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BIO: From concept to reality.

A closer view of the polyester industry. Sustainability accelerates with promising profit.

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World Bio Market
Barcelona
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About Tecnon OrbiChem

Tecnon OrbiChem has been a world leader in providing data and analysis to the petrochemical industry since 1976. We are now one of the world's foremost marketing consultancies to the bulk chemicals, petrochemicals and plastics industries. We specialize in Chemical Intermediates, Synthetic Fibres and Resins.

Third-Party Independence and Neutrality

Tecnon OrbiChem provides independent, third-party, expert assistance to chemicals producers and consumers, financial institutions and government agencies on projects and strategic issues. Our Individual Project Studies team advises customers on planning, marketing and market development, product diversification, mergers and acquisitions or divestments.

SOLUTIONS

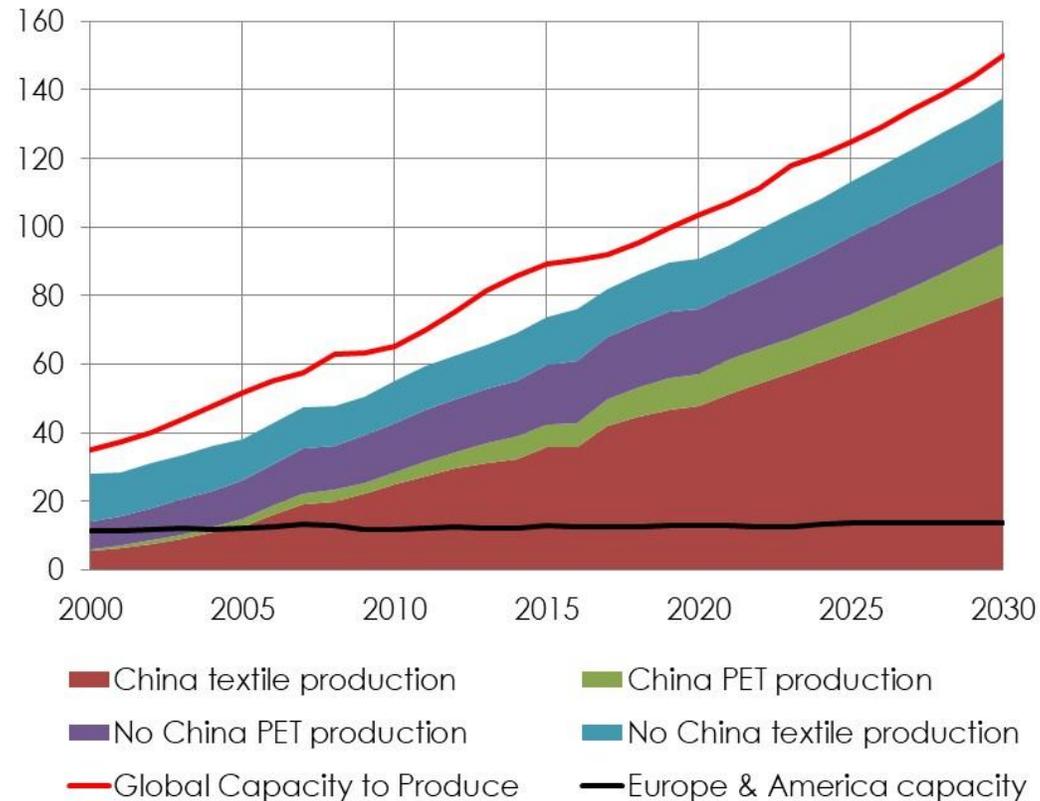


- Monthly Consultancy Reports
- Historical Prices
- Plant & Project Reviews
- World Market Surveys
- Plant Data
- Historical Demand Data

Polyester Global Overview

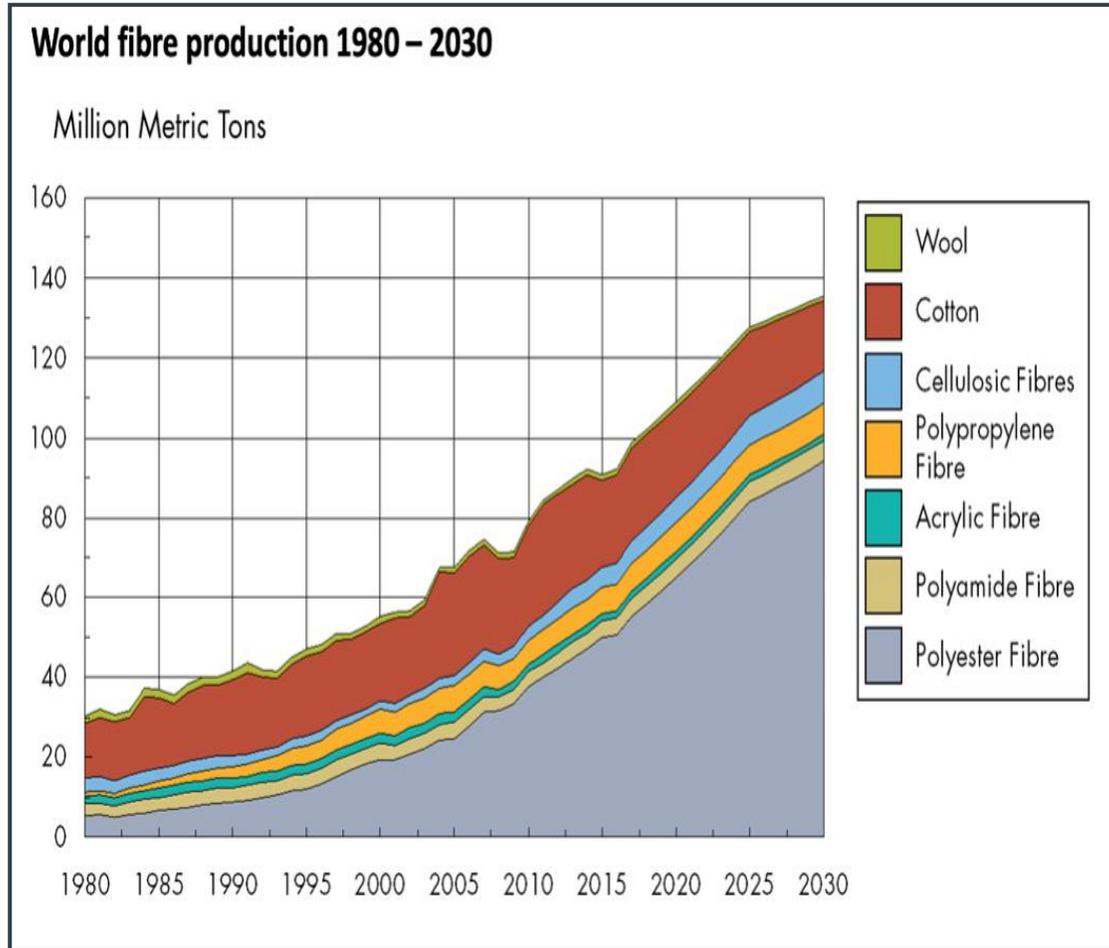
World polyester capacity and production 2000-2030

Million Metric Tons



- Enough global capacity for any demand level. This is the case for all products in the chain (PX, PTA, MEG, PIA, PET). PES the material of choice for some applications. Technology is available and very efficient.
- The polyester market is driven by China (produces about 65% of total polyester) and textiles/fibers (accounts for 65% of polyester production).
- Rest of the world, America, Europe and Middle East are “relatively” important, mainly in packaging and “followers” on raw materials settlements.
- Trend to integration continues with different drivers (cost/value)
- Is this the end of globalisation?
- Companies that think globally, act locally and take advantage of cost/value integration and multi-regional presence.

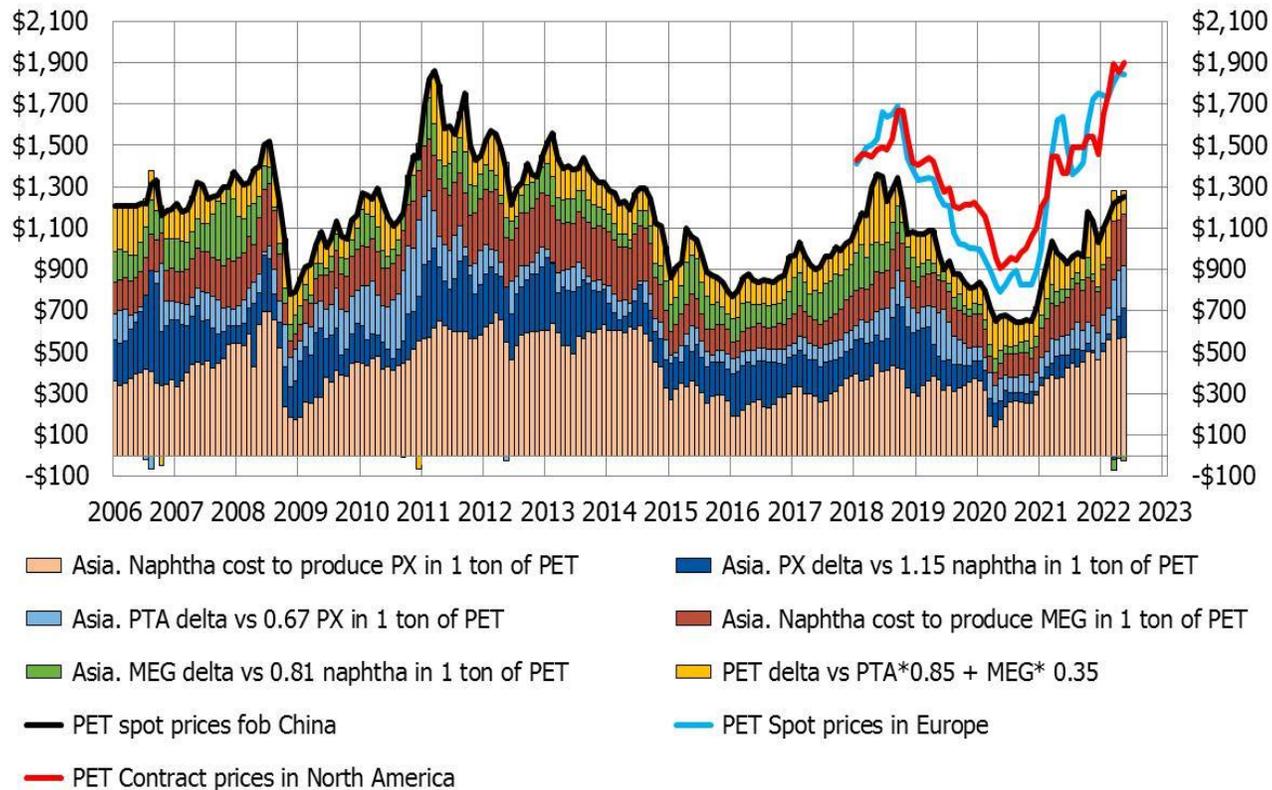
World Fibre Production



- Fibres expected to growth in line with GDP.
- Despite the strong push towards sustainable materials, synthetic fibres will continue to dominate (polyester).
- Different ways to approach sustainability.
 - Cellulose: fastest growing fiber group and bioeconomy's largest investment sector.
 - Polyester: recycling (fight for the feedstock) and bio.
 - Polyamide: bio-PA6 or bio-PA66 are difficult (Bio-based PA5X). Recycling is currently the best approach.
 - PP: Bio-naphtha (mass balance) or recycled.
- Supply disruptions, circularity, new feedstocks, production schemes and others benefit and encourage regional industries. Trend supported by brands and new technologies.
- China/Asia will continue to be the textile factory. Exports of finish products.

Cost/price dynamics. Global overcapacity, regional tightness

Analysis of the PES chain in Asia since 2006 PET prices in Asia, Europe and the US 2017 - 2022



- Complexity of the polyester chain in terms of prices (cost follow crude oil Brent value).
- The packaging/textile industries are placed between upstream volatility with daily/monthly prices and fix prices required by distribution.
- Prices in Europe and the US follow Asia + freight + Supply/Demand + others.
- The “disparity” with Asia increased in 2021-2022 (demand and logistics) leading to extraordinary results for polyester in Europe and America.
- There has been a lack of enough fossil feedstocks to operate PET at full capacity in 2021-2022.
- There is a lack of new feedstocks (recycled and Bio-feedstocks) for polyester.

2019 vs. 2022: What Changed?

Multiple disruptions

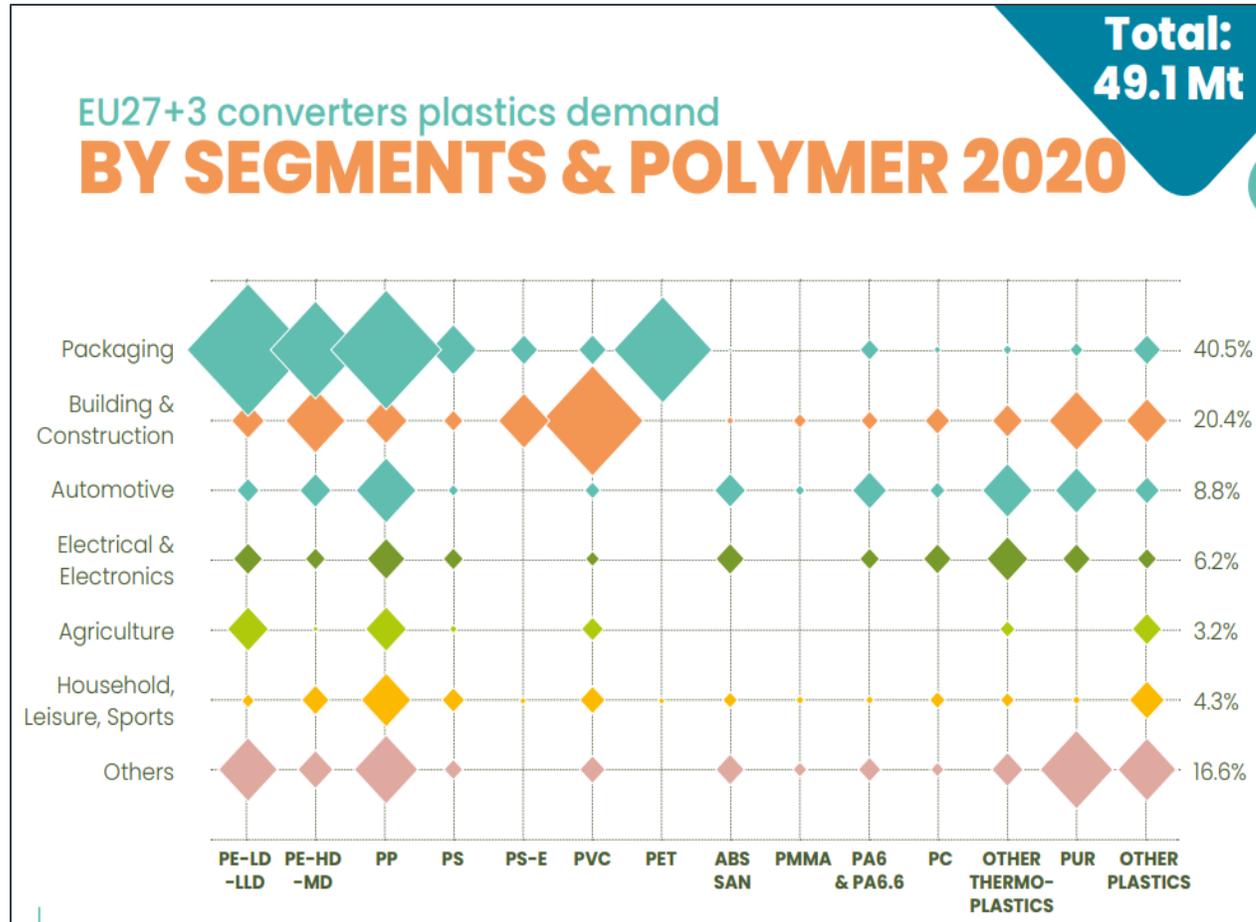
- Supply of chemicals, polymers and others (natural disasters, Covid, legislation)
- Demand (Covid & consumer habits, economic growth, E-commerce, ..)
- Logistics impacting trade
- Crude Oil Brent, cost/availability of energy, gasoline markets.
- Impact on cost/price (margin)
- Technology: EV, Digitalization, Blockchains, 3D printing, Artificial Intelligence

PEOPLE
PLANET
PROFIT

“If we want things to stay as they are, we need to change everything”

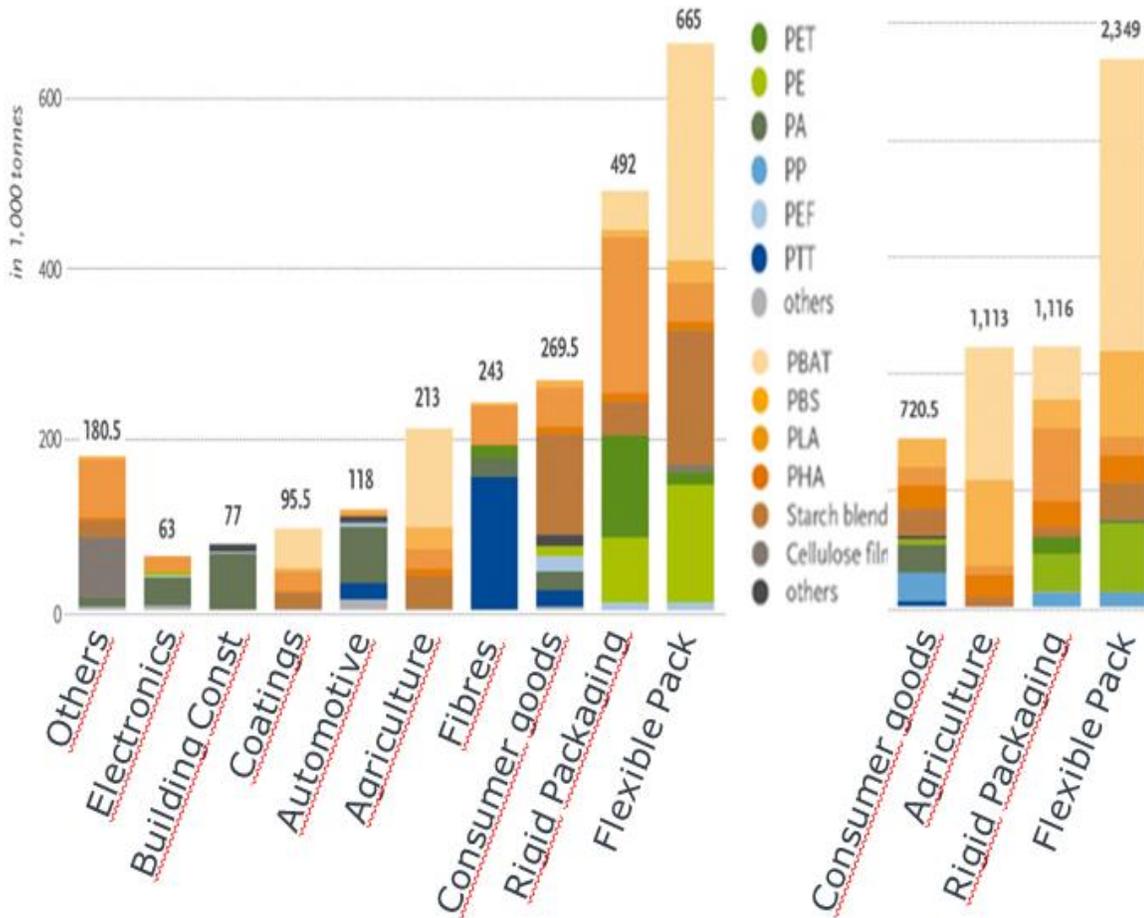
- Trend to sustainability has been accelerated (Climate, circularity, ESG).
 - Sustainability is a priority for companies, consumers, policy makers and investors (green financing).
 - From concept to reality.
- Globalization vs Regionalization (Logistics and supply chain disruptions accelerates the previous trend (trade war China-US) that continues (super fund in US 2022)
- Plastic consumption will continue to grow (oversupplied)
 - Higher % of oil consumption
 - Petrochemical investments in COTC

Dynamic Markets for Polymers Into All Applications



- Importance of packaging for polymers (above 40%) and almost exclusively for PET.
- Strong performance of packaging in 2020-2022
- Polymers have been fighting each other, as well as other packaging alternatives (aluminium, glass, tetra, paper) with the claim of being a more sustainable material.
- Polyester has increased market share
- Recycling
 - provides an alternative feedstocks that impact production schemes of PET, convertors.
 - Recycled is limited by consumption, collection system, technology.
 - reduces overall virgin polymer consumption, and it is used by producers to leverage sales.
- The fight for the feedstock impacts the supply chain of different segments (fibre, Film).

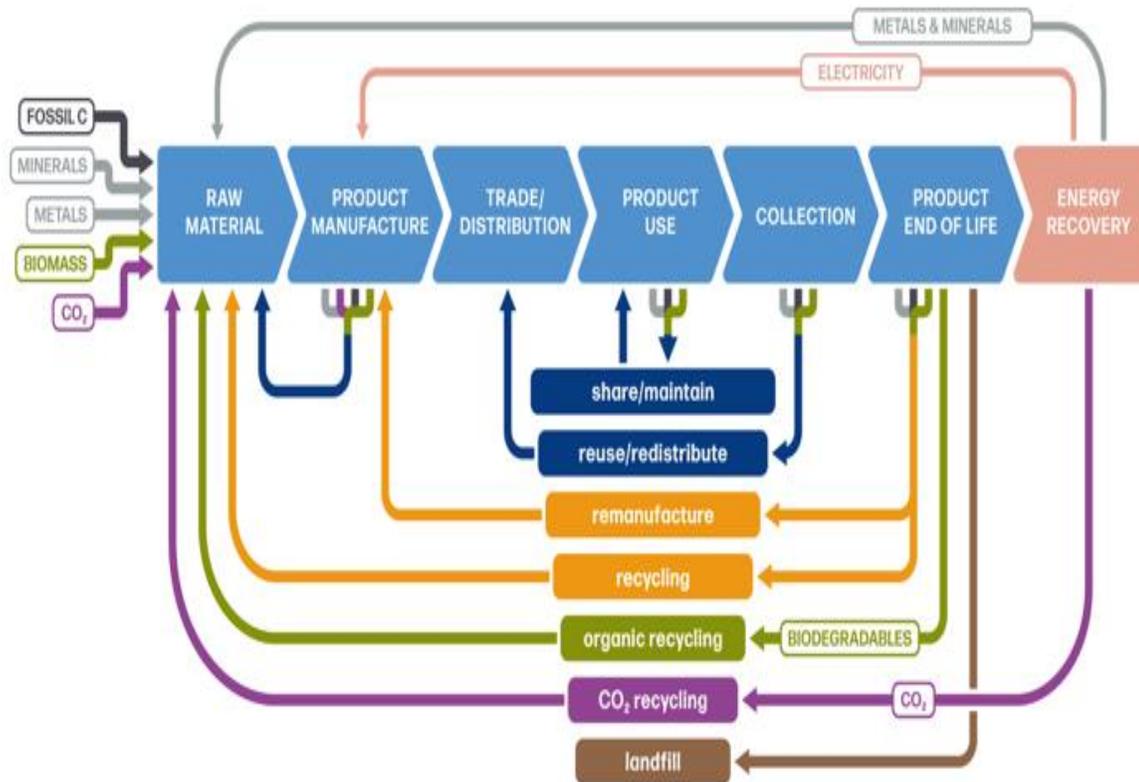
Dynamic Markets for Polymers Into All Applications



- Plastic consumption is growing and sustainability accelerates commitments, legislation, new packaging requirements, new products.
- Market very dynamic market, with continuous R&D and the need to provide solutions to current and future needs.
- The goal is to have products that provide value, good performance and environmental benefits.
- Consumption of “ready to use” products (PLA, PBAT) has increased, and new projects (Bio-PX, PHA) and technologies have accelerated. Ej. Packaging.
- Biopolymers affected by disruptions similar to those of fossil polymers. Ej. Volatility in demand (legislation, China)
- Using new or existing production schemes (mass balance)
- Trend to bio-based
- Price premiums helped by regulation, strategies and value.
- Infrastructure (recycled, compostable), education, benchmarks and metrics (LCA, others) are needed.

From Linear to Circular Economy

Comprehensive Concept of Circular Economy



- How to approach and implement sustainability (climate change, landfill, ...) has become a priority for governments, institutions, policy markets, brands, producers, legislators, consumers.
- Many participants involved and not standard solutions.
- The nature and supply/demand of the new feedstock (recycled and bio), but many other aspects, is a change from a global, commoditized and cost-oriented approach to a local, customized, cooperative and value-oriented scenario.
- The new model affects all activities of the company. Change in strategy, actions, mindset of companies (new values, new leaders)
- This is a way to differentiate and create additional value for regional producers (opportunity).
- Need to create strong and efficient circular chains.

How Polyester Companies Approach ESG



How Polyester Companies Approach ESG

- Importance of ESG targets (sustainability and others)
- Supply Chain transparency (commitments, traceability, ...). Financial and ESG results.
- Need for reliable, trustful certifications and metrics.
- Feedstocks
 - Market participants working in many different projects at different levels
 - Development in different/same steps of the chain will impact alternative options
 - Expansion of mass balanced will allow the integration of recycled and renewable materials in the existing production. Interim or definitive solution, but need a defined procedure and calculation methodology
 - Recycling as the short-term solution for polyester
 - Change the normal industrial schemes. Integration to bales. Polymer producers, convertors, bottle/fibre companies involved in recycling (mechanical, chemical, advanced recycling, waste-based feedstocks)
 - Fight for the new feedstocks change the way fibre/film/sheet approach sustainability
 - Bio based feedstocks and the goal of a 100% plant bottle by brand owners and technology. Technology, industrial scale, economics, and operations (chemical companies as convertors) need to be resolved.

Projects Aromatics and Glycols

2022 Status of Bio-MEG Commercialisation

Company	Location	Capacity (tpa)	Products
Avantium	Netherlands	10 (pilot)	MEG, MPG
Avantium/Cosun JV	Netherlands	TBD	MEG, MPG

Plants and projects for bio-based PX and PTA alternatives, 2022

Company	Location	Products	Capacity
Biokim	USA	BTX, C9+ aromatics	Pilot scale
Braskem	USA	BTX, C9+ aromatics	40 ktpa

Companies involved in recycled-based PTA R&D, 2022

Company	Location	Products	Status
BiobTX	CA, USA	BTX, C9+ aromatics	Lab scale
Bioche	Netherlands	BTX	50 ktpa facility by 2024
Corbio	France	PTA, MEG	Demo in operation
DuPont	France	PTA, MEG	50 ktpa facility by 2024
Eastma	Switzerland	PTA, MEG	Pilot scale
Gevo	PA, USA	BTX, PP	250 ktpa by 2024
Novam	TX, USA	BTX, PP, naphtha	Demo in operation
Origin	USA	BTX	360 ktpa by 2024
Gr3n	Switzerland	PTA, MEG	Demo plant in Italy
Ioniqa Technologies	Netherlands	PTA, MEG	10 ktpa by 2022
Stora Enso	Belgium	FDCA	Pilot-scale
Treemera GmbH	Germany	FDCA	Pilot
Vertimass	USA	BTX, Ethylbenzene	Licensing
Virent	USA	BTX	25-30 tpa (demo)

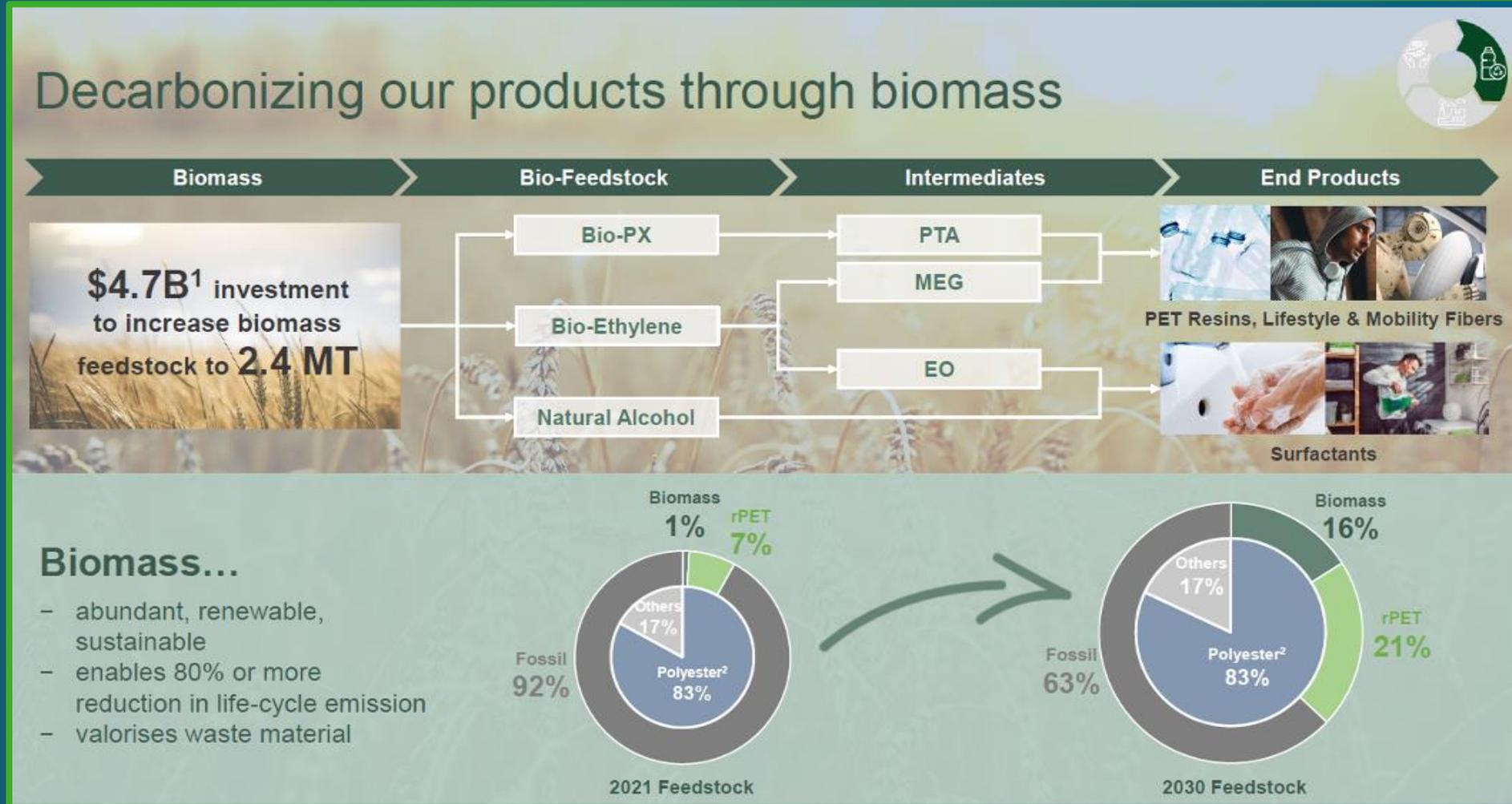
- Increase sugar cracking to MEG/MPG
 - UPM, Braskem/Sojitz, Avantium
- New glycerine-based MPG facilities
- CO₂-based MEG
- Isobutanol-to-PX (Sojitz, Gevo)
- Sugar cracking to BTX
 - Anellotech, Virent, BioBTX, Relement
- Furanics-based aromatics
 - Origin Materials, Avantium, Novamont, Stora Enso
- Aromatics from bio-naphtha
- Plastics Waste-to-Aromatics

Approach to Decarbonization and Others



Source: Indorama Ventures. Vision 2030

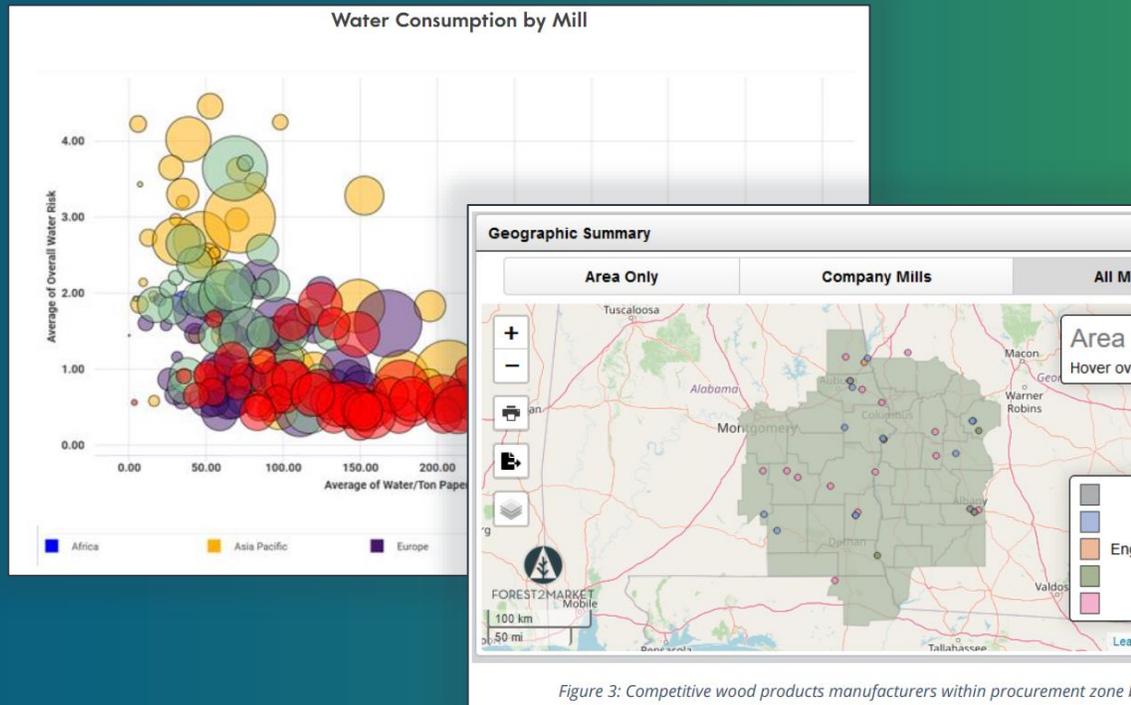
How Polyester Companies Approach Decarbonization



How Polyester Companies Approach Decarbonization

- Integrating Bioeconomy into a Circular Economy
- Economical displacement of fossil-based feedstock with bio-based alternative (sustainable, non-food, waste derived bio-mass feedstock) whenever possible
- Use bio-based, biodegradable and/or non-biodegradable materials where there is a benefit (recyclable/end of life)
- Growth of polymers (PET) at the cost of reducing fossil raw materials
- Complying with brand owners who have goals to incorporate bio-based/recycled-based chemicals and materials in their supply chain and packaging
- Tightening relationship between agriculture and chemical industries

Tecnon OrbiChem joined the **Resource Wise** group of companies. The move brings it together with its sister brands **Forest2Market**, **Fisher International** and **Wood Resources International**, all of which serve natural resource industries.



The market is changing.

Tecnon Orbichem is better prepared to served our customers by making wise decisions via Business intelligence platforms.

- Commodity pricing for natural resource feedstock, recovered fibre and chemicals
- Supply and demand data for timber, pulp, paper and other feedstock (fossil)
- Energy, carbon and water use data
- Fundamental cost model data and strategic consultancy

Sustainability SWOT of Polyester & Intermediates

Strengths

- PTA, MEG, PET are very energy efficient technologies
- PET recyclability. "Greener" than other plastics. Can substitute other plastics
- Large scale / low cost of production
- Established use in key sectors

Weaknesses

- A petroleum base material
- Consumer behaviour – disposal systems
- No fully Bio alternative
- Poor PET Collection
- Multiple participants involved
- Local, regional differences

Opportunities

- Scope for improved waste collection
- Developments in recycle technology.
- Deposit schemes proposed
- Plant-based alternatives feedstocks (timing, volume, process)
- Advantage for local/regional producers

Threats

- Consumer reaction to single-use plastic (PET)
- A return to glass or aluminium
- Extreme regulatory intervention
- Limited and expensive feedstock (bales)
- Reduction of fossil raw materials

Sustainability SWOT of Biomaterials & Intermediates

Strengths

- Use of renewable resources (also for fossil based bio-polymers)
- Less toxicity in production/feedstocks
- Higher consumer preference
- Biodegradability/ Compostability
- Sustainability Commitments of Brand Owners & producers

Weaknesses

- Price premium (regulation, value, Marketing)
- Lower supply / less production
- High investment risk
- New technology risks
- Feedstock uncertainties

Opportunities

- Potential biomass feedstocks –municipal and agricultural waste
- Regulation–led demand
- Priority for all
- 'Fits' with circular economy ideas
- Lower emissions / CO2 absorption
- Popularity in green financing

Threats

- Over-promised tech.
- Can it be done cost-effectively?
- Potential higher land / water use
- Greenwashing- Consumer confusion. Lack of traceability.
- Beneficial for the environment?
- Government subsidy dependence.

What companies will need to be successful

- Global overcapacity in intermediates and polymers (PET), but regional tightness
 - Enjoy current situation and margins
 - High volatility (cost/price, supply/demand, freight...)
- Politics, trade barriers, logistics, unplanned issues (Natural disasters, others)
- Chose your partners, build strong chain (new circular supply chain)
- How to contract feedstocks/sales of fossil and bio (cost or market references)
- How to approach Sustainability – Cultural change impacting all departments
 - Ambitious, measurable commitments, Realistic
 - Short, medium and long term view/actions/goals
- Where to be? cost advantage, demand and value
- New developments (products, production schemes, new technologies, AI, data)
- Trend to integration (upstream - downstream) cost and value
- What industrial clients – consumers want/need
- No matter what your involvement/role in the chemical and/or bio chain is, Resource Wise can help you to understand market dynamics, use existing benchmarks and new metrics to make wiser decisions.

It will need to be:

Competitive
Prepare the future
Covered (Bio)
Flexible / Lucky
Reliable / co-operative
Expert / Smart
Innovative, talented
co-operative, active
Participation/leadership
Regional/local
Continuous R&D
"Integrated"
Value-oriented, quick

Well informed



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