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The PCR Paradox:

The supply/demand challenge in PCR and 4 ways it could play out



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Brands require 25 million tonnes of PCR packaging polymer to meet their sustainability goals and comply with regulatory targets

Despite this demand outlook, current global capacity is less than 5 million tonnes with closures and bankruptcy taking out nearly 1 million tons of capacity, leaving stakeholders reluctant to invest in future growth.

If PCR targets can't be achieved, sustainability goals could get missed, causing consumer scepticism, potential investigations, fines and litigation, and affecting investor confidence. Better, credible data from robust sources will help mitigate the risks, but the nature of the uncertainty means that value chain participants should consider scenario-based approach.

This white paper will address 3 key questions to provide insight on future scenarios and their implications.

01 What is driving demand growth?

- Key drivers and trends impacting demand for PCR
- Demand forecast based on brand owner commitments
- Demand forecast based on current supply constraints

02 What is causing the supply chain problems?

- Current challenges limiting recycling capability
- Recent closures and their impact
- Planned investment outlook
- Future innovation landscape

03 What happens next? Potential scenarios for the supply/demand outlook for PCR

- Scenario 1: Overcapacity
- Scenario 2: Stagnation
- Scenario 3: Supply crunch
- Scenario 4: Radical growth

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PCR enables brands to continue to utilise high performance plastic packaging without inhibiting sustainability credentials or regulatory compliance

Regulatory Focus

PPWR mandates minimum levels of PCR content for plastic packaging: 30% for contact-sensitive PET, 10% for contact-sensitive non-PET packaging (with the exception of single-use plastic bottles) and 35% for other plastic packaging. From 2040, these rise to 40%, 25% and 65% respectively. Many EPR regulations have PCR mandates and incentivise PCR content through eco modulation

Cost and Performance

In many applications plastics still offers superior technical performance on key requirements like oxygen and moisture barrier and puncture resistance at lower price than fibre based alternatives. Increasing PCR use provides brands with an option to continue to use plastics and make progress on their sustainability goals.



Consumer Preference

Consumers have been educated that recycling is a good environmental outcome and so expect brands to both make recyclable packs and use more recycled material:

- 98% of consumers think recycling helps the environment*
- 92% agree that recycling is the bare minimum we can do for the environment*
- 91% agree that 'recycling makes me feel better about the amount of things I purchase or consume'*

**Source: Global Eco Pulse 2025*

Ongoing NGO Advocacy

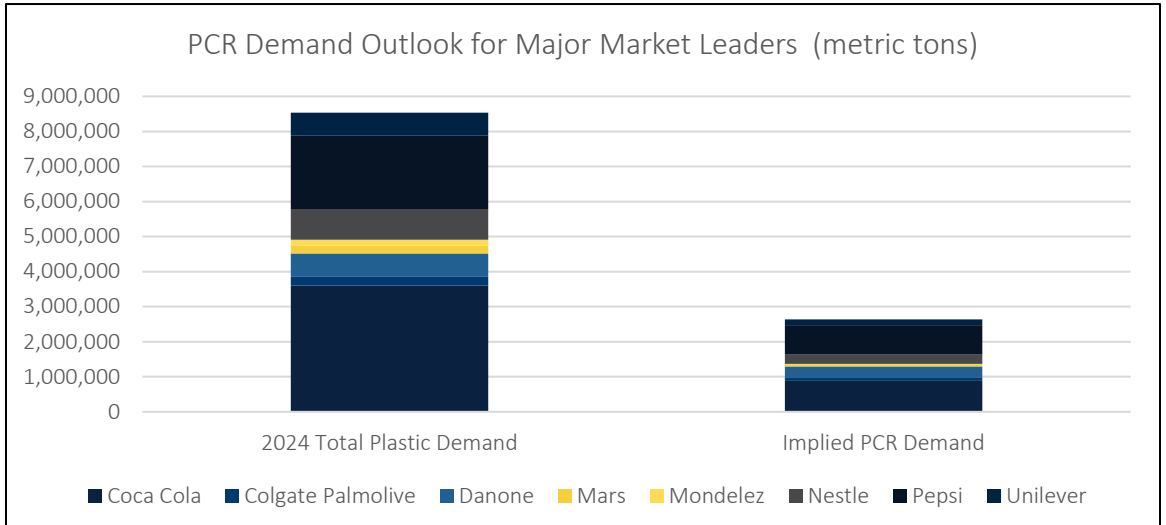
Ellen MacArthur Foundation and other prominent NGO's have successfully gained commitments from major brands and packaging companies to achieve minimum PCR goals

Groups such as As You Sow, Upstream, 5 Gyres, NRDC, Greenpeace, and the Sierra Club have instituted campaigns against companies to force them to move away from landfill-destined designs and toward those that incorporate recycled content.

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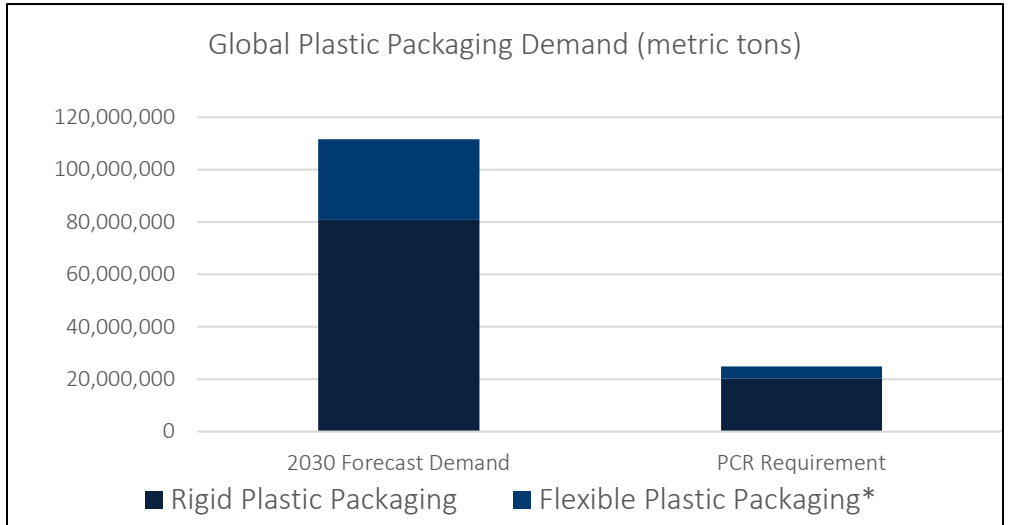
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PCR goals across global packaging would create nearly 25 million tonnes of PCR demand, 5x current availability



Stated PCR Demand for Major Market Leaders			
	2024 Total Plastic Demand	PCR Target	Implied PCR Demand
Coca Cola	3,606,172	25%	901,543
Colgate Palmolive	245,787	25%	61,446
Danone	670,107	50%	335,053
Mars	215,133	30%	64,539
Mondelez	177,900	5%	8,895
Nestle	872,865	30%	261,859
Pepsi	2,095,404	40%	838,161
Unilever	654,880	25%	163,720
Total	8,538,248	Average 29%	2,635,219

Source: EMF plastics pact data, Smithers Estimates and Analysis



Overall Global PCR Demand based on 20% PCR assumption			
'000 ktn	2030 Total Plastic Demand	PCR target	Implied PCR Demand
Rigid Plastic Packaging	80,837,000	25%	20,209,000
Flexible Plastic Packaging*	30,845,000	15%	4,626,000
Total	111,682,000	Average 20%	24,836,000

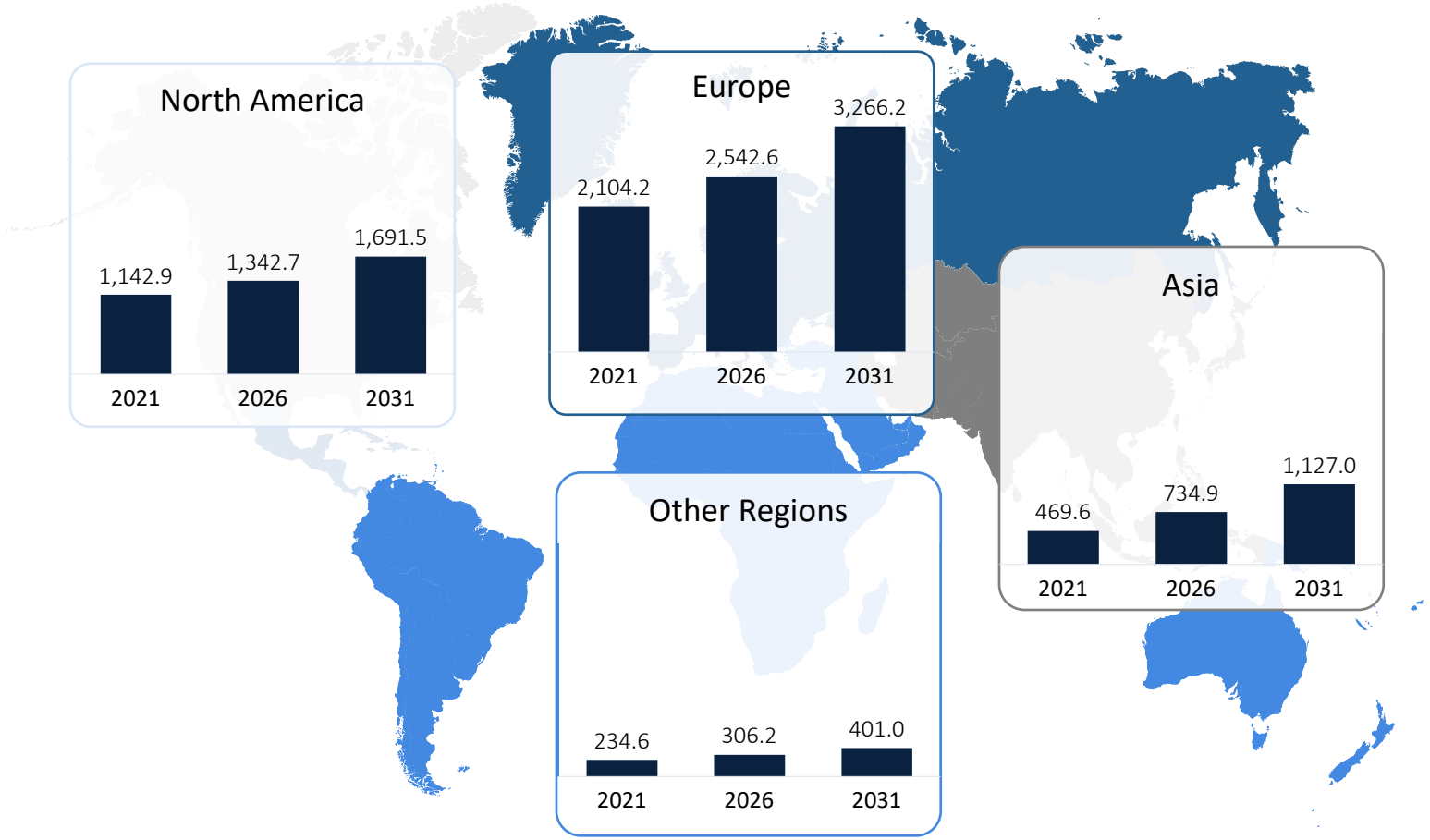
**consumer only - excludes industrial flexible plastic packaging*

"The pace of progress remains closely linked to the readiness of these systems and the availability of food-safe recycled materials in many markets". **Mars Sustainability Report 2025**

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The market for PCR is most established in Europe; Asia has room for significant growth rates from a relatively low base

GLOBAL: PCR PACKAGING CONSUMPTION BY REGION, 2021–31 ('000 TONNES)



*Note: * Totals may not add up due to rounding; projected and forecast values at constant 2024 prices*
Source: Smithers

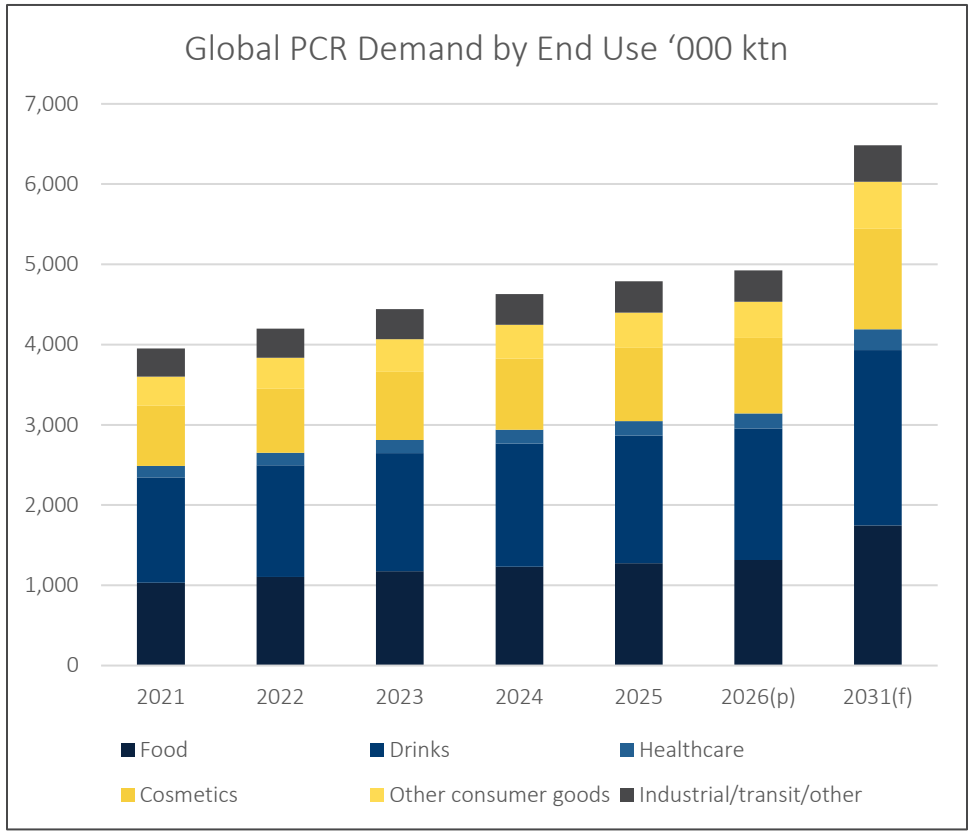
KEY HIGHLIGHTS

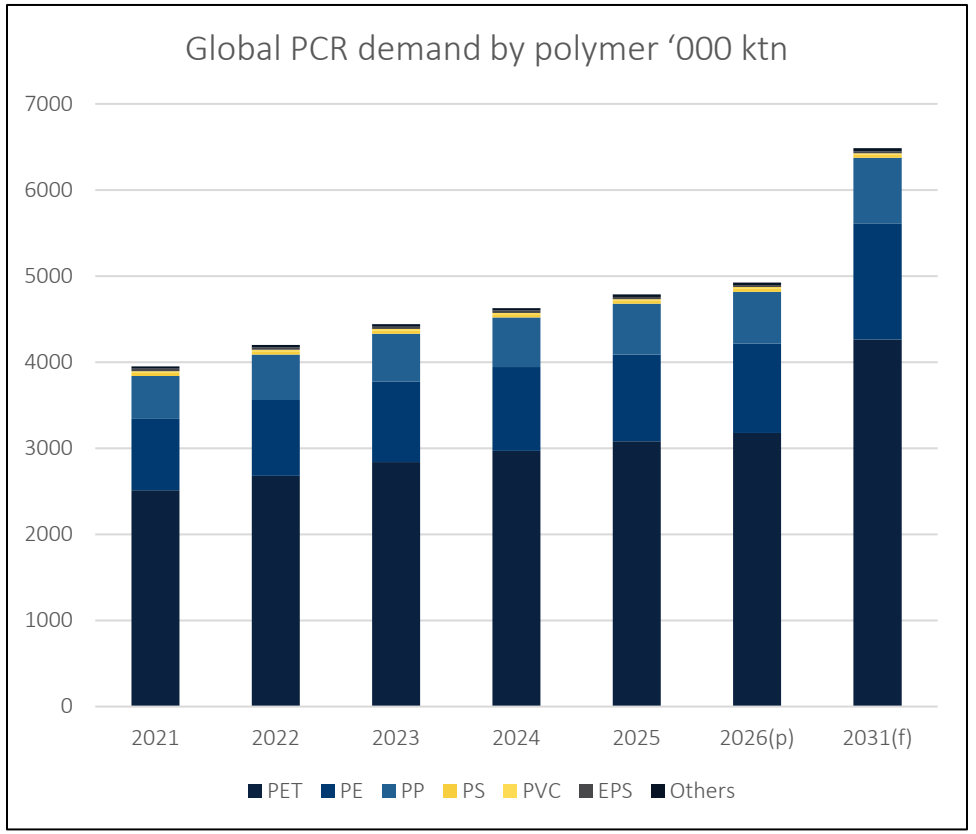
- Europe has grown at an average of 3.9% CAGR over the past five years and this growth is expected to rise to 5.1% as legislation starts to take hold.
- North America is lagging in terms of numbers, but growth is expected to be strong in the coming five years, based on EPR and brand owner leadership.
- Asia is uneven in terms of PCR content and demand growth. Overall, growth will be high, from a low starting point.
- Other regions, mainly in the developing world will be growing a a good rate, which should increase after 2031 once EPR starts to take hold in these regions.

Region	CAGR 2021–26	CAGR 2026–31
Europe	*3.9%*	*5.1%*
North America	*3.3%*	*4.7%*
Asia	*9.4%*	*8.9%*
Other Regions	*5.5%*	*5.5%*

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Smithers forecasts PCR demand will grow from 4.9m tons in 2026 to 6.5m tons by 2031 at a 5.7% CAGR well below the stated goals of 25m tons





2026-31 CAGR%	
By Polymer	
PET	6.1%
PE	5.4%
PP	4.8%
PS	0.5%
PVC	-3.3%
EPS	-1.8%
Others	3.6%

2026-31 CAGR%	
By End Use	
Food	5.8%
Drinks	5.9%
Healthcare	6.9%
Cosmetics	5.9%
Other	5.4%
Industrial	3.1%

Source: Smithers - the Future of PCR for Packaging to 2031

Additional competition from other industries like automotive and textiles can further constrain availability of high-quality PCR for packaging applications and create further pricing pressure

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What is causing the supply problems?

- Current challenges limiting recycling capacity
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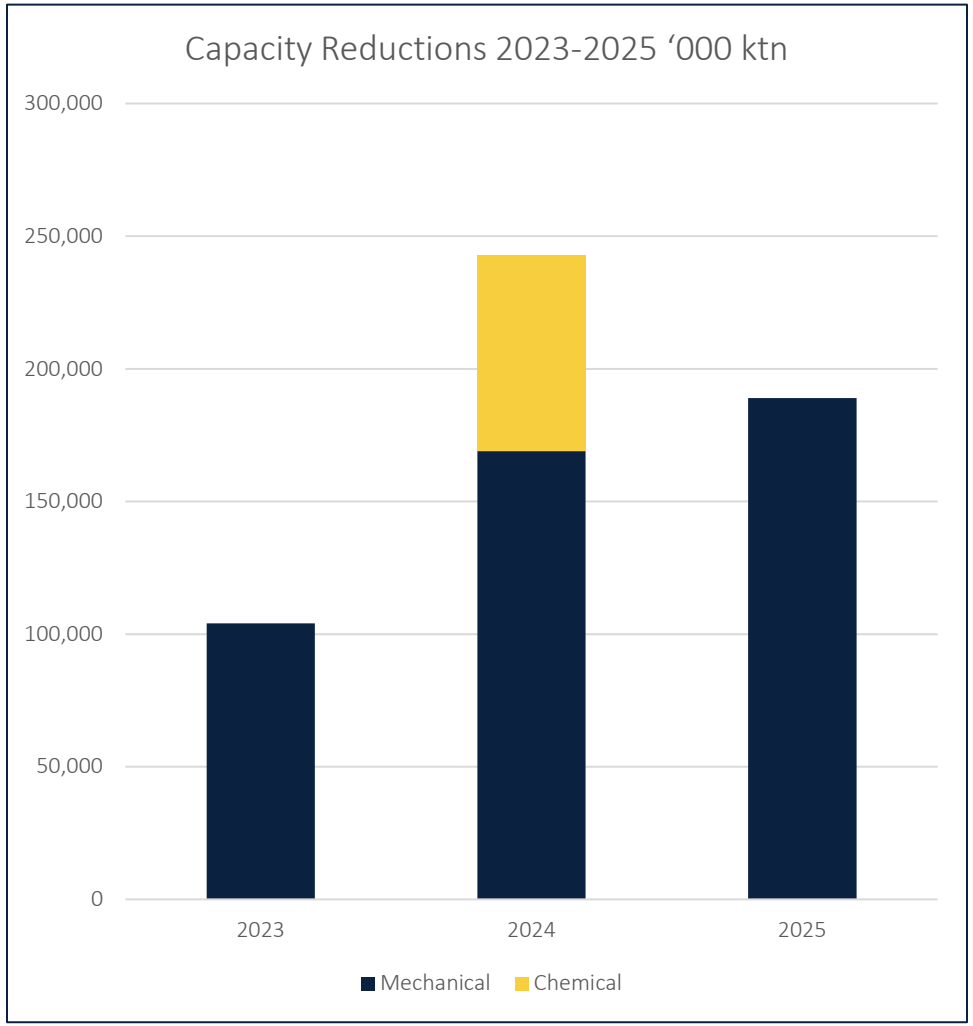
Despite growing demand, achieving sustainable, profitable supply of packaging grade PCR continues to prove extremely challenging

Challenge	Rationale
Sorting and Collection	Complex consumer waste streams with diverse materials in terms of both value and ease of recycling remain a challenge. Systems becoming faster, more automated and accurate but require capital and resource. Consumer education, standardized recycling instructions and improved collection systems required to increase recovery, reduce contamination and increase value.
Food Contact and Contamination	Recyclers struggle to distinguish between food-grade approved and non-food contact plastics during the sorting process. This is a significant barrier to meeting regulatory mandates, such as the PPWR, which require specific levels of contact-sensitive PCR content and limits access to higher value markets for PCR.
Operating Costs	Rising energy and labour costs, particularly in Europe combined with relatively low cost for imported PCR and virgin polymer has created a margin squeeze for recyclers despite rising demand. This exacerbated by a period of investment from recyclers in anticipation of new demand that never fully materialized.
Chain of Custody	There is an increasing need for rigorous audit trails and a certified chain of custody validated by 3rd parties. This is essential to prove to brands and regulators that the recycled content is legitimate and meets sustainability standards, it will also encourage localised sourcing, better quality and improve metrics to quantify and measure success.
Chemical Recycling Perception	Negative consumer and regulatory perception of chemical recycling combined with significant investment requirements has led to lack of approvals for new chemical recycling capacity.

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As a result many western recyclers are struggling to maintain the viability of existing operations, let alone invest in new capacity

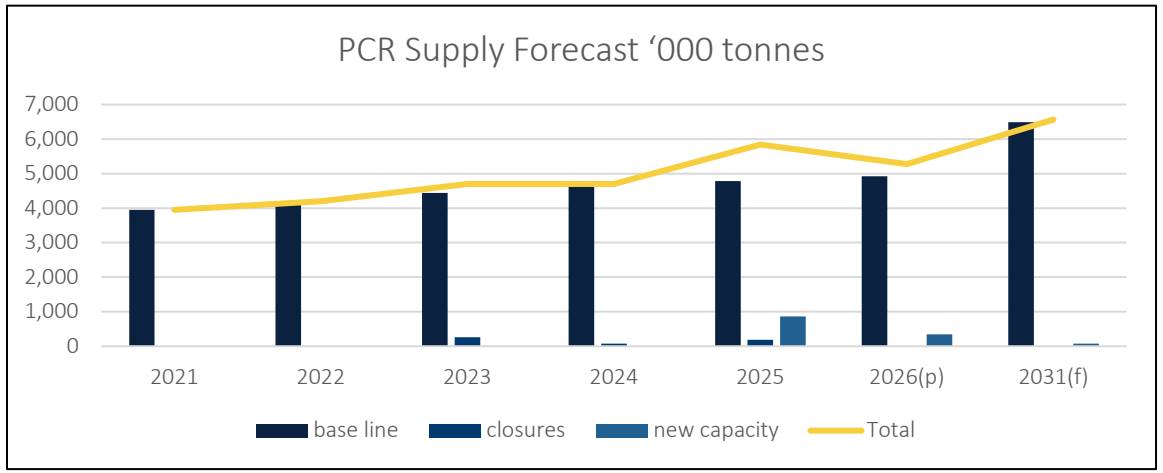
Recycling plant closures in the last 2 years				
Plant / Company	Country	Technology	Primary Polymer	Capacity (tpa)
HC Plastics	Germany	Mechanical	PP Film	15000
Veolia (Rostock)	Germany	Mechanical	PET	36000
Viridor (Skelmersdale)	UK	Mechanical	PET & HDPE	40000
Yes Recycling	UK	Mechanical	PE Film	13000
Bage Plastics	Austria/Germany	Mechanical	PE Film	30000
Stiphout	Netherlands	Mechanical	HDPE/PP	18000
Umnicorp	Netherlands	Mechanical	PET	20000
Vinylrecycling	Netherlands	Mechanical	PVC	25000
QC Polymer	UK	Mechanical	PET	18000
MyPlas	USA	Mechanical	PE Film	40000
Circulus	USA	Mechanical	PE Film	18000
Veolia Multipet	Germany	Mechanical	PET	169000
Veolia Multiport	Germany	Mechanical	HDPE	35000
Cedo Recycling	Netherlands	Mechanical	PE Film	80000
Biffa (Washington)	UK	Mechanical	HDPE & PP	39000
Blue Cycle	Netherlands	Chemical	Pyrolysis PO	20000
Agilyx-Regenyx	USA	Chemical	PS	3650
New Hope Energy	USA	Chemical	Pyrolysis PO	50000

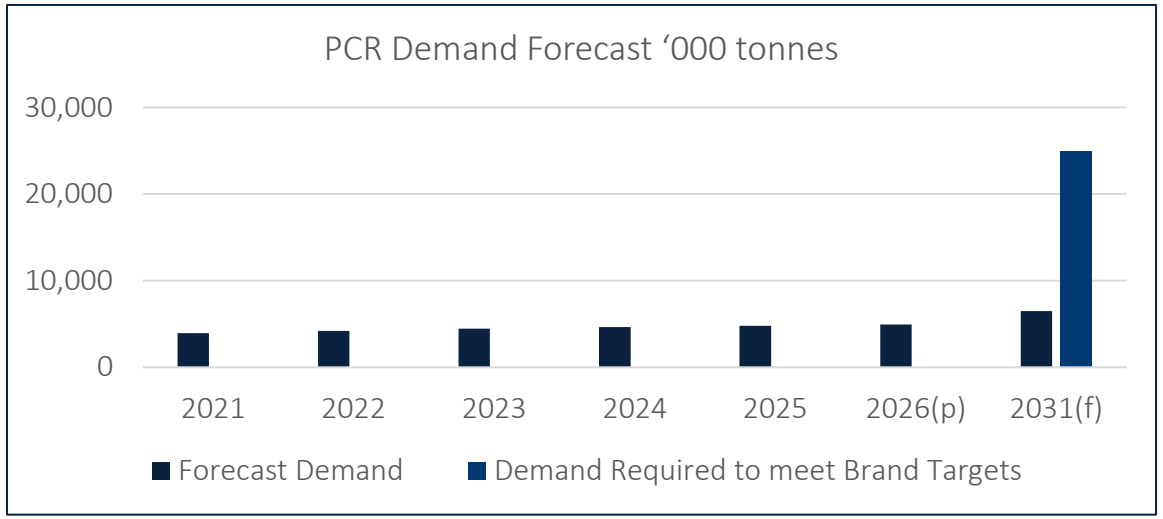


Source: various sources combined with Smithers analysis

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Planned investment will only contribute 1.3m tonnes of new capacity reaching 6.5m by 2031 leaving a 18.4m demand gap





New plants and capacity expansion				
Start-up year	Company / Project	Location	Technology & Output	Capacity TPA
2025 Q1	Circularix Florida facility	USA	Mechanical rPET (food-grade)	25,000
2025	Indorama JV (India) – 2 plants	India	Mechanical rPET	100,000
2026	Veolia tray-to-tray plant	UK	Mechanical rPET (food-grade)	80,000
2026	Srichakra expansion	India	Mechanical rPET (food-grade)	23,000
2027	Indorama Lagos plant	Nigeria	Mechanical rPET (food-grade)	45,000
2027	Enviroo plant	UK	Mechanical rPET (food-grade)	35,000
2024–ongoing	ALPLA multi-site expansion	Global	Mechanical rPET + rHDPE	700,000
2025–2026	LyondellBasell MoReTec	Germany	Chemical recycling	50,000
2026	ExxonMobil Baytown (total site)	USA	Chemical recycling	115,000
2025	Recon project	China	Chemical recycling	40,000
Announced 2026	WPU / Vitol Rotterdam	Netherlands	Chemical recycling	80,000
				1,293,000

Source: various sources combined with Smithers analysis

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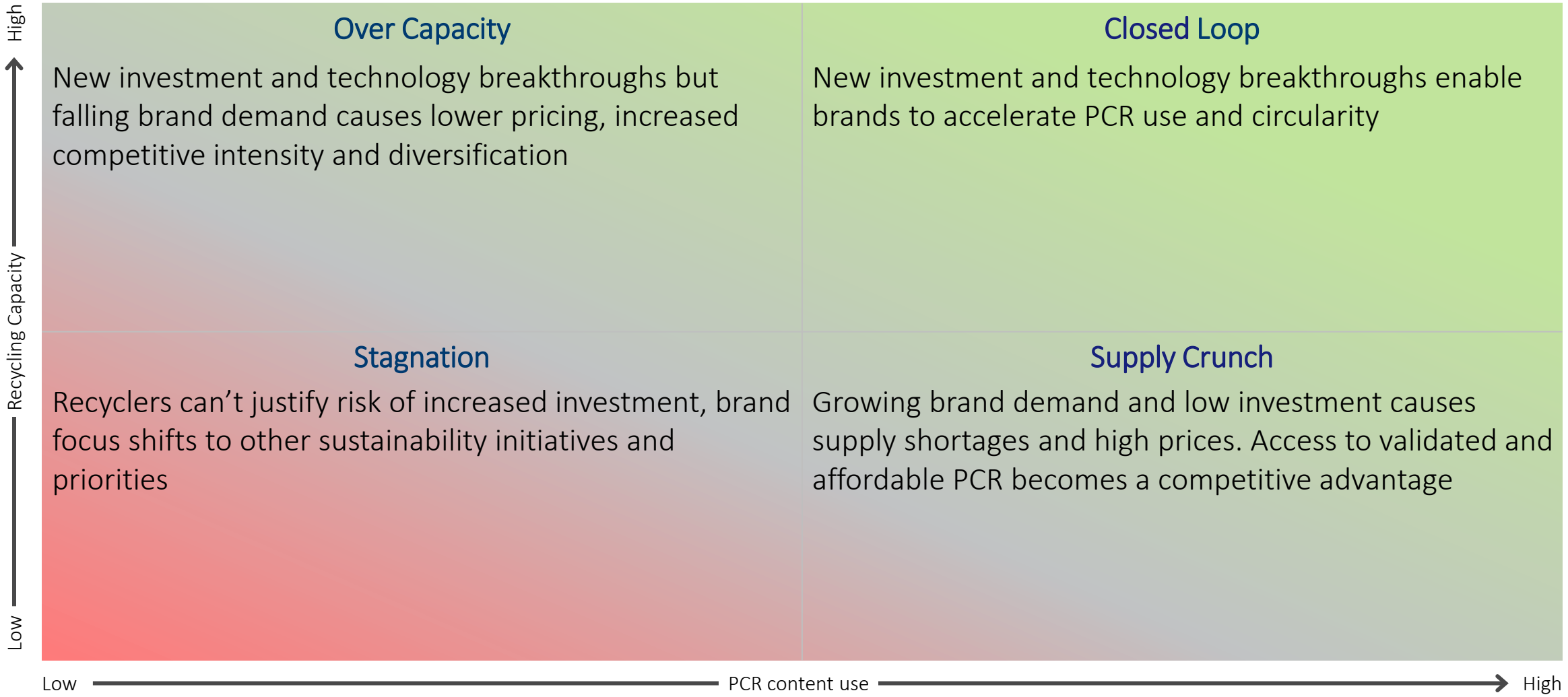
What happens next? Four scenarios for the supply/demand outlook for PCR

- Scenario 1: Overcapacity
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Supply and Demand hangs in the balance for PCR's future outlook as brands and recyclers watch each other for the next move



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Scenario 1: Overcapacity

New investment and technology breakthroughs but falling brand demand causes lower pricing, increased competitive intensity and diversification

Potential Drivers	Potential Outcomes
Recyclers	
Accelerated Recycling Investment Commercial and regulatory incentive for recyclers to invest in new technology and capacity Breakthroughs in AI, traceability, chemical recycling and other technological innovations improve throughput	**Decreased ROI and risk of capacity decline** Survival of the fittest: recycling plants that have strong balance sheets, excellent operational efficiency and strong customer relationships will win Shift to alternative markets (textiles and automotive)
Brands	
Brands shift focus away from PCR Pursuit of other end of life goals (compostability and reuse) and other sustainability goals (reducing GHG) means PCR use becomes less important	**Plummeting PCR pricing** Excessive competition and lower cost PCR production significantly reduce PCR pricing vs virgin polymer and other packaging formats
Packaging Suppliers	
Growing demand for alternative packaging solutions Brands pivot to alternative material strategies including fibre based packaging innovations	**Multimaterial strategy essential to survival** Packaging suppliers that can provide optionality to brands will be better positioned to retain and expand partnerships

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Scenario 2: Stagnation

Recyclers can’t justify risk of increased investment, brand focus shifts to other sustainability initiatives and priorities

Potential Drivers

Potential Outcomes

Recyclers



Lack of Investment

Lack of commercial and regulatory incentive for recyclers to invest in new capacity and new technologies

No new capacity

Increasingly difficult to attract capital and existing capacity stagnates due to lack of investment



Brands



Shift in sustainability focus

Increased emphasis on alternative end of life solutions including compostability and reuse and more emphasis on GHG and carbon reduction

Regulations are not strong enough to enforce compliance

Investment shifts to composting and reuse

Both composting and reuse systems are currently under developed and ill equipped to cope with a significant increase in demand without substantial investment



Packaging Suppliers



Radical increase in fibre based packaging solutions

Innovation in fibre based packaging such as novel moulded pulp techniques and sustainable barrier coatings accelerate plastic replacement in packaging

Shifting packaging economics

Fibre based packaging becomes more expensive due to growing demand but EPR and other regulatory incentives support growth



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Scenario 3: Supply Crunch

Ongoing brand demand causes supply shortages and high prices. Access to validated and affordable PCR becomes a competitive advantage

Potential Drivers	Potential Outcomes
Recyclers	
Lack of Recycling investment Lack of commercial and regulatory incentive for recyclers to invest in new capacity and new technologies Low-cost imports fill gaps in local capacity	**Higher PCR pricing** Validated PCR pricing remains stubbornly high relative to both virgin polymer and imports
Brands	
Strong Brand Demand Regulatory pressure and cost/performance means PCR remains an effective solution for brands to meet both packaging and sustainability requirements	**Increased Scrutiny** Rigorous audit trails and certified chain of custody validated by 3rd parties become standard to prevent dubious sources gaining market access Large players vertically integrate to protect supply
Packaging Suppliers	
PCR innovation Packaging innovation focuses on improving strength while reducing weight to maximise performance of PCR	**PCR access as competitive advantage** Long term supply contracts between large players restricts access to lower tier users

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Scenario 4: Closed Loop

New investment and technology breakthroughs enable brands to accelerate PCR use and circularity

Potential Drivers	Potential Outcomes
Recyclers	
Accelerated Recycling Investment Increased commercial and regulatory incentive to invest in new technology and new capacity	**High quality PCR available and affordable** Technology and investment combine to radically improve the quality and affordability of PCR
Brands	
Strong Brand Demand Regulatory pressure and cost/performance means PCR remains an effective solution for brands to meet both packaging and sustainability requirements	**Increased circularity in the value chain** Brands strengthen partnerships with recycling and feedstock to increase transparency, control and quality of PCR
Packaging Suppliers	
Mandated PCR use drives innovation Packaging innovation focuses on improving strength while reducing weight to maximise performance of PCR	**Other packaging formats under competitive pressure** Fibre based packaging is increasingly perceived as a higher cost and lower performance alternative in traditional plastic packaging markets

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Conclusions and Recommendations

The uncertain outlook for PCR requires agile, scenario based and data driven strategic planning



25m tonnes of PCR Demand by 2030

- Regulatory mandates to increase PCR content combined with brand promises will create demand for nearly 25 million tonnes of PCR demand for plastic packaging applications by 2030
- Rigid plastic packaging will create 20 million tonnes of demand and flexible plastic packaging will create 4.6 million tonnes of demand
- The strongest growth will come from food drink and healthcare sectors and rPET will be the fastest growing polymer due to existing infrastructure and established food grade demand

PCR Supply constrained to 6.5m tonnes by 2030

- Sorting, collection and food contamination make recycling a challenging process
- Rising labour and energy costs in Europe combined with competition from low cost imports and virgin polymer are creating a margin squeeze that some recyclers can't survive
- New capacity investment in both mechanical and chemical recycling is under heavy scrutiny from both regulators and investors
- There are several promising new recycling technologies but all require capital allocation with an uncertain future landscape



PCR supply/demand could play out in several ways

- Significant increases in investment in both new capacity and new technology will need to be matched with brand follow through and regulatory enforcement to ensure the future economic viability of the packaging recycling sector
- Ongoing brand demand combined with the current scale of investment will cause a challenging supply crunch where access to and control of high quality and affordable PCR feedstock will be a key competitive advantage for a small number of large players

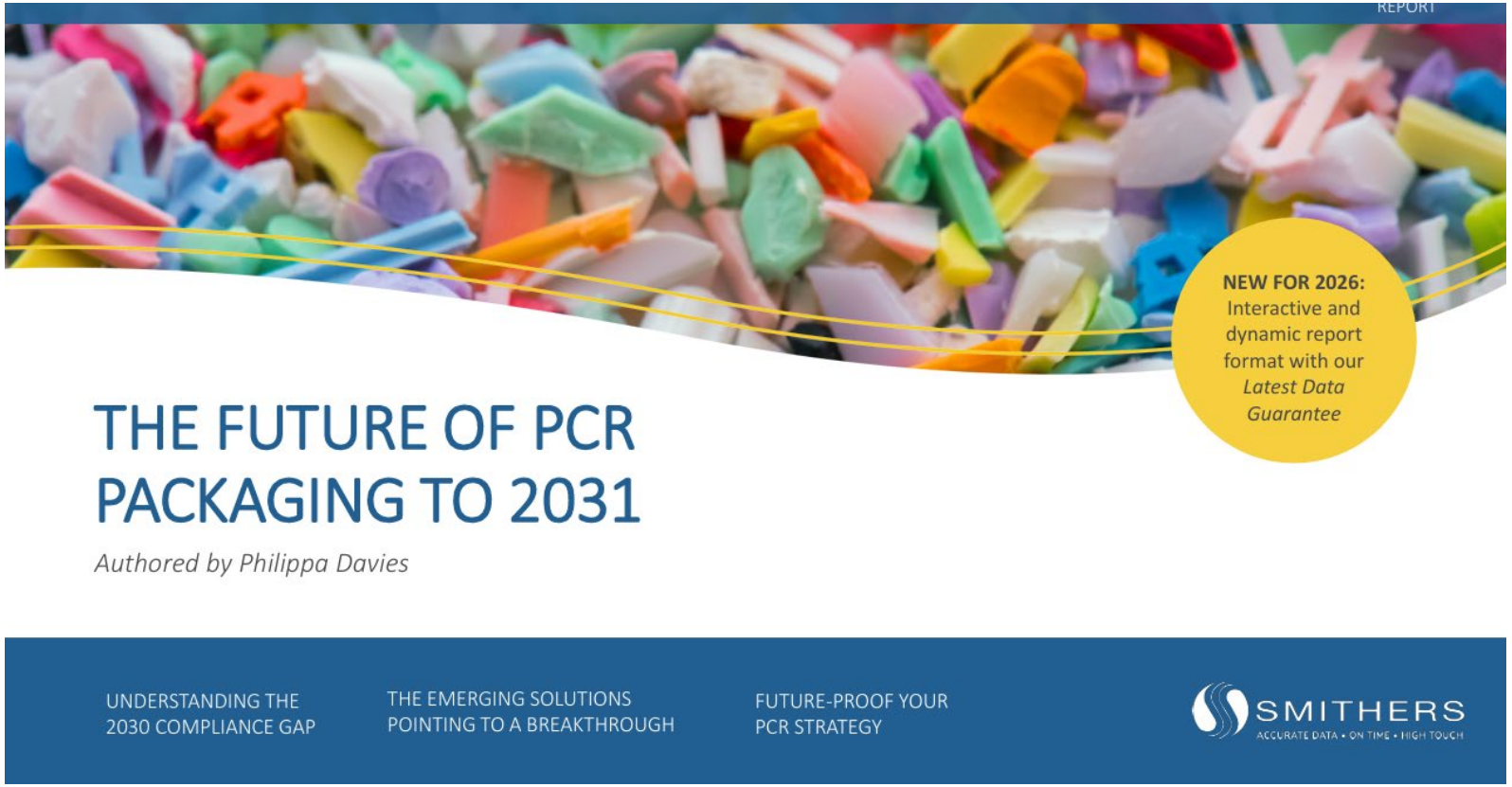


Preparing for the future outlook

- Companies across the packaging and waste management value chain need to pay close attention to the swiftly changing global regulatory landscape to both ensure compliance and capitalize on opportunity.
- Partnerships and collaboration that increase both quality of and access to PCR will be critical in both a supply crunch and a radical growth scenario
- Optionality and multi material strategy will be important for both brands and packaging suppliers to mitigate against likely ongoing constraints in availability and affordability of PCR

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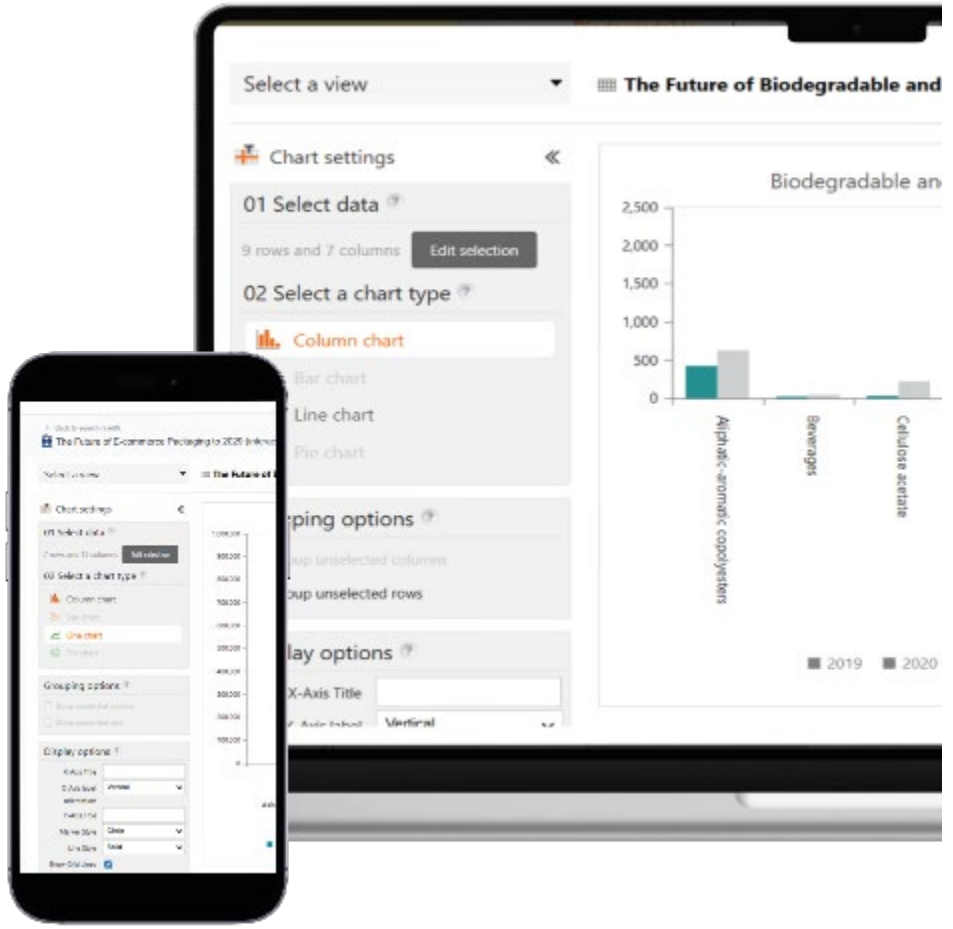
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