



LyondellBasell Technology: Advancing Possible

Steve Davis Licensing Manager - Americas

SPE International Polyolefins Conference

Houston, February, 2019

Presentation overview

- Introduction to LyondellBasell's Technology Business
- Market update / sustainability concepts
- Process technology update
- Catalyst technology update
- Conclusions

LyondellBasell delivers innovative products and solutions in five key areas



CHEMICALS

We produce the chemical building blocks for:

- automotive fluids
- furniture, household goods
- coatings, adhesives, cleaners
- cosmetics, personal care products



POLYMERS

Our versatile plastic resins are used to create a variety of products including:

- automotive parts
- packaging
- piping
- textiles
- renewable energy technologies
- agricultural films / irrigation
- healthcare
- food supply products



ADVANCED POLYMERS

Our diverse portfolio is used to create customizable products including:

- automotive parts
- differentiated packaging
- electronics / appliances
- construction materials
 - roofing
 - flooring
 - geomembranes
 - specialty pipe



FUELS

Our refinery in the U.S., produces:

- gasoline, fuel components
- low-sulfur diesel
- jet fuel
- lubricants
- oxyfuels that help improve air quality



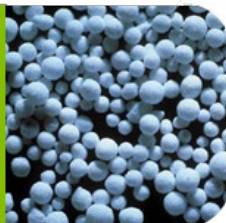
TECHNOLOGIES

We license our state-of-the-art manufacturing and process technologies:

- technologies that are used by chemical and plastics companies around the globe

Leading Catalyst Producer and Technology Licensor

Catalysts for PP and PE



- Leading provider of PP and PE polymerization catalysts
- More than 60 different *Avant* catalysts for broad set of applications
- Manufacturing locations in Italy, Germany, and USA

Licensing



- Process technologies for Polyolefins and Chemicals
- More than 280 polyolefin Licenses sold
- Introducing innovative technologies

Technology Services

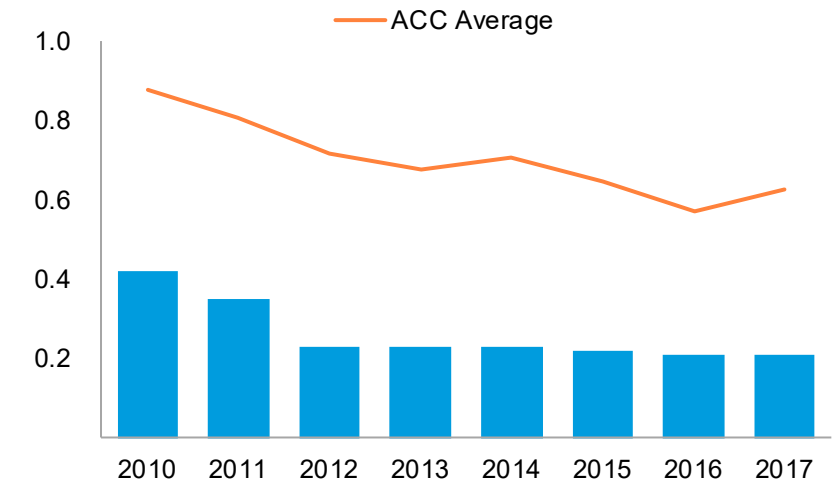


- High-level support in training, start-up, and safety reviews
- Continuous support for plant optimization and troubleshooting
- Supported by R&D sites in Italy, Germany, and USA

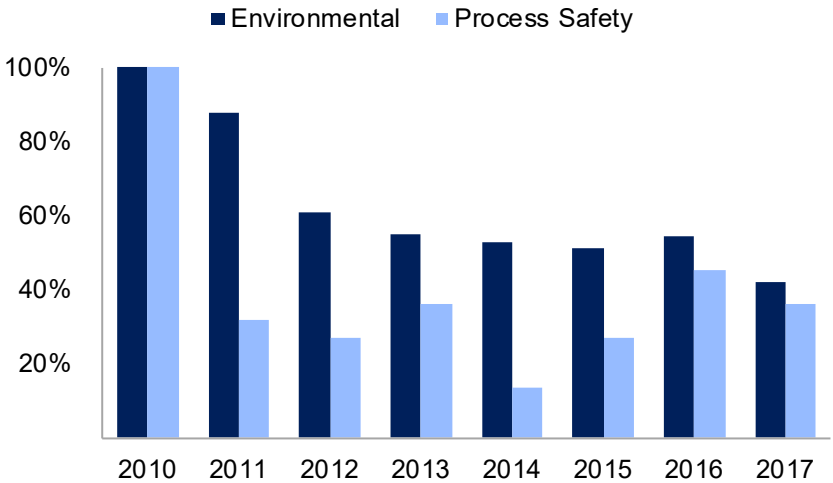
Continuous improvement of catalyst and process technology through innovation

LyondellBasell operates some of the safest, most reliable facilities in the industry

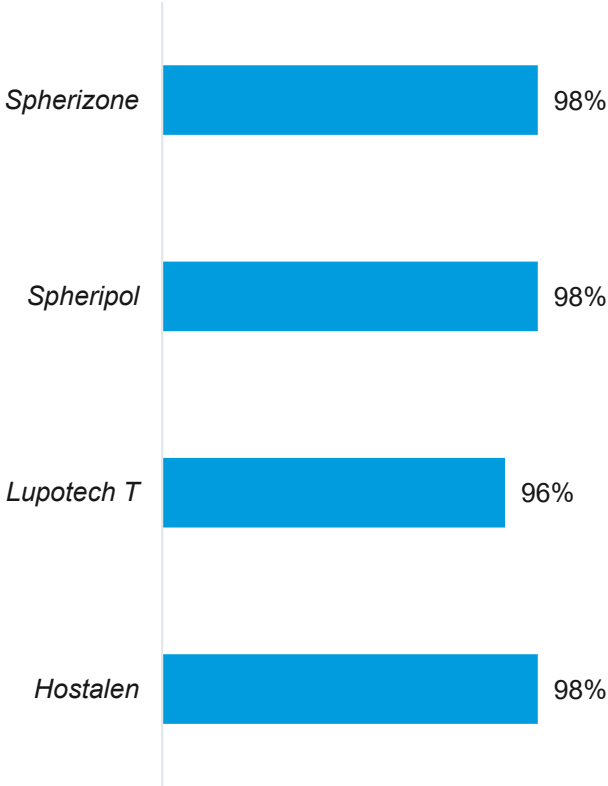
LYB Total Recordable Incident Rate⁽¹⁾



LYB Indexed Process Safety / Environmental Incidents



Strong onstream factors for polyolefin technologies ⁽²⁾

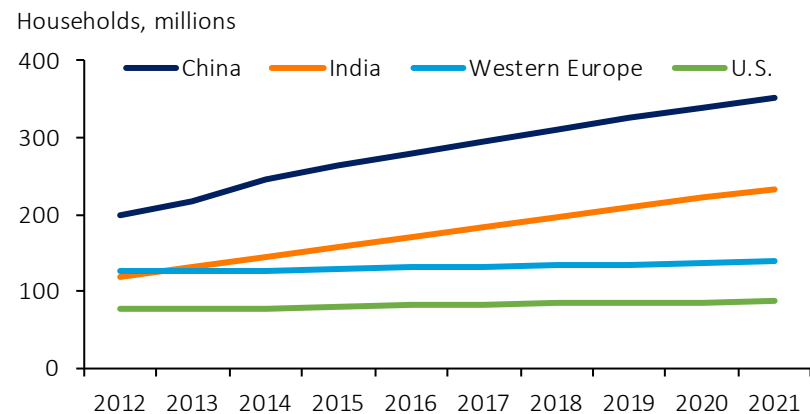


(1) Injuries per 200,000 hours. Includes employees and contractors. ACC is American Chemistry Council

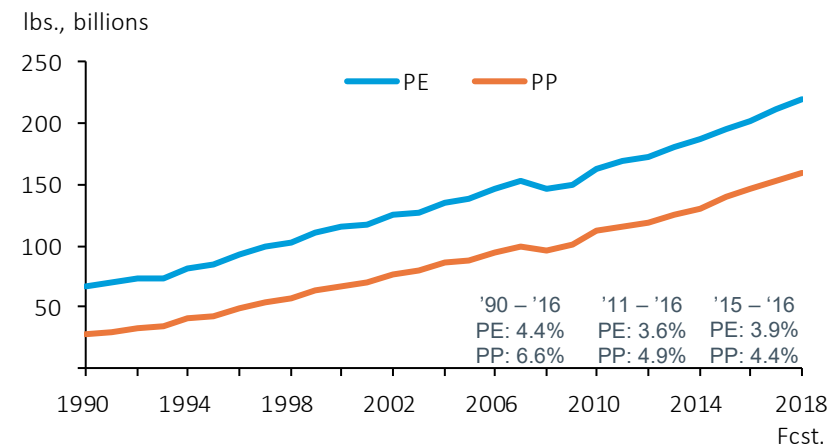
(2) LYB 2017 Benchmark survey. Excludes the impact of scheduled and unscheduled external shutdowns.

Global Macro Trends - Demographics Driving Demand

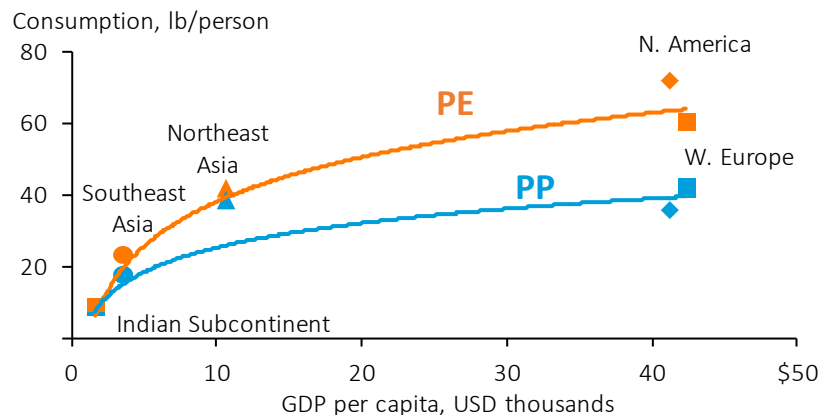
Upper/Middle Class Households



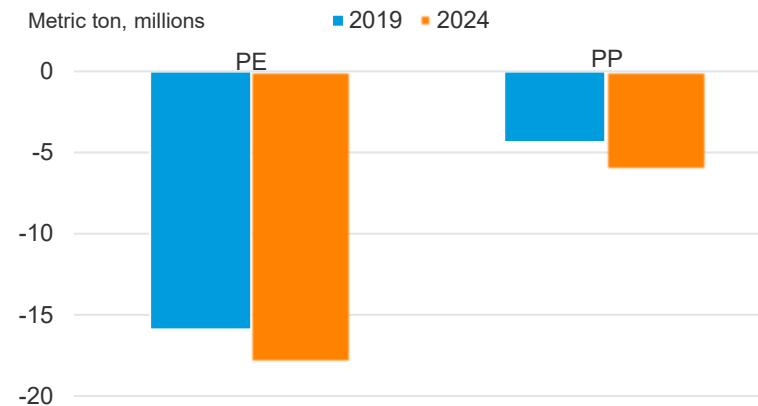
World PE and PP Demand



2016 Polyolefins Consumption



China Polyolefin Trade Deficit⁽¹⁾



Source: IHS.

1. China polyolefin trade deficit is production less domestic demand.

Key factors within the circular economy for plastics

Circular Economy

- In a circular economy, resources remain in use for as long as possible to extract their highest potential value



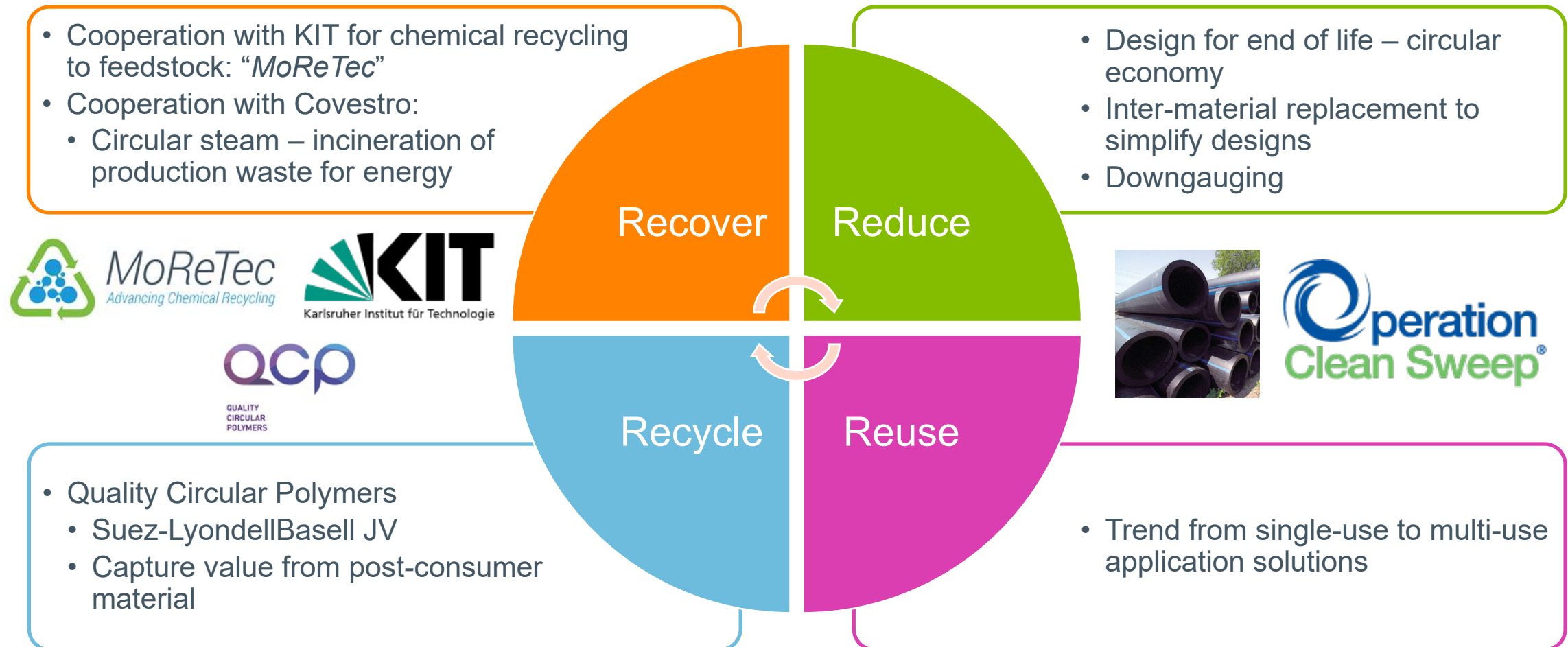
Source: European Commission

Market Drivers

- **Legislation (EU)**
 - **2018 EU Plastics Strategy**
 - **Packaging and Packaging Waste Directive** which sets a plastics packaging recycling target of 55% by 2030 which may include an element of reuse
 - **2019 EU Single Use Plastic Products**
- **Retailers, brand owners & consumers**
 - **World Economic Forum:** Companies working towards using 100% reusable, recyclable or compostable packaging by 2030
 - **Evolving consumer consciousness** concerning waste and recycling



LyondellBasell: Advancing the circular economy



Technology selection will play a strong role in the ability to deliver improved material properties required for the applications of the future

LYB licensing - A comprehensive portfolio of technologies for license

Polyolefins Technologies

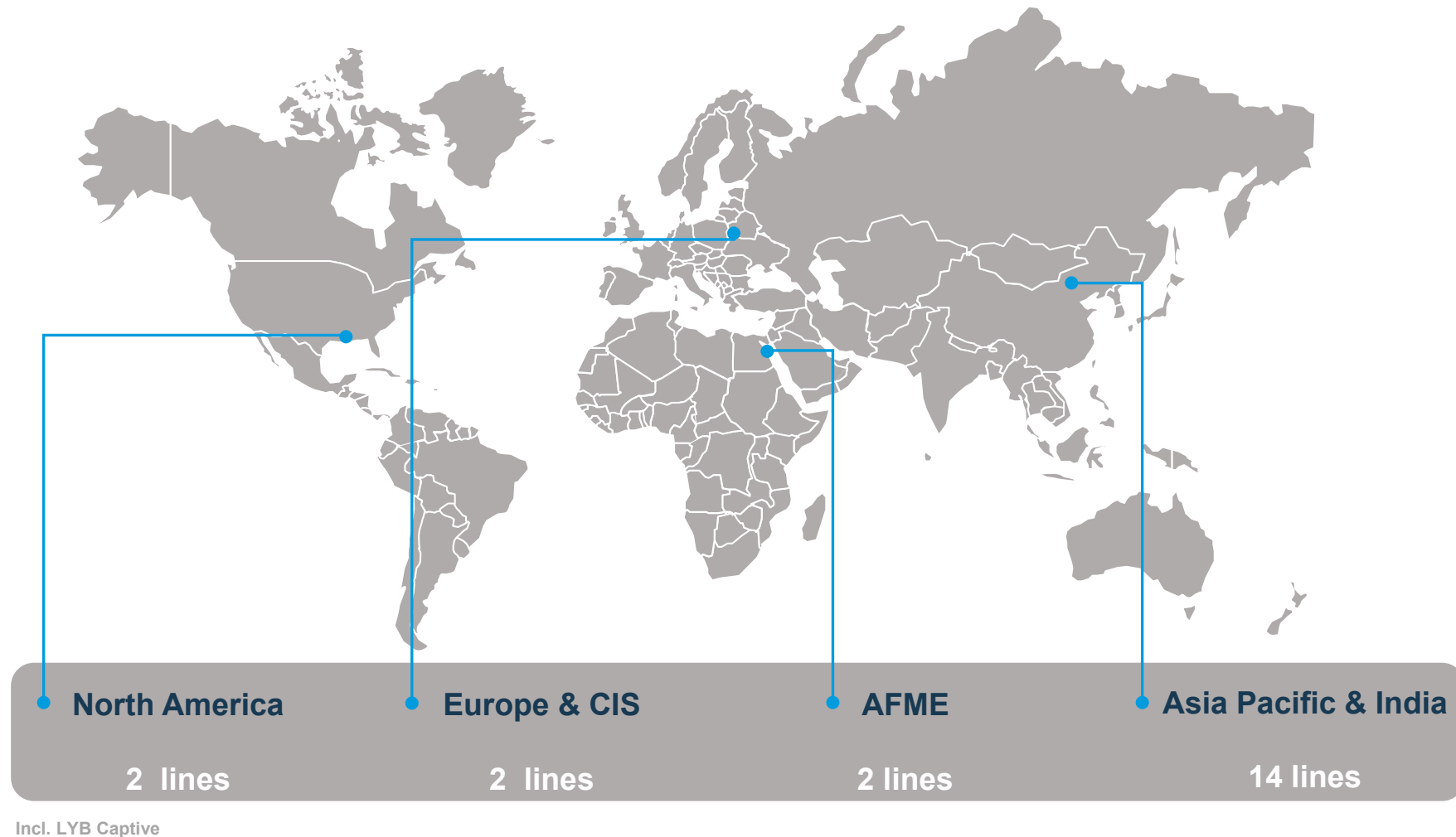


Cracking
Refining
Feedstock

Chemicals Technologies



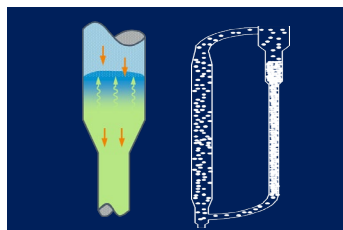
Spherizone – 20 lines licensed with a total capacity of 6.6 million MT/a



Unrivalled industry experience with recent licenses such as Zhejiang Petroleum (ZPCC) and Liaoning Bora

Spherizone – The breakthrough PP technology

Unique Platform



“N” in 1
Multizone
Circulating
reactor

**Lowest
CAPEX & OPEX**
for multi-modal products

Added Value Portfolio

**3 Unique
families**
Homo-Raco, dual-
Raco, Soft HeCo



**Inter-material
Replacement (IMR)**

Performance Products



45%
Weight Reduction
for novel Pipe
grades

**Increased
value in use**

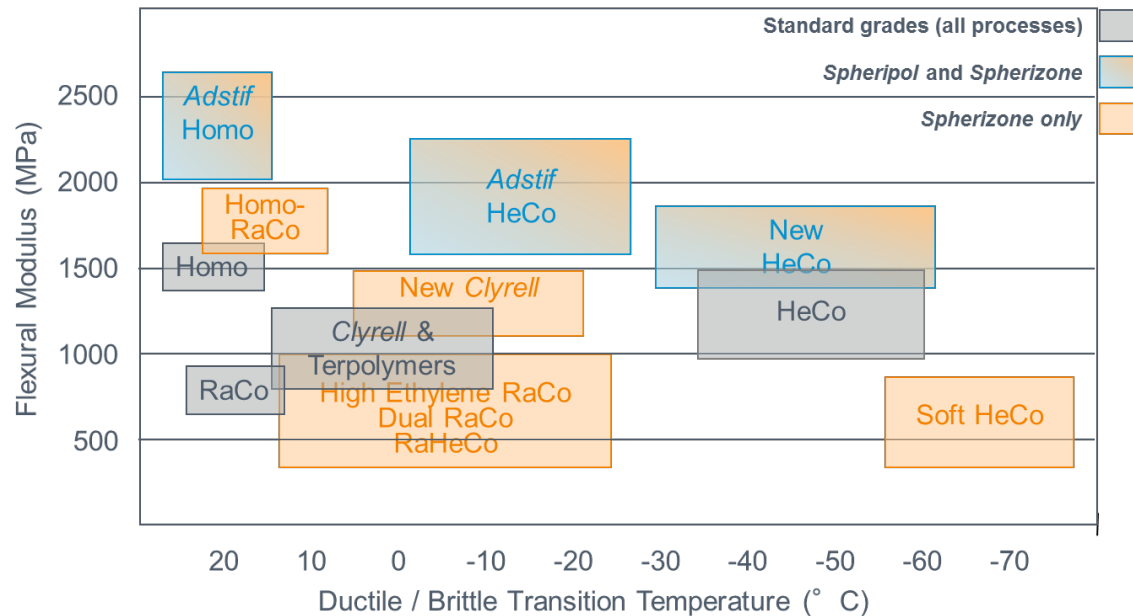
Operational Excellence

97%
Average Prime

>200
average
transitions
per year

**Reliable with efficient
transitions**

Spherizone – Delivering high value products



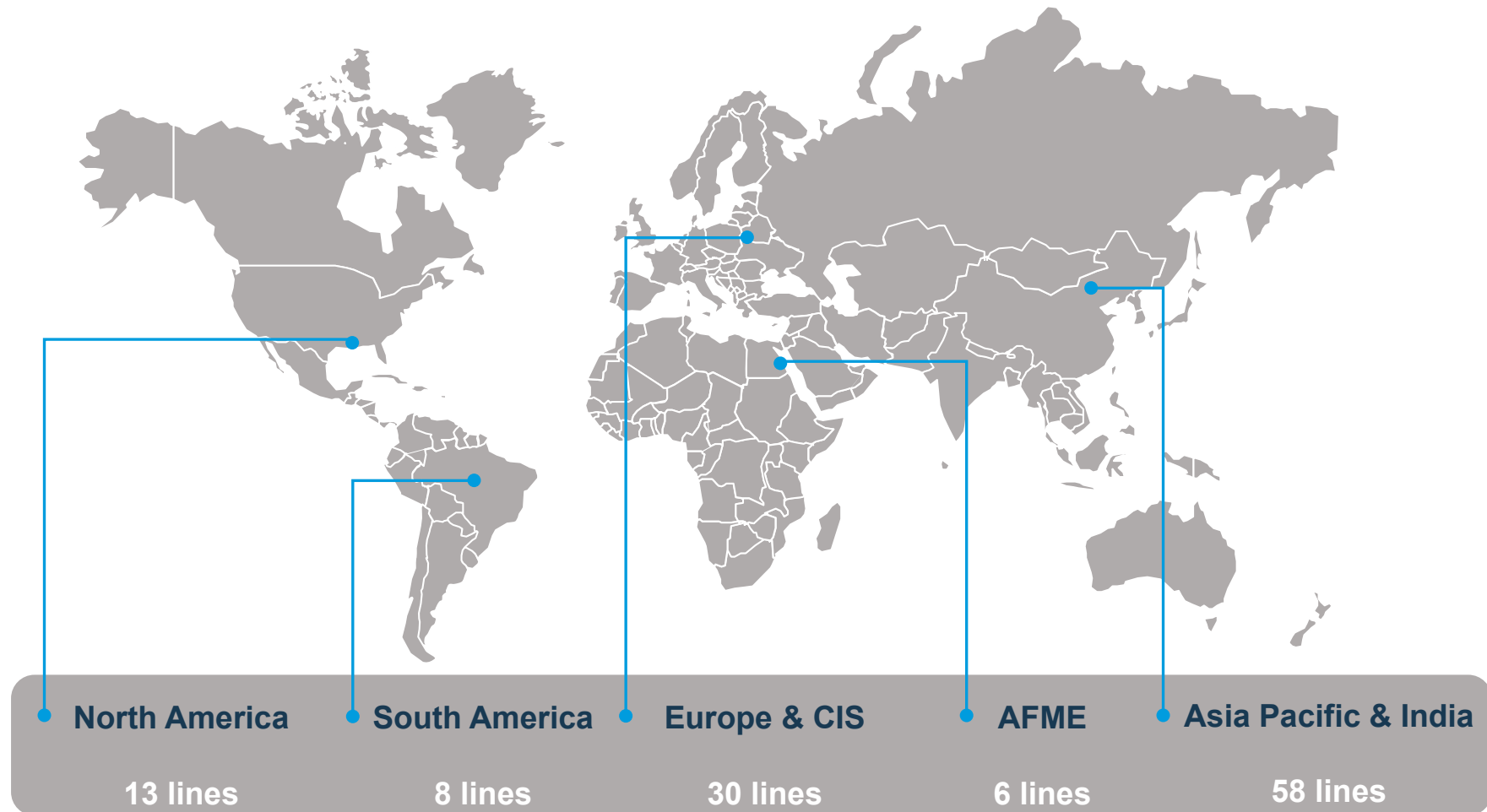
Significant opportunities for high performance products in automotive industry, ready for a new generation of “new energy” vehicles

Examples of customer benefits:

- Better fluidity: less energy consumption in converting and higher efficiency
- Better processability: multi-layers, multi-functional and bigger dimensions of products
- Better impact/stiffness balance: replacement of engineering plastics, such as ABS and PC
- Better transparency: clean products for medical applications; replacement of PVC, PET and glass
- Better low temperature impact: extending to elastomer

Enabling product differentiation to meet current and future customer requirements

Spheripol – 115 lines licensed with a total capacity over 25 MM t/a



Incl. LYB captive, scrapped lines not included

Recent licenses include: Qingdao Jinneng New Material and Ulsan Polypropylene Co., Ltd. (UPP)

Spheripol – The Benchmark PP Technology

Advantaged Economics

Best
class monomer
efficiency

12%
Lower
electricity
consumption

Benchmark Products



1st
installed
capacity

World Scale

600 kta
Largest single
line capacity



Operational Excellence

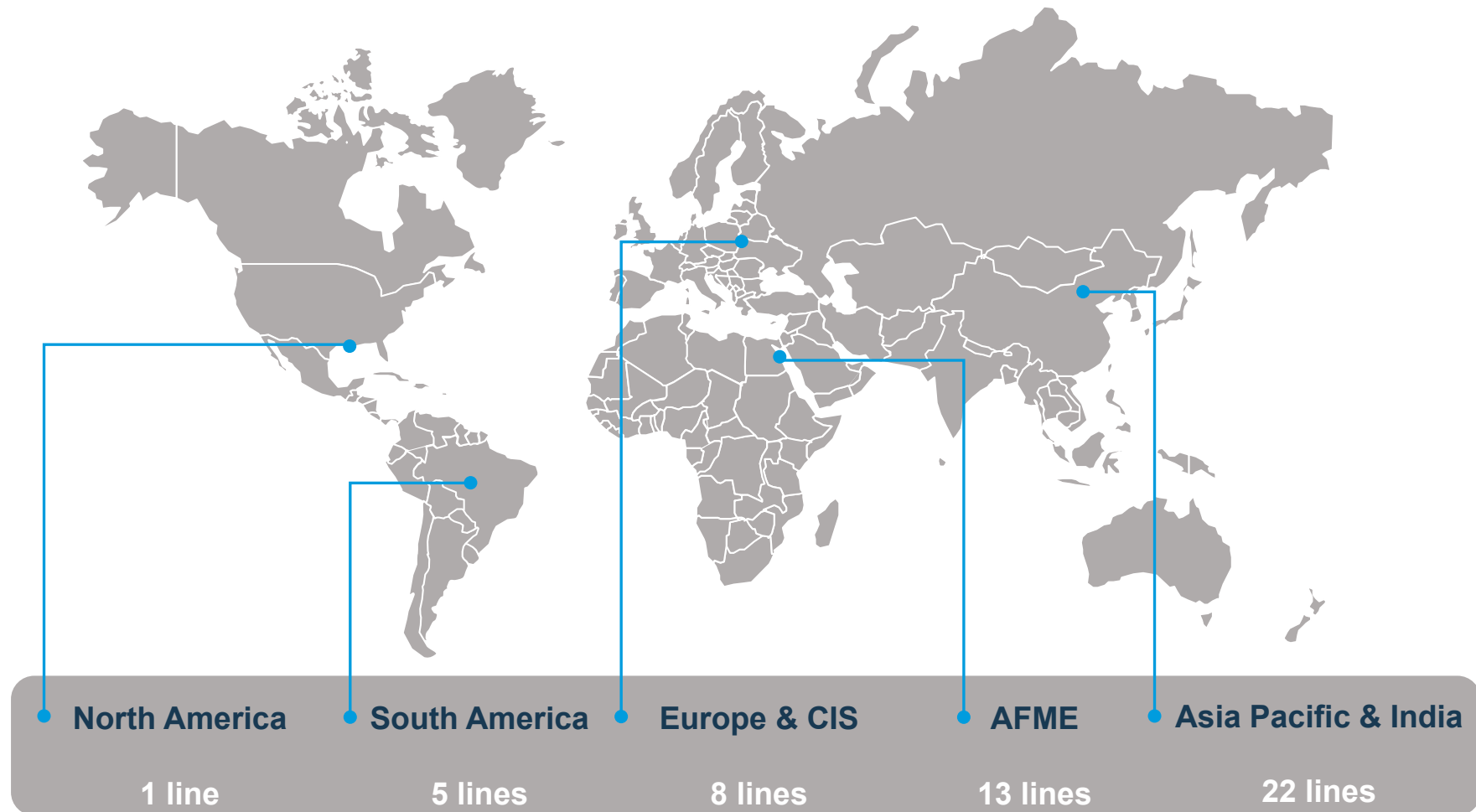
**Robust &
Reliable**

>100
Production
lines in
operation

Source: 2014 Industry
consultant data / LYB
analysis. Calculation vs.
average

Leadership Through Five Generations – Optimized for the Future

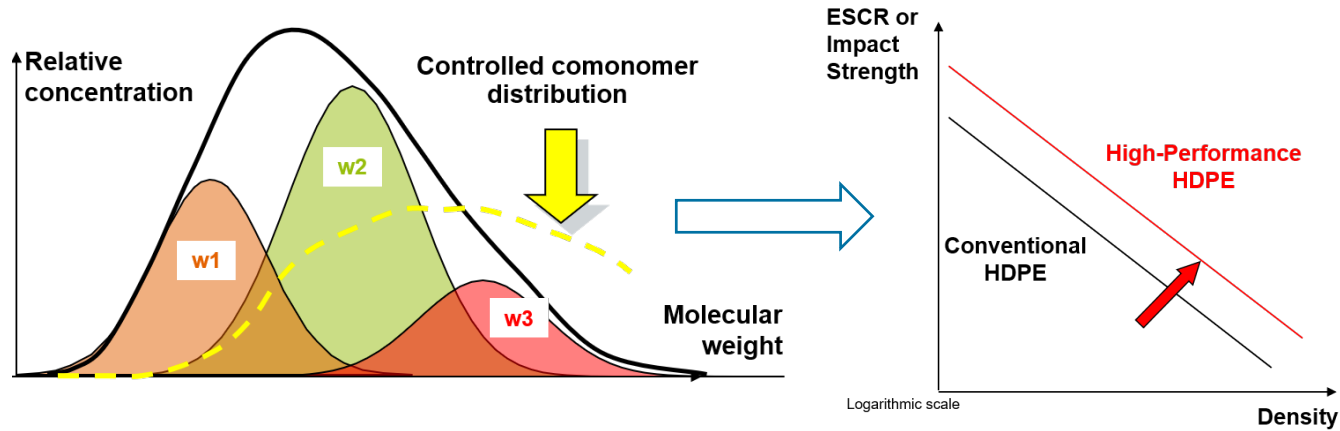
Hostalen – 49 lines licensed with a total capacity over 11 MM t/a



Incl. LYB captive, scrapped lines not included

Recent licenses include: Sinopec SK Wuhan and Zhejiang Petroleum (ZPCC)

Hostalen ACP - Providing products for high-performance HDPE applications



- ❑ Multimodal HDPE platform
- ❑ High Performance products
- ❑ Robust Process
- ❑ Operational Excellence

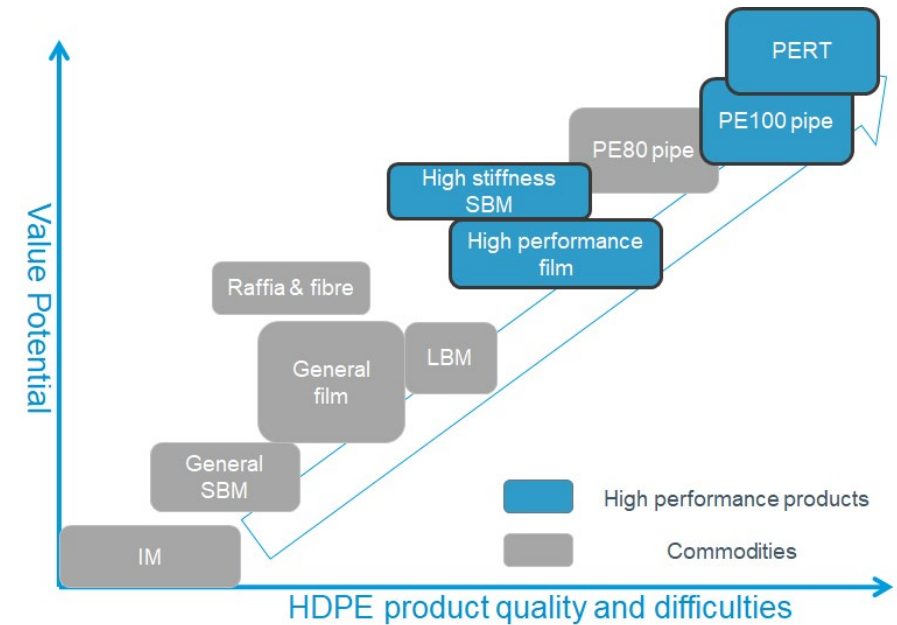


Enhanced stiffness/impact balance allows higher efficiency in HDPE applications

- Downgauge – weight reduction in packaging, SBM & film
- Higher performance – PE 100 pipe
- Extended territory – PERT for heating system

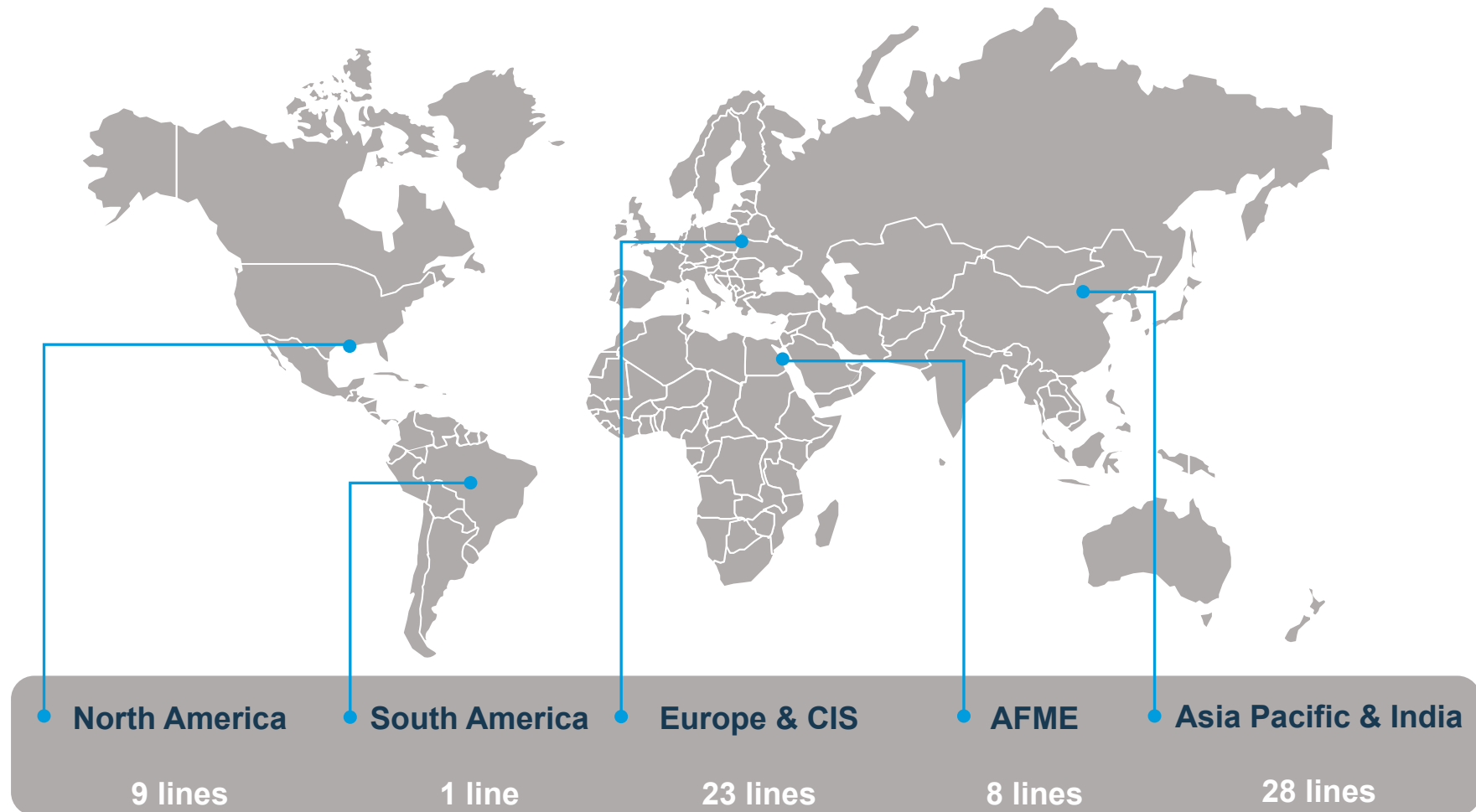
Added value through

- Downgauge – reduced material and energy cost
- Higher performance – PE 100 pipe and PERT
- Improved processability – higher productivity



Flexible and versatile technology for high-performance HDPE products

Lupotech T&A – 69 lines licensed with a total capacity over 11 MM t/a



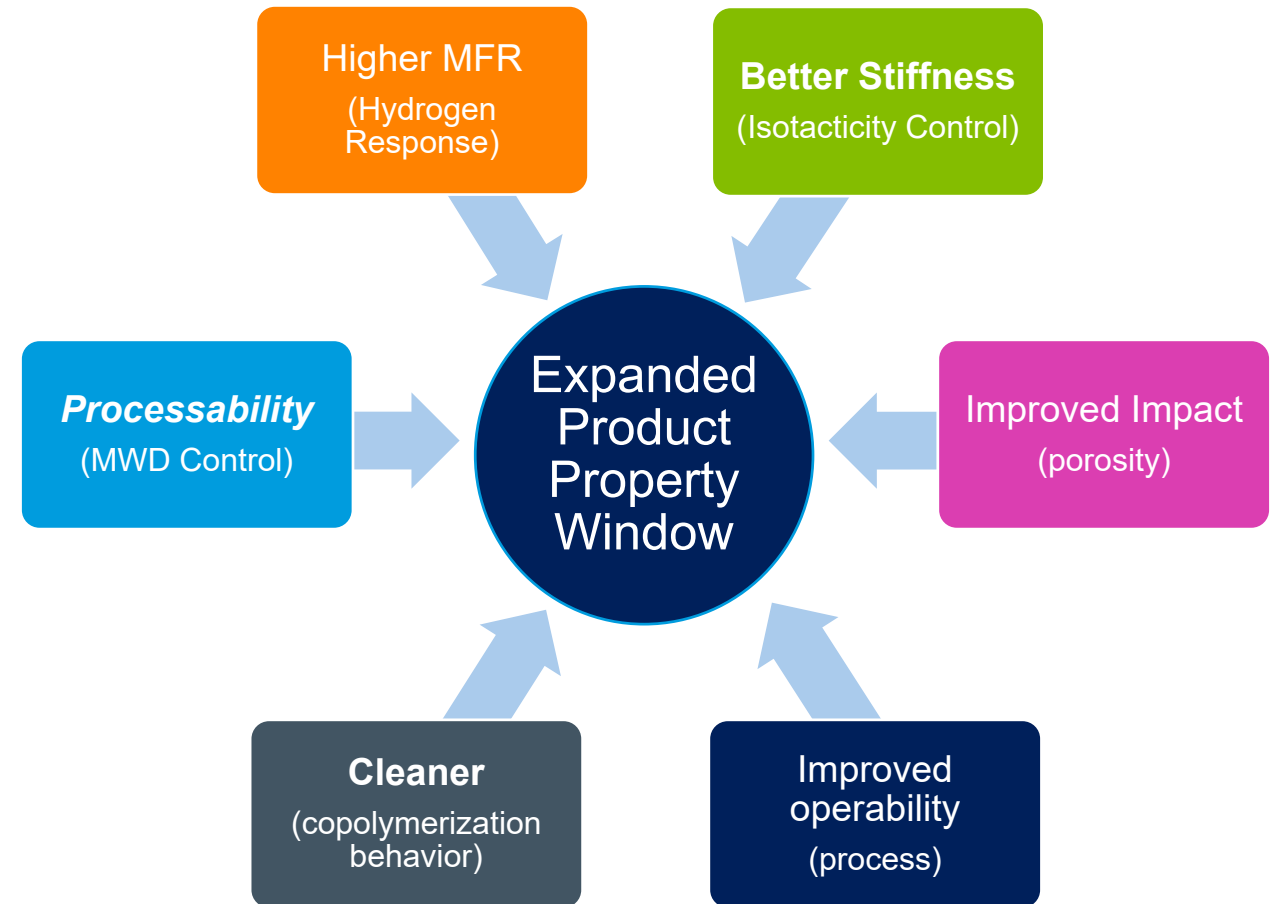
Incl. LYB captive, scrapped lines not included

Including latest licenses for Xinjiang Tianli Gaoxin, PT Chandra Asri Perkasi and ZPCC

Lupotech – At the Forefront of LDPE and LDPE/EVA Technology

The Foremost Process	Tubular reactor weight savings up to 40%	Maximizing energy recovery	Innovative peroxide dosing	Lowest CAPEX
Leading Economics	Lowest energy consumption	Lowest utility consumption	Lowest chemical consumption	Lowest OPEX
Configuration Differentiation	<i>Lupotech T</i> Tubular process VA% up to 30%	<i>Lupotech A</i> Autoclave process VA% up to 40%	Product differentiation Acrylic-modified copolymer available	
Operational Excellence	Market leader 11mln tons of licensed capacity and >40 lines in operating	RTO to ensure emission meeting the strictest requirement	Reliable, Safe and Environmental friendly	

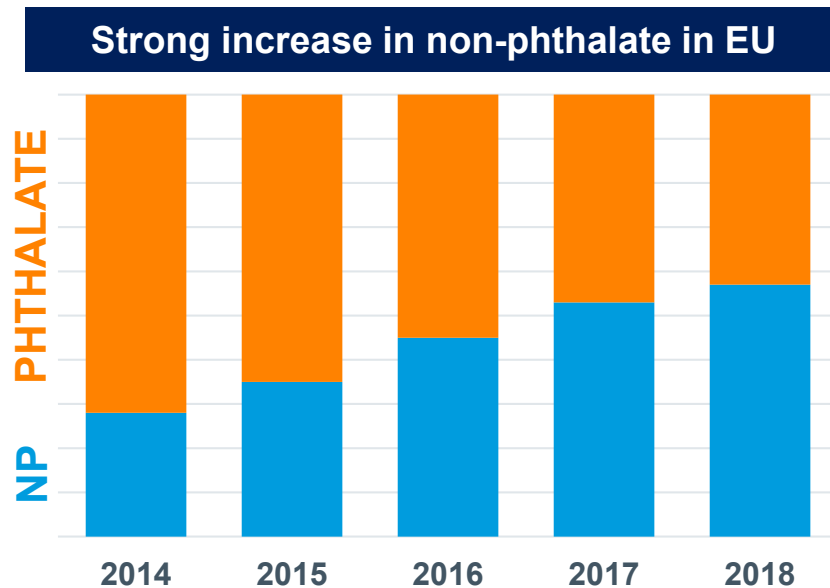
- **Long tradition of investment and innovation combined with latest innovations:**
 - High yield & high H₂ response production
 - Covering from narrow to broad MWD
 - Full range of PE and PP products
 - Available for broad range of slurry, gas phase and bulk technologies



***Avant* catalysts enable customers to improve and differentiate, in LYB and in 3rd party technology**

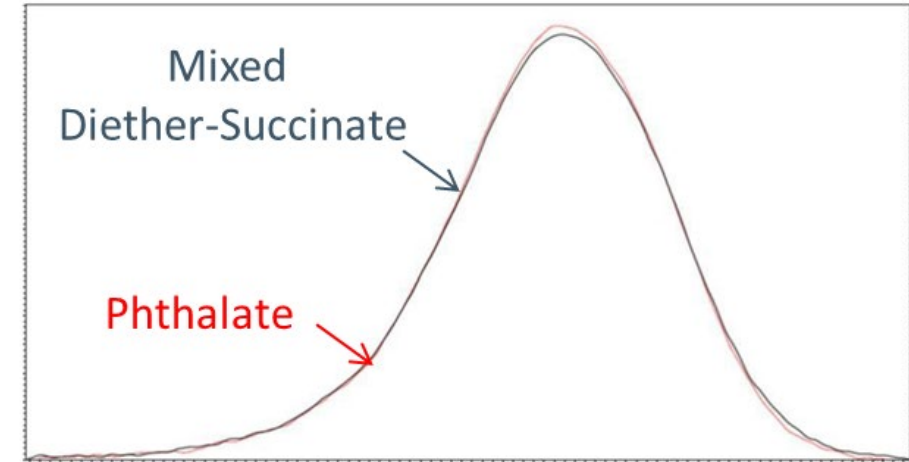
Avant catalysts – Phthalate alternatives

- LyondellBasell has introduced a new family of Avant PP catalyst: non-phthalate, but phthalate-like
- They exhibit strongly improved activity, hydrogen, and donor response
- Products are rheologically very similar to phthalate based-products



Americas market is following the increasing trend in non-phthalate catalyst usage driven by brand owners and converters

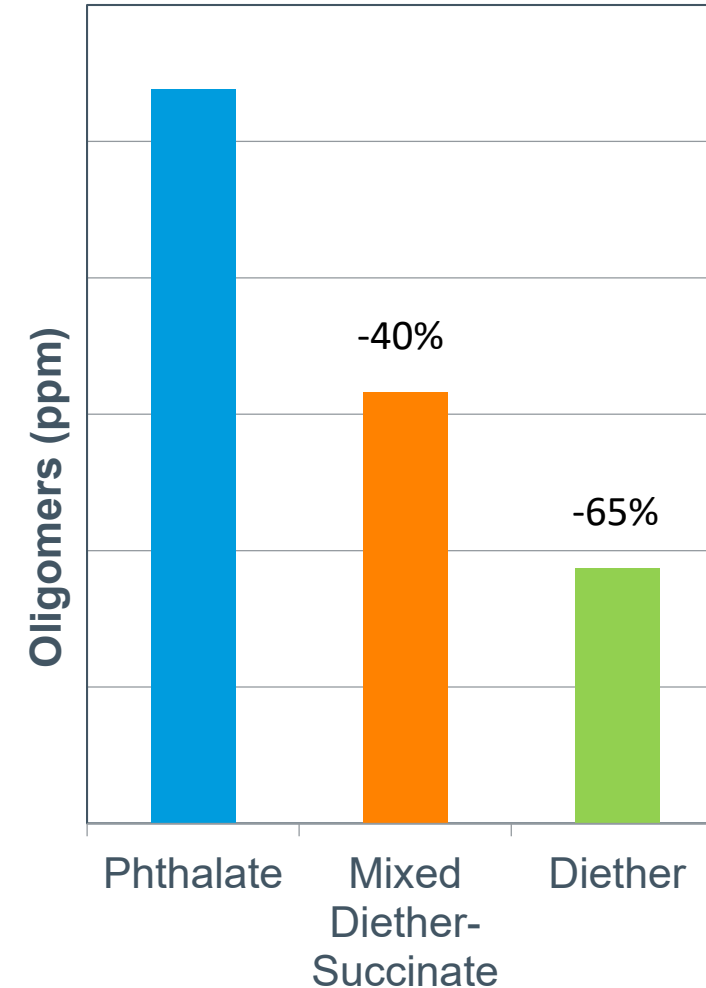
Comparison of Molecular Weight Distribution



- Customers use the new catalyst as a drop-in replacement of incumbent solutions, taking advantage of reduced C-emissions, and a widened product window
- In 3 years time, the majority of the European PP market converted to this non-phthalate solution

LyondellBasell 5th Generation Catalysts - Enabling cleaner, higher value products

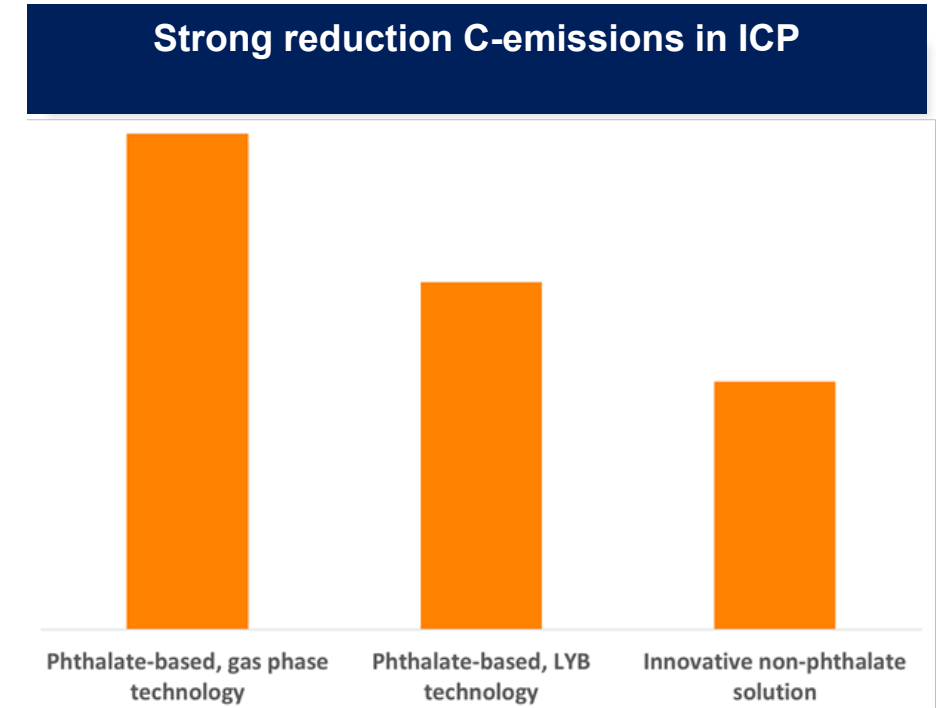
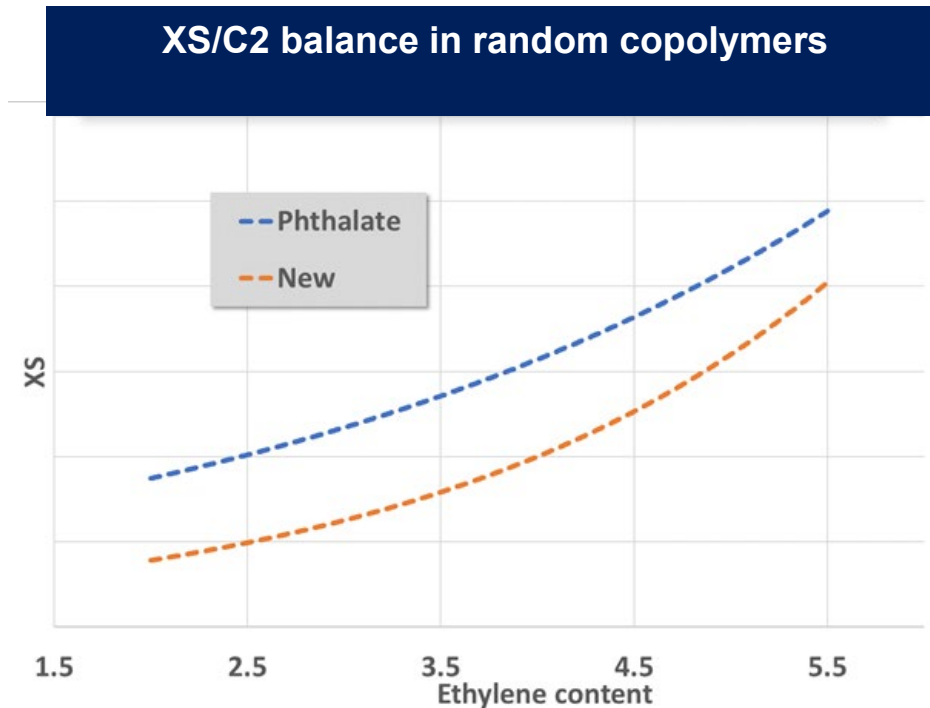
- **Oligomers and volatile organic compounds (VOC) reduced by 40-65% with use of 5th generation catalyst**
 - Example of as-polymerized impact copolymer 50 MFR, 18% rubber
- **Higher MFR targets without need for peroxides deliver improved organoleptics**
 - Improved hydrogen response of 5th generation catalysts as enabler
 - Higher stiffness maintained
- **High catalyst yields for reduced ash content and efficient production**
 - Enabling additive optimization



Source: LyondellBasell

Innovation - Delivering Cleaner and Better Polypropylene resins

- **LyondellBasell launches a new family of Avant catalysts**
 - Highly stereospecific homopolymers (4m pentads via NMR around 99%)
 - Unprecedented Ziegler-Natta randomization in random copolymers
 - Strong reduction in C-emissions in impact copolymer (ICP) grades
 - Increased melt flow, improved impact/stiffness balance ICP grades
- **Industrially launching in 2019**



Summary

- **Robust polymer demand anticipated globally driven by demographic megatrends**
- **Application design for life cycle: inter-material replacement and new material requirements**
- **Improving the end of life value chain: higher value recycling, chemical recycling**
- **LyondellBasell's process technologies**
 - More sophisticated manufacturing platforms such as Spherizone will best position companies to deliver innovative grades to meet the challenges of the future
 - Improvements in efficiency and reliability
- **LyondellBasell's catalyst technologies**
 - Proven 5th-Generation catalyst families with differential performance
 - A new innovative catalyst family which will deliver breakthrough performance for cleaner products
- **Long term technical support to licensees under Technical Service Agreement (TSA)**

Appendix

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