

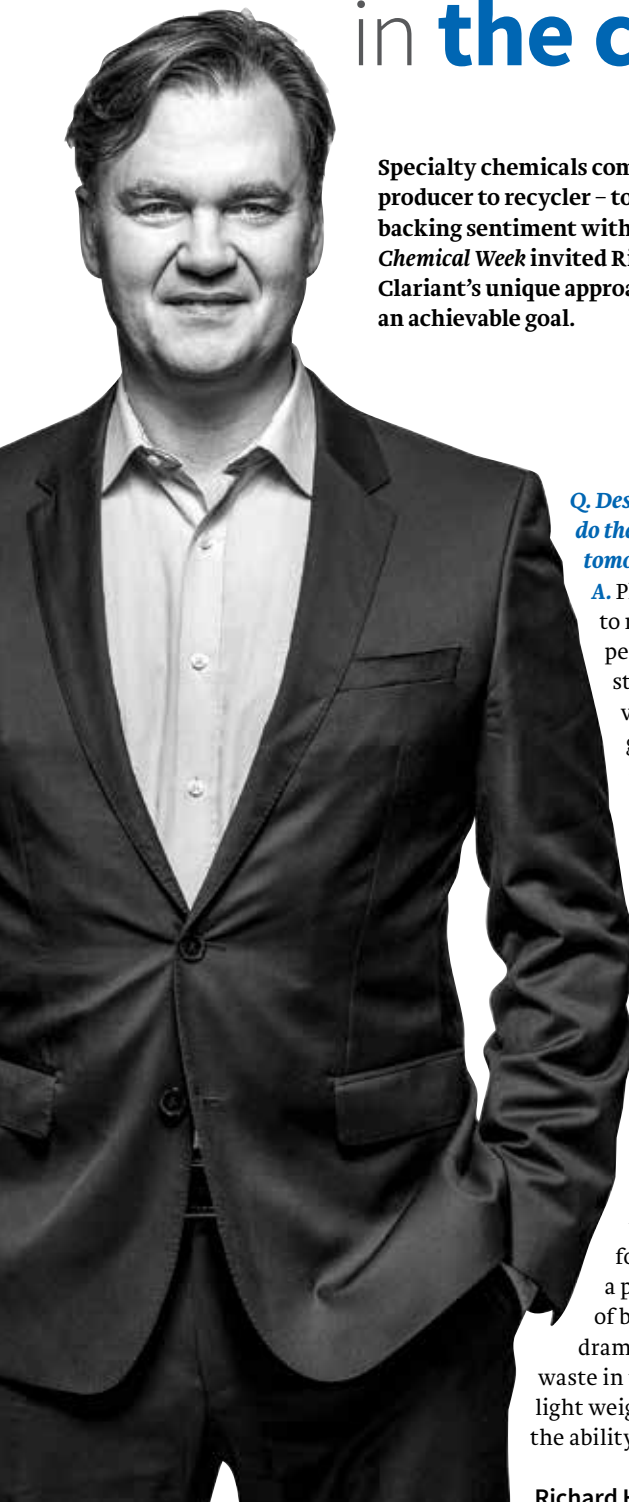
# Chemical Week

20/27 May 2019



## De-demonizing plastics use

# Creating a welcome home for plastics in **the circular economy**



Specialty chemicals company Clariant advocates collaboration across the whole plastics value chain – from producer to recycler – to assist transition from a linear to a circular, resource-efficient economy. And it is backing sentiment with proactive steps.

*Chemical Week* invited Richard Haldimann, Head of Innovation Excellence and Business Incubator, to share Clariant's unique approach to rethinking the plastics waste challenge and making a closed loop for plastics an achievable goal.

**Q. Despite plastics' negative image, do they still have a place in tomorrow's society?**

**A.** Plastics have become integral to modern life. Their superior performance in terms of strength, light weight and versatility has led to huge growth and popularity, with demand for plastics continuing to rise. Global plastics production reached almost 350 million tons in 2017, up on 2016. Plastics make technological advancements possible and make day to day living more comfortable.

But in the general sustainability picture, plastics are an interesting case, a challenge and a success. With all the negativity that surrounds their use, it can be easy to forget that they have mostly a positive impact. The advent of better plastic packaging has dramatically decreased food waste in the food value chain. The light weight of plastic containers and the ability to pack them tightly help

save fuel and space during transportation. And plastics have increased the durability of products in many aspects of modern life. A detailed life cycle analysis in the *International Journal of Lifecycle Assessments* in 2013 highlighted PET bottles for carbonated drinks as being more sustainable than glass or aluminium packaging, assuming typical recycling rates for glass and aluminium and the use of virgin PET. This picture will further improve with increasing use of recycled PET.

Industry and society have a collective responsibility to work more closely together to see how we can best embrace their advantages and take plastics into the circular economy. With our experience in improving plastic materials, we consider Clariant to be well positioned to contribute.

**Q. Is eliminating plastic waste the answer?**

**A.** There needs to be a definite move towards closing the loop and keeping plastics out of the environment, starting from single-use plastics. Every year, about 200 million tons are disposed of in landfills and about eight million tons leak into the oceans uncontrolled. There has to be an end to the current take-make-dispose consumer attitude and moving towards a circular economy for post-consumer plastic will help with changing that approach.

**Q. What is preventing broad adoption?**

**A.** These days it is quite common for big consumer brands to make commitments related to tackling plastic waste, getting rid of single-use plastics, and

Richard Haldimann, Head of Innovation Excellence and Business Incubator, Clariant

using higher amounts of recycled plastics. However, they need support to reach their goals. Chemistry has a crucial role to play in supporting changing awareness and new regulations, such as the EU ban on specific single-use plastics by 2021, with the solutions necessary to reduce, re-use and recycle plastics.

Clariant has been focusing attention on advancing plastics in this direction and that of the broader circular economy for years. But we've learned from experience that the wider problem can't be solved at an individual company level. It's a system problem and collaboration is key.

I'm proud to say that we're already doing it within our own organization, bringing together experts from across our business areas to identify and develop integrated solutions. This level of internal collaboration is a pretty unique approach within our specific industry. We're now systematically taking that to a macro scale through partnerships across the value chains we serve and we expect that will have a significant impact on the problem. Areas in focus include contributing towards advancing recycling potential, improving durability so that a plastic or plastic product maintains its properties and continues to be useful, and supporting innovation with regards to bio-based and bio-compostable products as potential solutions.

**Q. Has collaboration never been done to this extent before?**

**A.** Collaboration between chemical companies and individual parts of the value chain isn't new. Where our approach stands out is by drawing on our cross-business and technology capabilities and actively encouraging networks of partners from across the plastics value chain. Intense value chain collaborations - reaching from raw material suppliers to resin producers, masterbatch producers / compounders, to machine producers to converters and major brand owners - will ensure that the developed solutions will be finally adopted in the market.

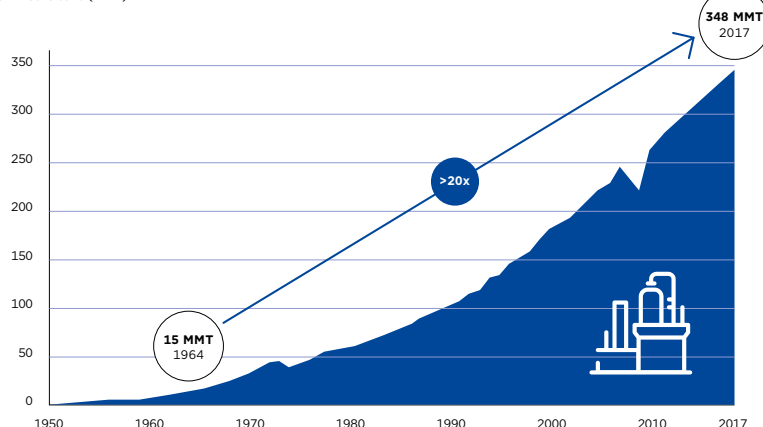
Additionally, to make sure these projects will have an impact, not only do we need to align the capabilities of different parties along the value chain but also collectively align on the same final and sustainable objectives, beyond each specific company interest. Finally, these objectives need to be the same norms that governments, NGOs and all interested stakeholders work towards.

We can deliver much more value this way than if we try one business at a time.

We'll be sharing more on our unique push for greater collaboration at K 2019, where we are

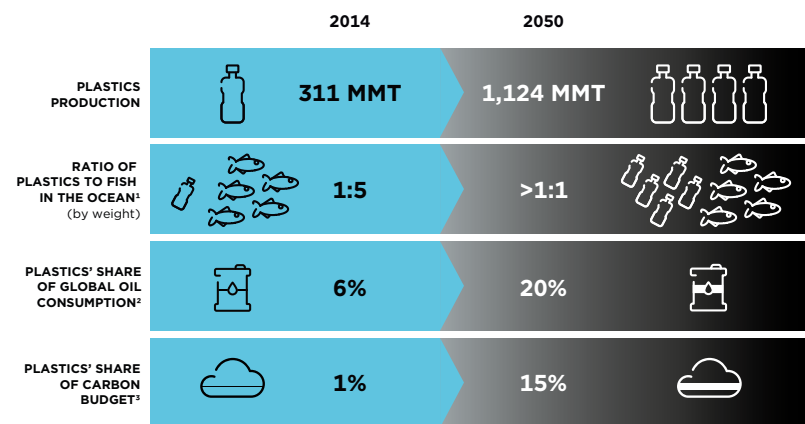
## GROWTH IN GLOBAL PLASTICS PRODUCTION 1950-2017

Million metric tons (MMT)



Note: Production from virgin fossil-based feedstock only (does not include bio-based, greenhouse gas-based or recycled feedstock)  
Data source: PlasticsEurope Market Research Group (PEMRG) / Conversio Market & Strategy GmbH accessed via: Plastics - the Facts 2013, 2015, 2018 by the PlasticsEurope Association of Plastics Manufacturers

## FORECAST OF PLASTICS VOLUME GROWTH, EXTERNALITIES AND OIL CONSUMPTION IN A BUSINESS-AS-USUAL SCENARIO



<sup>1</sup> Fish stocks are assumed to be constant (conservative assumption)

<sup>2</sup> Total oil consumption expected to grow slower (0.5% p.a.) than plastics production (3.8% until 2030 then 3.5% to 2050)

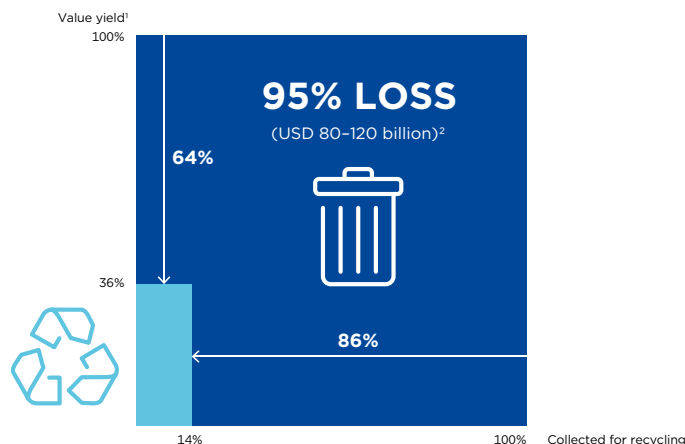
<sup>3</sup> Carbon from plastics includes energy used in production and carbon released through incineration and/or energy recovery after-use.

The latter is based on 14% incinerated and/or energy recovery in 2014 and 20% in 2050. Carbon budget based on 2 degrees scenario Source: PlasticsEurope; ICIS Supply and Demand; IEA, World Energy Outlook (2015) (Global GDP projection 2013-2040 and Central 'New Policies' scenario oil demand projection 2014-2040, both assumed to continue to 2050); Ocean Conservancy and McKinsey Center for Business and Environment, Stemming the Tide: Land-based strategies for a plastic-free ocean (2015); J. R. Jambeck et al., Plastic waste inputs from land into the ocean (Science, 13 February 2015); J. Hopewell et al., Plastics recycling: Challenges and opportunities (Philosophical Transactions of the Royal Society B, 2009); IEA, CO<sub>2</sub> emissions from fuel combustion (2014); IEA, World Energy Outlook Special Report: Energy and Climate Change (2015); Carbon Tracker Initiative, Unburnable Carbon (2013).

excited to be launching a specific initiative to help get the various value chain partners talking and collaborating so that developments progress in the right direction. It will also make it easier for the market to see the extent of Clariant's current recycling-related offerings and where these can support their particular business needs.



## PLASTIC PACKAGING MATERIAL VALUE LOSS AFTER ONE USE CYCLE



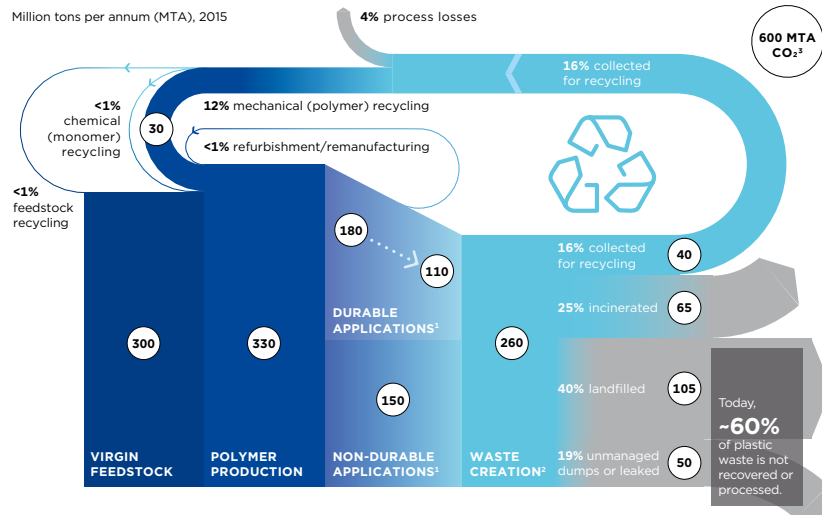
1 Value yield = volume yield x price yield, where volume yield = output volumes/input volumes, and price yield = USD per ton of reprocessed material/USD per ton of virgin material  
 2 Current situation based on 14% recycling rate, 72% volume yield and 50% price yield. Total volume of plastic packaging of 78 Mt, given a weighted average price of 1,100-1,600 USD/t  
 Data source: Expert interviews; Plastic News; Deloitte, Increased EU Plastics Recycling Targets: Environmental, Economic and Social Impact Assessment Final Report (2015); The Plastics Exchange; plasticer; EUWID; Eurostat

something we have already extensively done, together with our customers, in all regions of the world. For example, through additives that extend the usable lifetime of plastic agricultural films beyond their typical lifespan. Or additives that extend the property spectrum of plastics, thus allowing more efficient use even with thinner gauges.

Our second contribution comes from helping to design plastic products for improved recyclability and reuse. That can mean both selecting the type of additives which fit best to the current and future recycling processes e.g. use of our halogen-free flame retardants, as well as supporting the industry in designing or redesigning materials and products to make them easier to separate, recover, and reuse. For example, use of Licocene® adhesive allows for easier recycling of carpets and other plastic parts in vehicle interiors.

Some of these products come from renewable resources and many of them, including stabilizers, flame retardants and surface modifiers, additionally carry our EcoTain® flagship label for sustainability excellence. This highlights solutions offering excellent sustainability advantages and which add value to customers and society as a whole. Each product and solution carrying the EcoTain® label has undergone a systematic, in-depth screening process using 36 criteria spanning all three sustainability dimensions: social, environmental and economic.

## GLOBAL POLYMER FLOWS



1 Durable applications with an average lifetime >1year will end up as waste only in later years, non-durable applications go straight to waste  
 2 150 MT mixed plastic waste from nondurable applications that end up as waste in same year plus 110 MT of mixed plastic waste from production in previous years  
 3 Total CO<sub>2</sub> production per annum including virgin plastics production but excluding plastic processing  
 Data source: McKinsey plastic waste stream model

### Q. What could Clariant's contribution to closing the loop look like?

A. We can contribute in several important ways. First, we can help improve efficiency in the use of plastic products by, for instance, extending their effective lifetime and reducing the amount of material needed for plastic parts. Reusing a plastic product several times because it's more durable reduces waste. That's

### Q. Do you see room for improvement with regards to post-consumer or post-industrial recycled plastics?

A. We are further developing solutions that can help eliminate some of the present challenges in the functionality, appearance and other critical properties of post-consumer (PCR) or post-industrial recycled (PIR) plastics, also by compensating for the inconsistent quality of the recycled material. This way we can make them more suitable for the demanding consumer or industrial requirements.

For this we have engaged in several value chain collaborations where we work on pressing issues arising from PCR usage, for example, in the production of PET and Polyolefin bottles, using bespoke masterbatches to guarantee consistent coloration, reduce smell and ensure better mechanical properties. Together with material development, these solutions will enable brand owners to fulfill their pledges of using significantly higher percentage rates of PCR in their packaging.

Another area where we presently see short-term room for improvement across the industry is the actual production of recycled resin materials at



recyclers. For example, it's no good having manufacturers pushing to use 100% recycled materials if the necessary quality of post-consumer or post-industrial recyclate is not available for them to access. Collaboration between brand owners, Clariant, resin producers, plastics and packaging processors, and the recycling companies will help find the answer to the challenge.

**Q. Are you already seeing the results of your partnership approach?**

**A.** Collaborating across our business units has already opened opportunities that we would not have identified otherwise. In one case we had a workshop involving representatives of three different businesses and a recycling company that would usually not be in focus for any of the business units. The potential solution we identified requires input from all three business units and has the potential to dramatically improve the quality and economics of the company's recycling process.

**Q. Can you give a taste of recycling projects on the horizon?**

**A.** One of the long-term sustainable solutions is enabling chemical recycling of plastic with plastic waste converted into either a state that makes it suitable to be completely re-used or converted into product streams from which brand-new plastics, or fuels can be made. We are working particularly on enabling technologies to help convert plastics chemically, for example by providing adsorption technologies that help remove harmful impurities detrimental to this new type of recycling. Within Clariant, by collaborating across our disciplines in chemical- and mineral-based enabling technologies, we are uniquely positioned in the industry to help make these promising new technologies become commercially viable.

**Q. Is it realistic to envisage a future where all plastics can be 100% recycled or will biodegrade?**

**A.** The aspiration of many of our customers is to switch to using mostly or only plastics that are recyclable or fully biodegradable, if they would suit their needs. We believe that, through innovation in the recycling industry as well as designing products for recycling, this is a possible long-term objective. It will require, however, significant investments and a close collaboration between regulators and the industry.

**Q. Is the new recycling initiative just one of many being introduced by Clariant to support the circular economy?**

**A.** Creating a circular economy is more than promoting

improved recyclability or reusing the technical attributes of plastics for other products. It also involves a cradle-to-grave approach.

An example of a product range which already fits to the circular economy is Clariant's new Licocare® RBW. This is a family of high-performing lubricants and dispersing agents based on renewable crude rice bran wax that fulfil the highly demanding requirements set, for example, by the transportation and electrical and electronic industries.

**Q. Can the industry ultimately move towards a circular plastics economy?**

**A.** K 2019 will provide us with an excellent opportunity not only to introduce our unique approach to the plastics industry but to reinforce that we are willing partners, ready to listen and open to collaborate to develop solutions to advance this goal.

Internal collaboration is only the first step in the right direction to a true circular plastics economy. Collaboration with different players in the broad recycling ecosystem will be crucial. Meet us at K 2019 in Düsseldorf to discover more on our sustainable collaborations' projects and the products behind them.

*Richard Haldimann PhD is an "out-of-the-box" thinker, passionate about innovation and sustainability. He has a chemistry background and hands-on expertise in identifying and developing sustainable growth opportunities. He also was part of the founding team of the startup XiMo and sits on the board of the ETHZ spinout Haelixa AG.*

# Repsol and the **circular economy**



↑ Repsol Technology Lab in Madrid. There are more than 200 researchers from around the world with a variety of specializations working for all businesses within the company.

➤ **For Repsol, it is a priority to facilitate the** Circular Economy model set in its 2018-2020 Strategic Plan, continuously looking for opportunities within its business lines to evolve to a new manufacturing model based on waste reduction, as well as optimization of virgin raw materials in line with the European Union objective to achieve the transition from a linear economy towards a circular model.

Repsol, the leader in the polyolefin market in Spain and Portugal, offers to its clients the capabilities of its Technology Lab research center, as well as its experience in the development of new products for its value chain. The company, committed to the circular economy of plastics, has dedicated many years to innovation and has participated in numerous innovation

projects aiming towards increasing the circularity and efficient use of the plastic materials it produces. Anticipating society's demands and with the intention of offering its customers highly differentiated products, Repsol intends to promote this new business model among its customers and suppliers.

Following Repsol's adherence to the "Pact for a Circular Economy" in October 2017, together with the main economic and social agents of Spain, the company's chemical business additionally signed up to the PlasticsEurope Voluntary Commitment "Plastics 2030," subsequent to the European Commission's announcement on their Plastics Strategy that aimed to have 60% of plastic packaging coming from recycled or reused polymers by 2030.

Additionally, Repsol joined the “Circular Plastics Alliance” (CPA), in December 2018, an initiative of the European Commission to promote recycled plastics, by increasing the volume of recycled plastic in the EU market to 10 million metric tons by 2025 compared to the 3.8 million metric tons recorded in 2016.

#### Reciclex project

As a specific commitment to the CPA, Repsol presented its Reciclex project, which focuses on the commercialization of polyolefins that incorporate a percentage of mechanically recycled plastics as a secondary raw material, preserving and prioritizing the functionality of the composite, at the same time to provide a high-quality material, focusing on upcycling in the final application. This strategic project to promote the circularity of its materials involves agreements with different members of the value chain to guarantee the supply of homogeneous materials, as the shortage of recycled material with consistent quality levels required by the market is one of the causes that limit the potential use of recycled plastic materials. With this project, Repsol aims to reach new markets and more technically demanding final applications.

Additionally, to further support its commitment to the CPA, Repsol has an ongoing initiative to incorporate mechanically recycled plastics in the formulation of its 25 kg multi-layer industrial bags, which will directly increase the demand for recycled plastics.

Within the scope of this project, Repsol and Saica Natur - Spanish based company with expertise as a waste manager and low density polyethylene (LDPE) recycled pellets producer - signed a collaboration agreement in order to maximize the use of low density polyethylene (LDPE) film waste. With this agreement, Repsol and Saica Natur intend to combine their knowledge and skills to achieve a new polyolefin that incorporates post-consumer recycled material, and ensure quality consistency, to access new applications where recycling has hardly penetrated yet.

“In an environment increasingly oriented to the circularity of resources, film waste recovery is a challenge and a business opportunity alike,” says Roberto Gómez, Circular Economy Manager at Repsol’s Chemicals Division. “The objective of these agreements is to offer new materials that meet the demanding requirements of the end markets, combining the know-how of companies

As one of the targeted applications, Repsol through its Reciclex project commercializes a new polymer range for the automotive industry containing a percentage of recycled product from end-of-life vehicles ↓







At this cutting edge Technology Lab, strategic projects are carried out that seek to meet the energy needs of the present and the future, as well as facilitate the evolution towards a more efficient and sustainable energy model.



↑ Located in the heart of the Spanish capital, Repsol's Campus is regarded as an architectural benchmark worldwide that reflects its culture and the company's ongoing evolution. It is an open space specially designed to facilitate communication and teamwork between more than 4,000 professionals from across all of the company's areas and business units that work there every day.

in waste management, plastic recycling, and development of new polyolefin applications."

Additionally, Repsol is boosting its Reciclex project in the automotive sector with a collaboration agreement with the Spanish plastic recycler ACTECO and the Authorized Treatment Facility (ATF) Autodesguaces El Choque. This agreement guarantees the supply of homogeneous materials, required to investigate the possible development and commercialization of polyolefins containing a percentage of recycled product from end-of-life vehicles, to be marketed for new applications, including Repsol's polymer range for the automotive industry.

Further successful milestones within the Reciclex project are the recent approval of some tailor-made grades for packaging, obtained from

scraps, and non-woven bags for special applications.

#### Mandala Project

Repsol is participating in the Mandala Project, a Horizon 2020 EU funded project, aiming for a sustainable solution for the flexible plastic packaging sector, based on a combination of a novel product and technology to efficiently delaminate multilayer films—fully produced with recycled and/or bio-based polymers—to help sorting and cleaning processes, to recover all fractions of the original product with high purity levels. According to PlasticsEurope, approximately 40% of the plastic demand in 2016 in Europe went to packaging (around 20 million metric tons). Although in the last 10 years, the plastic packaging recycling rate has increased by almost 75% in Europe, a large percentage is still landfilled or used in energy recovery.

#### Zero Project

Repsol has devoted through its Zero Project many resources to help to industrialize the emerging chemical recycling of plastic waste technology, and it is one of the leaders in seeking novel solutions to boost the Circular Economy. For that purpose, Repsol has been a pioneer in the use of the materials obtained through plastics' chemical recycling on an industrial scale.

In 2015, Repsol started to experimentally feed pyrolysis oil to its industrial complex in Puertollano (Spain) from chemical recycling of plastic waste. This project focuses on chemically recycling plastic waste streams at the end of their life cycle, that cannot be otherwise recycled and therefore would cause a negative environmental impact.

The company intends to promote a large amount of plastic waste, that currently goes to landfill, by transforming it into new raw materials for Repsol's petrochemical processes and, thus, it aims to boost the new Circular Economy business model.

This presents a transversal opportunity to support the Circular Economy, allowing Repsol's Refining and Chemical businesses to deliver potential benefits to society. On the one hand, it is an alternative raw material for the Refining business, and on the other hand, a means for Repsol's Chemical business to offer its clients polymers from a "plastic to plastic" source with equivalent properties to those of virgin polymers. It is a potential solution to the problem of plastic waste to landfill, based on the circular economy, to close their life cycle.

### Polyinspire Project

Repsol is additionally working on the Polyinspire Project, a Horizon 2020 EU funded project, to develop new solutions for polyurethane waste. The Polyinspire Project seeks to improve the recyclability and efficiency of polyurethane foams by using microwave and smart magnetic particles to increase the yield of chemical recycling processes.

Additionally, within the framework of Repsol R&D initiatives, the company is developing a new technology for the biotechnological conversion of polyurethane waste into added-value products using microbial activity

### Operation Clean Sweep (OCS) Project

Plastics are indispensable, contributing to energy and resource efficiency and enhancing the quality of our lives. To prevent marine litter, plastic products require responsible management through their life cycle by implementing proper waste management systems, mindful product design, and responsible consumer behavior. Repsol continues to actively engage with other interest groups and partners to advance long-term, collaborative solutions to meet this goal.

The phenomenon of plastic waste leaking in the environment is one of the most alarming challenges the industry currently faces as a global community. Plastics are crucial in enabling more sustainable solutions across a wide range of applications. However, the loss of this valuable material to our environment is unacceptable. The plastics industry remains fully committed to contributing with solutions to plastics pollution. Plastic pellets might not be one of the top items found on beaches, but plastic producers are determined to prevent pellet spill from their facilities. The industry has set up a voluntary program, Zero Pellet Loss, based on Operation Clean Sweep (OCS) to drive best practices in pellet management and strive towards zero loss of pellets, flakes, and powder.

Accidental pellet spills can occur at any point of handling along the plastics value chain – whether during routine processes or in unexpected circumstances, like extreme weather.

Measures adopted by Repsol, such as good worksite practices, training for employees and engaging with value chain partners have been taken by investing over 2 million euros at their sites and there is already a budget to be spent to cover these required investments.

Repsol is fully committed to innovation in order to increase the circularity and efficient use of plastics materials, with the aim of encouraging the transition towards this new economic model and is carrying out multiple projects to continuously provide solutions to its customers, society and the environment.



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↑ Repsol, is fully committed to the OCS voluntary program that strives towards zero pellet loss. The measures adopted by Repsol to drive best practices in pellet management have been taken by investing over 2 million euros at their sites and there is already a budget to be spent to cover these required investments.

## ➤ About Repsol

Repsol is a global multi-energy company present throughout the value chain. It employs more than 25,000 people; its products are sold in more than 90 countries and reach 10 million customers. It produces over 700,000 barrels of oil equivalent per day and has one of the most efficient refining systems in Europe. It operates low-emission power generation assets and is developing renewable photovoltaic and offshore wind projects. The company is a pioneer in the development of mobility initiatives that contribute to innovative solutions and new energies for transportation.

Repsol manufactures and markets a wide variety of chemical products, ranging from basic petrochemicals to derivatives. In addition, the company has three large petrochemical facilities in Europe where high added-value differentiated products are developed.

[www.repsol.com](http://www.repsol.com)



# Chemistry drives the circular-economy transition



↑ The Crescentino plant.

➤ **The circular economy model should be considered as** a natural and necessary evolution of our economic system. There is no doubt that the future of industry will be driven by low-carbon and circular solutions and chemical companies can really improve their competitiveness and grow by pursuing innovation in this framework.

Daniele Ferrari, CEO of Versalis, the Eni chemical company, discussed extensively these topics at the annual IHS World Petrochemical Conference in San Antonio (Texas), and emphasized that turning these challenges into opportunities is the key to securing sustainable economic growth for global society and industry.

## Growing world, growing needs, growing waste

Our world is at the crossroads of major transformations: the global population is expected to increase by another billion by 2030 and concentrate in megacities with more than 10 million citizens. Products, food and energy will increasingly be required and consequently emissions, pollution and waste will grow.

Therefore, industry will face a dual challenge: on one side contributing to the development of innovative solutions for the increasing demand for energy and goods, on the other managing this growth and the needs that derive from it, by the efficient use of primary resources and by providing technologies allowing the valorization of waste while reducing CO<sub>2</sub> emissions. Accelerating the circular model and waste enhancement is particularly significant in a region such as

Europe, with limited access to natural resources that have made the success of other regions of the world.

The chemical industry can play a leading role in the transition towards a circular economy, leveraging technological expertise to develop innovative solutions able to improve circularity in every step of the life-cycle of the products.

## Circular economy rules: from waste to new resources

At Eni circularity is a strategic driver across the entire group in an integrated and synergic way, from products, processes, to assets. Eni already implemented circular principles by the transformation, in a low carbon perspective, of assets in order to produce green products or green energy to project the assets into a longer term future. Examples include the conversion of some refineries into bio-refineries to produce green diesel from used cooked oil or bio-masses, or the installation of solar farms using disused land where we have finalized our remediation activities, which is called "Progetto Italia."

Eni is directing research towards innovative solutions in all the businesses, identifying new products and processes that aim to reuse and enhance waste materials in a regenerative way. For example, it developed a technology for the production of bio oils from organic municipal waste which can be used directly as low sulfur fuel oil for naval vessels or sent to a refining stage for the production of biofuels to be used in transport. Syndial, Eni's environmental company, launched a pilot plant for this innovative technology "Waste to fuel" in December 2018.

Another example encompasses the use of residual biomass as feedstock for the bio-run activities the company acquired from Mossi & Ghisolfi. Versalis is re-launching plant operations at the Crescentino (Italy) site, based on the Proesa® technology for converting biomass into second-generation sugars, able to produce "advanced" biofuels (i.e. obtained from non-food feedstock) and, potentially, other chemical bio-intermediates and bio-polymers.

This platform paves the way for a new phase of chemistry from renewables at Versalis, for two important sectors such as bio-chemicals and bio-fuels. Now Versalis can take advantage of the opportunities deriving from the integration of the upstream Mossi & Ghisolfi process (second-generation sugar production), with research and downstream know-how already developed by Versalis. This allows us to pursue further goals in the production via fermentation of bio-oils for



the Green Refinery, and intermediates for biopolymers and biochemicals.

All these efforts are driven by the belief that, as already happened with traditional refineries over the years, bio-refineries producing up to now mainly bio-fuels will expand their portfolio towards higher added value feedstock for chemistry.

### Plastics waste deserves a new life

A strong commitment of everyone, from citizens to associations, institutions, governments and, of course, industries, is needed to close the life cycle of plastics: a valuable material like this does not have to be thrown into landfills or - worse - the environment, becoming an integral part of the marine litter problem. The issue is real and is at the center of the public debate: it is estimated that 8 million tonnes of plastics leak into the ocean every year, and Asia accounts for more than 80% of the total leakage. The European Union, placing itself at the forefront of the global transition towards a low-carbon and circular economy, has recently launched a number of initiatives aimed at increasing plastics sustainability, such as the European Strategy for Plastics.

Increasing cooperation along the value chain is fundamental to reducing waste generation and improving resource efficiency. For example, Versalis is carrying out a project for the recovery of industrial polyethylene packaging utilized for the shipping of its products. Specifically, the project involves the collection of used bags and liners and their recycling for the production of secondary raw materials suitable for new packaging. It allows the design of a circular “Bag to bag” and “Liner to Liner” scheme, in collaboration with supply chain operators. For the industrial bags, after the successful experimentation with 30% of regenerated material, an experimental test was started with 50%.

Cooperation within the value chain can also give the opportunity to apply Eco-design principles and improve product recyclability. A valuable example is the recyclable synthetic turf developed jointly by Versalis, supplier of polyethylene (the raw material), Radici Group (yarn producer) and Safitex (turf producer). Thanks to this industrial partnership, synthetic turf that currently is landfilled or incinerated when it reaches end-of-life, can be recycled and used as secondary raw materials for other applications in the sports sector, where high quality standards are required. Sustainability of this product has been assessed as the players in the value chain have obtained the Product Environment Footprint (PEF) certificate.

Eco-design means also finding high added value applications for secondary raw materials from plastics waste. Versalis has successfully tested the use of 20% post-consumer polystyrene products from domestic separate collection (like yoghurt cups, plates, cups, cutlery etc.), for the production of expanded polystyrene for thermal insulation sheets that improve energy

## ➤Versalis and Montello give new life to recycled plastics packaging

A winning example of value chain collaboration is the agreement Versalis very recently signed with Montello S.p.A., a leading European company dealing in post-consumer plastic recovery and recycling technologies, to develop a new range of polyethylene products from recycled packaging.

Thanks to consolidated technological and commercial expertise in the polyethylene business, the two companies have developed new grades that can contain up to 70% of post-consumer recycled plastic, designed to meet the needs of the packaging and agricultural sector, two of the main market applications of this material.

The agreement also provides for the development of new processes to create highly sustainable products that will satisfy the performance demands required by the market.

Through this initiative, Versalis takes a step forward towards the creation of an effective plastic circular scheme, offering to the market products with high recycled content for valuable applications.



Recyclable synthetic turf

efficiency of our buildings. The project is now into the next steps: industrialization within the existing polystyrene plant at the Mantua site.

Last but certainly not least, a key factor for the resolution of the plastics waste issue is the development of new recycling technologies. As Eni we are working to valorize plastics waste by producing energy or advanced bio-fuels. Moreover, we need to push for a more and more efficient and performing mechanical recycling, that is undoubtedly very important and used on a large scale, but it is not enough. Only with innovative physical and chemical recycling technologies able to overcome the limited effectiveness of mechanical recycling, will it be possible to really close the plastics life cycle.

One of the most ambitious goals is bringing back the polymer to virgin material: Versalis together with Eni is developing a research project on a pilot scale for the chemical recycling of mixed post-consumer plastics deriving from separate collection of plastic waste that is no longer separable. The project is carried out by merging chemical expertise for feedstock pre-treatment and innovative refining technologies, in order to obtain the right raw materials for polymers with the same quality and applications as virgin polymers, and realize full plastics recycling.

To conclude, the circular economy is a fundamental part of Versalis business activities and a driver for innovation throughout the entire value chain. Such a complex issue needs in fact powerful global vertical industry chain alliances with practical initiatives: Versalis is proud to be one of the founding members of the global “Alliance to help end plastic waste,” that represents the best example of joining forces and actively facing this ambitious challenge giving a new valuable life to plastics.

# Maximising the Opportunities of the Circular Economy

**T**he growing need for sustainable solutions is reshaping established industrial processes and conventional business thinking. However, meeting these demands isn't just good for the environment, it's also good for business and collaboration across the value chain, explains Abdulrahman Al-Fageeh, Executive Vice President, Petrochemicals, SABIC.

Reducing plastic waste is a long-held objective for SABIC and forms a key part of our drive for increased sustainability. Our work towards a breakthrough in the chemical recycling of challenging mixed plastic waste back to polymer, and drive to develop circular solutions by working side by side with organizations throughout our value chain, have positioned us an industry leader on this front.

An example of SABIC's drive for increased sustainability is that from 2014 to 2018, SABIC chaired the World Plastics Council, a global, industry-led effort to develop sustainable solutions to marine debris. This year we've upped our game and become a founding member of the Alliance to End Plastic Waste (AEPW). This non-profit organisation will bring together players from across the chemicals and plastics industries and use their collected knowledge, resources and experience to address the problems of plastic waste.

As part of this initiative we aim to engage with governments, multilateral institutions, companies, NGOs and communities to support investments and programmes. Over the next five years we aim to leverage these relationships across four key areas:

- Infrastructure development to manage waste and increase recycling
- Innovation to bring to scale new recycling technologies that further minimise waste and create value from post-use plastics
- Education and engagement to enlist governments, communities, businesses, and individuals in the movement
- Clean-up of concentrated areas of waste in the environment, particularly in rivers that carry land-based waste to the sea.



Abdulrahman Al-Fageeh, Executive Vice President, Petrochemicals, SABIC.

As no company, country or community can solve these issues on their own, SABIC is committed to working with alliances around the world. For instance, we are actively involved in the American Chemistry Council (ACC), and in 2018 joined other resin manufacturers to support ambitious goals for capturing, recycling and recovering plastics. Our goals include participation in Operation Clean Sweep-Blue, a programme focused on the stewardship of plastic material at manufacturing sites, and aiming to achieve the full re-use, recycling and recovery of all plastics packaging by 2040.

## Inspiring objectives

These are ambitious targets but our sustainability goals are an important part of SABIC's overarching business objectives. They not only help us to understand and adapt to long-term trends and expectations in society, but sustainability itself has a positive impact on bottom line performance by providing a strong emphasis on resource and energy efficiency. We strive to embed our goals into every aspect of our corporate strategy, culture and operations.

Our commitment to resource and energy efficiency is more than an ambition – we have specified, monitored targets: reducing

greenhouse-gas, energy and water intensities by 25 percent, and material-loss intensity by 50 percent, from 2010 levels by 2025. We have achieved positive results to date by driving a sustainability culture, training employees and implementing operational excellence.

## Operational excellence

As part of a company-wide commitment to excellence, we strive for improved resource controls throughout our operations. To help ensure this, in 2017, we launched the SABIC Certified Energy Expert Program, an innovative in-house training scheme that helps to improve our energy efficiency capabilities and build a network of experts.

As we develop mega-projects globally, we rely on comprehensive sustainability assessments of each proposed project during the design and execution stages. Our teams of experts strive to ensure that the energy and sustainability performance of each project meets or exceeds best in class. To date, we have assessed and identified energy-improvement opportunities for 22 mega-projects. Furthermore, at every new plant we design, we remain committed to adopting the latest in energy-efficiency technologies and systems to continue our progress.

## A national commitment

SABIC also continues to support the government-led Saudi Energy Efficiency Program (SEEP) to reduce fossil fuel consumption in Saudi Arabia and improve the Kingdom's overall energy efficiency. To this end, we work with manufacturing affiliates to collect annual data on performance at all of our Saudi sites and then use this data to implement specialised, energy-efficiency projects.

Ultimately, our 2025 vision to improve efficiency at every step will ensure we intensify our focus on the four key performance indicators of greenhouse gases, energy, water and material loss, and we will target projects that help achieve our goals.

# Cracking Open **the Value** of Waste Plastics

**C**onventional approaches to handling plastic waste have their limits. That is why SABIC is studying an innovative process that breaks down mixed plastic waste into pyrolysis oil so it can be reused to reduce impact on the environment, meet customer needs and support the move to a circular economy, explains Abdulrahman Al-Fageeh, Executive Vice President, Petrochemicals, SABIC.

Plastic waste remains a highly emotive topic actively responded to by the public, with increasing demands for more sustainable products and greater reutilization potential. The current approach to end-of-life plastics still includes landfill, which locks the value of plastics out of reach, while combustion risks releasing elevated levels of CO<sub>2</sub> and also destroys any future value.

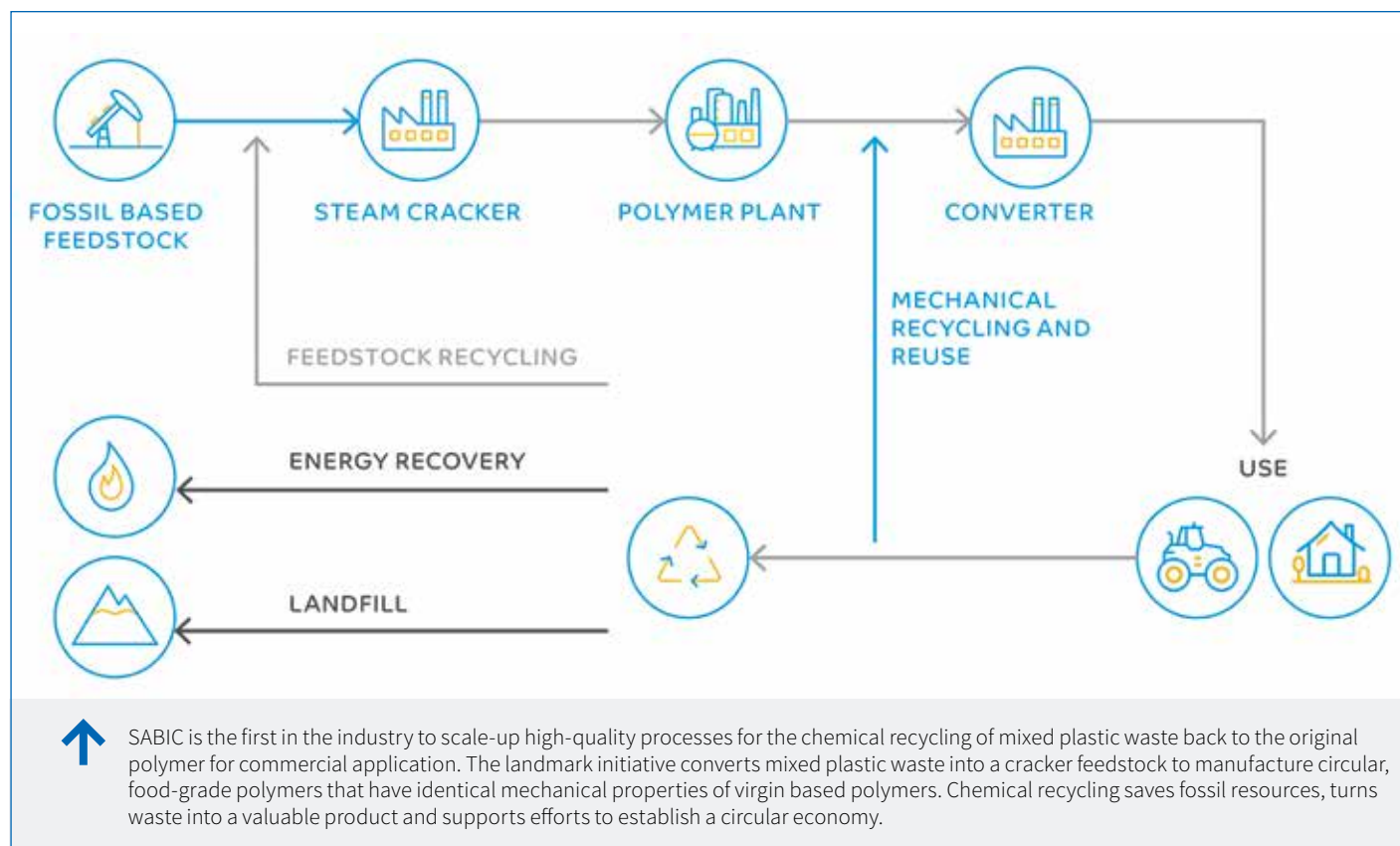
Good progress has been made with mechanical recycling, but while it is effective in some applications, it is not a complete answer.

To build a truly circular economy and meet the needs of our customers and consumers, the maximum value of the plastics waste stream needs to be retained and reused. That is why we are pursuing what we believe will be a significant part of the answer.

#### **A fresh approach**

To support the change from a linear economy to a circular one and create a new value chain, SABIC has invested its scientific and technological expertise into focused collaborations, both upstream and downstream.

As a result, SABIC is the first in the industry to





scale-up high-quality processes for the chemical recycling of mixed plastic waste back to the original polymer for commercial application. Bringing together collaborators from across the value chain, this landmark initiative converts mixed plastic waste into a cracker feedstock to manufacture circular, food-grade polymers that have identical properties of virgin based polymers.

The polymers are certified through the International Sustainability and Carbon Certification plus (ISCC+) scheme that certifies circular content and standards across the value chain from source to end product. The ISCC+ certification works on what is known as a “mass balance system,” meaning that for each tonne of circular feedstock fed into the cracker and substituting fossil-based feedstock, roughly a tonne of the output can be classified as circular.

SABIC’s certified circular polymers project includes an investigation into the possibility of building a semi-commercial plant at the company’s Geleen facility in the Netherlands. It would mark the first project of its type and scale anywhere in the world and has the potential to make an important contribution towards a circular economy.

#### Meeting customer needs

Earlier this year, the initiative reached ‘market foundation stage’ with production and commercialization of the first certified circular polymers. These are being supplied to customers who will use the plastics to manufacture consumer packaging for food, beverage, personal care and home care products and other consumer goods. Brand owners recognize the critical role that purity, quality and safety play in consumer packaging, requirements met by certified circular polymers as an alternative to traditionally produced materials.

#### Inside the process

Plastics, which represent a small portion of the world demand for oil derivatives, are melted in an oxygen-free environment and then broken down into pyrolysis oil. The oil needs to be refined and upgraded for use as feedstock in traditional petrochemical processes. In order to extract the maximum value, the waste first needs to be put through a shredder to increase surface area, which ensures better heat transfer, optimising yields.

#### The bigger picture

Keeping plastics in the material stream and out of the environment is desirable because it reduces resource demand and prevents the environmental impact of waste. Mechanical recycling has its place

## » The circular economy

A circular economy establishes systems that retain as much value as possible from resources, products and materials, helping ensure optimal reuse and recycling. It also protects the environment by preventing or reducing the generation of waste by increasing the efficient use of resources.

## » A guiding light

At SABIC, sustainability is a core business driver that ensures short-term growth goes hand in hand with long-term benefits to the environment, the economy, and society as a whole. It underpins the company’s mission of becoming the world’s preferred supplier of chemicals by 2025 and informs strategic decisions. Sustainability is the guiding light for SABIC in product and process innovation; providing materials for deploying renewable energy as part of an energy mix; continuing to minimize carbon intensity; and embedding circular economy solutions throughout the value chain.

but it’s not the whole story. The product properties of mechanically recycled plastics typically are of lower value than for virgin plastics, and this combined with possible contaminants is limiting the use of such products in applications driven by high standards as for example in food packaging.

Chemical recycling, however, ensures outstanding mechanical and processing properties as well as purity, making it an attractive upcycling route for brand owners and customers that demand high purity packaging solutions.

That’s why SABIC is pursuing this project. While we hope this project not only offers part of the answer to the toughest plastic recycling challenges, it is also aimed at supporting the transition from a linear to circular economy by enabling processes to adopt recycling without compromising on quality. It can additionally maximise the societal benefits available from valuable natural resources. This combination of features and benefits is expected to be good for its customers’ enterprises, consumers and the environment.

*Read more in our Sustainability Report 2018 at [www.sabic.com](http://www.sabic.com)*



# IN THE CIRCULAR ECONOMY, NOTHING IS WASTED, EVERYTHING IS TRANSFORMED.

We are moved by improving people's lives through sustainable solutions in chemicals and plastic. That is why the transition to a Circular Economy where everything can be used and reused in a continuous cycle—moves us to action. And it starts with education on how we produce and how we consume in society.

We know that plastic is essential for our quality of life, from providing agricultural productivity to ensuring food safety and hospital hygiene. We also know that plastic should be used sustainably—either reused, recycled or reclaimed.

Braskem believes in the strength of this movement and invites everyone to join us. Each one of us has a role to play.

Get to know our positioning in full  
[braskem.com/circulareconomy](https://braskem.com/circulareconomy)



PASSION FOR TRANSFORMING

HERE IS WHAT BRASKEM  
IS COMMITTED TO DOING TOGETHER:

