

Bimodal Borstar[®] PE Process & Catalyst Technology -

An updated view on the leading bimodal PE technology

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Borealis at a glance



2nd largest polyolefin
producer in **Europe**



EUR 7.7
billion
sales revenue
in 2015

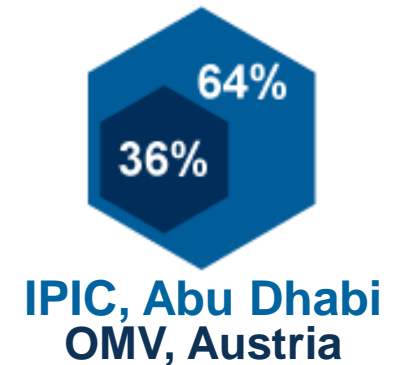


Operates in over
120 countries
on **5 continents**



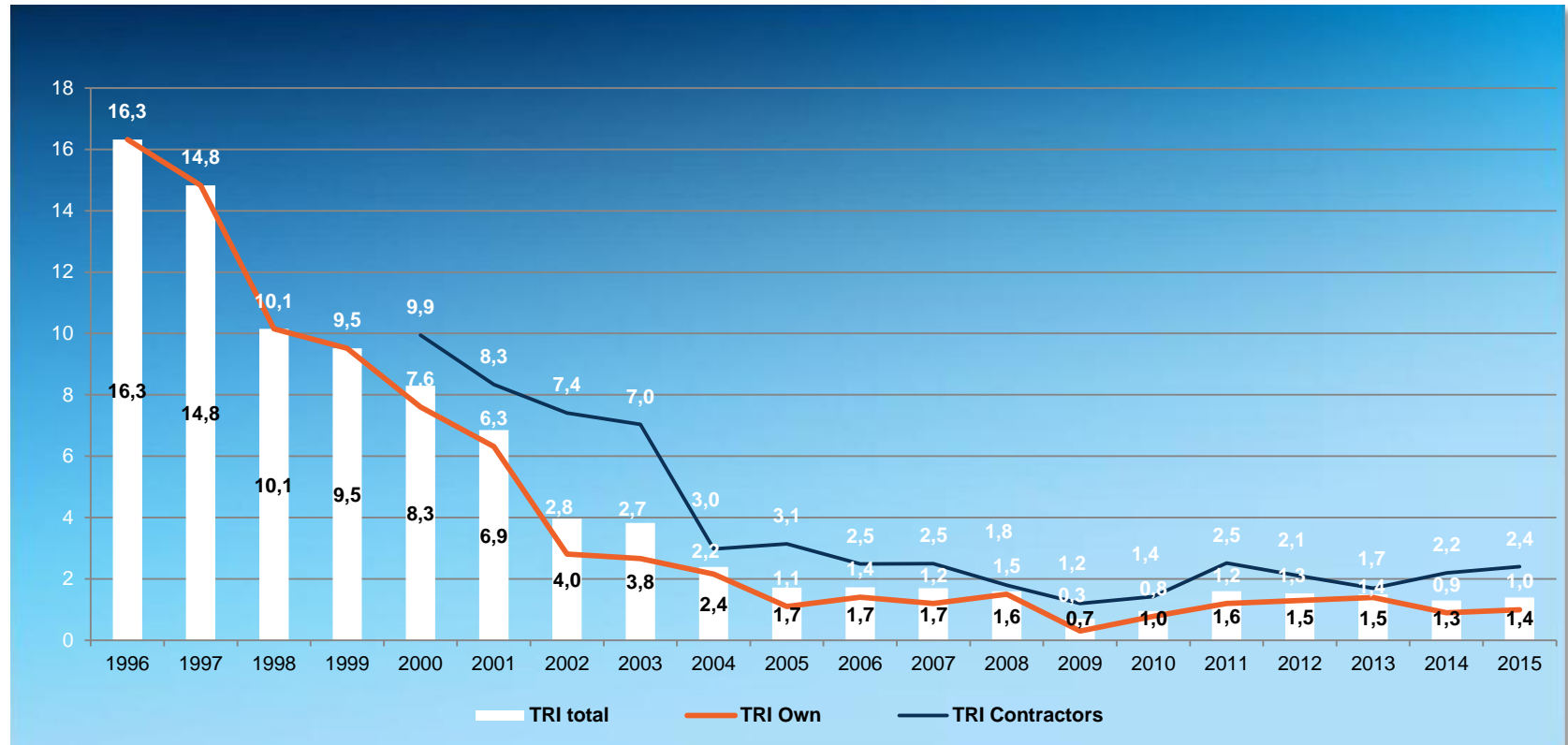
Sales of
polyolefins,
base chemicals
and **fertilizers**

Ownership structure



World-class safety standards

TRI frequency - Own Employees vs. Contractors 1996 – 2015



Note: TRI being defined as total recordable incidents per million hours worked

Life Saving Rules



Portfolio of leading Polyolefin technologies

Polyolefin Technologies

Borstar® PE

Bimodal LLD, MD & HDPE

Borstar® PP

Multimodal PP

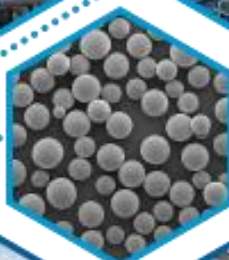
Borealis SIRIUS Catalyst Technology

Compact™

Plastomers and Elastomers

Borlink™

Wire & Cable Technology
Platform



Post-Reactor Technologies

Daploy™ HMS PP

High melt strength PP

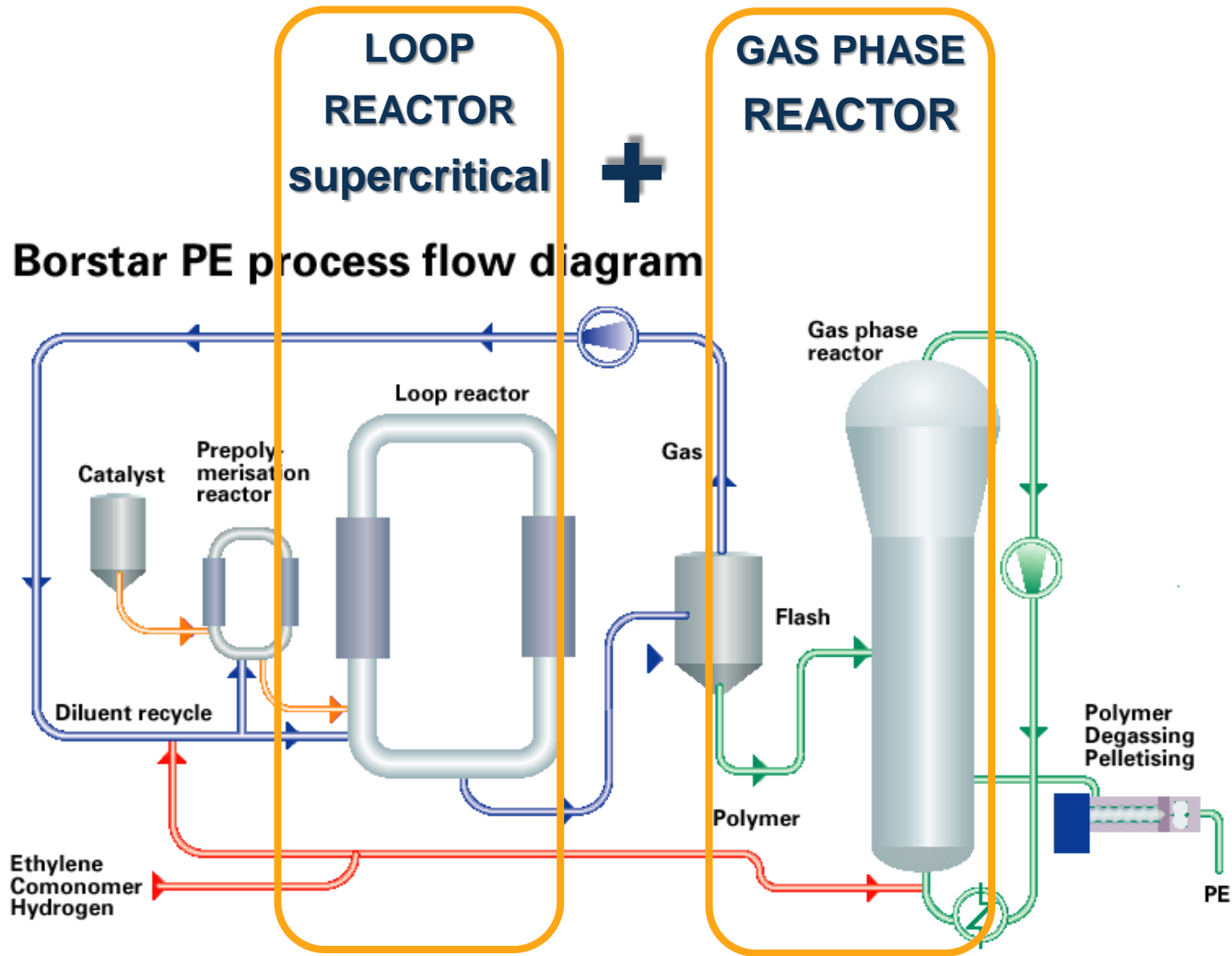


Fibremod™

Engineered
Fibre Compounds



Borstar® PE, Borealis' PE technology



Independent reactor controls

Borstar® PE – special features

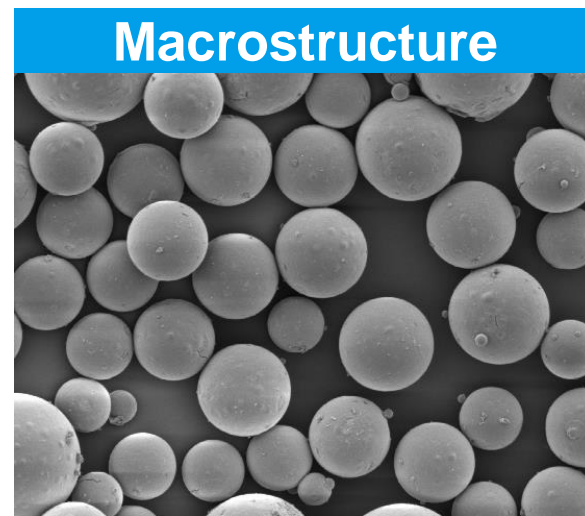
- Unique, Dual-Reactor combination
 - Slurry loop reactor with supercritical mode capability
 - Specially designed fluidized bed gas phase reactor
- Tailored range of proprietary Ziegler Natta catalysts



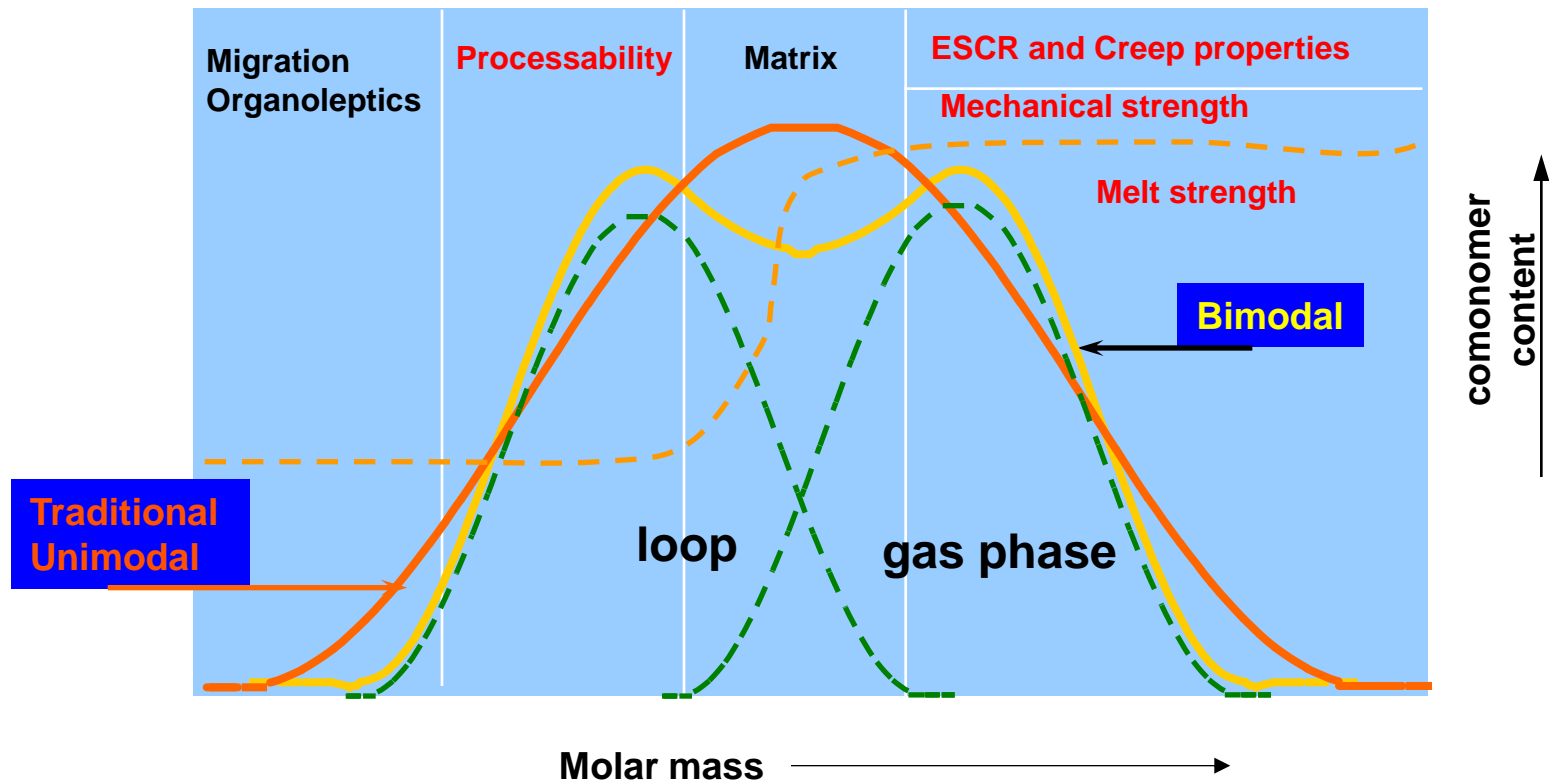
Borealis Sirius catalyst technology platform

– Key to advanced products with Borstar technology

- Excellent control of catalyst particle internal and external morphology for an optimized polymerisation behaviour along the polymerization sequence
- Superior morphology control
- Flexible chemistry for tailored response concerning molecular weight and co-monomer incorporation



Bimodal Borstar PE – Differentiating features



Borstar® PE – flexibility

- Independent reactor control plus specific catalyst selection enables

- LLDPE

- MDPE

- HDPE

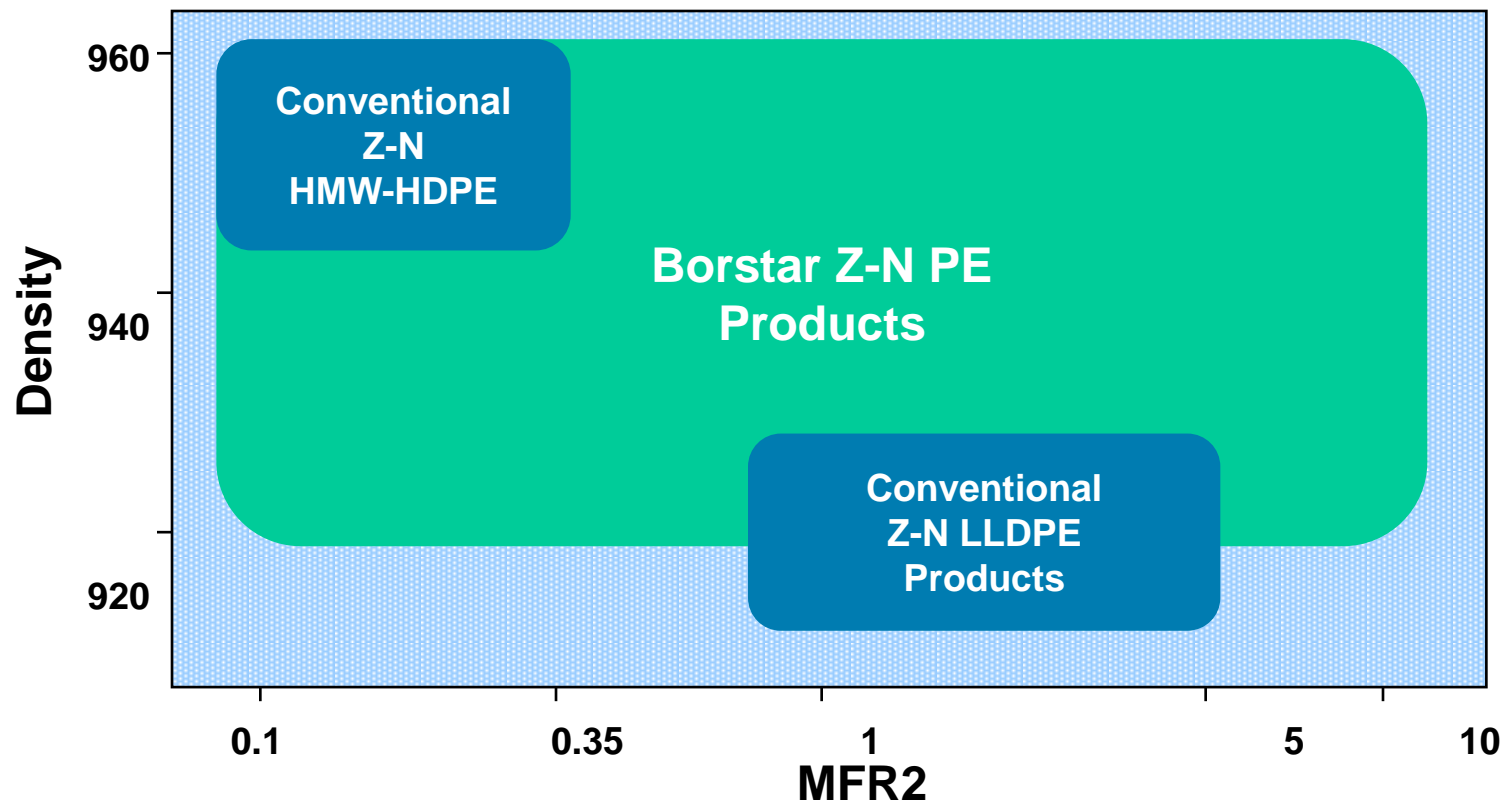
@ bimodal MWD and

@ tailored CCD including variable comonomer options

Based on one single process platform

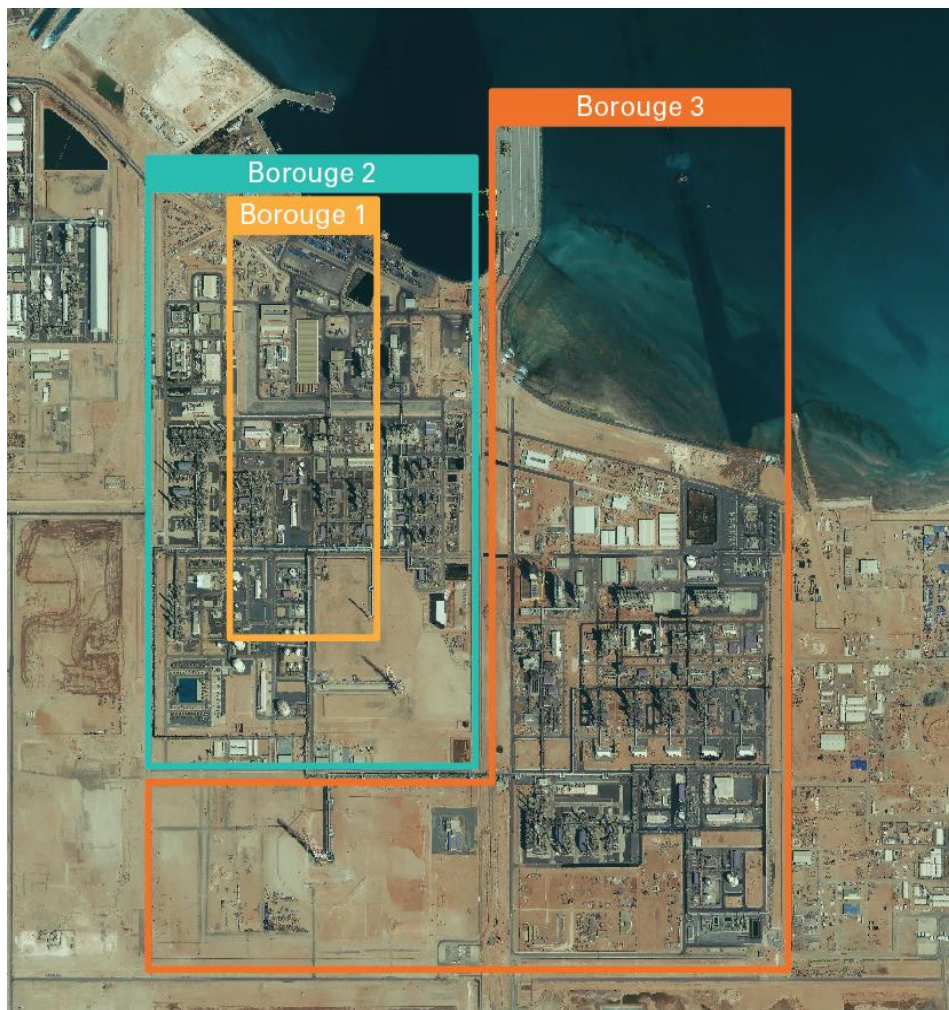


BORSTAR PE- DIFFERENTIATING FEATURES



4.5 MT polyolefin capacity at Borouge demonstrated

- World's largest integrated olefin/polyolefin complex
- World scale capacity units



BOROUGE 3 - MEGAPROJECT

Equipment > 2500 pieces



Steel > 6 Eiffel Towers



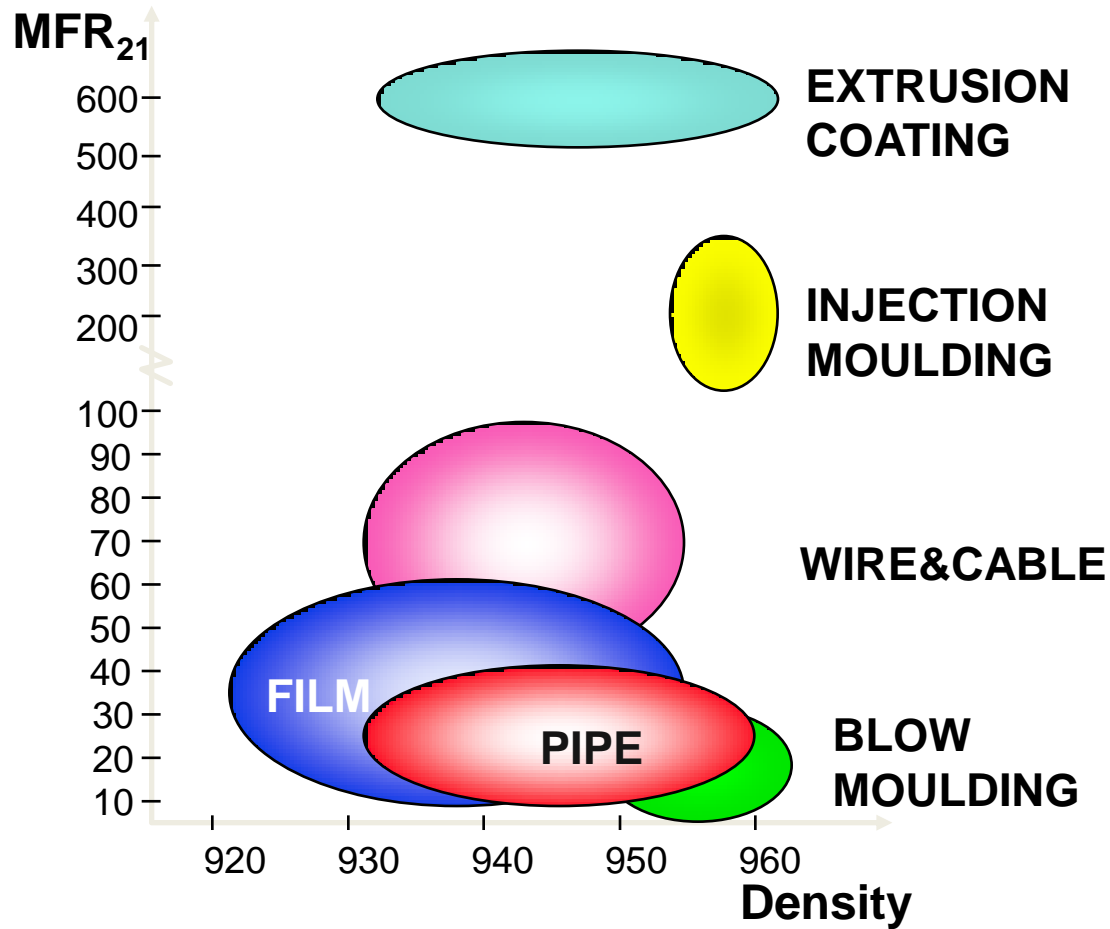
Cabling length of UAE-Singapore roundtrip



Concrete > 170 Olympic pools



BORSTAR PE PRODUCT RANGE



Everyday infrastructure Pipe solutions

Infrastructure



Utilities



Construction



Industrial



HE3490-LS-H: A PE100+ High Stress Crack Resistant PE100 for the toughest conditions

Problem

Demanding installation techniques are increasingly being used. Including:

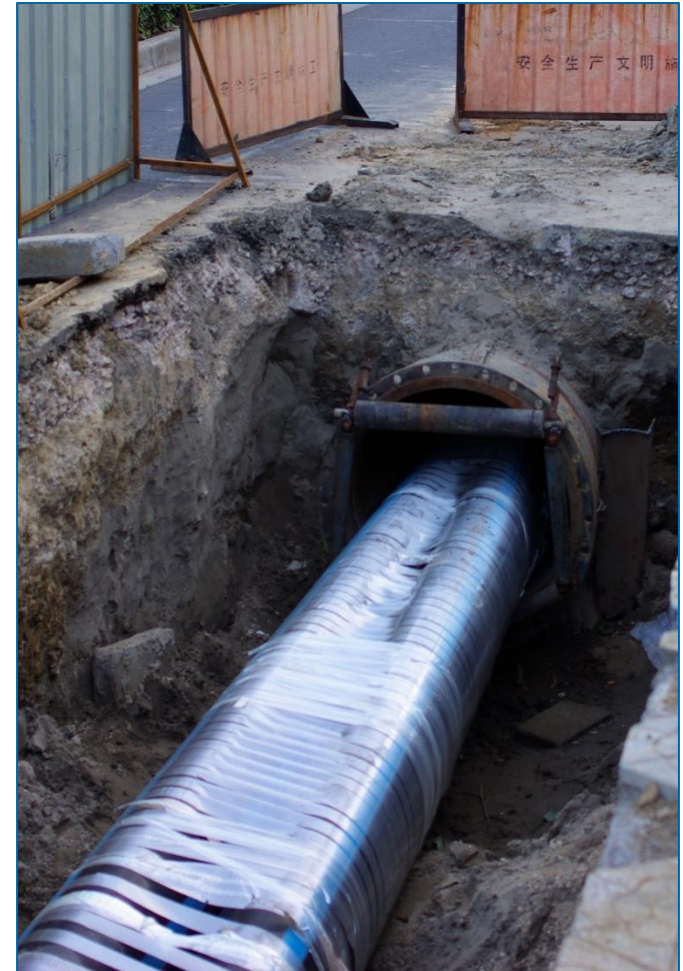
- Open-trench without sand bedding for cost reduction
- Directional drilling
- Lining, relining and pipe bursting

Challenge

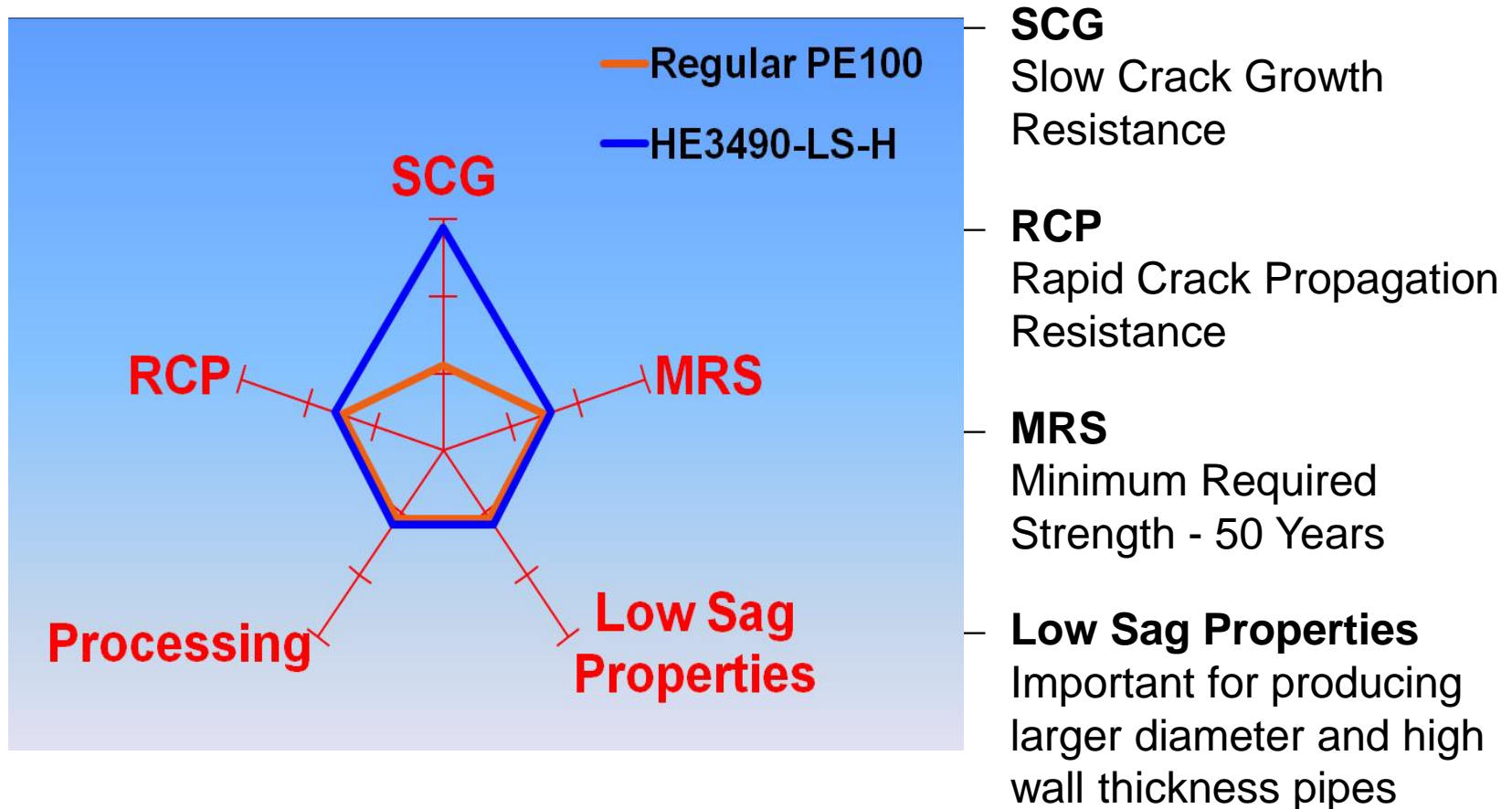
Pipe failure from slow crack growth initiated by external scratching / scoring and rock impingement (point-load)

Solution

High stress crack resistant PE100 (PE100-RC)



Properties of Borsafe HE3490-LS-H, a HSCR grade, as compared to a 'regular' PE100



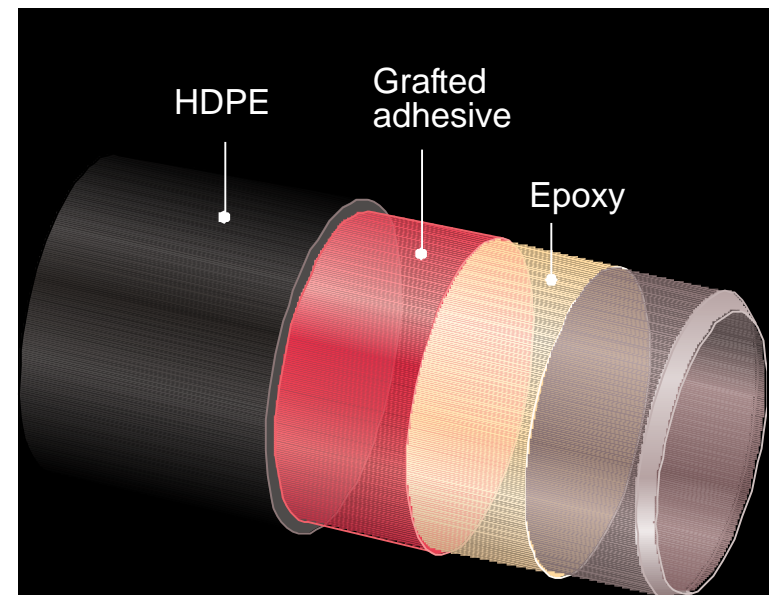
Advanced 3 Layer Pipe Coating Solutions

Minimize risk of outer layer damage through :

- ❑ Mechanical impact strength
- ❑ Indentation Resistance
- ❑ Resistance against UV degradation
- ❑ Resistance against Thermal degradation
- ❑ Resistance against Chemical attack
- ❑ Low built in “extrusion stresses”

Avoid delamination between outer layer & epoxy

Maximize coating production speed



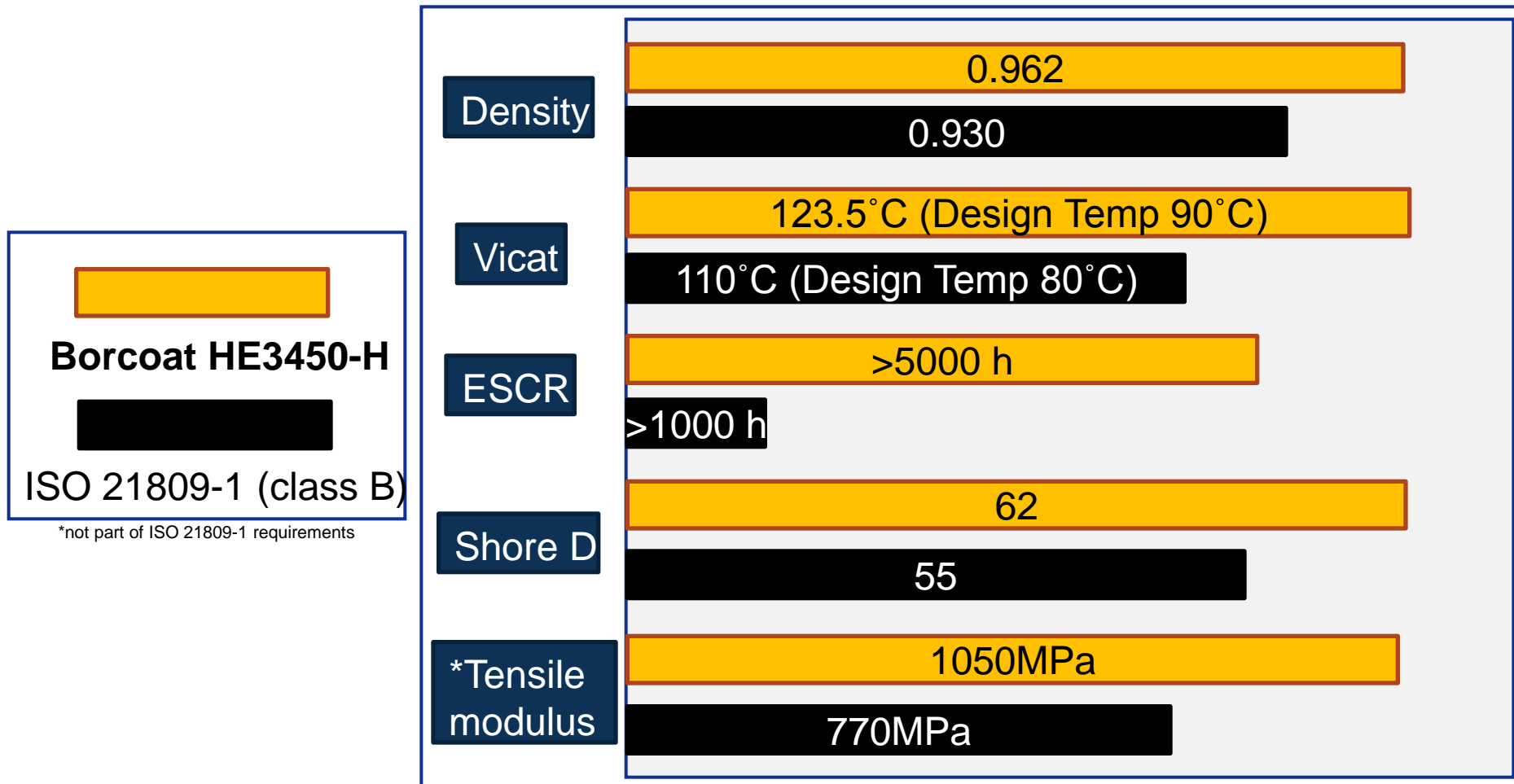
From Unimodal MDPE to Bimodal HDPE – a step improvement

Borcoat HE3450 :

- Excellent ESCR (>5000 hours vs. 300-1000 hours for unimodal MDPE/HDPE)
- Processability far superior to Unimodal
- Design Temperature (85°C vs 75°C for MD and 80°C for HD)
- Higher Moisture barrier
- Higher Resistance to Abrasion
- Very high impact resistance (also at low temp)

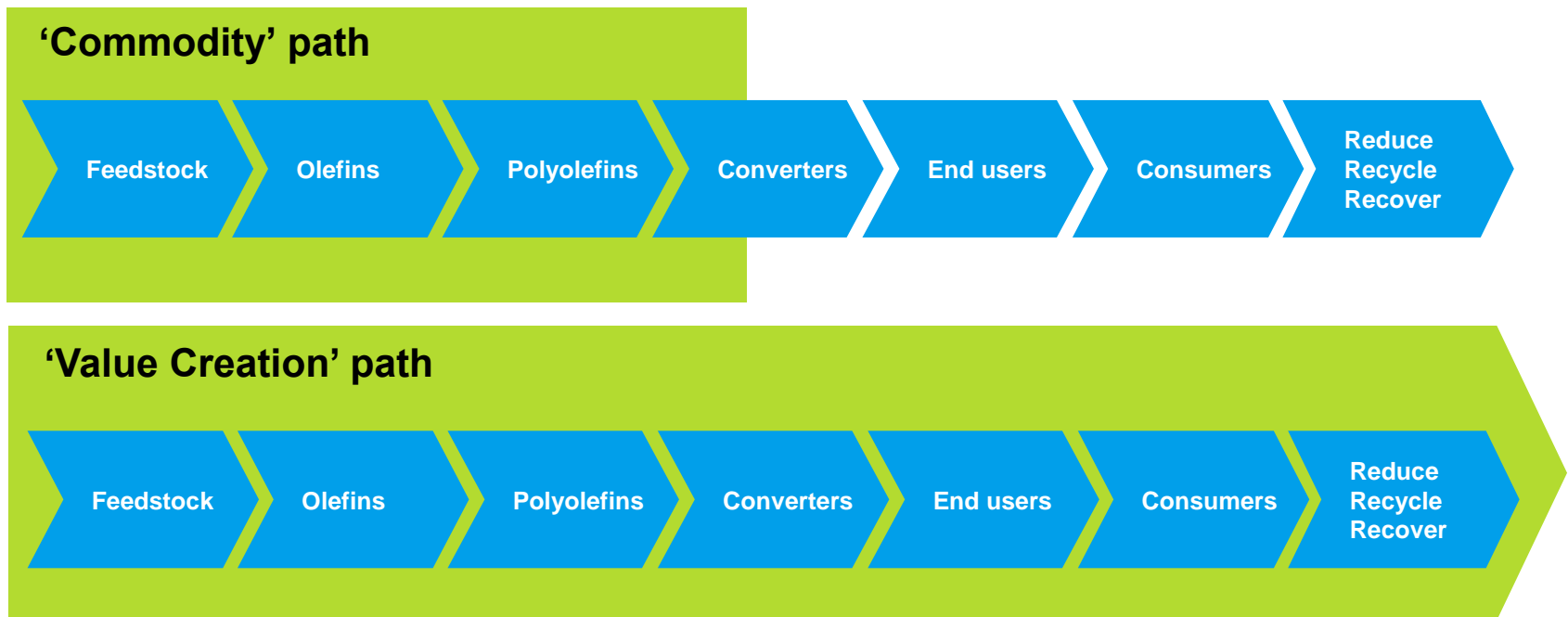


HE3450-H Performance in comparison with ISO 21809-1 Class B Requirements



Value Creation through Innovation results in continuous technological improvements

Borealis continuously invests in its people, the Borstar® and other proprietary technologies and working processes internally and with external partners.



Value Creation through Innovation – closing the cycle



Vienna, Austria | 15 December 2016

Borealis leading the way in promoting the Circular Economy for Polyolefins

“Borealis is committed to discovering and realising the opportunities presented by the circular economy, so we are pleased to be involved in both the PCEP and the New Plastics Economy,” says Alfred Stern, Borealis Executive Vice President Polyolefins and Innovation and Technology. “These initiatives will play an important role in bringing all stakeholders to work together to overcome the barriers to implementing a circular economy and achieve the European Commission’s 2025 target.”

Borealis group recycling products portfolio today



Dipolen®

Dipolen® is a polyolefin blend for use in either extrusion or injection moulding, either unmodified or treated with additives according to the customer's specifications.

Purpolen®

Purpolen® is a high-quality polyolefin recyclate available in a wide range of colour for the manufacture of products for demanding applications.

Daplen™ PCR

Combination of post-consumer recyclate (PCR) with high-impact PP grades and fillers for producing advanced compounds. Portfolio comprises three innovative materials combining high quality with improved sustainability.



Design for recyclability (DFR): plastic packaging recycling begins with design

- DFR is an important aspect of **eco-efficient design** which – on the basis of a **life cycle approach** – needs to carefully and intelligently **balance** the production, usage, and after usage phases of a product



Deploy HMS PP to replace difficult-to-recycle existing cup solutions

100% recyclable HMS PP foam developed for food service (cups), automotive, and construction



Full PE laminate to replace non-recyclable multilayer packaging

100 % recyclable full PE stand-up pouch developed in cooperation with various value chain partners

Summary

- Borstar® PE – Unique, highly versatile technology platform for a wide range of PE products
- Borealis Sirius Catalyst Technology - Key enabler for products with superior properties in the Borstar® process
- Borstar® proven capacity in a mega project
- Development of next generation Borstar® technology to further push the boundaries of product versatility and process performance.
- In depth understanding of the value chain from raw materials via polymer design to application properties and beyond
- Sustainability of Borealis polymer solutions as driver for future developments and differentiator in the polyolefins market.

Differentiation through innovation



**Borealis – taking on the challenges of tomorrow
for more than 50 years**



BOREALIS

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Contact: innovation@borealisgroup.com

Thank you

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