



IPAC-RS Roundtable Part II (2/7/23)

Achieve Healthcare product circularity

with data-based evidence of no change in regulatory status

Paulo Cavacas
Business Development Manager Healthcare

Borealis AG



Who we are

What makes us us

120

Countries. Head Office
in Vienna, Austria

6900

employees
worldwide



Production and distribution
of polyolefins solutions, base
chemicals and fertilizers

Ownership structure:

75%

OMV, Austria



Our JV's: Bayport Polymers
(**Baystar**™) – brings Borstar®
technology to American polyethylene
markets



Our JV's: Borouge – one of
the world's largest integrated
polyolefin complexes (Ruwais,
UAE)

25%

Mubadala, United
Arab Emirates

#2

Among polyolefin
producers in Europe

#8

Among polyolefin
producers worldwide

1.4 bnEUR


net profit, total sales 12.3
bnEUR (2021)

>100

Priority patents filed
in 2021, #1 in Austria

3

Polyolefin recycling
operations in Europe

An underwater photograph showing a sea turtle swimming towards the left. The water is filled with various pieces of plastic waste, including a clear plastic bottle, a green straw, and several pieces of clear plastic film. The turtle's head and front flipper are visible in the lower-left quadrant.

Today's linear, wasteful way is a problem

Waste from energy inefficiency & carbon loss
Waste of natural resources
Waste through leakage into environment

Today, only 14% of our plastic waste gets recycled. Only 2% is “effectively recycled”; converted into an equally useful item.

Source: World Economic Forum & Ellen MacArthur Foundation.

It starts with A / B / C ...

Carbon circularity
will end reliance on
fossil-based
carbon.



Atmosphere
... direct carbon
capture



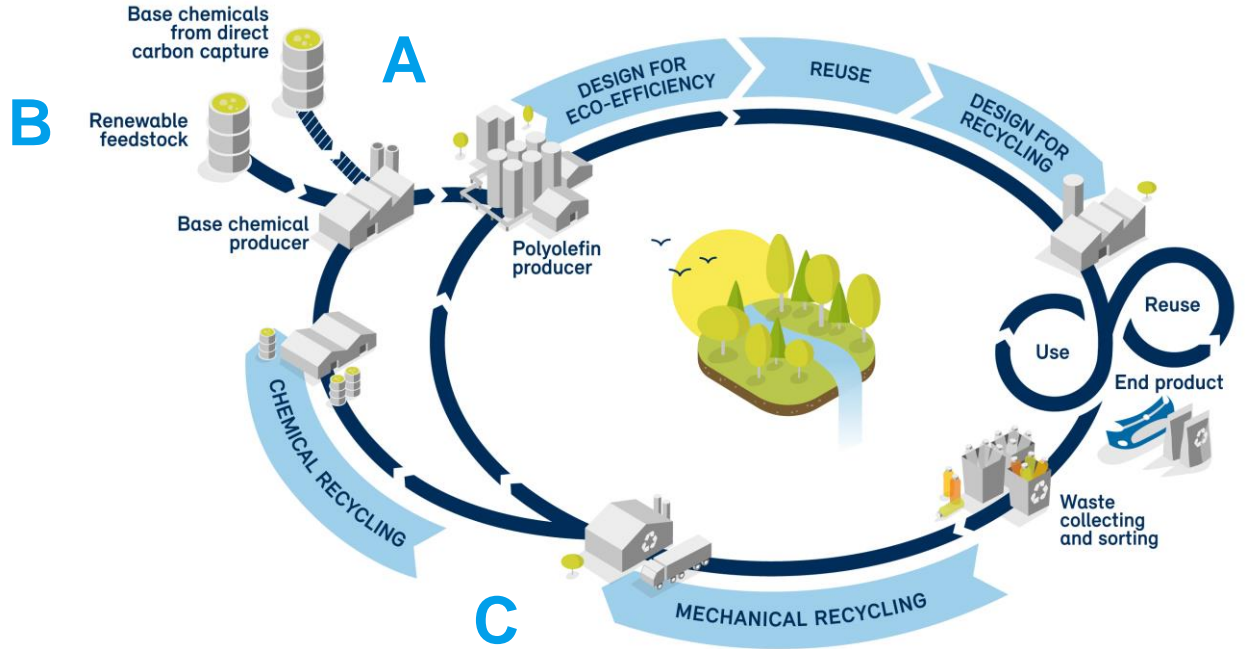
Biomass
... using carbon
from plant-based
feedstocks



Circular Tech
... recycling fossil-
based carbon in
mixed waste streams

Borealis aims to keep plastics and carbon in the loop to become 100% circular

Introducing the circular cascade



Acceleration of circular production

We will increase circular product capacity to 1.8 mt by 2030



Six-fold increase in share of circular products and solutions from today's 100 kt to 600 kt by 2025 and further to 1.8 million tons by 2030



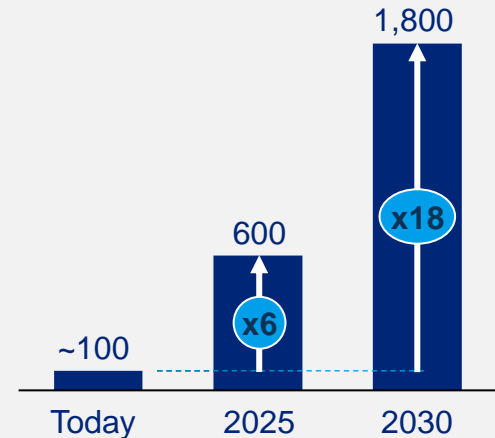
Moving from a linear towards a circular economy will also significantly reduce Scope 3** emissions



Invest in compounding and adjacencies to accelerate value creation through innovation

Circular products and solutions

in kt*



*Includes recycled and renewable polymers and chemicals as well as renewable hydrocarbons

** Scope 3 are indirect GHG emissions that are a consequence of company activities but occur from sources outside or not controlled by the company.

How in Healthcare?

Borealis is fully committed to closing the loop

Accelerating the transition to a circular economy by addressing DfR, plastic waste and climate change

Design for Recycling



Design for Recycling

- Eco-efficient design so that healthcare applications can be collected, sorted and recycled (e.g. “mono” material)
- Example: substitution of PVC/Al blister materials with 100% PP solution

Borcycle™ C



Chemical recycling

- Plastic Neutrality
- Value: fight plastic waste; meet recycling targets
- Virgin equivalent, food approved and medical grade (Bormed)
- ISCC+ certified mass balance

The Bornewables™



Renewable-based (2nd gen.) POs

- Carbon Neutrality
- Value: reduce carbon footprint by at least 120%; fossil depletion by ~70%*
- Virgin equivalent, food approved and medical grade (Bormed)
- ISCC+ certified mass balance

Commercially available solutions for Healthcare

*vs. fossil-based in terms of GWP and abiotic resource depletion / LCA based on ISO14040, ISO14044, ISO14067 critically reviewed by third party panel

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The Bornevables™: virgin quality and a significant reduction in CO₂

Making the right choices



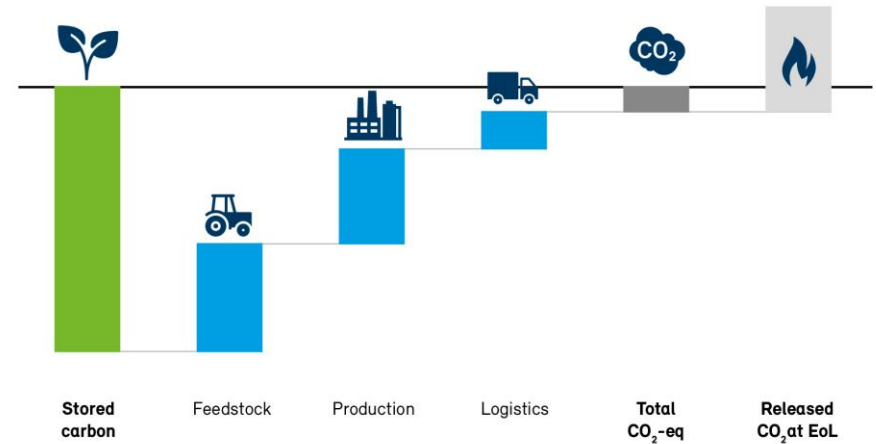
Second generation

Renewable feedstock not suitable for consumption (non-food crops, waste)

Such as:

- Waste and residues from vegetable oil refining
- Used cooking oil (UCO) collected from food industry and restaurants

Reducing carbon footprint with the Bornevables™



Size of the bars is only for indicative purposes and is not representing the actual situation.

Comparison of CO2-footprint reduction

When replacing 1 tonne of conventional PP with Bornewables™ PP you save 2.1 ton of CO2 -eq.

This is comparable to CO₂ emission of:



3 Return-flights
from London to
Beijing¹



20 people
trying vegetarian
for a month⁴



95%
of average
European
household's annual
energy usage³



driving
17.000km
with new car
in EU²



Charging **2100**
smart phones for a
year⁵

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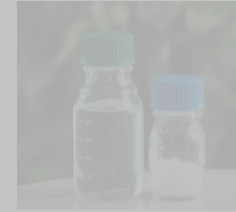
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Chemical recycling, a part of the solution for closing the loop

Renews plastic back to plastic



The solution for high purity, high performance materials

- Borcycle™ C is our portfolio of **transformational chemical recycling solutions**, giving polyolefin-based, post-consumer waste another life.
- It offers all-round benefits, supercharging the transition to a circular polyolefin industry whilst creating **virgin quality plastic products**.
- A solution creating both virgin-level grade materials and high safety and performance qualities fit for demanding applications.
- Borcycle C renews plastic back to plastic; creating recycled materials with a level of purity fit for protective, food-safe and other demanding applications.

Borcycle™ C in action

Advancing the introduction of Borcycle™ C with several project and collaborations



Borealis collaborates in OMV's Patented Chemical Recycling Technology

- Fully integrated into the OMV's Austria refinery
- Current (pilot) plant has a capacity of up to 100kg per hour



Renasci to exclusively supply Borealis with chemically recycled output material

- Projected output 20kT/year from their high-tech recycling centre



New chemical recycling unit in Stenungsund, Sweden expected to commence operations in 2024

- Feasibility study underway for chemical recycling plant in Sweden (2024)

Bornewables™

Data based evidence on equivalency

Following the renewable/fossil feedstock through the value chain (1/2)



Oil and gas production

Polyolefins traditionally begin with **oil and natural gas** (~4% becomes plastic raw material)



Refining (fossil-based)

The oil and gas mixture is separated into different products by distillation to produce **fossil-based hydrocarbons**



The cracking process

Hydrocarbon molecules are modified into new molecules, including the gases **ethylene and propylene** (the monomers of polyolefins)

Renewable (2nd gen.) production



Collection of **used cooking oil and waste and residue streams** from vegetable oil refining

Refining (renewable-based)*



Renewable raw materials are pre-treated, then hydro-treated (NEXBTL technology) to produce **renewable-based hydrocarbons**

*Source: Neste

Following the renewable/fossil feedstock through the value chain (2/2)



The polymerisation process

Polymerisation is a chemical reaction caused by a catalyst (for PP and HDPE) where monomer purity is key for a continuous process in this closed environment



PE and PP

Bormed™ PE and PP polymers: dedicated to the healthcare industry and delivered to converters / CDMOs, usually as 2-to-3-millimetre particles (pellets)



Healthcare solution

Borealis' customers melt Bormed PP and PE and process them into the end healthcare application

The Borneables™: Controlled blending trial

To create data-based evidence of no change in regulatory status



What, How and Why?

- Renewable-based monomer was controlled blended to produce:
 - PP with 46% physically present and certified renewable-based content (externally tested by Beta Analytic via C14 analysis)
- Reference: same PP grade made by fossil-based monomer

Purpose:

- Gather data and evidence of no change also on output material

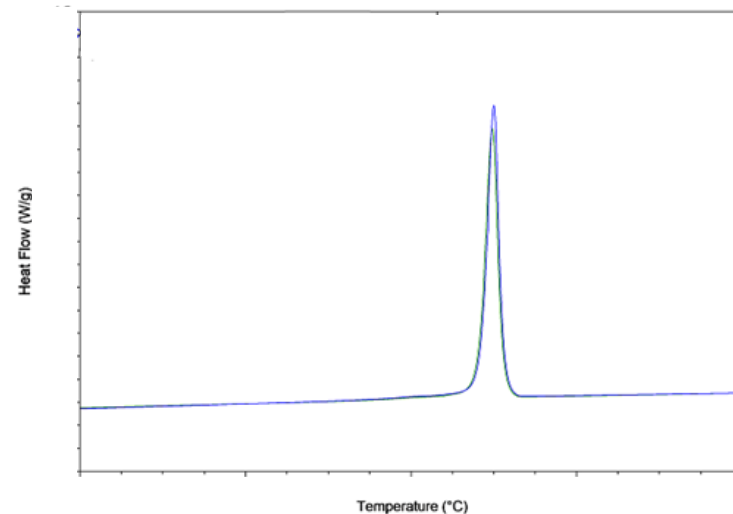
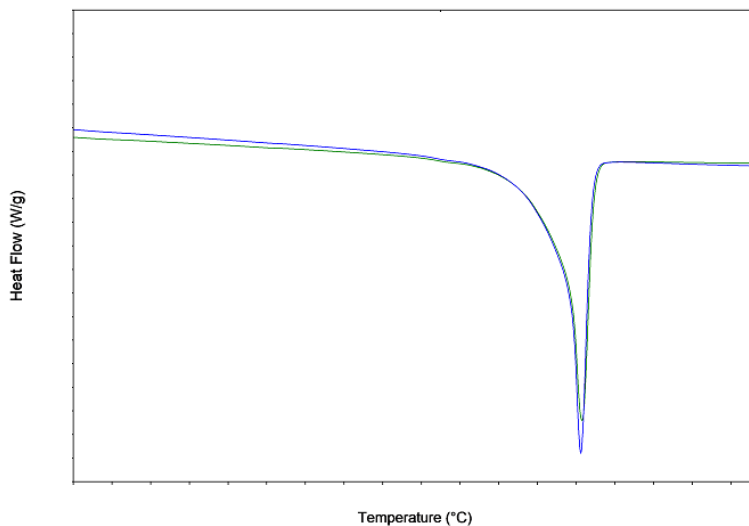
Polymer Design, Food Contact & Mechanical Properties remain in the range of lot-to-lot variation

			Fossil reference	46% Borneables
C6 solubles film (FDA)*	Weight fraction	wt%	2,95	2,81
HDT (ISO 75-2), B 0.45MPa	Tm	°C	87	87
Tensile properties (ISO 527-1,-2) 1A +23°C >96 hr	Tensile modulus	MPa	1411	1380
	Tensile strain at yield	%	5,0	5,3
	Tensile strength	MPa	26	26
	Tensile stress at break	MPa	16	16
Charpy notched (ISO 179-1), + 23°C >96 hr	Impact strength	kJ/m2	5,1	5,1
Charpy notched (ISO 179-1), - 20°C >96 hr	Impact strength	kJ/m2	2,9	3,0

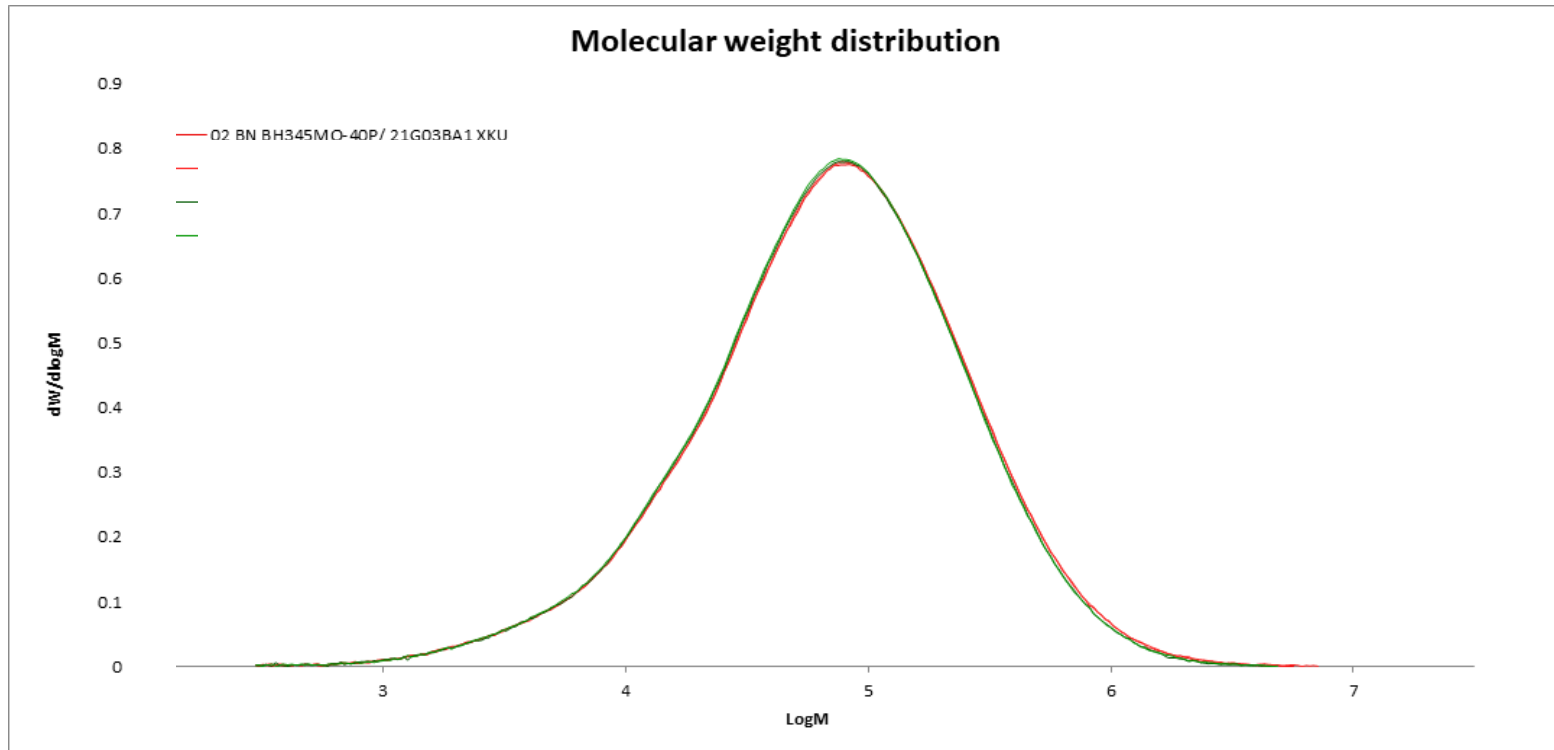
*Food contact requirement: < 5.5 wt%

DSC: No change in crystallisation and melting temperature meaning no change in processing and sterilisation behaviour

			Fossil reference	46% Borneables
DSC	Tcr	°C	125	125
	Tm	°C	164	164

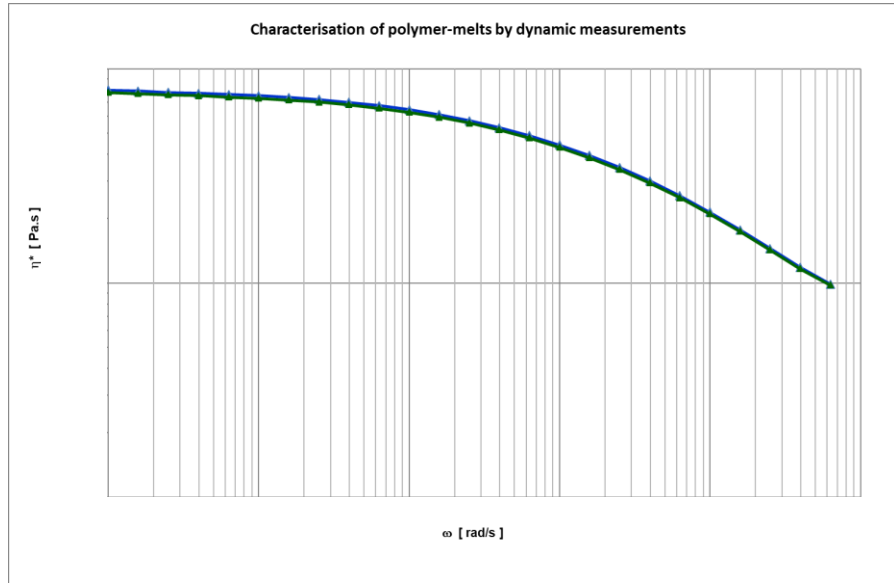


No change in MWD meaning no change in material performance / characteristics (processing, shrinkage, dimensional stability)



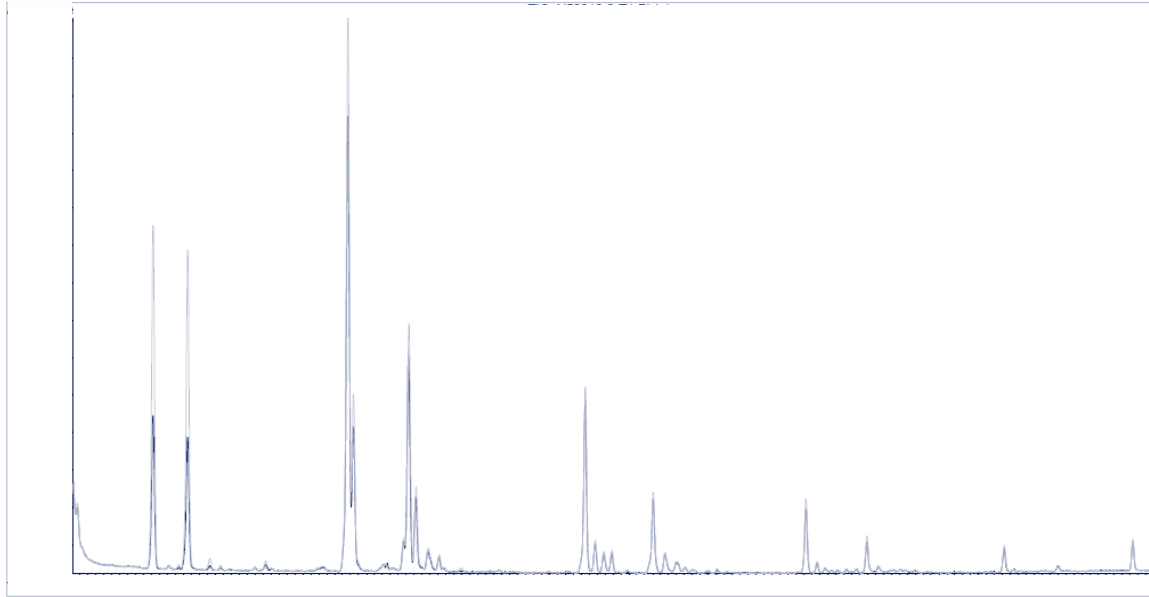
No change in rheology meaning no change in processing (flow behaviour, polymer design)

Frequency sweep @ 200°C



No change in HS-GC/MS meaning same emission fingerprint of material

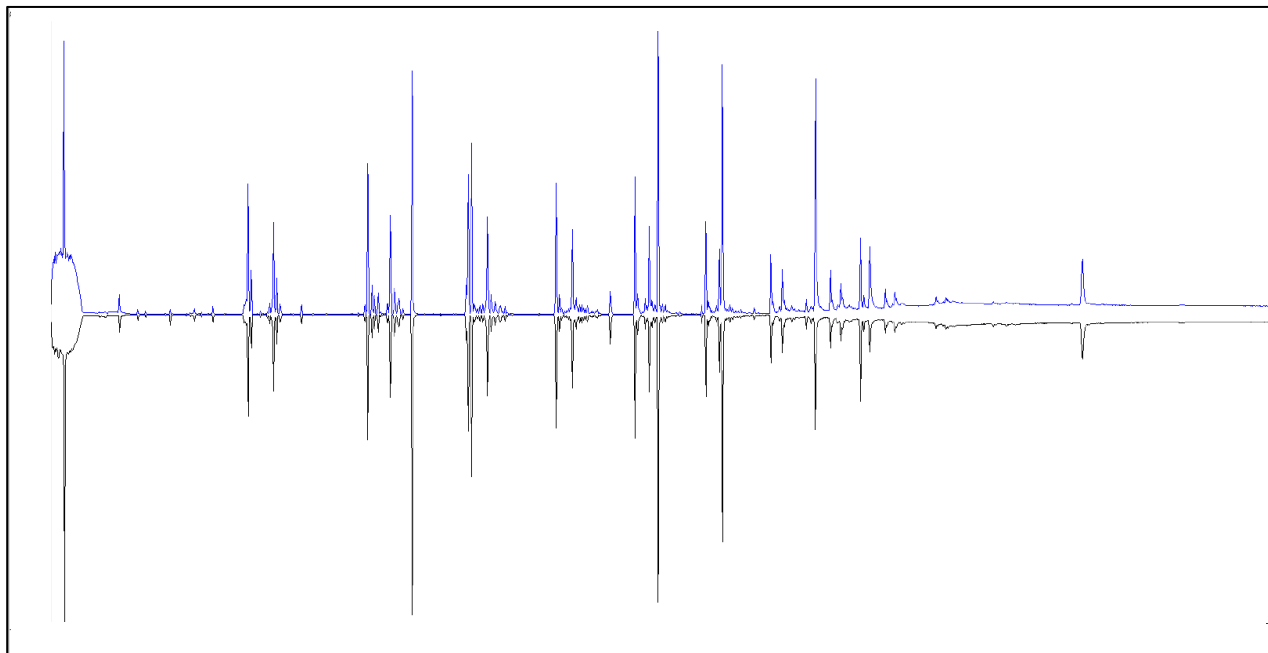
HS – GC/MS



HS-GC/MS confirms no differences in peaks between 46% Borneables and fossil-based reference

Extractable results in Ethanol confirm no change in chemical fingerprint

GC/MS analysis for semi-volatiles in the EtOH closed vessel extract



Fossil reference
Vs.
46% Bornevables

Medical Grade Plastic

Bormed™: Borealis portfolio of medical grade PE and PP

Commitment

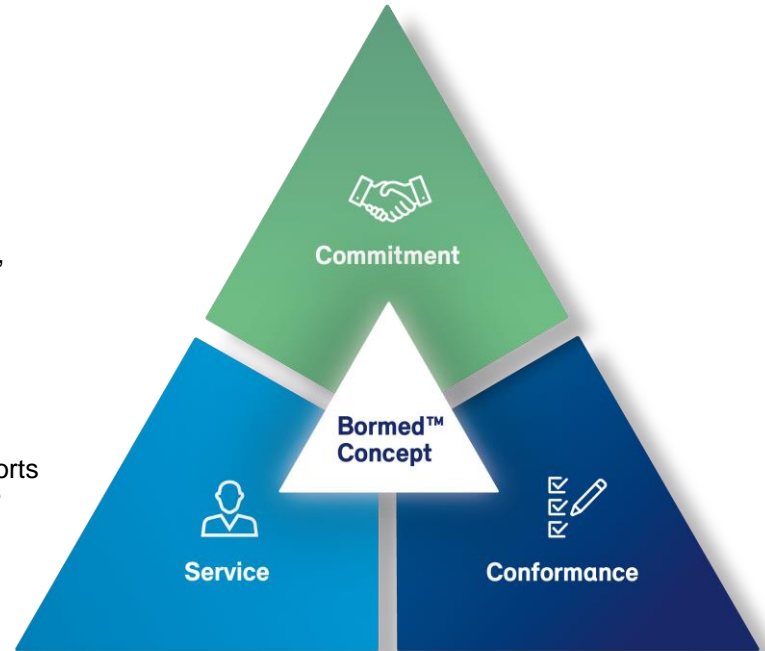
- Consistency of product recipe via rigorous change control procedure
- Continuity of supply regulated by Technical Delivery Specification
 - Product made available up to 5 years (2 years pre-notification and a last call volume combined with 3-year shelf life)
- Bormed Directive (PO-4047): internal operating instructions for the development, production, storage and delivery of Bormed grades

Conformance

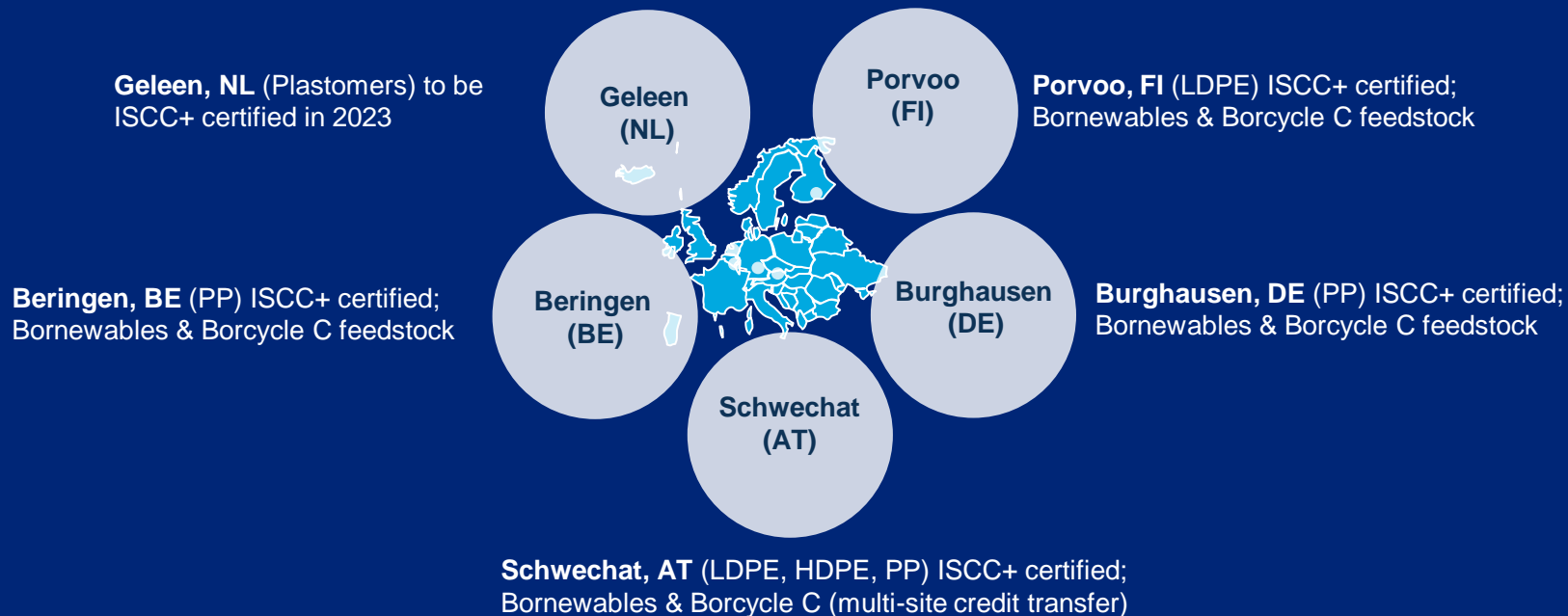
- Pharmacopeia compliance
 - External Ph. Eur., USP (incl. 661.1) and ISO 10993 testing: analysis reports can be shared on request; DMF listing; following VDI guidelines on MGP

Service

- Extractable profiles / recipe disclosure: shared on request under NDA
- Globally available dedicated team of experienced technical and regulatory specialists



All Bormed™ products are available as Borneables™ and Borcycle™ C under ISCC+



Summary

Bormed™ circular solutions for healthcare

No change in regulatory status and no compromise on patient safety



- **Environmentally sustainable** Bormed alternatives **available now** with:
 - **Reduced carbon footprint** by at least 120% vs. fossil
 - **No change** in quality, purity, processing, specifications
 - **No change** in biocompatibility
 - **No compromise** on patient safety

Thank you!

Let's re-invent!

Paulo Cavacas

Business Development Manager Healthcare

+351 966778019

paulo.cavacas@borealisgroup.com

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