, SGS etc.)

Source: ISCC+ (International Sustainability & Carbon Certification)

ISCC principles – a balanced set of ecological and social criteria

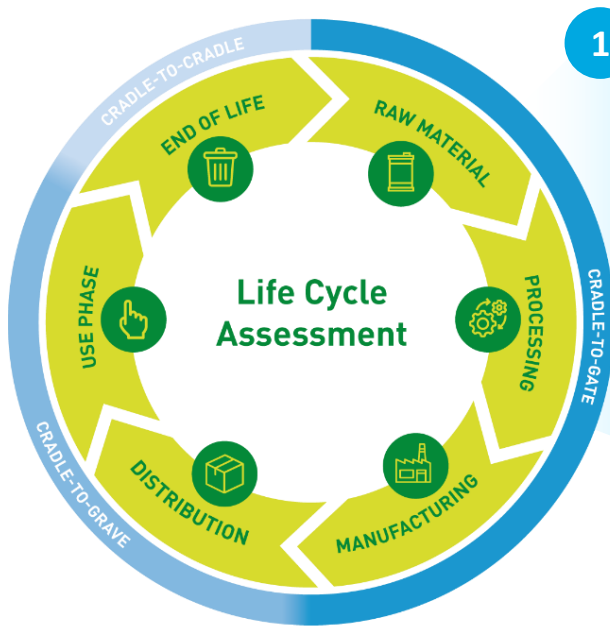
Agricultural feedstock	Agricultural crop residues	Forestry feedstocks	Wastes/ processing residues	Renewable non-bio feedstocks
				
Principle 1: Protection of biodiverse and carbon rich areas	Principle 2: Good Agricultural Practice	Principle 3: Safe Working Conditions		
				
Principle 4: Compliance with Human, Labour and Land rights	Principle 5: Compliance with Laws and International Treaties	Principle 6: Good Management Practices and Continuous Improvement		

Traceability, Chain of Custody and GHG emission calculation along the supply chain

ISCCPlus

- Feedstock identity
- Defined system boundaries
- Clear allocation rules
- Credible claims
- Transparent documentation
- Third-party verification

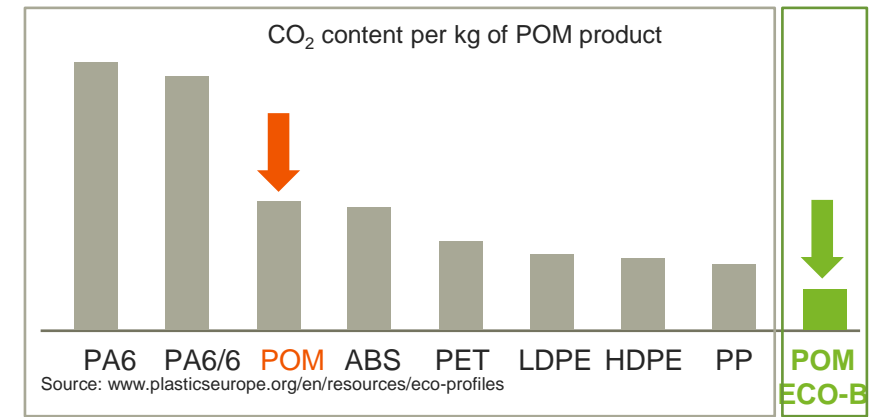
4 Phases of LCA according to DIN EN ISO 14040/44



- 1 Definition of Scope, Site/Product Combination
- 2 Life Cycle Inventory (LCI) Analysis Phase
- 3 Life Cycle Impact Assessment (LCIA) Phase
- 4 Life Cycle Interpretation

Discussing the results with consultant in terms of quantified ecological effects, identified significant issues, evaluation of completeness, sensitivity and consistency. Provide conclusion, limitation and recommendations
CO₂ values generated at this point

- Mapping options for further reducing overall environmental impact
- of POM considering all LCA parameters
- Comparative Data of conventional POM versus a more sustainable
- POM = POM ECO-B
- Celanese opted for an external critical review performed by an independent expert
- **LCA report issued for POM ECO-B showing ~50% reduction in CO₂**



* Based on POM ECO-B produced at our Frankfurt, Germany site in 2019, and may not reflect future POM processes.



POM ECO-B

Product	Mass-balance Bio-POM
Availability	Any EU-manufactured grade: Available Now Any US-manufactured grade: 2Q 2022 Any China-manufactured grade: 3Q 2022
Renewable Content	Up to 97% certified Bio-content via ISCC Plus mass-balance
CO ₂ Benefit	Reduction in CO ₂ footprint (GWP – Global Warming Potential) of ~50% of CO ₂ per KG of POM polymer*

* Polymer-only basis, compounded products may differ

- ▶ Mass-balance bio-based POM using renewable feedstocks
- ▶ Chemically identical to traditional POM, ***no product requalification required***
- ▶ Option on any grade in portfolio
- ▶ Does not use or contain food or feed crops
- ▶ Celanese uniquely positioned to offer ECO-B solution given fully integrated chain

Sustainability and Circular Economy


ECO-CC: Carbon Capture





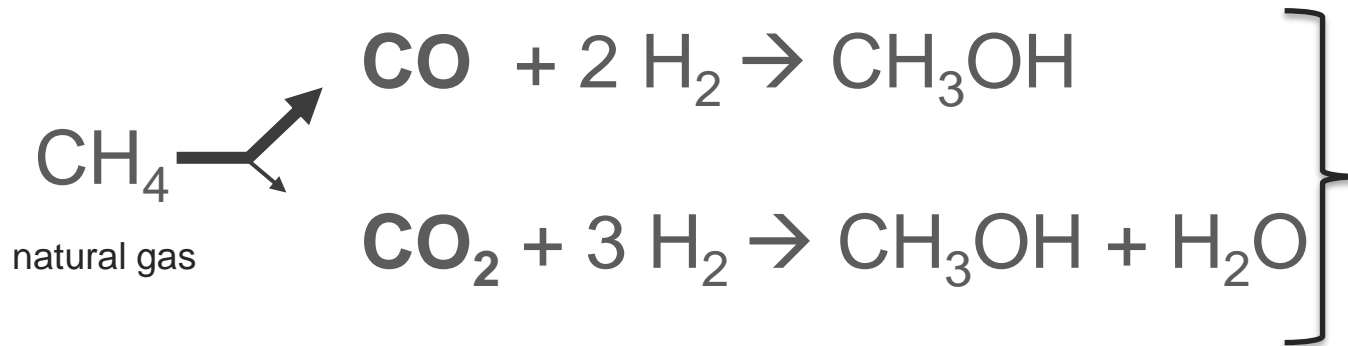
ECO-CC Concept

- ▶ Leveraging backward integration into methanol production where **industrial waste CO₂** as byproduct from other plants is used as **feedstock for methanol**
- ▶ Resulting POM polymer estimated to come with >90% **renewable content** and a **CO₂ footprint reduction** in a similar range to bio-mass balance POM ECO-B
- ▶ Independent **3rd party audited** mass balance certification (ISCC+)
- ▶ End products in identical quality and properties enable **drop-in replacement**
- ▶ Flexible commercial model with broad applicability to all grades
- ▶ Estimate available starting 2Q 2023

Material	Available	CO ₂ footprint reduction	Renewable content	Circular feedstock
POM ECO-CC	2Q 2023 	under evaluation	up to 90%	Circular Methanol

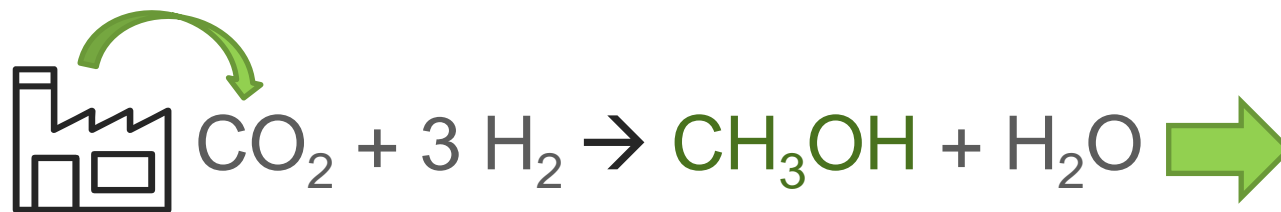
Methanol Synthesis - conventional vs carbon capture

Conventional Route



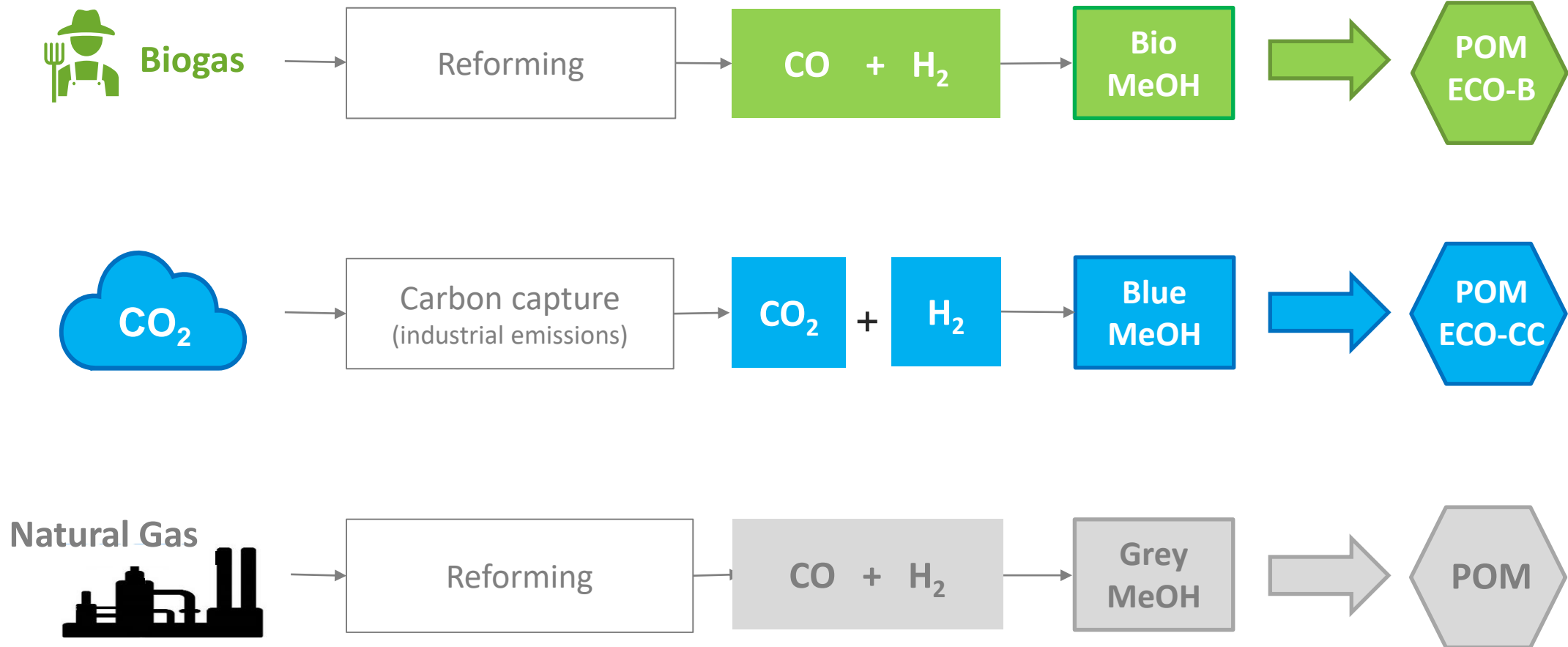
- Both reactions occur in parallel
- In current set up, equilibrium is pushed towards CO route because of better yield

CO₂ Capture Route

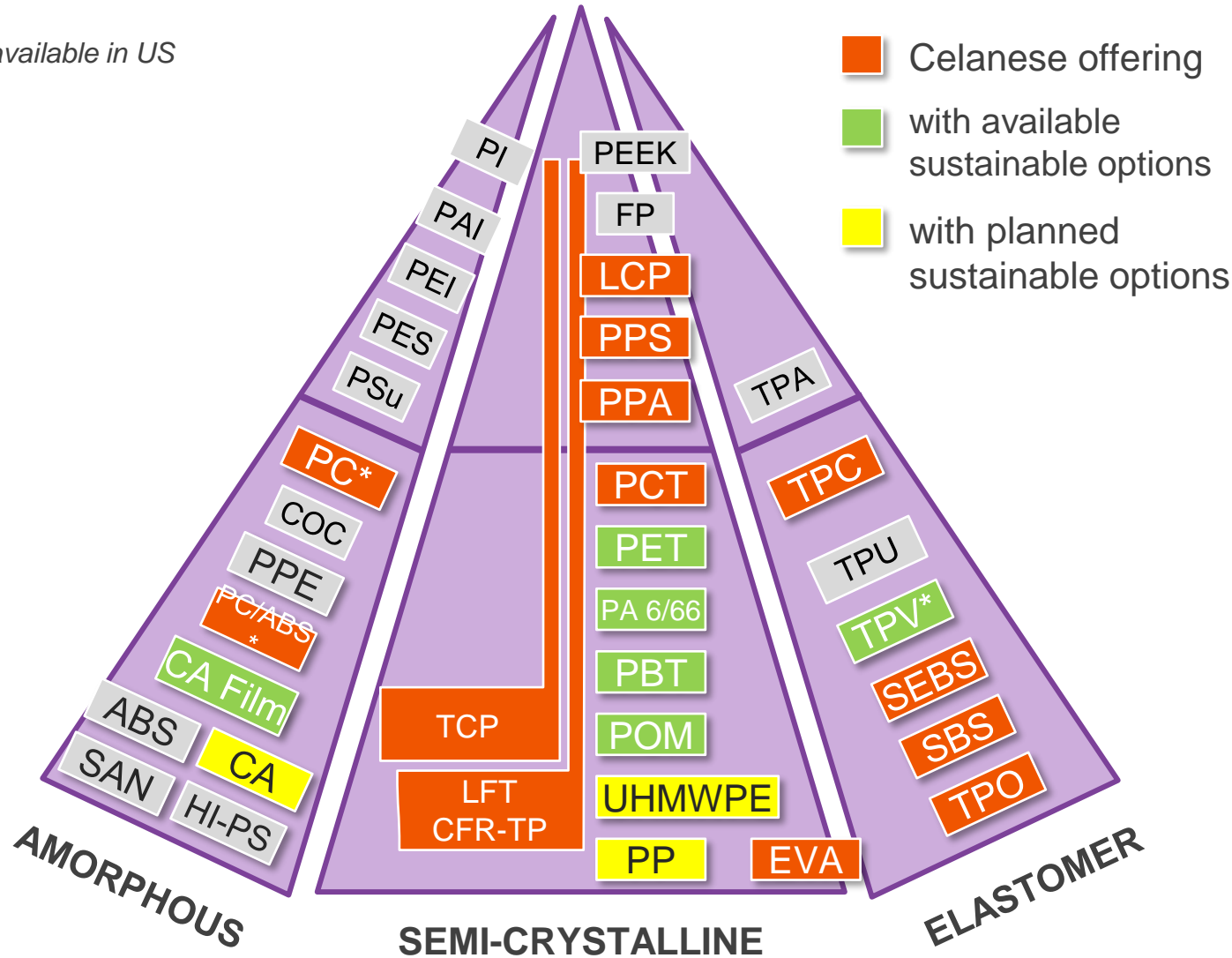


- Uses existing reactor, same chemistry
- Suboptimal yield of CO₂ route compensated by high CO₂ concentration
- Methanol produced is indistinguishable from standard Methanol

POM ECO-CC vs ECO-B



* available in US



- Celanese EM offers the broadest range of Engineered Thermoplastics in the market
- Key strength overall and for sustainable solutions is within the semi-crystalline part of the plastics pyramid
- A range of sustainability options are available across the portfolio

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Contact Information

Americas

8040 Dixie Highway, Florence, KY 41042 USA

Product Information Service

t: +1-800-833-4882 t: +1-859-372-3244

Customer Service

t: +1-800-526-4960 t: +1-859-372-3214

e: info-engineeredmaterials-am@celanese.com

Europe

Am Unisys-Park 1, 65843 Sulzbach, Germany

Product Information Service

t: +(00)-800-86427-531 t: +49-(0)-69-45009-1011

e: info-engineeredmaterials-eu@celanese.com

Asia

4560 Jinke Road, Zhang Jiang Hi Tech Park

Shanghai 201203 PRC

Customer Service

t: +86 21 3861 9266 f: +86 21 3861 9599

e: info-engineeredmaterials-asia@celanese.com