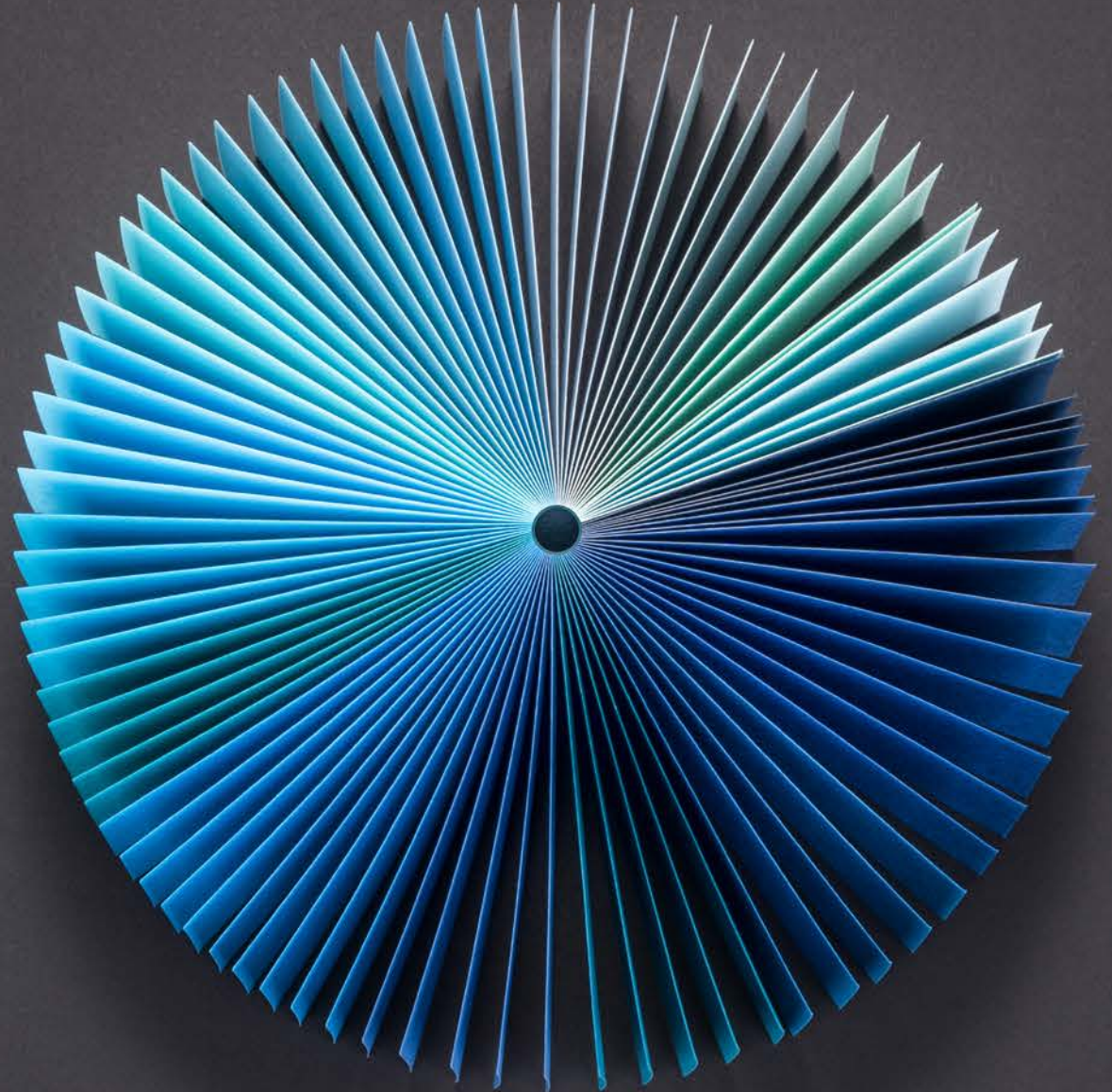




WINNING IN A CIRCULAR ECONOMY

Practical steps for the
European chemical industry



Dear reader,

At a time of multiple global sustainability challenges, the circular economy has been listed as one of the biggest market opportunities for delivering the Sustainable Development Goals. The incremental opportunities for circular economy manufacturing are estimated at US\$ 1,015 billion by 2030, based on estimated savings or projected market size across all manufacturing sectors.¹

Not only is the circular economy considered an important piece of the puzzle in addressing the resource challenge, there is growing awareness that a circular economy could also be a contributor towards the Paris goals by reducing the overall level of greenhouse gas emissions. Beyond offering solutions to become less dependent on primary raw materials, moving towards a circular economy has additional environmental benefits. Giving value to wasted materials by setting up appropriate waste management and recycling infrastructure will help reduce environmental littering—bringing several benefits.

The European chemical industry sees itself at the center of this trend, acting both as a producer of products valued by society and a leader in recycling. Products are increasingly being designed to stay longer in the loops, to be recycled more easily, or being based on renewable feedstock. The industry has the expertise and knowledge to transform waste into valuable, new raw materials.

This has been recently outlined in our Mid-Century Vision report titled “Molecule Managers” which kicked off a dialogue about the future of the chemical industry and its role in building a prosperous and more sustainable Europe by 2050.

Especially in the area of plastics, we’ve seen an ever-increasing number of initiatives being announced by the chemical industry, on its own or through partners, aimed at closing the loops for plastic waste where today no economic or technological solution exists. In this new report, Accenture develops a comprehensive view on the unfolding industry transition which they consider to be driven by regulators and consumer demand. Also, on supply and demand dynamics; on the building blocks to close loops, such as recycling technologies, reverse logistics, circular product design, and enabling technology; as well as the overall impact on value chain dynamics, business models, and breakeven economics of secondary raw materials versus virgin fossil feedstock-based chemical products.

We welcome Accenture’s study as a valuable input to the necessary dialogue between all stakeholders so that Europe can truly become a circular hub with the chemical industry at its heart.

Marco Mensink
Director General,
Cefic



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Call for Action

The concept of the circular economy is not new, but over the last two years, activity related to circularity has increased dramatically—and it is changing the chemical industry fast.

Since the publication of our first report, “Taking the European Chemical Industry into the Circular Economy” in early 2017, six factors have accelerated the move to the circular economy. End-consumer preferences have shifted to sustainable and eco-friendly products, and people are willing to pay a premium for those products. Brand owners have announced voluntary sustainability commitments that are changing the structure and the dynamic of existing markets and demand. Investors now apply strict sustainability targets in their investment decisions, and participants all along the value chain are seeking ways to contribute to greenhouse gas (GHG) reduction targets.

The number and variety of regulations in individual countries and the EU has increased significantly. Many established and startup companies are investing in the development of new recycling technologies. And a broad range of public and private initiatives around the globe have been established, from the European Commission’s “European Strategy for Plastics in a Circular Economy” to the global Alliance to End Plastic Waste, which includes over 40 companies.

The shift towards circularity brings significant opportunities. The circular economy seeks to replace today’s linear, “take-make-dispose” approach to resources with one in which materials are kept at their highest material value and constantly cycled back through the value chain for re-use, resulting in less energy and resource consumption. With their connections that reach both upstream and downstream, and products that are woven deeply into everyday life, chemical companies can help society as a whole to address some of its biggest environmental and sustainability challenges.

Indeed, they will find growth opportunities in designing chemical products for circularity, in enabling downstream value chains to keep materials in use for longer, in fulfilling the demand for new materials, and in creating and operating molecule-circulating loops.

However, the move to circularity requires vigilance and decisive action, as it promises to disrupt the industry's value chains, profit pools and demand patterns while creating new opportunities for growth. The transition is in full swing and has arguably passed the point of no return, so that corresponding action is a strategic necessity for the chemical industry and the value chains it serves. As a consequence, a race to occupy key "sweet spots" is underway. Engaging in circularity is no longer a "nice to have"—it is a key source of competitive advantage.

The circular economy train is leaving the station soon—and chemical companies have a decision to make. They can simply be passive passengers on this journey.

“The circular economy train is leaving the station soon—and chemical companies have a decision to make.”

Or they can play a more active role, laying the tracks that make the journey possible or even driving the train, and thus helping to determine the pace and arrival time of the journey—positions that will let them shape and benefit from the emerging circular economy. And although chemical companies have been exploring circularity, they still have considerable work to do. The sooner they make these decisions and move forward with comprehensive actions, the better—for the industry and society.

Chapter 1

The Accelerating Shift to Circularity

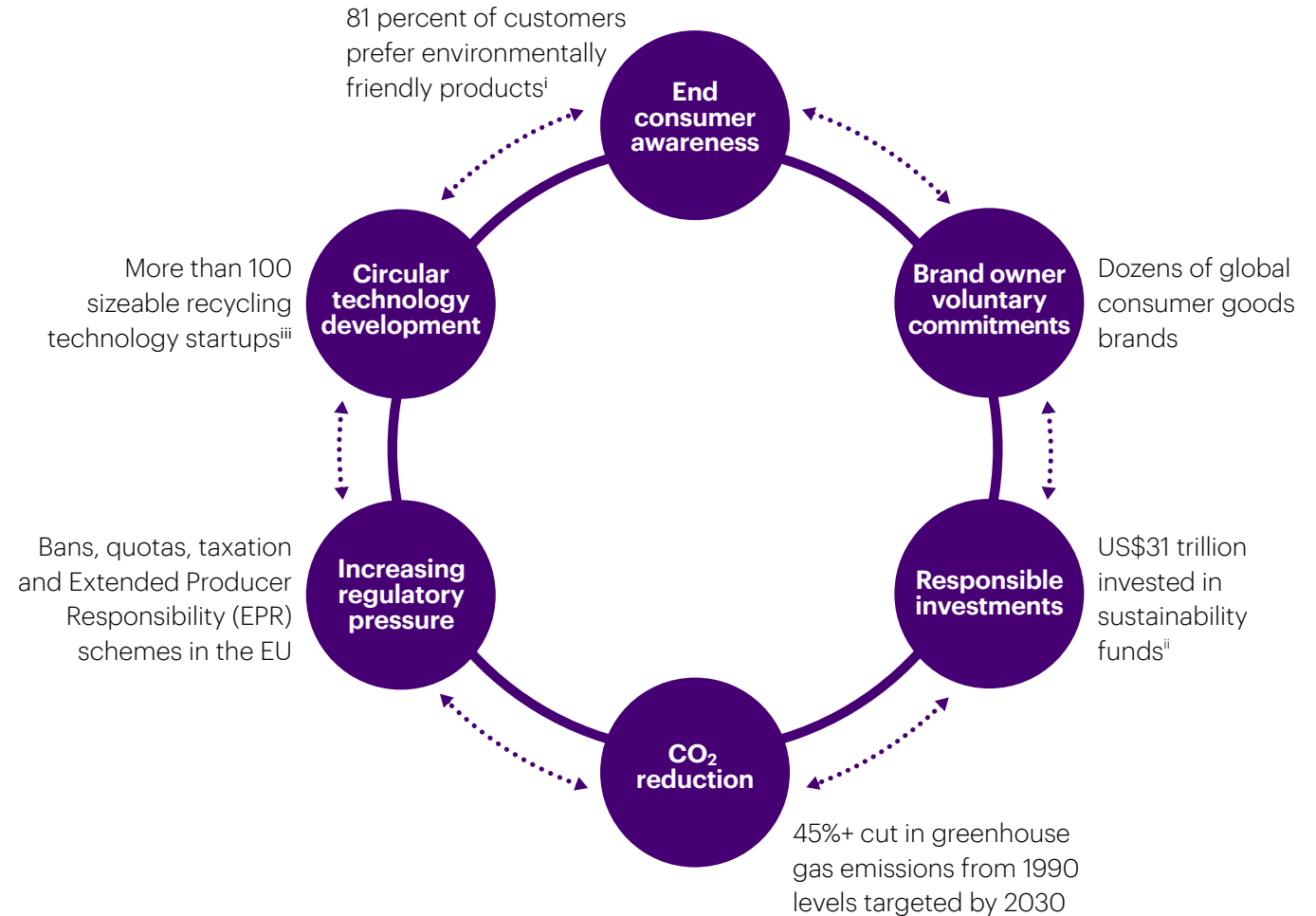
Accenture has identified six driving forces behind the accelerating shift towards a circular economy (Figure 1).

First, **end-consumer** awareness of the issue is growing. In a 2019 Accenture study, 72 percent of consumers said that they bought more environmentally friendly products in the last five years, and 81 percent expected to buy more environmentally friendly products in the next five years. In addition, 50 percent stated that they are willing to pay more for a product that is designed to be re-used or recycled. Although survey results on “willingness to pay” generally warrant a bit of caution, these findings highlight a new demand and thus, an opportunity for chemical companies.²

i Accenture Research
ii Global Sustainable Investment Alliance
iii Accenture, AngelList, angel.co, Closed Loop Partners

Figure 1

Drivers of circularity



Source: Accenture

Second, **brand owners** are adapting to consumer preferences on circularity and taking a strong position by making voluntary commitments to increase the percentage of recycled and bio-based content in their products.³ For example, Coca Cola has committed to making its packaging recyclable by 2025 and its bottles and cans of 50 percent recycled material by 2030.⁴ Unilever has committed to reducing its virgin plastic packaging by 350 kt by 2025, with 100 kt coming from an absolute plastic reduction.⁵ To fulfill these commitments, new value chain collaboration will be required. And the consequences of these commitments are clear: The demand for plastics and chemicals will not be the same in the future—but there is a massive new market opportunity for solutions that help brand owners meet their circularity commitments.

Third, there is an ongoing change in the **investment criteria of debt and equity investors**. For example, in a pioneering move, the sovereign wealth fund of Norway has started to invest only in businesses that adhere to high ethical standards that were agreed upon by the Norwegian parliament.⁶ The European Investment Bank has announced that it will stop financing fossil fuel projects.⁷ And leading global investment management firms are increasingly likely to factor in a company's impact on the society and the environment to determine its worth.⁸

According to the Global Sustainable Investment Alliance, sustainable investments grew from US\$23 trillion in 2016 to US\$31 trillion in 2018,⁹ an increase of 35 percent in just two years. In this environment, access to capital will become increasingly challenging for companies that don't adjust their strategies.

Fourth, the EU has committed to achieving a 45 percent reduction in **GHG emissions** by 2030, compared to 1990 levels. Reaching this target will require a reduction in the CO₂ emissions of the chemical industry. But even more important, it will also require the chemical industry to contribute significantly to the reduction of CO₂ emissions in downstream industries. In 2017 in the EU, the GHG emissions from the chemical industry's energy consumption accounted for 3.3 percent of overall GHG emissions from final energy consumption.¹⁰ By contrast, the combined GHG emissions of the transport, commercial and residential sectors accounted for 72 percent of emissions caused by final energy consumption, indicating a potential reduction from those sectors that is more than 20 times greater than the chemical industry's target. Achieving these targets will require more lightweight materials, more insulation materials, new processes and manufacturing technologies, new solutions, and new behaviors.

Fifth, these changes are taking place against a backdrop of increasing **regulation** related to product or material re-use and recycling in both developed and emerging economies (Figure 2).

The number of sovereign states with circular economy-related regulations, and the variety of regulations, has increased significantly, leading to a heterogeneous, fragmented regulations landscape. At the same time, increased regulation means that more and more end-of-life (EoL) material will become available. Recycling methods that are not yet profitable will benefit from regulation, such as EPR schemes, which are gradually shifting breakeven economics in favor of secondary raw materials. However, a fragmented regulations landscape creates fragmented markets, with niche models tailored to the individual country regulation, thereby compromising the efficiencies and economics needed to migrate to a true, widespread circular economy.

Figure 2

Regulation is taking many forms

		Raw materials	Chemical industry	Converters	OEMs/brand owners	End user	Waste manager		
Types of regulation	Bans	Material ban	Global ban on chlorofluorocarbons (CFCs)						
		Application ban		Single-use plastic bans					
		Import ban					Waste import restrictions		
		Export ban						OECD plastic export limit	
	Quotas	Recycling quota				Batteries & accumulators and packaging waste EU 2030		Quota on domestic waste recycling	
		Recyclate use quota			Not yet applied				
		Collection quota (WEEE)*						>70-80% EU WEEE collection	
	Taxations	Taxation of low recyclate usage		UK tax on packaging with <30% recyclate					
		Recyclability tax incentive		Lower fees on recyclable packaging in upcoming packaging law in Germany					
		Taxes on certain materials	Taxes on virgin feedback-based plastics in packaging in UK and discussed in Canada						
		Taxes on certain applications				Plastic bags taxed in the US			
	EPR schemes	Take-back policy				Retailers have to take WEEE back in Europe			
Private waste-specific disposal organization					Eco-mobilier for furniture in France				
Waste orchestrator					Dual system pays licensed waste manager for kerbside packaging collection in Germany				
State-owned organization						US, E.g. batteries, carpets, electronics, mattresses, tyres			

*WEEE: "Waste Electrical and Electronic Equipment recycling"

Source: Accenture

And sixth, new players are entering the market to address the need for **new technologies**, and some established players are developing their own recycling technology units or cooperating with startups. One study found that there are more than 100 technology providers, mainly startups, targeting an estimated US\$120 billion market for recycled plastics. The need for recycling technologies is by no means limited to waste processing; it also involves platforms to trade recyclates*, enterprise software to reduce waste, and sorting technology, among other things.

Altogether, these facts and figures imply substantial change for the chemical industry. Currently, the narrative and media imagery around sustainability and the circular economy is compelling—driving consumers, brand owners, governments and others to act.

***Recyclates definition:** Output materials from a waste recycling plant or materials recovery facility which can be further processed in similar ways as virgin materials.

Chapter 2

Closing the Circular Economy Loops

Closing the circular economy loops will require several key building blocks: material flows, infrastructure to handle the material flows, a broad evolution of technologies, and last but not least, favorable economics associated with these factors. Each building block involves some uncertainties that could compromise the ability to close the loops. Material flows, and especially waste streams, are not transparent. The magnitude of investments in infrastructure and assets for handling material flows depends heavily on how technologies are being developed—in an orchestrated manner, or separately within each value chain step, which could lead to challenges when it comes to integrating them into circular material flows. And finally, a single industry cannot achieve circularity alone. By definition, it requires collaboration between value-chain segments. The uncertainties of how value chains will rearrange themselves are significant and can only be addressed through new collaborations and partnerships.



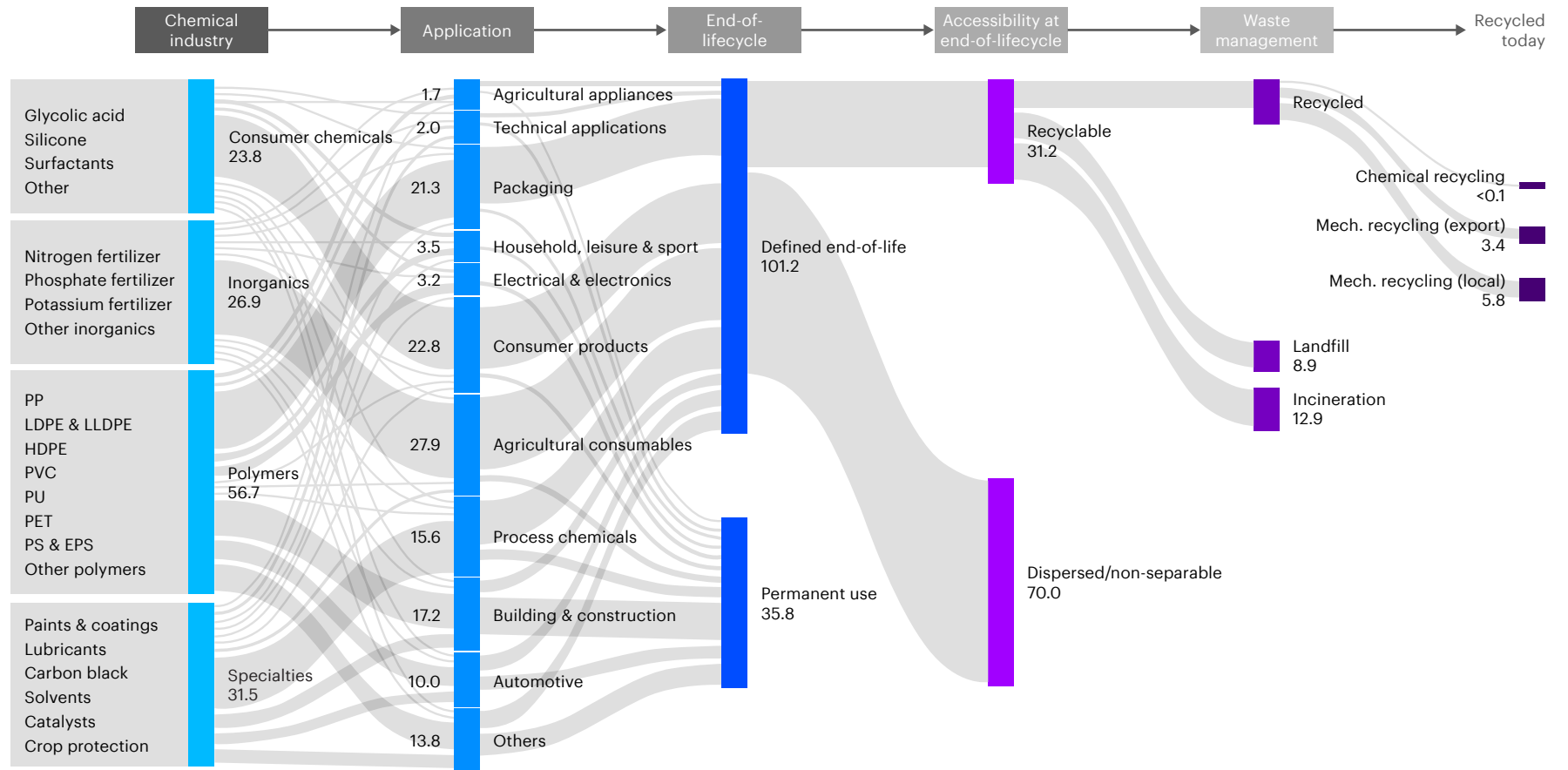
End-of-life materials as alternative sources of feedstock

There are numerous efforts underway to explore bio-based materials as alternative feedstock sources, and today approximately 10 percent of the organic feedstock is bio-based.¹² While the benefits of this are clear—a renewable source, consumption of CO₂, lower energy intensity than production from fossil feedstock—there are practical limitations to the amount of bio-based feedstock that can be produced: Accenture estimates that it would require harvesting the biomass from an area comparable to the size of Romania year after year¹³ to replace the EU's current demand for fossil-based feedstock. Therefore, the exploration of EoL materials as alternative sources of feedstock will be a necessity.

However, there are challenges to doing so. In contrast to crude oil, which is generally concentrated in specific locations, chemical product-based material streams reach their EoL points in a geographically dispersed manner and often as only a small fraction of a waste stream that is poorly sorted or not sorted at all, with few or no specified standards. To establish basic transparency into the material flows, especially waste streams, Accenture has mapped the material flows in Europe. Fragmented data (often at the community level), insufficient classifications, and a lack of standardized definitions are among the major challenges for developing circular economy concepts, and turning those concepts into operational, circular business models (Figure 3).

Figure 3

Mass balance of consumed chemicals to EoL materials in EU28 in 2018 (in million tons)



Source: Accenture

Accenture's research shows that compared to the approximately 140 million tons per annum (Mtpa) of chemical products consumed across various applications, only 101 Mtpa reach their EoL point. The balance falls into the "permanent use" category—that is, it will reach its EoL later, potentially many years into the future. And about 70 percent of the material reaching its EoL point is not accessible, due to its being dispersed in the environment or being inseparable from the products it is contained in. Out of the 31 Mtpa remaining accessible chemical EoL products, the majority (approximately 22 Mtpa) still ends up being incinerated or even landfilled, and only 9 Mtpa becomes available in recyclable, and typically fragmented, waste streams.

Chemical firms in today's value chains don't have access to these fragmented waste streams, and waste managers don't have customers for raw materials. As a result, it is highly probable that raw material supply will shift, creating new dependencies and driving circular value chain integration. For example, chemical firms could become involved in the steps preceding EoL stream processing, or waste managers might forward-integrate into raw material supply, resulting in new competition.

“Chemical firms in today's value chains don't have access to these fragmented waste streams, and waste managers don't have customers for raw materials.”

What's more, Accenture's analysis clearly reinforces the idea that further innovation in sorting and processing technology is needed to reduce the amount of materials being incinerated or landfilled; that separability of materials needs to be improved (design for circularity); and that new solutions will be required to handle the "permanent use" materials, such as materials used in buildings, when they eventually do reach their EoL points.

Infrastructure transition

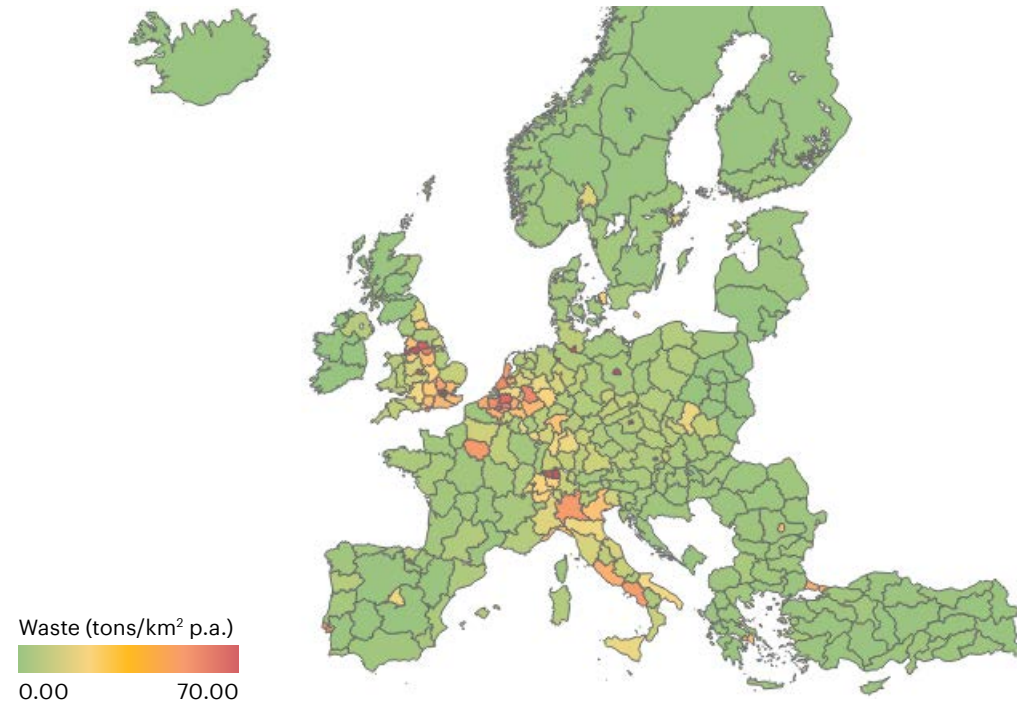
An emerging circular economy in Europe will likely require an asset base that is different from that of today. This will affect everything from product design, chemical manufacturing, transport and EoL points to waste stream collection, reverse logistics, sorting, pre-treatment and processing into recyclates and back into chemical monomers.

Recycling facilities, for example, can only operate economically at a certain industrial scale and therefore need a stable supply of appropriate waste streams that consist of a single material or product and are free of contaminants. The less densely populated a geographic area is, the less waste is generated in that area. Thus, the tradeoff between scale economies of the recycling plant and the transportation costs within the catchment area will be a key factor in economic viability.

Figure 4 shows the current density of plastic waste generation in Europe. As one might expect, that density is higher in metropolitan and more populous areas. Waste density is particularly high in the Benelux region, the western part of Germany and metropolitan regions such as London and Paris.¹⁴

Figure 4

Density of plastic waste in Europe



Source: Accenture

A typical chemical cracker processing fossil feedstock at scale today has a capacity of about 1 Mtpa. A similar scale operation for plastic waste processing would require a catchment area of 33,000 km² in a typical metropolitan agglomeration—more than 20 times the area of London. For a more realistic region that has urban and rural parts, it would require a catchment area larger than the size of Hungary. And if the waste per capita were to decline due to changing consumption patterns, the catchment area would need to be even bigger. In a catchment area of such dimensions, the cost of transporting waste from its EoL point to the processing facility would become prohibitively high.

Smaller facilities could be attached to and use the infrastructure of existing waste management facilities. Even mobile units for chemical recycling are possible, and have already been tested.^{15, 16} On the other hand, large-scale plants acting as centralized hubs could efficiently access large logistics infrastructure such as railroads and harbors. In any case, waste processing at scale will require massive investment, which makes it critical to have certainty on key assumptions, as well as smart approaches to infrastructure transition.

Accenture has investigated three principal scenarios for orchestrating waste flows across Europe (Figure 5).

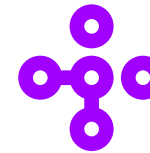
Figure 5

Scenarios for chemical product circularity in Europe



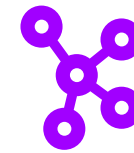
Free flow

- Competitive race for “sweet spot” niches
- Disjunct loops, value chains and assets
- Mutually beneficial value chain collaborations
- Potentially sub-optimal scale and pace of transition



Semi-orchestrated

- Balanced disruption to existing value chains
- Some central coordination, semi-connected loops, value chains and assets
- High leverage of existing asset configurations
- Good fit with characteristics of EU’s political structure



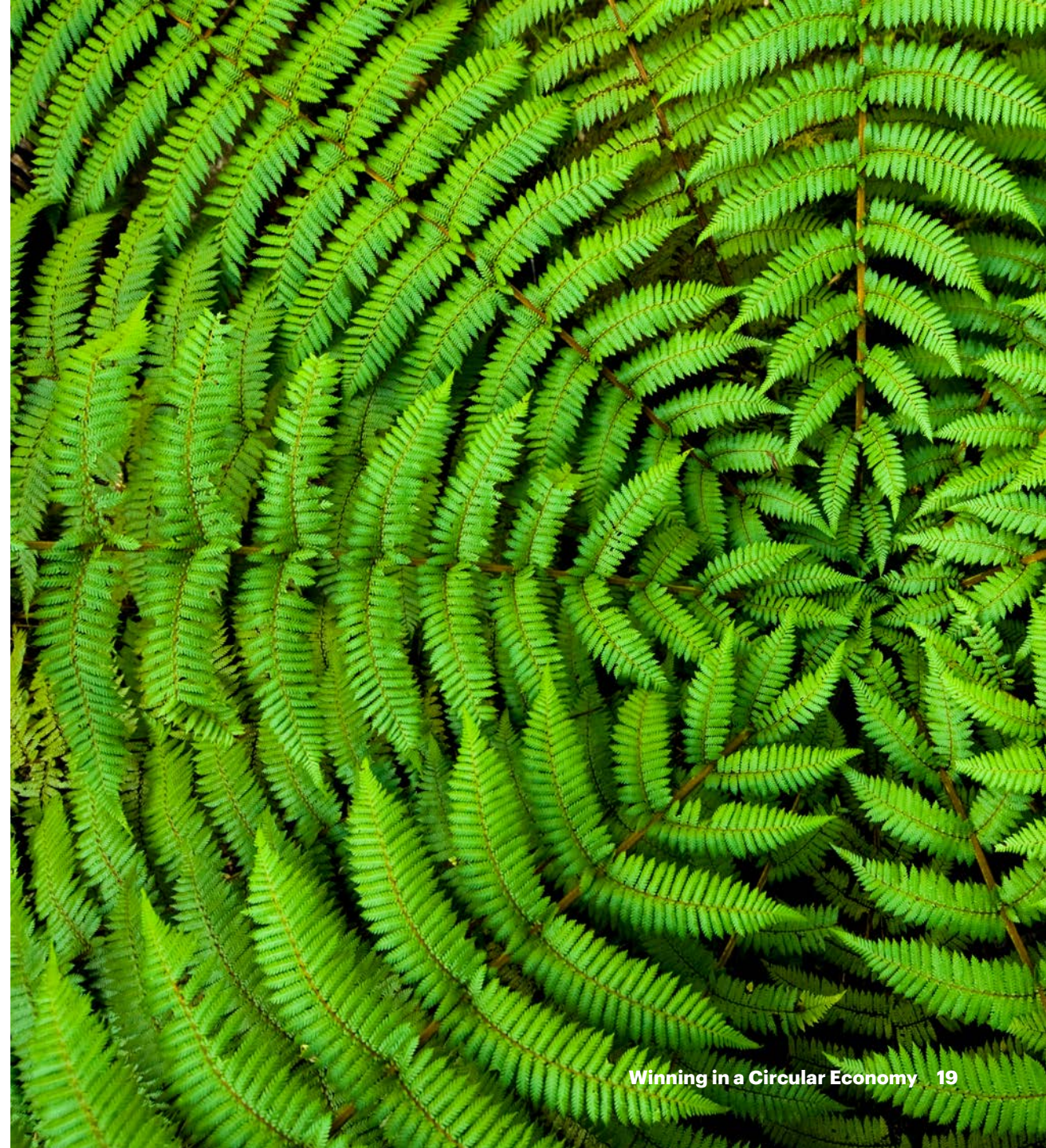
Re-invent

- High degree of innovation and scale benefits
- Centrally controlled, fully connected loops, value chains and assets
- Fast transition
- Typical disadvantages associated with “planned economy”

Source: Accenture

First, in a “free flow” approach, market forces would govern all development. Market players would establish their own loops and value chains, consisting of partnerships, ventures or simply long-term contractual agreements. Second, a semi-orchestrated approach based on existing asset configurations and locations would involve an orchestrating entity recommending and/or incentivizing the development of new business opportunities. Finally, a third approach could involve a complete reinvention of the European asset and infrastructural landscape, with a central authority fully coordinating and integrating value chains and material flows into loops. This would entail large-scale investments in new assets, such as chemical recycling plants with state-of-the-art technology, as well as transportation infrastructure to move waste streams and recycled feedstock.

Each of these scenarios has its pros and cons. For example, having a strong and active central authority might speed up the transition to a circular economy. But it also could run the risk of acting like a planned economy, which is typically associated with short-term improvements and long-term runaway costs, as actual market forces are dampened. A free flow scenario, on the contrary, while ensuring alignment and economic viability, may not achieve potential synergies and transition speed, and may turn out much more costly than a fully re-invented or orchestrated scenario. The extent to which the transition is managed by a central entity, or even by states, is a key question for the future.



Evolution of technology

There are five distinct loops for circulating molecules: using renewable feedstock, reusing products, mechanically or chemically recycling EoL materials, and capturing and utilizing carbon. Many of these have material- and application-specific challenges.¹⁷ The biggest challenge is current product design that features multiple blended, compounded or layered materials, which end up as dispersed mixed waste. If current product design is not changed, then mixed waste, which accounts for just 9 Mtpa today, will be the main secondary raw material source—literally, a non-specified mix of materials with highly varying quality, amounts of contaminants, etc. For example, while natural gas is tracked on a per-minute and m³ basis for each pipeline in Europe, there is currently a complete lack of such standardization, classification and tracking for EoL material flows. If, then, dispersed mixed plastic waste is to become such an important raw material source, machine learning-based sorting, digital product passports and other material identification technology, and new material-processing technology will be key to address the challenges it brings.

There is an immense emerging need for more powerful technologies to sort and clean EoL streams prior to mechanically or chemically recycling them, without causing severe degradation in material quality and asset performance. Machine learning, for example, is expected to enable completely new ways of sorting plastic waste. Sorting systems using image recognition software are already operating in various companies. But these have their limitations, because they must be trained manually to recognize different objects—and thus do not work well when sorting through the numerous shapes and patterns found in many waste streams. With machine learning, on the other hand, a system could keep learning over time automatically, as it inspects every single piece of garbage, strengthening its ability to recognize many types of objects in a very short time.

Digital passports of products could also improve waste sorting.¹⁸ These could be applied to numerous products in the form of codes or implanted chips, letting interested parties know at any time exactly which components are in the product. This information could be stored in a blockchain, making it possible to retrieve product-component data for many separate parts from different manufacturers, without any manufacturer having to disclose its complete product design. With such clear and error-free labeling, sorters could know exactly what they are working with. Using digital track-and-trace solutions could give brand owners an opportunity to prove clearly their circularity claims to consumers, helping to build trust and fuel the further adoption of circularity. And digital technologies applied to manufacturing could help chemical producers reduce waste generation, a key step in implementing more circular operations.

Novel and more effective methods for material processing are now being developed. Molecules obtained from chemical recycling routes, for example, can be inserted back into the chemicals value chain at different places, including much further upstream as feedstock for petrochemicals or as a direct precursor for plastics or other chemical products (Figure 6).

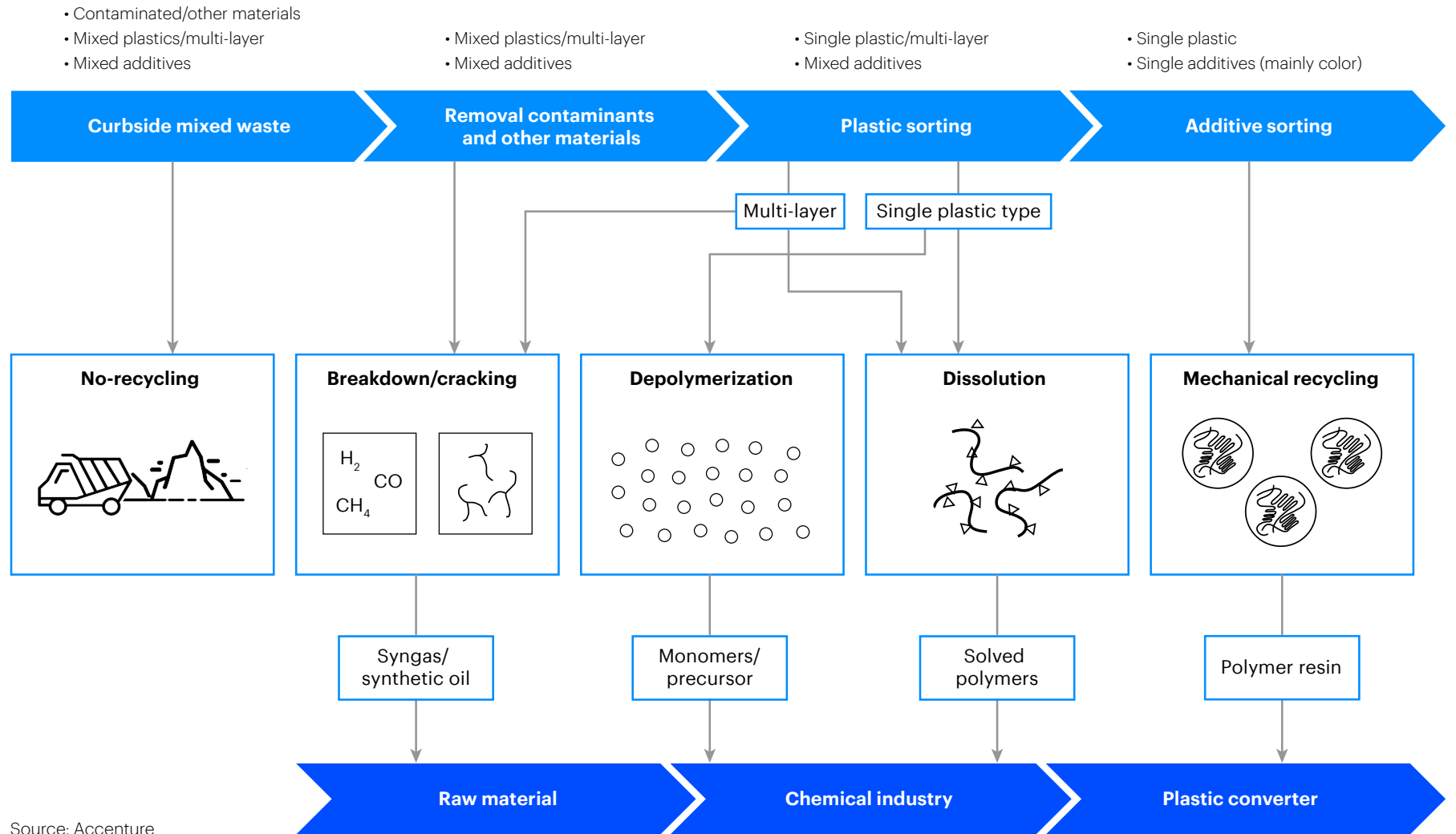
“Novel and more effective methods for material processing are now being developed.”

Chemical recycling technologies are needed to close the loops and complement rather than compete with traditional mechanical recycling.¹⁹

All in all, a broad range of technology development is under way. However, implementing new solutions at an industrial scale will require substantial research and development efforts to address technological challenges, and large investments will be needed to build assets. The voluntary commitments by brand owners to utilize recycled content are important; what’s needed now are supply-focused commitments to entire value chain steps in order to provide more certainty and make investment cases more attractive.

Figure 6

Overview of plastics recycling routes and corresponding waste stream feedstock



Source: Accenture

Break-even economics

The economic viability of engaging in particular loops is highly dependent on the combination of materials in the specific waste stream and the application that the secondary raw material made from that waste stream will be used for.

Today, there are already chemicals waste streams with clear breakeven economics, such as PET. High levels of homogeneity, a focused application spectrum and defined EoL points, coupled with easy identification, few contaminants, and the material properties of PET, are enabling low handling and processing costs, and thereby ensuring competitiveness compared to virgin material. For several additional plastic waste streams, such as polystyrene (PS), polyethylene (PE) and polypropylene (PP), there appears to be good potential for positive business cases.

However, there is also a growing number of emerging waste streams, such as textiles, lithium-ion batteries, photovoltaic cells, wind turbine rotor blades and even fertilizers, for which breakeven economics and technical feasibility are still challenges. There is greater promise, however, when sufficient amounts of high-value components, such as cobalt in lithium-ion batteries, are contained in waste streams.

The key value drivers of breakeven cases include the revenue potential (for both the recycle and valuable side products, such as precious metals) and cost drivers (of collection or waste purchase, pre-treatment, sorting, cleaning, reverse logistics and the recycling process).

Chapter 3

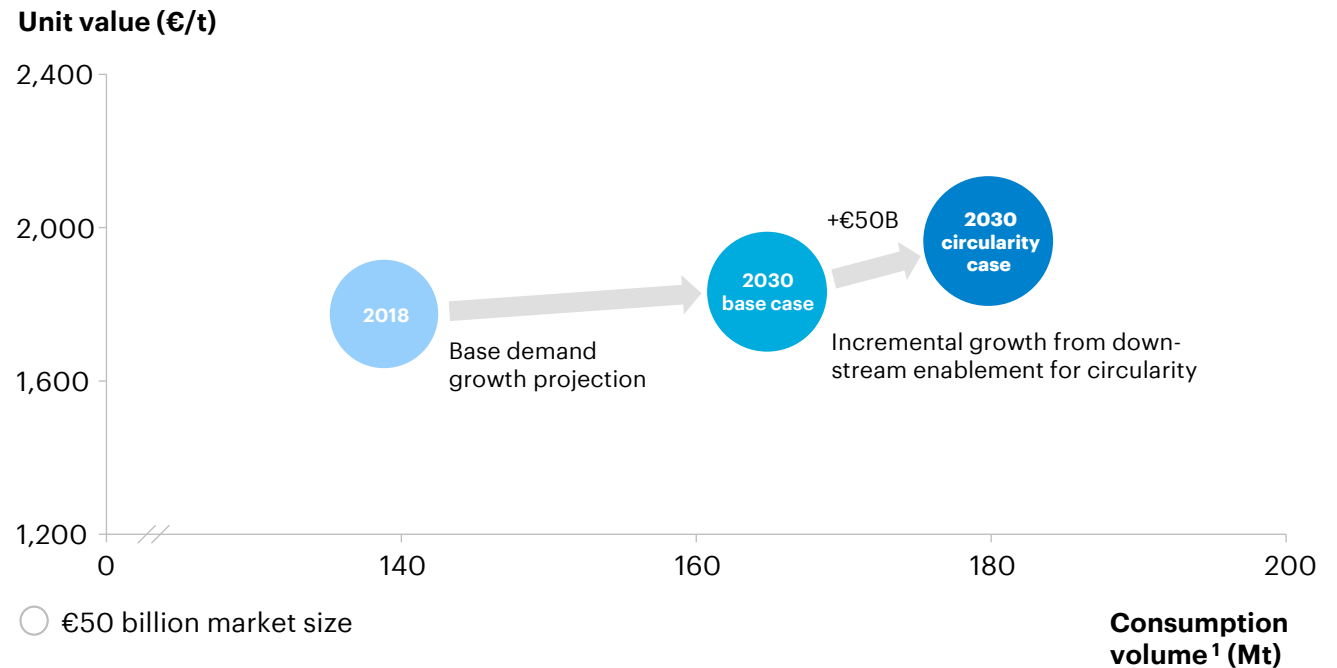
Moving into Circular: Options for Chemical Companies

In the EU, about 51.2 million tons of plastics were consumed in 2018, but only 29.1 million tons of plastic waste were collected.²⁰

In the absence of disruptions, Accenture expects plastics consumption to grow to 60.5 million tons by 2030. But consumer preference and brand owner commitments are reshaping current demand patterns, while bioplastics and non-plastics are partially substituting fossil volumes, and single-and short-term uses are increasingly being banned.²¹ The pursuit of reduced energy consumption, more re-use, higher durability and greater recyclability requires advanced material properties. Helping brand owners meet their commitments and enabling circularity in the downstream value chain offers considerable growth potential for chemical companies.

Figure 7

EU28 chemicals consumption across all products: Volume and unit value projection 2018-2030



Note: Data refers to chemicals sold to industry customers, not counting basic chemicals and intermediates that are further processed within the chemical industry

Source: Accenture

Incremental demand growth is likely to bring a price premium, relative to base demand growth. Taking into account all chemical products—not just plastics—and integrating numerous assumptions, the Accenture model projects consumption growing from 139 million tons in 2018 to 180 million tons in 2030, along with an increase in average unit value from €1,770 per ton to €1,960 per ton (Figure 7). Compared to the 2030 base case projection, circular economy-driven incremental growth represents a €50 billion value upside potential. The circular growth drivers can vary widely by product, and even within one product across various applications (Figure 8).

To take advantage of the huge opportunities that lie ahead, chemical companies should continuously challenge and develop their product portfolios, be on the lookout for cross-value-chain design partnerships, and evolve their organizations and capabilities by, for example, understanding EoL material streams, mastering the reverse value chain, and developing and marketing applications for secondary raw materials.



Figure 8

Heat map of circular economy impact on demand by chemical product and application

Projected overall CAGR 2018 – 2030 as the sum of base growth and circular economy incremental growth

		Chemicals/chemical group																																						
Segments	Acrylic paints & coatings	ABS, SAN	Alkyd paints & coatings	Carbon black	Catalysts	Crop protection of chemicals	Dyes	Epoxy paints & coatings	Ester solvent	EPS	Fertilizers	Glycolic acid	HDPE	Ketone solvent	LDPE & LLDPE	Lubricants	Other plastics	Other solvents	Other thermoplastics	Other paints & coatings	Pigments	PA 6 & 66	PC	Polyesters paints & coatings	PET	PMMA	PP	PS	PTFE	PU	PVC	Silicone	Specialty silica	SBR	Surfactants	Titanium dioxide	Wax			
Agricultural appliances													0.7%		0.8%		0.8%		0.8%						0.8%		0.8%	0.8%			0.8%									
Agricultural consumables						2.1%					0.2%																											1.7%		
Automotive	0.6%	0.2%	-0.3%	0.1%	<0.1%			1.1%					-0.1%		-0.1%		-0.1%		-0.1%			0.1%	0.6%	0.4%		0.2%	0.1%	-0.1%	0.9%	0.9%	-0.1%	0.4%			-1.4%					
Building & construction	7.5%	7.1%	6.6%					7.8%	7.2%				6.9%		7.0%		7.0%		7.0%			7.0%	7.0%	8.2%	7.0%	8.4%	7.8%	6.5%		8.3%	7.3%	7.6%				7.4%				
Consumer products												5.6%																						1.3%	1.6%		5.1%	1.2%	1.7%	
Electrical & electronics		1.2%											1.2%		1.0%		1.0%		1.0%				1.1%	1.9%		1.0%	2.3%	1.4%	0.1%	1.7%	1.5%	0.8%	1.7%							
Household, leisure & sport	1.1%	2.2%	0.3%				2.8%	2.8%		3.3%			3.4%		3.4%		2.4%		2.4%				2.5%	3.4%	2.1%	2.4%	2.4%	2.9%	1.8%		2.9%	1.8%	1.5%		1.6%	2.1%		3.1%		
Others	4.3%	1.2%	1.9%	1.6%			2.3%	5.2%	2.0%			2.5%	1.1%	0.9%	1.1%		1.0%	1.0%	1.0%	5.4%	0.7%	1.0%	1.0%	3.1%	1.9%	2.5%	1.6%	0.8%	1.6%	2.1%	1.5%	0.9%	2.5%	-2.8%	1.7%	0.6%	1.1%			
Packaging		-1.0%		1.1%						-0.9%			-0.2%		-0.2%		-0.4%		-0.4%				-0.4%	0.8%		<0.1%		0.4%	3.5%		0.4%	-1.2%							0.7%	
Process chemicals					3.9%				1.2%			2.6%		2.5%		0.8%		0.9%				3.5%								1.8%					3.5%		11.8%	5.0%	3.1%	
Technical applications	2.0%		1.2%	1.9%	2.5%			2.3%																1.6%										1.2%						

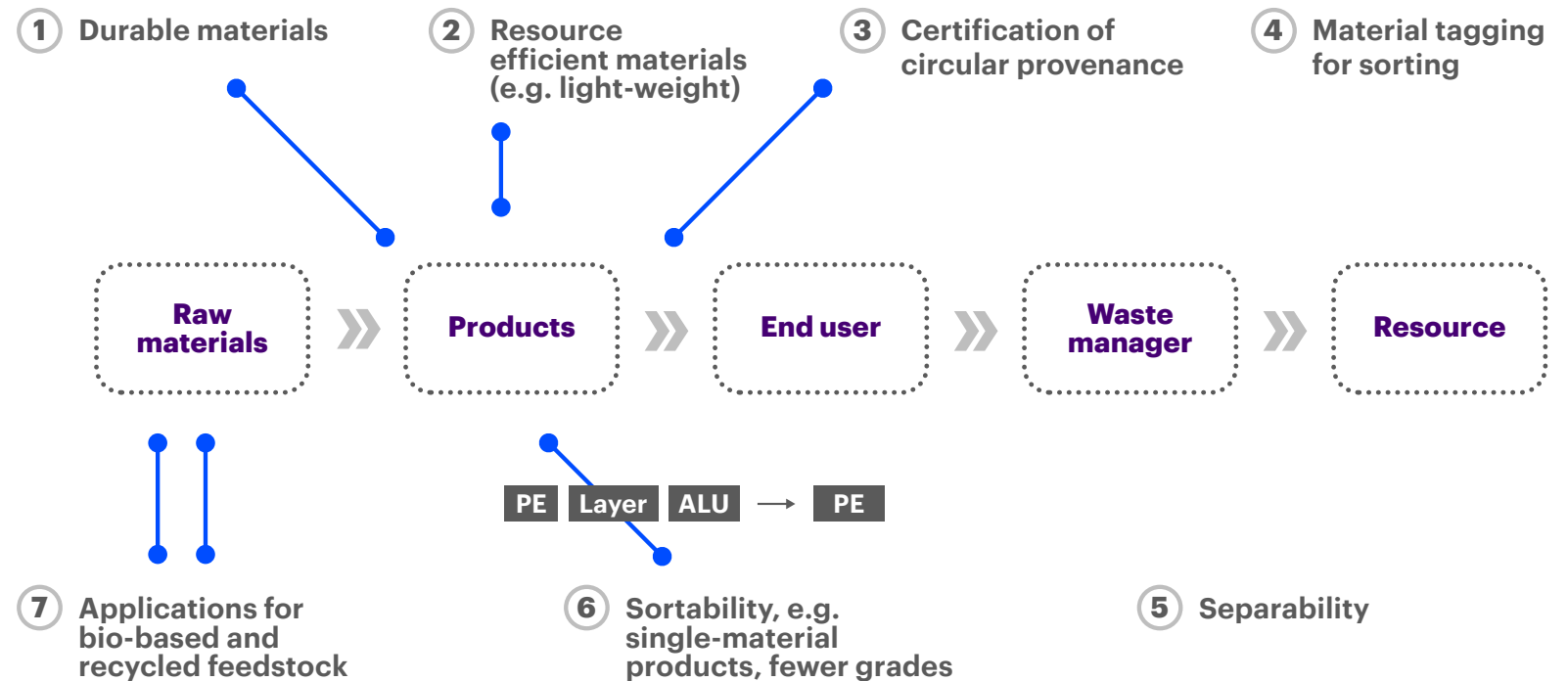
Source: Accenture

Designing for circularity

The redesign of products for circularity will need to be far-reaching and widespread. Otherwise, massive investment will be required, inefficiencies will increase due to the large portion of waste that cannot be handled, and a costly system that consumes large amounts of energy will emerge. Chemical companies have an opportunity to help avoid those problems by supplying high-performance materials that are resource-efficient, durable, separable, sortable, and recyclable—and thus enhance circularity in the downstream value chain (Figure 9).

Figure 9

Designing for circularity



Source: Accenture

For example, multi-layer and multi-material packaging is not easy to recycle due to the difficulty involved in separating the layers to produce single-material streams—which implies a need for more high-performing single-layer materials, as well as adhesives that are easier to split up.

There are very few rules or guidelines that obligate product manufacturers to enable upcycling in the design of their products or to ensure that individual product components can be replaced. In fact, manufacturers are often motivated to do just the opposite, since it is currently more lucrative to sell a completely new product than just a few individual replacement components. Thus, many products, such as mobile phones, are disposed of completely when only a single component, such as the battery, has reached the end of its lifetime, resulting in an immense waste of raw materials and energy. Without much more comprehensive

classification of materials and transparency on EoL streams, the move to circularity is bound to involve trial and error—an approach that would be uncertain, prone to poorly targeted investments, costly, and slow.

On the positive side, some policymakers are requiring manufacturers to introduce more modular designs for their products,²² and to design longer lasting products.²³

Being the first in the market with new circular-material solutions could provide a chemical company with a unique chance to tap into new sources of revenue and profit. Adjusting their organizations for circularity, identifying brand owners for development partnerships, and quickly building cross-value-chain pilots will be key to success.

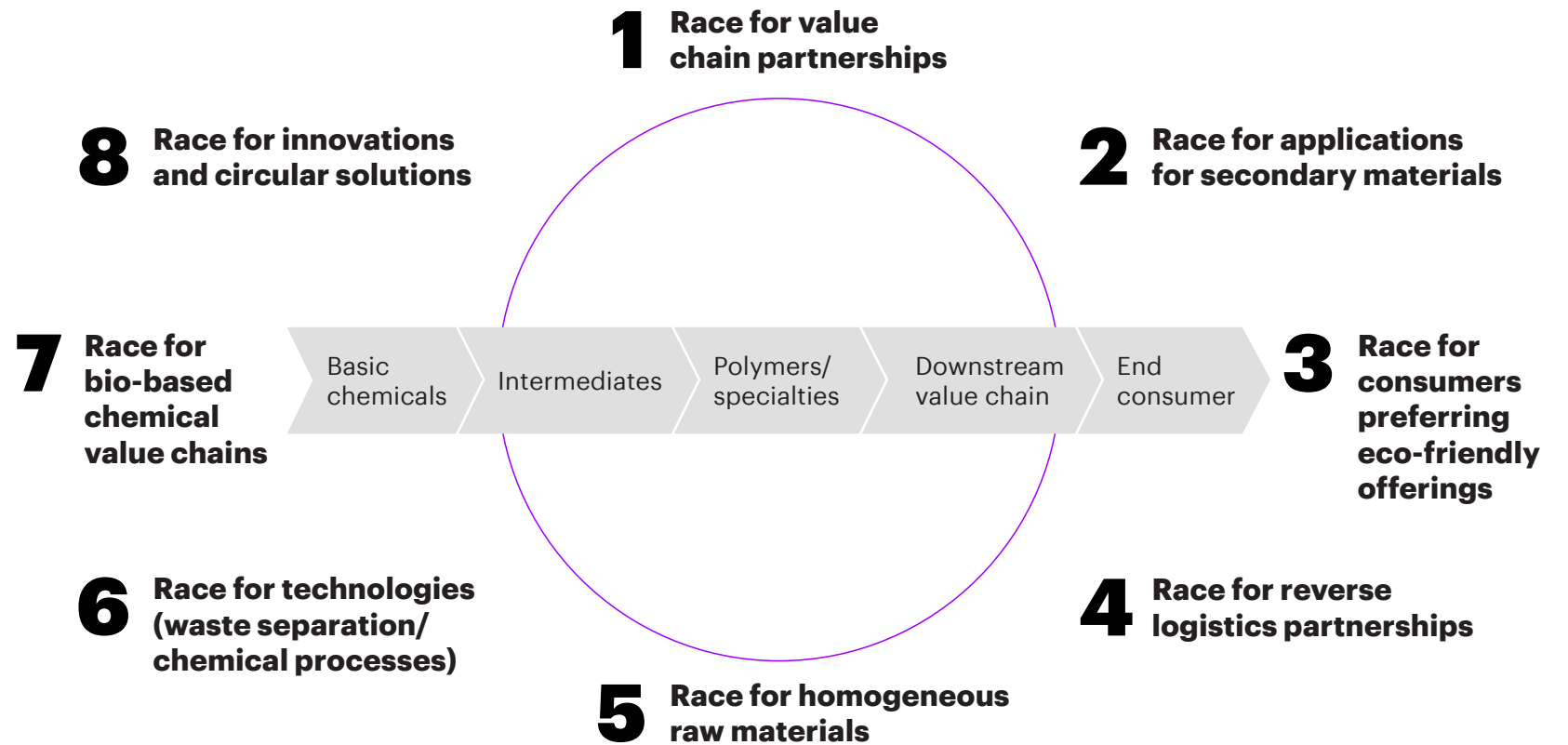
Occupying key “sweet spots”

In this environment, chemical companies will need to embrace the disruptive change that is reshaping the industry.

The emerging circular value chains will provide an opportunity for chemical producers to go beyond the traditional business models of simply making and selling molecules, and instead participate in more portions of the value chain. The race to occupy “sweet spots” in the future value chains is already on (Figure 10).

Figure 10

Races for “sweet spots” in future value chains



Source: Accenture

Increasing collaboration across the value chain

In the circular economy, there is a need to ensure constant quality and quantity in the supply of waste streams as feedstock; to gain access to the reverse logistics infrastructure; to operate recycling assets (or find partners to do so); and to drive continuous demand for recycled products. None of today's players have the capabilities and experience needed to meet all these requirements on their own, especially when it comes to chemical recycling. Therefore, it will be increasingly vital to collaborate across the value chain and forge new alliances in order to take advantage of many of tomorrow's opportunities. Potential collaboration models range from chemical company/waste manager cooperation to a variety of combinations that could involve multiple parties, such as chemical recycling technology providers, converters and brand owners.

These partnerships already are starting to appear and coalesce into circular ecosystems along the value chain. For example, in a project supported by the European Commission, BASF and Adidas are working together to develop a textile fiber reinforced composite for infinite recycling loops. And the SABIC chemical company is partnering with chemical recycling startup Plastic Energy and several customers to substitute recycled plastic waste for petrochemical feedstock.²⁴ Going forward, Accenture also expects to see collaboration enhanced by an increasing transition from the traditional domain boundaries of the established industry associations towards outcome-driven cross-value-chain associations, such as the Alliance to End Plastic Waste that was established in early 2019.

For chemical companies, it will be important to make value chain collaboration part of a systematic overall circularity strategy, and to enter strategic partnerships sooner rather than later.

Chapter 4

Call for Action

Most chemical companies are now recognizing the importance of adapting to the circular economy.

They often have an executive or department charged with circular economy-related activities, but those activities tend to be fragmented. And they are often not fully embedded in the strategic context of the company. Massive opportunity exists for those who craft a circular vision, place strategic bets, build new niche business models and take advantage of novel technologies in this emerging world. That will require significant change—and deciding how to proceed can be daunting.



However, the following sequence of steps can serve as a high-level guideline:

- 1.** Re-evaluate the target product portfolio for expected changes in demand patterns and integrate an understanding of the associated opportunities and risks into business strategies.
- 2.** Shift capital investments from assets designed for linear, virgin materials to new, circularity-focused assets—with an eye toward large-bet investments in unproven technology such as chemical recycling or carbon management. Develop a long-term ramp-down/exit strategy for assets and applications where demand is likely to decline.
- 3.** Systematically develop circular capabilities across the entire organization—e.g., train the sales force to locate customer segments that are willing to pay price premiums for circular products.
- 4.** Reorganize for circularity. Legacy organizations optimized for linear business models will block the shift to more circular approaches. Consider setting up separate new companies/organizations to focus on circular growth and accelerate time-to-market for circular solutions.
- 5.** Capture opportunities from brand owners' voluntary commitments. Build cross-value-chain pilots rapidly, in areas such as identifying brand owners for development partnerships and securing access to EoL streams and reverse logistics capabilities.
- 6.** Pressure-test and redefine existing business models, business by business.
- 7.** Build trust with consumers by proactively driving circularity in operations, and by developing communication strategies to build public confidence in chemical companies' messages about environmental impact and, ultimately, help regain control of the circularity narrative.

Chemical companies have a powerful opportunity to lead the way to a more circular and sustainable world. But much of what will be required in the circular economy represents new territory.

As a result, it will take time to develop and execute circular economy plans and build the new capabilities and business models that will be needed. But the world is already moving ahead: The circular economy train is leaving the station, and chemical companies need to pick the role they will play in its journey. This makes it critical for them to develop systematic, strategic approaches. Those that do will be positioned to help set the agenda for change—rather than simply react to events—and ultimately thrive in the circular economy.

About the research

This executive summary is based on a comprehensive report produced by Accenture that explores the practical implications of the circular economy for chemical companies. The report acknowledges that bio-based feedstock, as well as carbon capture and utilization, will play a role in the circular economy, too. However, with the growing interest of economic stakeholders and increasing technological readiness, it focuses largely on the opportunities from end-of-life waste stream recycling and fossil feedstock substitution, particularly through chemical recycling.

This report is a continuation of the conceptual research completed in 2017 on what the circular economy means for the chemical industry (“Taking the European Chemical Industry into the Circular Economy”), as well as how changing consumer demands and buying behaviors are impacting the industry (“Chemical (Re)action: Growth Opportunities in a Circular Economy”) and other Accenture research on the circular economy in general.

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