

INK, HEART & SOUL

RethINK PACKAGING

**reconfiguring the packaging system
for a circular future**

Essentials on the need to change, the path forward
and opportunities created.



SIEGWERK

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TIME TO STEP IT UP

Foreword

ALINA MARM

Head of Circular Economy Hub

We know today that our linear economic system has reached its limits. Natural resources are sourced under increasing risks, packaging waste is continuously littering our environment, and growing CO2 emissions are driving climate change. At the same time the need for packaging has increased and packaging will continue to be necessary in the future.

For the past 50 years we were mainly focused on the benefits of packaging due to consumer convenience and attractive market growth potential. But diverting our attention from the negative effects has led us to where we are today: a broken packaging system. This is especially true for plastic. It combines high performance with low cost, is vital to protect and preserve goods in global value chains but also comes with some of the biggest challenges in a linear system such as ocean littering, toxic illegal burning, micro-plastic in food chains and other health concerns.

Today, we are at the beginning of a change in the packaging industry: Increased consumer awareness, higher demand for **sustainable packaging solutions**, newly established policies around the globe, and a growing number of large Fast Moving Consumer Goods (FMCG) companies committing to change their packaging for the better. They all feel that it is **time to rethink packaging** and move away from a broken linear packaging system to a flourishing circular packaging system.

"Let's make change happen and join us now in becoming a pioneer for the Circular Economy shaping the future of the packaging industry" Alina Marm

Moving from a linear to a circular packaging industry can preserve the natural environment and mitigate the effect on ecology – while allowing consumers to **still benefit from the advantages of packaging**. The circular approach is based on three principles: designing out waste and pollution; keeping products and materials in use; and regenerating natural systems. This offers new forms of value creation with significant economic potential for the packaging industry.

As a leading global ink supplier for packaging applications and labels, we at Siegwirk strongly believe in the **benefits of a Circular Economy** to tackle this challenge and protect our environment **by recycling, reusing, and reducing** packaging. It is time to transfer packaging from a linear to a circular model that decouples economic growth from using finite resources and targets zero waste, allowing for wellbeing while respecting the natural boundaries of our planet. This is not only about improving existing packaging solutions but to really transfer packaging to a **new way of management** that limits the amount of resources entering the system and maximizes their utilization along the value chain; thereby, stopping the generation of waste.

Here, inks and coatings play an important enabling role for the realization of circular packaging solutions. Their technical functionalities support the (re-)design of packaging following the three levers of a Circular Economy **"Reduce, Reuse and Recycle"** helping to keep materials in the loop to maximize their use. That's why we at Siegwirk are actively driving the development of **inks and coatings specifically addressing the needs of circular packaging solutions**. Our customized products help to increase recyclability or reduce the need for plastic use and other non-renewable raw materials, enabling the development of innovative sustainable and circular packaging solutions.

We at Siegwirk want to see the budding change translating into a system change of the packaging industry towards a Circular Economy. And we are strongly committed to play our part and be a driver in the circularity change to a new industry standard.

It is **our shared responsibility** to further **enhance the performance and circularity of packaging** while minimizing negative side effects. So, let's make change happen and join us now in becoming a pioneer for the Circular Economy shaping the future of the packaging industry.

Kind regards,

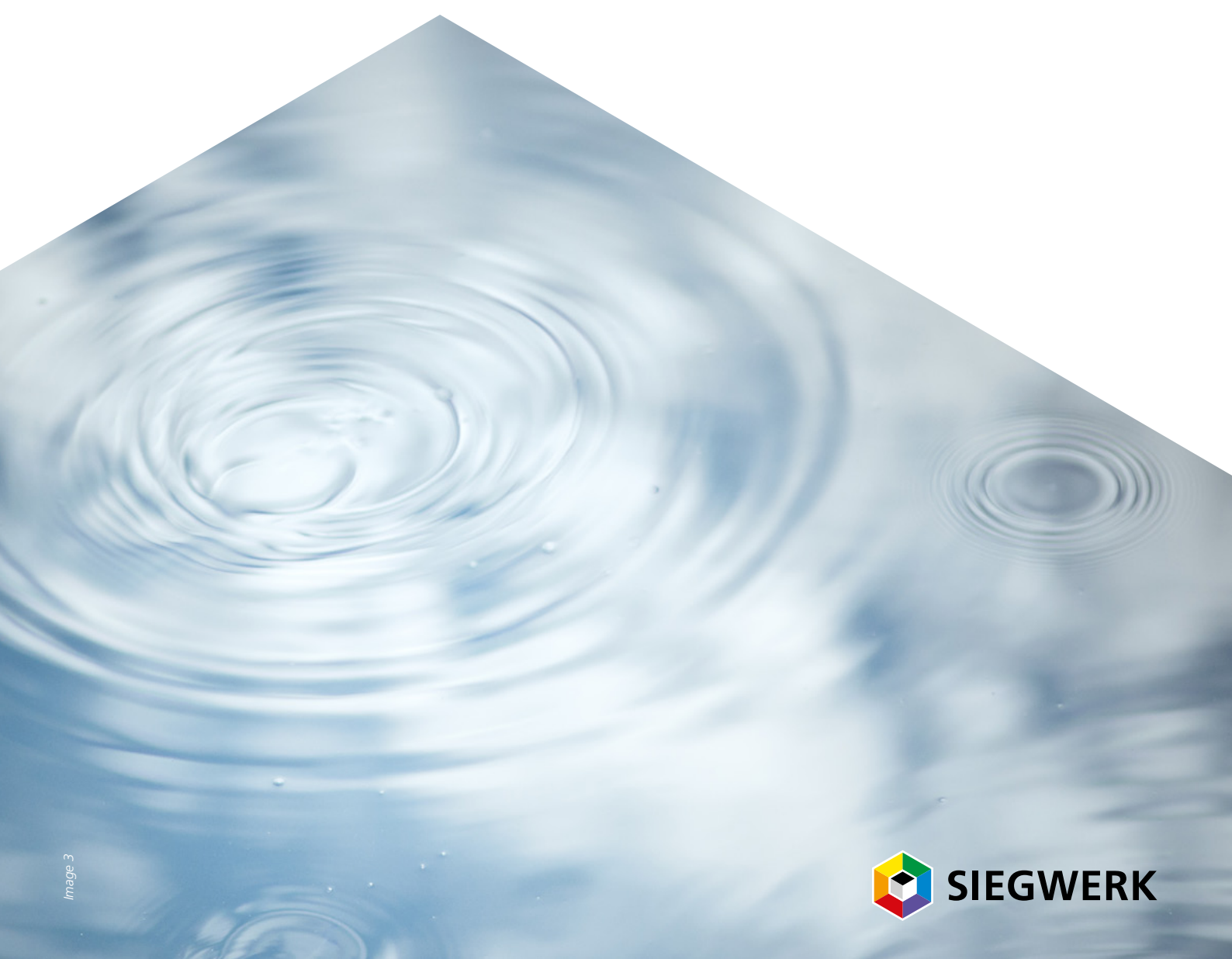
Alina Marm

Head of Circular Economy Hub at Siegwirk

For more information or in case of questions please contact us at ce@siegwerk.com.

1

TIME TO RETHINK: Moving from a linear to a circular packaging industry



Solving a paradox

Our linear economic system has reached its limits especially when talking about plastic packaging. Its failure leads to major negative consequences for the environment, the economy, our society and our health. Such consequences include but are not limited to: uncontrolled littering; illegal waste disposal and incineration leading to a deterioration of air quality; the contamination of water supply; and the accumulation of micro-plastics in the food chain endangering our health to just name a few of today's problems that significantly underline the urgency of change. It is time to rethink packaging and move from a linear to a circular model.

The Plastic Paradox

Packaging plays an essential role in our lives today. There will not be a world without packaging anymore. While, paper, glass and aluminum also have their advantages as packaging substrates, plastic has become the most popular packaging material due to its high functionality and its comparatively low production costs. Over the last 50 years, plastic packaging has played a major role in economic growth and society's wellbeing. Plastic keeps medical products sterile, creates access to safe food and water, and reduces food waste. It has significantly helped to address major global challenges. Today, plastic is the substrate of choice for many consumer products and industry applications.



Figure 1: Due to its technical advantages, plastic packaging can help to address some of the main global challenges¹

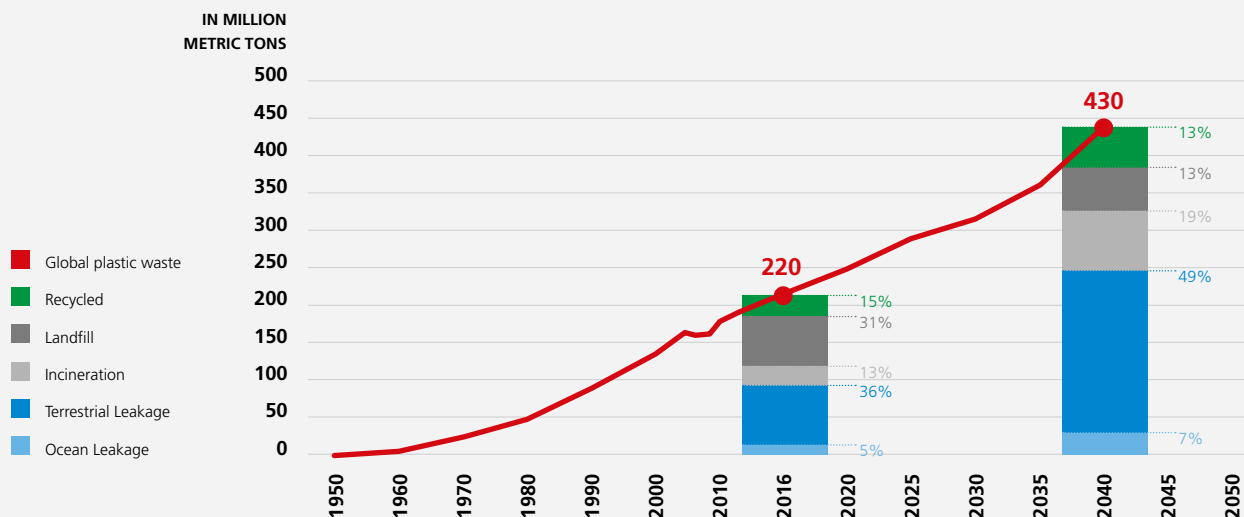


Figure 2: The dark side of success - becoming ever darker. Development of global municipal plastic waste, in metric tons in a business as usual scenario.²

Plastic packaging also comes with challenges as it enters a failing system. A linear economy follows the principle “take-make-use-dispose”. Almost all plastic packaging is used once and then thrown away³. In 2016, ~220mn metric tons of municipal plastic waste was created globally, of which **only 15 percent was recycled**.⁴ Even more alarming: around **41 percent⁵ (91mn metric tons) of the annual municipal plastic waste has not been formally disposed** but leaked into the environment. A growing world population has increased the demand for plastic packaging; therefore, this problem will only further intensify. The world’s plastic production is expected to double in capacity by 2040. In a Business-as-Usual scenario this could lead to a doubling of plastic waste and a tripling of plastic leakage to the ocean by 2040.⁶

The contradiction between challenges and opportunities of plastic packaging is known as the plastics paradox. How can we maintain the benefit from the indisputable advantages of plastic packaging while avoiding negative side effects – in the interest of consumers and a packaging industry with future?

Why has plastic become the black sheep within the packaging materials?⁷

- Plastic needs ~300 years to degrade
- Plastic degrades into nano, micro and macro plastics – each posing different threats to environment and health
- ~99% of total plastics are made from non-renewable resources; only one percent are bio-based⁸
- High CO₂ emission when incinerated
- Low recycling rates of 15% - most of the recycled plastic cannot be used for packaging again (“downcycling”)
- With ca. 30%⁹ packaging is the largest segment for plastics



“Global annual plastic production has increased from 1.7 mn metric tons in 1950 to 422 mn metric tons in 2018 and is further growing”¹⁰

THE ANSWER: Follow the approach of a Circular Economy

A Circular Economy is the vision of a new economic model, where economic development is decoupled from using finite resources, respecting the natural boundaries of our planet. By moving from a linear to a circular model, the amount of resources entering the system is limited, their utilization along the value chain is maximized and the generation of waste is stopped. Therefore, the Circular Economy follows three key principles:



1. DESIGN OUT WASTE AND POLLUTION



2. KEEP MATERIALS IN USE



3. REGENERATE NATURAL SYSTEMS

From the beginning, products and processes are designed in a way that no pollution and no waste occur. Resources and materials are kept in a closed loop where they are reused as often as possible instead of discarding them after single use, and the natural environment is enabled to regenerate itself where possible.

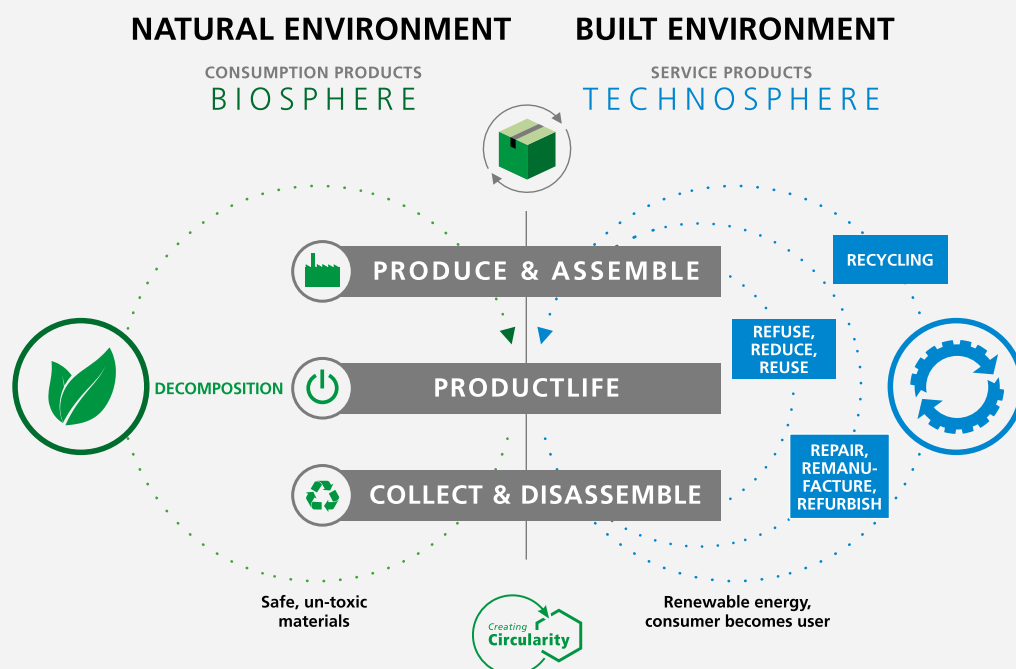


Figure 3: Closed and regenerative loops keep resources in use as long as possible

In general, a Circular Economy distinguishes two different cycles: the biosphere and the technosphere. The biosphere focuses on consumables made from biologically based materials like e.g. food, wood or cotton that are designed to be feed back into the system through decomposition processes. It regenerates living systems that provide renewable resources. The technosphere, focuses on durables such as built products which are recovered and restored through reuse, repair, remanufacture, refurbish or recycling strategies.

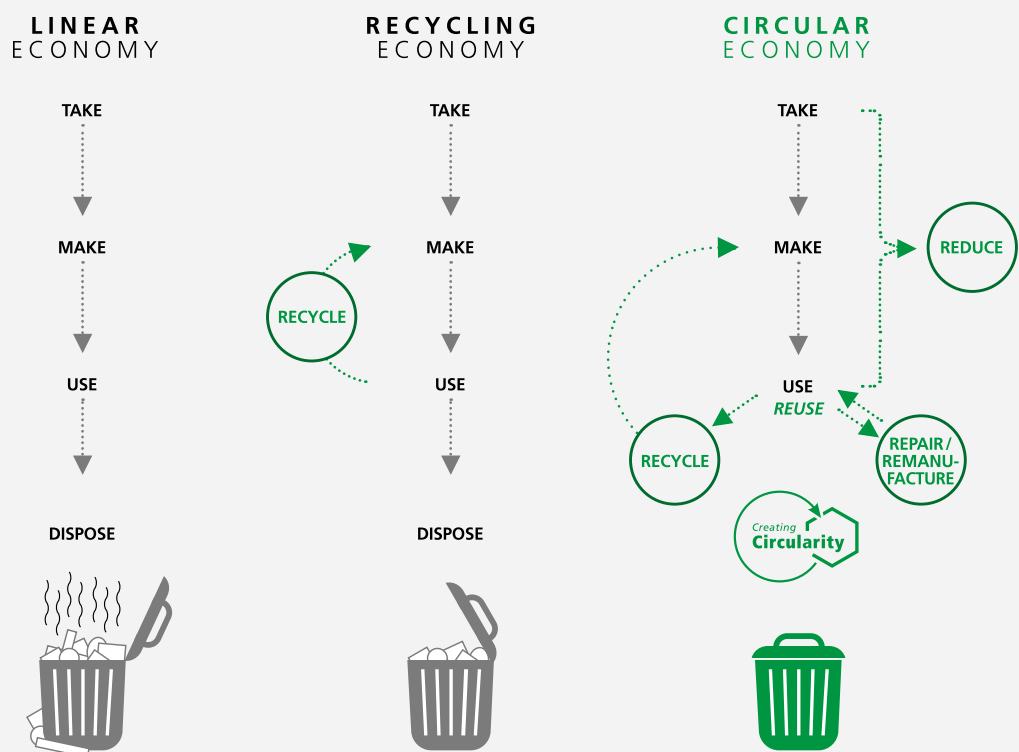


Figure 4: The evolution of economies: Moving from a linear to a circular economic system minimizes the use of finite resources and aims at creating zero waste

In a nutshell, a circular economic model creates closed and regenerative loops of materials to keep resources as long as possible in the system so that waste is reduced, and the depletion of non-renewable resources is minimized. It offers **a promising solution to benefit from the advantages of (plastic) packaging while preventing unwanted negative repercussions and regenerating natural systems.**

FACTS & FIGURES



TO MEET TODAY'S WESTERN CONSUMPTION PATTERNS, WE WOULD ALREADY NEED THREE PLANETS

EACH PACKAGING SUBSTRATE HAS ITS ADVANTAGES, BUT THE HIGH FUNCTIONALITY AND COMPARATIVELY LOW PRODUCTION COSTS HAS MADE PLASTIC TO THE MOST POPULAR PACKAGING MATERIAL NOWADAYS¹:

GLASS

- + Oil-resistant
- + Inert, no reaction with contents

- Heavy
- Fragile
- Price



PAPER

- + From renewable sources
- + Compostable

- Low durability
- Lack of barrier functions (that are not plastic)
- Price



PLASTIC

- + Light
- + Durable
- + Cost-efficient
- + Flexible

- Long decomposing time
- Decomposes into microplastic
- Mostly from non-renewable sources



20
20

THE USE OF PLASTICS HAS INCREASED TWENTY-FOLD IN THE PAST HALF-CENTURY AND IS EXPECTED TO DOUBLE AGAIN IN THE NEXT 20 YEARS^{2,3}



AS OF 2017, 8 BN METRIC TONS OF PLASTIC HAD BEEN PRODUCED FOR HUMAN USE⁴



THE ADVANTAGES AND DISADVANTAGES OF PLASTIC PACKAGING LEAD TO THE PLASTICS PARADOX



WEIGHT EFFICIENCY
COST EFFICIENCY
COMPARATIVELY LOW CARBON PRODUCTION FOOTPRINT
DURABILITY
FUNCTIONALITY

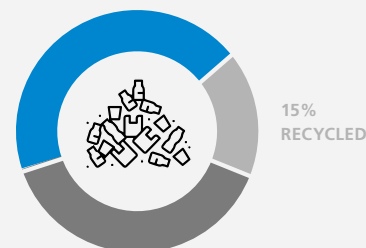


LOW COLLECTION RATES
OCEAN LITTERING
AVAILABILITY OF COLLECTION & RECYCLING INFRASTRUCTURE
DECOMPOSING TIME
FOSSIL RESOURCE DEMANDS
HEALTH CONCERNS
MICROPLASTIC

6.4
BN METRIC
TONS OF
PLASTIC HAD
ALREADY
BECOME
WASTE BY
2015⁵

⁶WITH THE PRINCIPLE "TAKE – MAKE-USE – DISPOSE" THE LINEAR ECONOMY IS CREATING TOO MUCH WASTE (2016):

44% FORMALLY DISPOSED (Incineration, landfill)



41% LEAKED TO THE ENVIRONMENT

TODAY 2BN PEOPLE STILL DO NOT HAVE ACCESS TO WASTE INFRASTRUCTURE⁸



2040
2x
TODAY



WORLD'S
MUNICIPAL
PLASTIC WASTE

THE LEAKAGE PROBLEM GROWS DISPROPORTIONAL TO OVERALL PLASTIC WASTE GENERATION



2040
3x
TODAY



PLASTIC
LEAKAGE INTO
THE OCEAN



2040
4x
TODAY



PLASTIC
STOCK INTO
THE OCEAN

Putting the Economy in Circular

In general, there are three economic perspectives in the Circular Economy for packaging:

- 1. The BUSINESS case for individual business:**
Generating cost savings, higher output or increased income
- 2. The SYSTEM perspective looking at the industry as a whole:**
Financial impact created by and opportunities created through the dynamics of the different value chain actors, from raw material producer to NGO
- 3. The cost of EXTERNALITIES:**
Cost perspective (often difficult to quantify and rarely monetized) which comprises the effect of an economic activity on an unrelated third party



Figure 6: The three economic perspectives of a Circular Economy

The externalities the linear economy creates are felt most severe and immediate by those least responsible. Also, they pose a long-term threat to business. They do not, however, function well as a short-term driver for business change. To drive short-term change, the strong business case supporting the Circular Economy can be focused on. More specially on the business case of a brand owner and why there is incentive and need to move towards circular solutions and what the threat is for Circular Economy laggards.

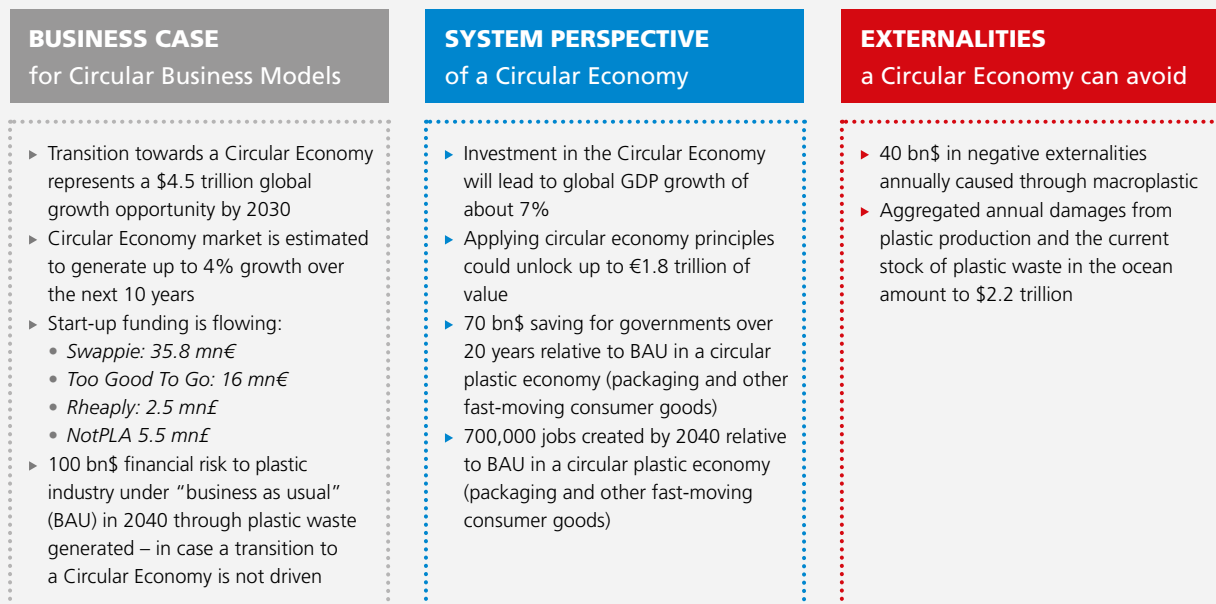


Figure 7: The Circular Economy for packaging and beyond as a financial opportunity¹²

There are three key dimensions how adopting a circular approach can have direct impact on a brand owner's P&L:

- 1. Maintain revenue by addressing changing consumer preferences**
- 2. Increase revenue by exploiting new market opportunities**
- 3. Minimize costs by complying with environmental regulations**

1. First of all, consumers' purchase decisions are increasingly influenced by a brand's sustainability commitment and corresponding offering. More and more consumers attach greater importance to sustainable products and environmental-friendly solutions. Studies in the United States have shown that 75% of Millennials are willing to pay extra for sustainable products in 2018.¹³ This willingness can lead to overlapping other decision criteria at the Point of Sale, making consumers open to change to brands that better match these values. Between 2013 and 2018 sustainability-marketed products delivered 50% of CPG (consumer packaged goods) market growth in the US¹⁴. To keep loyal customers and stabilize the customer base there is a growing need to invest in sustainability and offer eco-friendly alternatives, ideally more sustainable ones than the competitors. In other words, maintain revenue by addressing changed consumer preferences.

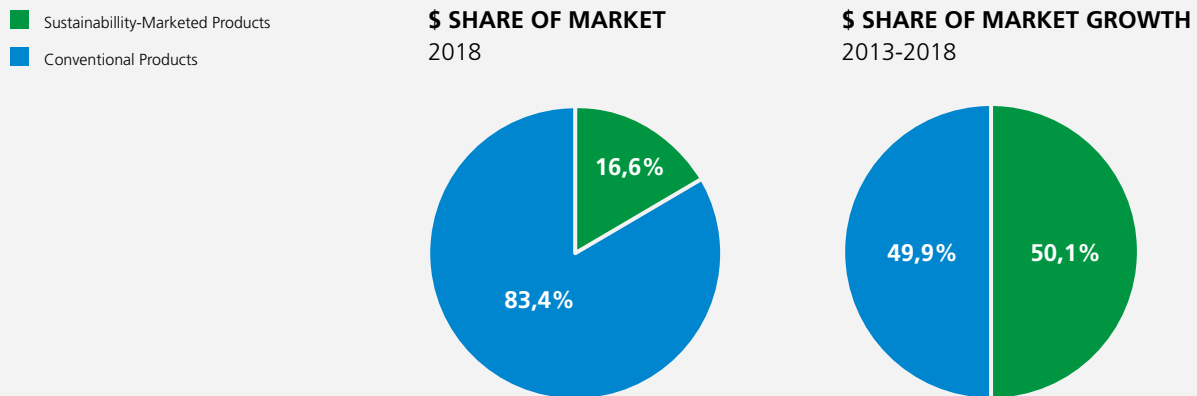


Figure 8: Even though sustainability-marketed products only represent 16% of the CPG market in the US, they delivered 50% of the market growth in 2018¹⁵

2. Secondly, where the market reconfigures itself there is new demand; and a new demand always entails new business opportunities, and exploiting new markets enables revenue growth and long-term potential for success. A start-up world is developing around new packaging solutions. One example is Notpla, a sustainable packaging start-up that creates advanced packaging solutions that disappear, naturally. The venture capital backed company saw a gap in the circular packaging value chain and is now filling it by the development of a revolutionary material made from seaweed and plants that is naturally biodegradable and suitable to pack liquids. Additional products are already under development.¹⁶ Thus illustrating that discovering new market opportunities opened up by new consumer preferences can result in a promising revenue increase. Start-ups can have the advantage of being small and agile, while incumbents can be smart about leveraging their well-established know-how, network and stable cash flow.
3. Thirdly, stricter legislation and regulations are continuously increasing companies' accountability for the environmental damage by applying what is broadly known as the "polluter pays principle". One example comes from the EU - the largest single market agreed upon a tax as of 2021 that will be added to all non-recyclable plastic packaging based on its weight to incentive producers to minimize the use of non-recyclable plastic.¹⁷ In general, extended producer responsibility (EPR) programs for packaging have already spread around the globe over the last decade continuously increasing the political pressure. In 2018, EPR programs have already been in place or in implementation process in 60 countries.¹⁸

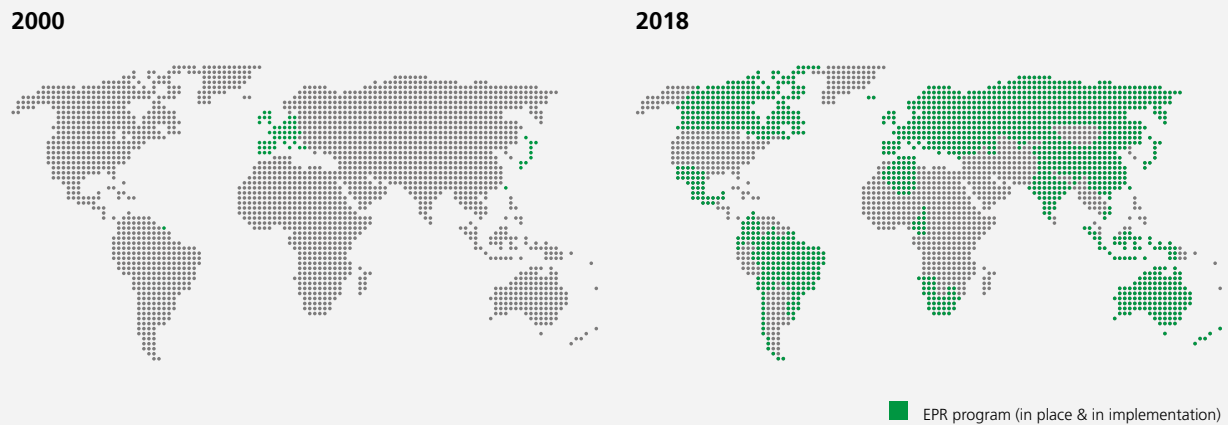


Figure 9: EPR programs are on the rise¹⁹

Analyses show that the costs for recovery of the municipal plastic waste in 2040 are three times higher than the gross profit of the plastic production. There will be a 100 bn US\$ global cost for plastic waste management and governments will not cover it all. There is a realistic risk for the plastic industry required to cover significantly more costs for waste management through stricter EPR programs or other legislative schemes by 2040. Moving to circular packaging solutions means keeping these costs off the P&L.

In addition to tangible cost aspects, a sustainable business also includes considerable intangible assets in the form of an increasing brand value and an improved investability.

Sustainability is not a trend; it is a new rationale offering unbeatable advantages for future business success.

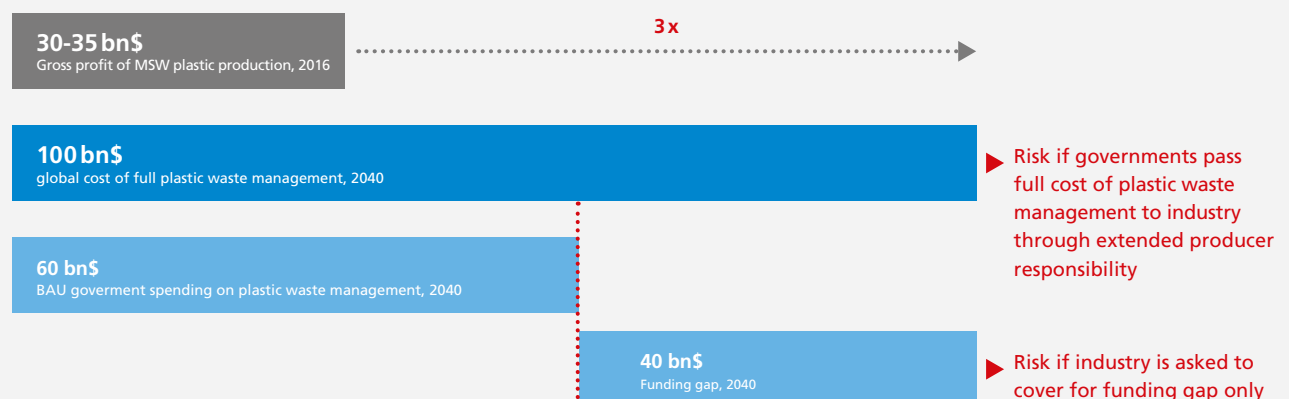


Figure 10: The plastic industry could face an annual 100 bn US\$ financial risk by 2040²⁰

2

TIME TO ACT: Rethinking packaging for a Circular Economy

Creating circularity is key to sustainably shaping the future of packaging by keeping resources in closed loops instead of using them once. For the packaging industry this means rethinking packaging in a way to enable a circular use of all materials. This translates into a “Reduce-Reuse-Recycle” approach calling for innovative packaging design and new structures to increase utilization rates and recyclability of packaging, for technical innovation, increased use of renewable energy sources and the creation of new circular thinking business models. In other words, a Circular Economy requires to comprehensively think outside the box in order to reach the scale of change needed to create a sustainable impact.



REDUCE, REUSE, RECYCLE:

Creating circular packaging solutions

To realize packaging circularity, new design approaches are required that specifically address the three levers of a Circular Economy: REDUCE, REUSE and RECYCLE.

A DESIGN 4 LESS focuses on packaging design in terms of the levers REDUCE and REUSE.



REDUCE means, that the amount of resources, and in particular finite resources, entering the cycle is being reduced. This is done by waiving unnecessary packaging parts, e.g. overpacks solely for marketing purposes, or substituting oil-based virgin plastic through renewable resources, such as paper, which is especially suitable for dry food and on the go food packaging.



REUSE means, that all packaging entering the cycle is being used multiple times before disposal in order to exploit the maximum of all used resources, extending the product lifecycle. This requires a move away from disposable, one time use products to returnable containers. It is about expanding deposit systems and develop new business models enabling multiple use of packaging while maintaining consumer convenience.

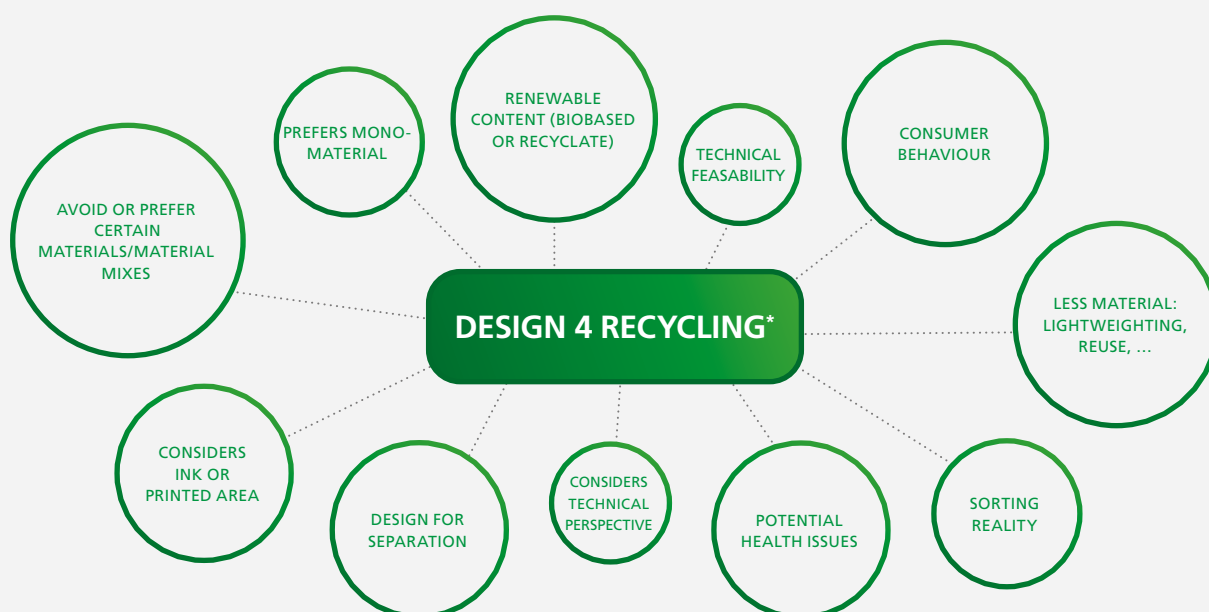


Figure 11: Design 4 Recycling guidelines are key in creating standards for D4R – many value chain partners are working on guidelines, making the field at times challenging to navigate²¹

^{*} Guidelines by the following organizations taken into account (list is not exhaustive): EPBP, Lidl, Walmart, Circular Analytics, Rewe, VerpackG, APR, Suez, Interseroh, Borealis, PRE RecyClass

DESIGN 4 RECYCLING aims at increasing the recyclability of packaging supporting the third lever:



RECYCLING. In a Circular Economy recycling means, that packaging waste is converted into reusable material through sorting and recycling technologies (mechanical and chemical). The circular aspect of recycling is called closed loop recycling in which packaging waste is converted into recyclates so that it is suitable for the use in packaging again. However, the quality of the majority of today's recyclates is not adequate yet and thus is removed from the packaging cycle (see EXCURSUS "BETTER PLASTICS RECYCLING: Enhancing the quality of recyclates through deinking" – page 33). Much attention is given to the DESIGN 4 RECYCLING in the context of plastic packaging, but is evenly important for other packaging substrates, such as paper.

In a Circular Economy, recycling is the only acceptable scenario for an end-of-life; however, reducing should be the prioritized prevention strategy. Going forward, reducing and recycling packaging will play the most important roles in the development of new packaging. Latest circular solutions already available at the market include e.g. wrapper-less ice cream, paper-packed snack bars, re-fillable packs and fully recyclable mono-plastic pouches.

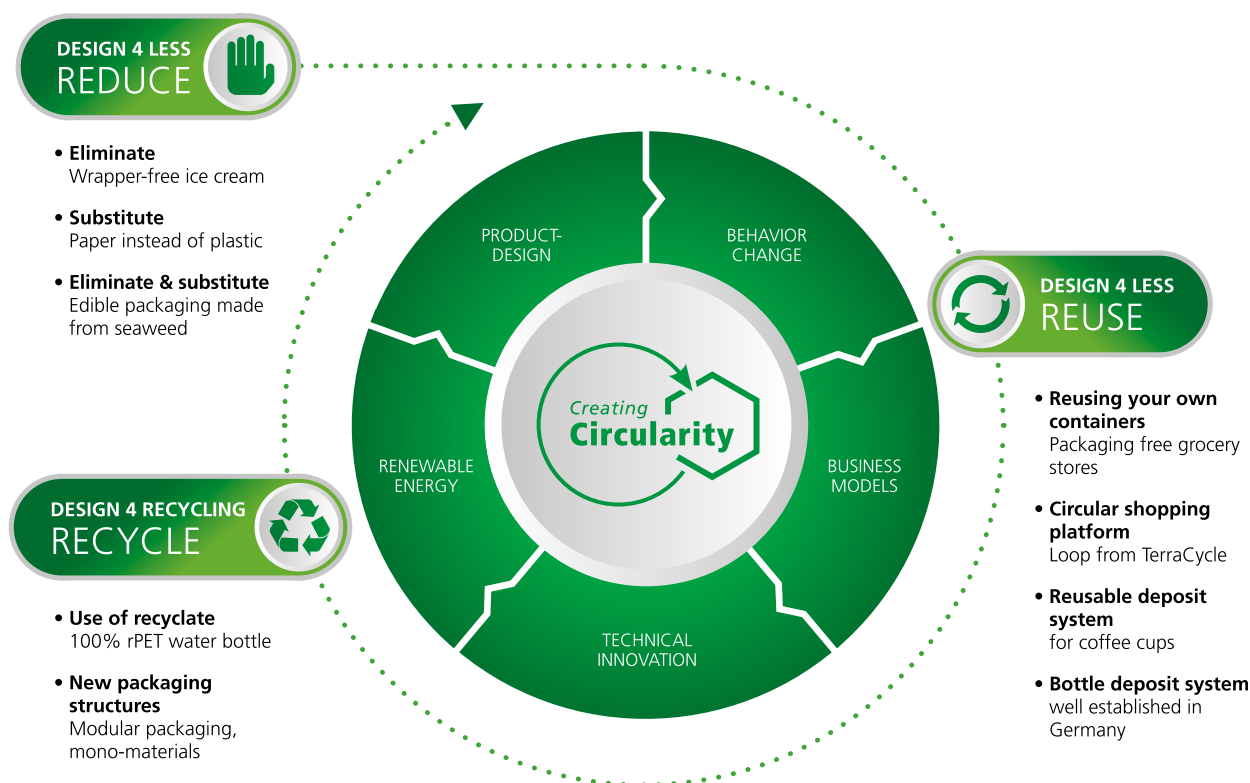


Figure 12: Rethink packaging for a Circular Economy

**“To realize a Circular Economy,
we need to fundamentally
rethink packaging based on
Design for Less and Design
for Recycling solutions”**

Applying a Circular Economy design process

Following the levers of REDUCE, REUSE and RECYCLE will bring new circular packaging solutions to store shelves. However, the full potential and opportunity space of a Circular Economy can only be unfolded when already considered in the design process.

*1st step:
Exploring the concrete need*

Firstly, gain a clear understanding of the needed utility and secondly the needed functionality. Utility is the purpose the product is really serving. Based on which you can derive the needed functionality. To understand the difference between utility and function imagine a chair. It has many different utilities: sit at the dinner table, pile your clothes on, use as an art piece etc. Understanding which utility is demanded helps designing the right functions (size, price, material etc.) into the chair. Or if required design something entirely different than a chair that actually meets the utilities demanded much better. Taking this step back is crucial to avoid overengineering or opting for default options. Keep it simple and to the core needs to exploit the maximum solution space.

*2nd step:
Creating the solution*

Here, it is about finding adequate circular design options to address the needed utility while **using the three circular packaging levers**: REDUCE (eliminate & substitute), REUSE and RECYCLE. Stay open-minded and do not only think in familiar models to serve the needed packaging utility and functionality in order to open up the circular solutions space. It is important to **keep local aspects in mind when creating a solution**:

- Which circular infrastructure is available at the Point of Sale?
- Is the local market familiar with recycling of different materials?
- Is there a specific shopping culture?
- Do locals prefer to go shopping by foot or by car?



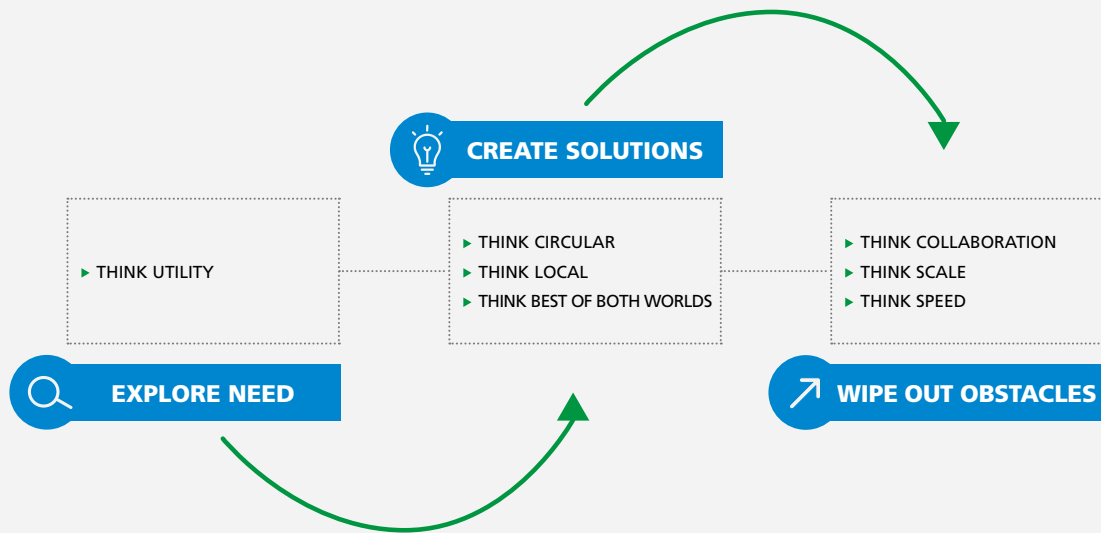


Figure 13: 3 phases of a circular economy design process

Answering this kind of questions allows an assessment of the technical feasibility of circular options based on local strengths and weaknesses. At the end you combine your results to **a design that best serves the needed utility while offering the most feasible circularity.**

*3rd step:
Wiping out potential
obstacles*

Here, partners play an essential role for success as **collaboration and exchange** helps to break down silos and develop the best circular solution possible. If a circular option is not economically reasonable for a single product this does not mean that it could not be scalable to a whole product group or even a brand, enabling a reuse or integrated collection. Never limit your options and think **about a solution's potential for scalability.**

It is sensible to quickly create a basic version of your idea (MVP - Minimum Viable Product) and bring it to the market for testing and feedback, as this is the fastest way to see if you are on the right track with your designed solution or not.

**“Following the levers of
REDUCE, REUSE and RECYCLE
will bring new circular
packaging solutions to
store shelves”**

THE RELEVANCE OF BIOPLASTICS: Potential and limitations in today's system

Excursus



When are bioplastics a valid sustainable alternative to conventional plastics?
Following the principles of a Circular Economy using bioplastics as a renewable source and regenerate the system is an attractive route for many. However, there are potholes to navigate past which can ultimately limit the true potential of bioplastics for a Circular Economy. So, what do bioplastics mean and under which circumstances do they really offer a sustainable alternative to conventional plastics?

*Renewable vs. biodegradable plastics**

According to European Bioplastics and the Institute for Bioplastics and Biocomposites, a plastic material is defined as bioplastic if it is either bio-based, biodegradable, or features both properties.²² Thus, bioplastics is rather an umbrella term for two different aspects: The origin of the material, i.e. based on renewable materials (1) and the after-use pathways, e.g. managed biodegrading through composting (2).

1. The specification in terms of origin indicates if the plastic material is based on biological or fossil feedstock. The so-called **renewable plastics** describe plastic in which constitutional units are totally or partly made from biomass. This includes bio-based plastics as well as plastics made of greenhouse gases (GHG) like carbon dioxide – the latter however represents a niche. Bio-based plastics play a significant role to de-fossilize the plastics system, which is an imperative in the Circular Economy.
2. The after-use perspective is important because **not all bio-based plastics are biodegradable**. There are in general two broader types of bio-based plastics which decide on the after-use perspective:
 - **Partly bio-based** ('drop-ins'): *These plastics have chemically identical properties to their non-renewable versions and can therefore be easily mixed with conventional plastics. Drop-ins are not biodegradable but can be recycled in the plastic recycling stream.*
 - **Fully bio-based**: *These plastics are fully from renewable (often starchy) sources. Fully bio-based plastics are biodegradable and can be disposed in the composting waste stream.*

* The information provided explicitly does not refer to oxo-degradable plastics. Please refer to <https://www.newplastic-seconomy.org/assets/doc/Oxo-statement-May2019.pdf> for more information.

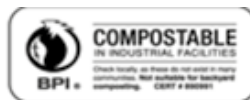


So, where are the potholes?

1. For bio-plastics biodegradation has to mean composting:
Fully bio-based plastics do not biodegrade sufficiently in an uncontrolled environment, e.g. when leaked into nature.
Rather it needs a controlled environment of either industrial or home composting. Industrial composting needs a managed waste stream whereas home composting needs enough space, knowledge and personal effort.
2. **Fully bio-based plastics harm the recycling process:**
If compostable plastic ends up in the plastic recycling process it causes harm to the extruder*. As consumers are not able to differentiate between conventional plastic and fully bio-based plastic it is likely that they might not dispose the packaging correctly. Therefore, it needs clear consumer information about the correct disposal and waste stream.
3. Research has shown that plastic packaging (imprecisely) **labelled as biodegradable increases littering behavior among consumers**.
To no surprise: It is plenty to expect from consumers to correctly assess the limits of biodegradability.
4. "Stealing" from the plastic waste stream: Depending on the country the plastic recycling rates are often much higher than the composting rates. In case a packaging today has a high likelihood of being recycled, it should ideally not be considered for a non-recyclable bio-based plastic for the compostable stream. As the chances of it ending up in a circular end-use (e.g. recycling or composting) decrease. Some composters follow the practice of sorting out compostable packaging as they see a risk in it minimizing their output quality.

* The extruder is the main recycling equipment for melting the plastic waste into pellets which then can be used for new plastic production.

Examples of industrial compostability conformity marks:



Role of inks & coatings concerning bioplastics:

- Can contain high levels of renewable materials increasing the total renewable content of packaging
- Can be designed to not hinder the composting process but they are NOT compostable

“Materials that are industry compostable do not necessarily biodegrade in nature”



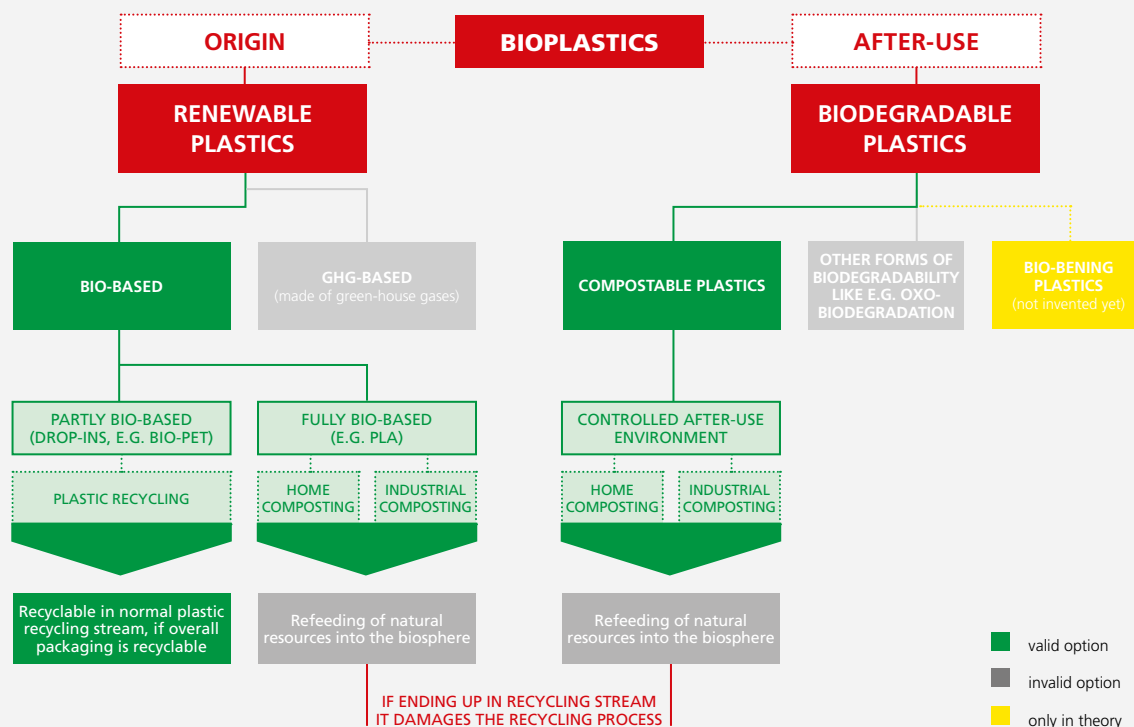


Figure 14: When are bioplastics a valid option?

So, when are bioplastics a valid circular packaging solution?

Drop-in bioplastics are a valid option for plastic packaging that is designed for the recycling stream; allowing the reduction of finite resources while the packaging remains recyclable. Fully bio-based plastics can be used for packaging that currently is likely to not be recycled. However, this needs clear labelling stating that the packaging should be composted or disposed with the residual waste and is not suited for recycling. This has the potential to move from a conventional plastic that is discarded as residual waste to a fully bio-based plastic packaging that has a circular after use in composting.

The worst case would be that the packaging remains part of the non-circular residual waste stream but is at least de-fossilized. Examples include single-serving sachets (e.g. for condiments) and coffee caps.

SIEGWERK offers OK compost certified inks supporting compostable packaging only for applications where a compostable plastic can help bring more organic waste into the appropriate after-use system (e.g. organic nutrient) by ensuring that ink layers do not interfere with the defined composting process. There are several product categories where biodegradable plastics make sense today and where inks and coating can add value like e.g. clamshells, condiment sachets or coffee pods.

Bioplastics have their limitations as of today when applying a differentiated well-considered assessment. We will not create a circular packaging industry without driving reuse and high-quality recycling as much as possible.

However, the reality is that leakage is likely to remain significant. Even in the United States and Europe, with advanced collection systems, 170,000 tons of plastics leak into the ocean each year.²³ In this context, the potential of bioplastics should be recognized as motivation to drive game-changing innovation in material sciences moving closer to truly biodegradable (bio-benign) plastics. Furthermore, to invest into expanding the composting infrastructure, which would be an essential trait to mitigate the negative effects of leakage into the nature. Whether this kind of bioplastics will ever be developed remains uncertain, even with massive investment in innovation, research and development.

While this section focused exclusively on bioplastics, please note that other materials which contribute to the de-fossilization could also be a valid option for the composting waste stream, most significantly paper.

3

TIME TO ENABLE: Printing inks & coatings as essential enabler for packaging circularity

Printing inks and coatings are not only crucial for branding, appearance, and functionality of a packaging, but also for creating circular packaging solutions. Their technical functionalities can actively support all three levers of a Circular Economy: Reduction, Reuse and Recycling of packaging.



Image 12

**SIEGWERK**

Inks' contribution to realize circular packaging:



REDUCE:

Innovative inks and functional coatings offer the opportunity to close technical performance gaps of certain materials, such as paper, improving their properties and therefore allowing their use for new applications. They enable e.g. the switch from multi- to mono-material packaging while maintaining the functionality of the original packaging, both with respect to converting and the protection of the packed good, and thereby enable the reduction of packaging components.

Relevant solutions include e.g. special sealing coatings for converting of packaging, barrier coatings that protect contents in paper packaging while extending shelf life or scratch resistant inks and coatings that enable the reduction of packaging elements such as the cellophane wrapping around paper packages.

Moreover, inks and coatings that are based on renewable content also contribute directly to reducing the use of finite resources such as fossil based polymers.



REUSE:

For the reuse of packaging special ink and coating systems can meet the diverse packaging requirements asking for different ink properties for each use cycle. While the best-before date might have to change with each use, other information like the brand name have to be more resistant compared to single-use packaging. Here, inks and coatings play a crucial role to provide reusability with maximum cost-efficiency to achieve economies of scale. A well-known example for this is the German multi-cycle system for certain beverage containers. The bottles are equipped with easily detachable labels that do not discolor during the washing process while the crates can be equipped with a protective coating to improve the resistance of the crate itself but also of its printing. Going forward, inks will play an important role in enabling effective reuse business models in terms of scale, performance and cost.



RECYCLING:

The right selection of inks and coatings ensures that necessary packaging functionalities are maintained when switching from multi- to mono-plastics. They provide certain barrier properties and therefore allow for reducing different film layers. Similar to switching to paper this applies to functionalities in respect to both converting and the protection of the packed good. In this context, the switch to surface printing also needs to be mentioned as relevant for the switch to mono-plastic packaging, especially concerned with flexible packaging. Surface printing not only enables single layer film set-ups by providing functionality such as high gloss and heat resistance, it is also an important pre-requisite for successful deinking (see EXCURSUS “BETTER PLASTICS RECYCLING: Enhancing the quality of recyclates through deinking” – page 33).

With regard to flexible packaging the use of easy to recycle polyolefins (PE and PP) is further increasing, creating new challenges for both packaging converting and functionality of the pack. For these particular substrates the right inks and coatings can help to successfully address these challenges. For example, if the packaging structure is moved from a PET/PE to a PE the functionalities of PET, such as high glossiness and heat resistance, do not become obsolete but have to be mimicked by other parts in the packaging structure. Inks and coatings can create glossiness and heat resistance – enabling the removal of the PET layer while maintaining the functionality of the pack.

Next to moving towards mono-plastic which ensures that only compatible plastic types are processed together during recycling, modular packaging set-ups present another way to realize a clear separability of materials, improving overall packaging recyclability. Here, dehesive lacquers or perforations can e.g. support an easier dismounting of packaging structures e.g. separating plastic from paper.

Finally, successful recycling requires ink solutions that do not hinder the recycling process. In this regard designing out certain components such as PVC is crucial. Also, certain binders are more compatible with the extrusion process than others. Ink solutions can therefore have significant impact on the recyclability and recyclate quality. For some applications such as label inks and coatings, the products need to be resistant to the point to enable the removal of product residues during the washing process but without discharging any color into the washing water in order to facilitate its filtration.

Considering that 40% of today's packaging is flexible packaging – due to its material properties, its cost saving potential and low carbon footprint – their low recycling rates show how important the creation of packaging circularity is.²⁴

There are also recycling challenges with regard to other packaging such as multi-material packaging like plastic-coated or metallized cardboard. The separation of the layers would be needed in most cases but is technically challenging. For paper specifically UV-cured and coated paper packaging are more difficult to deink. Paper that is applied with a plasticizing adhesive may lead to sticking contaminants, so-called “stickies”.

All in all, innovative ink and coating solutions can significantly support the development of circular packaging.

Inks & coatings can actively support all three levers of a Circular Economy

They close technical performance gaps and open up entirely new application possibilities of certain substrates such as paper and mono-plastics. They are also able to significantly increase the recyclability of a packaging. Furthermore, inks and coatings (separate from visible color) are the essential key to enable a circular packaging industry and will be an indispensable part of any future circular packaging solution. For the printing ink industry this carries the need to identify and actively drive future areas of innovation where inks and coatings either can further serve as important enabler or must be addressed as obstacle leading to further adjustment requirements to enable final circularity. This might include the identification of ways to further increase inks' compatibility with the extrusion process of mechanical recycling not only addressing the quality of recyclates but also the behavior of printed materials in the extruder. Even though this comes along with further challenges it could make a significant contribution to future recycling especially given the still lacking infrastructure for deinking which needs to become standard going forward.

As one industry within the value chain cannot move the whole system towards a circular packaging industry it is imperative that all areas along the packaging value chain need to contribute with own findings and innovation while increasing collaboration and jointly drive research, development and testing of ideas to quickly gain further insights and make important technical progress increasing packaging circularity.

BETTER PLASTICS RECYCLING: Enhancing the quality of recyclates through deinking

Excursus



image 15



SIEGWERK

In a Circular Economy the goal is to create a closed loop recycling in which packaging waste is converted into reusable materials (recyclates) using respective sorting and recycling technologies. In order to use those recyclates for the production of new packaging a SUFFICIENT QUANTITY in the REQUIRED QUALITY is needed.

Both quantity and quality are still a challenge today. In Germany for instance only 10% of PET, PE and PP plastic used for packaging is made from recyclates*²⁵ – the reasons for this are ranging from challenging economics of recycling in light of low virgin plastic prices to the high technical and safety requirements of packaging and recyclates.

When it comes to the economics of recyclates it is already known that the creation of higher quality recyclates improves the value proposition compared to virgin plastic. It would strengthen the economics especially when resulting in close to virgin-like quality that put the recyclates on the same level as new material adding significant value for converters, brand owners and consumers. Today, brand owners are increasingly committed to the use of recyclates (see the Global Commitment by the Ellen MacArthur foundation) and more legislation is being passed to prescribe a minimum recycled content in packaging (e.g. the Extended Producer Responsibility Laws in the UK) already improving the value proposition of recyclates.

One of the key criteria for the quality of a recyclate is the purity of the input material. Sorting is the first essential step ensuring the right separation of material types followed by a cold washing of the material. However, even perfectly sorted and cold washed materials are in fact still quite “dirty”. The reasons for these impurities range from, organic residues, to adhesives, and of course inks and coatings. For the latter, there are current “deinking” technologies that enable ink removal from plastic waste.

The paper industry can provide some guidance on the future of the deinking of plastics. In the paper industry deinking is an established process (including a set of standard parameters and deinkability testing), driven by a pull for high quality recycled paper. The demand incentivized the creation of a recycling infrastructure that can deliver the quality and quantity needed. It is not unrealistic to expect a similar dynamic for the deinking in the plastic recycling process – filling the current gap of deinking as a standard process step in the recycling of plastic.

* Of which 4% come from the post-consumer waste stream, 6% come from post-industrial waste.

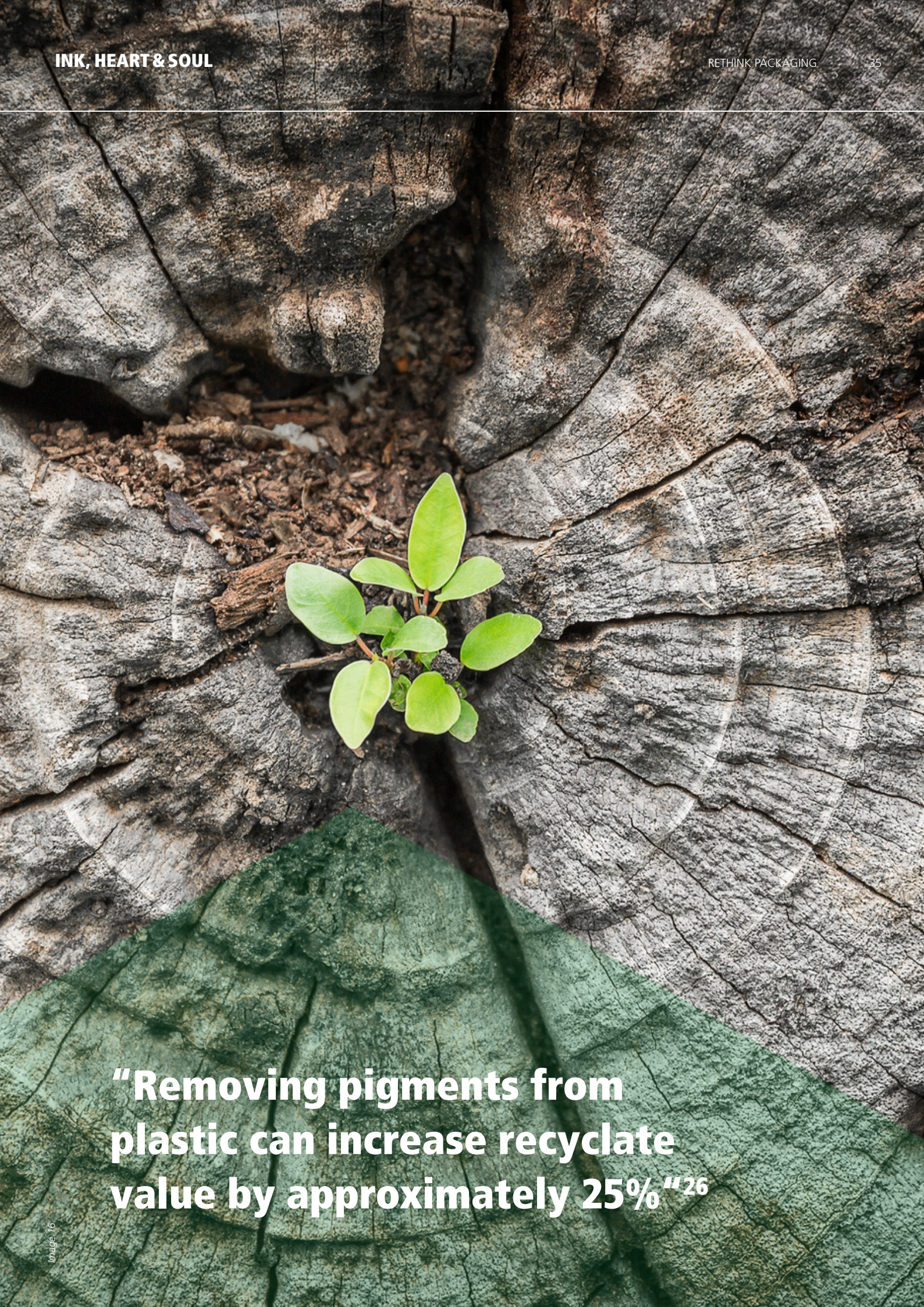
Current deinking technologies (as part of mechanical recycling):

WATER-BASED

Caustic aqueous solution plus mixture of washing active surfactants

SOLVENT-BASED

Suitable solvent



"Removing pigments from plastic can increase recycle value by approximately 25%"²⁶

Successful deinking tests of plastic films completed:

Siegwerk and APK AG have shown that inks could be removed from the polymer matrix of twofold printed LDPE-films using the solvent-based recycling technology Newcycling®. A first step towards facilitating the efficient recycling of flexible packaging applications.

Learn more

The overall aim should be that the deinking process works for all kinds of inks and printing set-ups. Of course, there are design for recycling (or in this case design for deinking) considerations that increase the ease and success rate of any deinking process. In this context, surface printing on polyolefinic substrates gains importance compared to the commonly used reverse printing for laminated structures. It makes the ink removal and therefore the recyclability of packaging possible and helps to realize novel packaging ideas while delivering functional features and good visual design opportunities at surprisingly attractive costs.

While, new inks and coatings with improved deinking properties can generally help to remove printed layers more easily and therefore increase recycling volumes and quality; the key to success will be creating industry wide standards and ensure an appropriate deinking infrastructure. Deinkable packaging will only make a difference in the journey towards a Circular Economy if it is completely deinked.

The above information applies for mechanical recycling, the only recycling process applied at scale today by using extrusion to break down plastic into its polymers.

Other recycling technologies include solvent-based recycling process and chemical recycling. In the case of solvent-based recycling, a recycling polymer is dissolved, and the ink remains as a residue which can be removed from the polymer. Deinking doesn't play a role in the chemical recycling process as the ink - like the adhesive and the polymer itself is pyrolyzed in decamped molecule fragments which are then further refined.

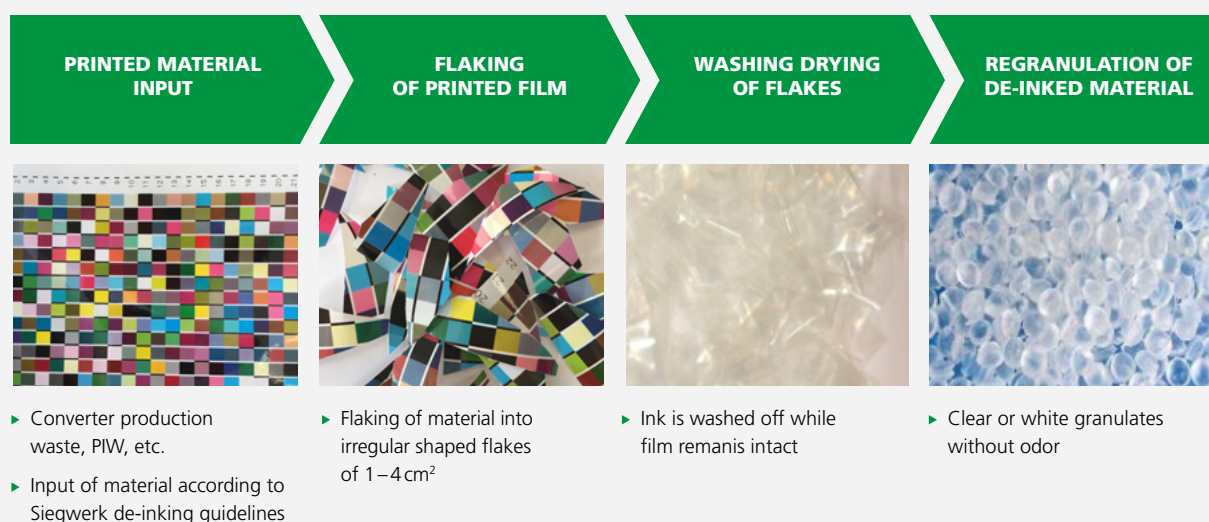


Figure 15: High-level deinking process

4

TIME TO TEAR DOWN VALUE CHAIN SILOS: Joining forces along the packaging value chain

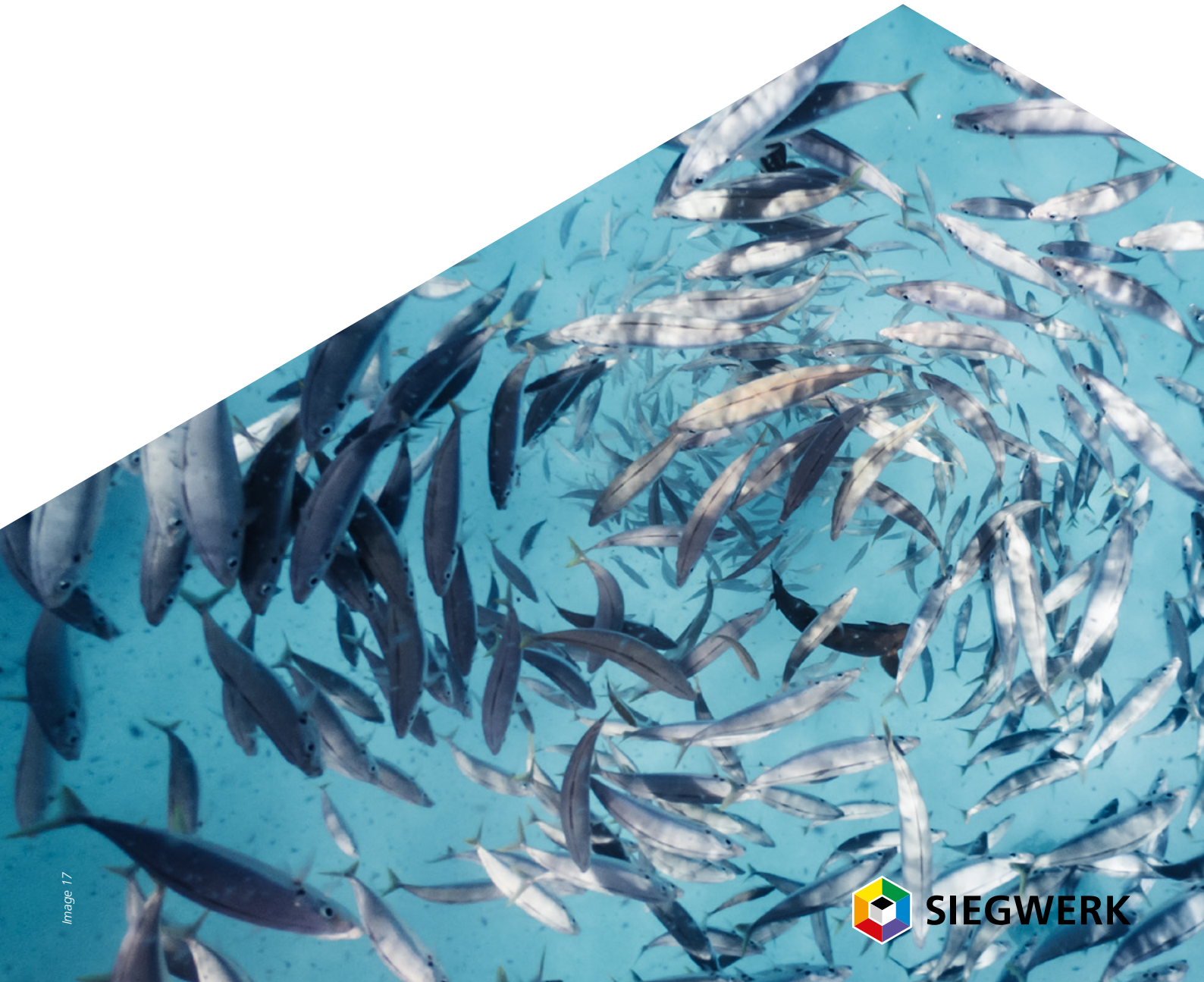




Figure 16: Creating Circularity – Together!

Creating circular packaging solutions is not only about innovations it also requires new ways of collaboration along the entire packaging value chain. It is a collaborative task considering the complete life cycle of packaging – from design through use to recycling – in order to fuel the creation of circularity by driving reduction, enabling reusability and enhancing recyclability of packaging. Therefore, proactive exchange and close cooperation are key to test and optimize new ideas and jointly develop responsible and sustainable packaging solutions.

That's why Siegwerk as one of the leading global packaging ink providers is actively contributing its ink expertise to different industry initiatives that drive the concept of a Circular Economy.

Today, the company already has a strong partner network and integrated know-how along the packaging value chain. Sharing knowledge with other industry players is key for Siegwerk to provide special inks and coatings that enable the development of new circular packaging solutions.

Examples of collaboration and engagement:

The **ASSOCIATION OF PLASTIC RECYCLERS** (APR) is “The Voice of Plastics Recycling”. As the national trade association, APR represents companies who acquire, reprocess and sell the output of more than 90 percent of the post-consumer plastic processing capacity in North America. APR strongly advocates the recycling of all post-consumer plastic packaging and therefore strives to expand the postconsumer plastics recycling industry through a cooperative effort aimed at identifying and eliminating barriers to successful commercial recycling. As member Siegwerk USA contributes its packaging and ink and de-inking expertise supporting the joint search for new ways to make the recycling of plastics more economically and environmentally sustainable. [Learn more](#)

CEFLEX is the collaborative initiative of a European consortium of companies representing the entire value chain of flexible packaging. The project mission is to further enhance the performance of flexible packaging in the Circular Economy by advancing better system design solutions via collaboration. Members include manufacturers of packaging films, converters and brand owners as well as retailers, recycling companies and equipment manufacturers for the entire recycling process – making CEFLEX the most significant and solution-oriented industrial initiative.

Siegwerk joined CEFLEX in 2017 as the first ink supplier. Since then, the company has contributed its extensive know-how in ink technology and formulation to improve the performance and recyclability of flexible packaging. Company experts contribute to understand the influence of inks and printed layers on the automatic sortability of flexible packaging waste as well as on recyclates derived from mechanical recycling including extrusion. Moreover, the company is engaged in investigations on the improvement of recyclates through deinking and on the ink influence within advanced recycling technologies like chemical recycling. [Learn more](#)

The **CIRCULAR ECONOMY INITIATIVE DEUTSCHLAND** (Germany) is a network of economic, scientific and societal stakeholders that is funded by the German Federal Ministry of Education and Research. Its aim is to develop a joint target vision and a concrete plan how the transformation towards a Circular Economy in Germany could be fostered. The initiative opens a science-based discourse about the potential opportunities and develops a roadmap for transformation towards a Circular Economy in Germany. The initiative will complete its work end of 2020 with the publication of several reports.

Siegwerk is an active member of the working group “Packaging.” Together with other experts in this group, the company investigates new value networks for packaging considering the entire lifecycle including subsequent use potential to develop options for the optimization of packaging according to circular approaches.

The **EUROPEAN PLASTIC PACT** (EPP) brings together governments and frontrunner companies from across the value chain to accelerate transition towards a European circular plastics economy. The initiative has been launched by France and The Netherlands but over 80 other organizations including governments, companies, NGOs and business associations from across Europe joined to shape the final text of the European Plastics Pact. Today, they work together towards four goals aimed at design, responsible use, recycling capacity and the use of recycled content. The Pact supports this work by offering a unique platform to exchange ideas, display good practices and discuss challenges, needed to build a new circular default for all to follow. As member Siegwerk contributes its ink and packaging expertise to further drive the creation of a circular (plastics) packaging industry.

HOLYGRAIL 2.0 is a follow-up project of the Pioneer Project HolyGrail, a multi-company collaborative venture that was led by Procter & Gamble and facilitated by the Ellen MacArthur Foundation. The HolyGrail project was designed to solve one of the largest obstacles facing plastic recycling: inefficient sorting at recycling facilities. Therefore, the first project (1.0) investigated how tagging of packages can have a drastic impact on more accurate sorting and high-quality recycling via tracers and digital watermarks embedded in the plastic. HolyGrail 2.0 is now continuing the work by putting digital watermarking technologies into practice across more packages and more recycling facilities to prove their viability for accurate sorting and financial feasibility at large scale. The participant group again consists of representatives from the full packaging value chain, covering brand owners, waste manufacturers, resin producers and converters, retailers, technology providers and others. As member, Siegwerk can actively contribute its packaging ink expertise and exchange with other players across the value chain to jointly improve sorting and thus the success of recycling.

PLASTICS RECYCLERS EUROPE (PRE) represents the interests of plastic recycling companies in Europe and provides a network for the exchange of expertise. As part of its strategic campaign for more plastic recycling the association defined "Design for Recycling" as one of its pillars. In this context, PRE wants to encourage designers and manufacturers to pay particular attention to recyclability when designing a package to further support the transition towards a green, circular European market. RecyClass PRE promotes a tool for finding the correct way to approach and evaluate the design for recycling of packaging products, with the goal of improving their recyclability. RecyClass is also a label certifying packages as being environmentally friendly. Siegwerk is a non-recycling member of the PRE in the unique position to enrich the assessments on recyclability with ink expertise.

PROJECT STOP is a frontline initiative, co-founded by Borealis and SYSTEMIQ, that designs, implements and scales Circular Economy solutions to fight marine plastic pollution in Southeast Asia. It uses a "system enabler" approach in which a team of experts in waste management, plastic recycling, organics management, behavior change, and program governance helps cities to design and implement low-cost waste management systems for all households. The overall goal is to increase recycling rates, achieve zero ocean leakage and create social benefits for local communities.

Since its launch in 2017, Project STOP has welcomed various industrial and governmental partners committed to support the establishment of on the ground solutions in Indonesia and eliminate leakage of plastics into the environment. As a strategic partner, Siegwerk can actively deliver on its sustainability commitment in a way that empowers local communities by building a circular system to successfully tackle the very real and immediate problems of plastic waste pollution. [Learn more](#)

The **SUSTAINABLE PACKAGING COALITION*** (SPC) is a membership-based collaborative that believes in the power of industry to make packaging more sustainable. Its mission is to bring packaging sustainability stakeholders together to catalyze actionable improvements to packaging systems and lend an authoritative voice on issues related to packaging sustainability. As a trademark project of GreenBlue Org, a 501(c)(3) nonprofit dedicated to the sustainable use of materials in society, SPC brings together businesses, educational institutions, and government agencies to collectively strengthen and advance the business case for more sustainable packaging. As member Siegwerk joined more than 300 other companies across the packaging supply chain to exchange knowledge, develop new ideas, and collaborate on projects to make packaging more sustainable.

5

TIME TO ADD COLOR TO CIRCULAR ECONOMY: Siegwerk is your circular packaging solutions partner



Siegwerk offers customized inks, coatings, and services for circular packaging solutions of any kind. Its products promote reduction of non-renewable raw materials, reusability, and recyclability by closing technical performance gaps while offering best ink performance & perfect color results.

Thereby, the company has not only highest technical expertise in developing inks for all printing technologies and nearly any material; Siegwerk has also a deep understanding of how its solutions effect the entirety of a packaging in regards to both costs and circularity and has vast experiences in the FMCG industry. Its Brand Owner Collaboration approach enables the company to gain profound insights and understand the pain points of both brand owners and converters essentially supporting an integrated communication along the value chain. Moreover, its material-agnostic know-how offers customers objectivity and cross-application support.

As one of the leading global ink providers for packaging applications, Siegwerk has made Circular Economy a strategic priority going forward and is fully committed and invested to actively driving change towards a circular packaging industry. As the company sees inks and coatings as an essential enabler for the realization of circular packaging solutions, it is actively driving the development of special inks and coatings that concretely support the reduction, reuse and recycling of packaging.

Today, Siegwerk already has a strong track record in customer-specific ink development projects for circular packaging solutions that can increase recyclability and recycle quality, allow composting, or reduce the need for plastic use and other non-renewable raw materials.

**Sustainability means
progress**

As one of the world's leading ink manufacturers Siegwerk is committed to the principle of sustainability: Achieving a sensible balance between ecological, social and economic needs without compromising the resources of future generations. [Learn more](#)

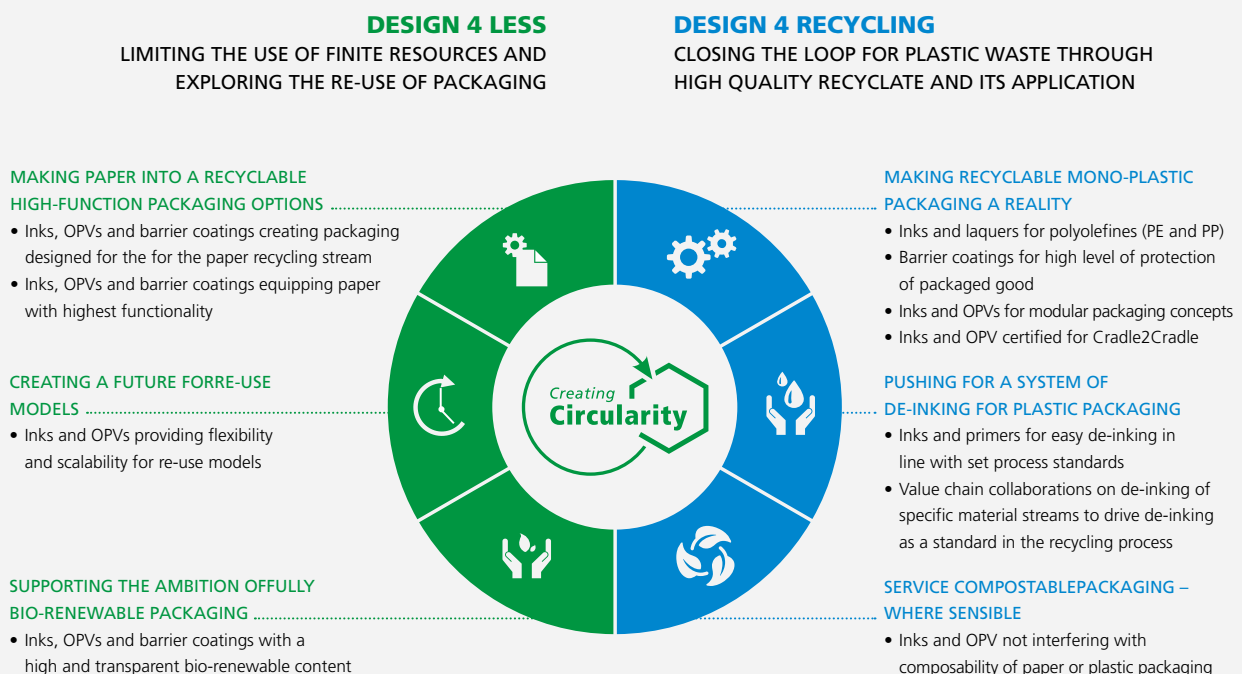


Figure 17: Siegwerk's roadmap to support the creation of packaging circularity with new ink developments

Making packaging fit the needs of today & tomorrow

Becoming a Circular Economy solutions company

Siegwerk has already started its own journey towards becoming a "circular" company by not only developing circular ink solutions but also rethinking its own operations and business according to a circular approach.

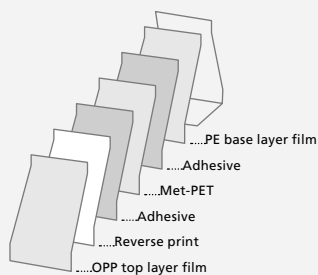
The company has developed PVC-free inks and coatings covering a broad application spectrum covering high end applications such as various kinds of stand-up pouches. New NC-based inks have already been used for a stand-up pouch for detergent that represents a completely new modular packaging structure with a detachable outer layer for an improved recyclability.

New water-based inks with good composting properties already enable the production of single use party plates out of 100% paper. The ink series UNIBio Siegwerk also offers water-based inks that consist of up to 80% renewable raw materials and already have been successfully used for cups and fast food packaging. This series offers at least the same performance level as conventional inks and an even better mechanical resistance.

These are just a few examples of how Siegwerk supports the creation of packaging circularity. The company is constantly working on new sustainable ink technologies and functional formulations to further expand its circular solution offering and enable new circular packaging applications.

The way forward to create a recyclable pouch with high functionality: Transition from a multi-layer/ multi plastic (PE, MetPET, OPP) to a single layer/ single plastic pack (MOPE)

THE STATUS-QUO OF POUCH SET-UP IS NOT RECYCLABLE:

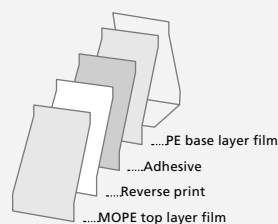


- Three different types of plastic are used which cannot be recycled together – OPP, PE and metallized PET
- The layers are bonded by adhesives, making a separation of the film layers nearly impossible
- Even if it could be recycled, certain inks and adhesives react in the extrusion step of the recycling process, diminishing the quality of the output material and damaging the equipment in the long run

TWO TRANSFORMATIONS NEEDED FOR A RECYCLABLE POUCH:

1. CREATE MONO-PLASTIC STRUCTURE (MOPE/PE)

- 1.1 Top layer: switch to MOPE, with an optimized MOPE (strengths, barrier functions etc.)
- 1.2 Eliminate Met-PET
- 1.3 Reverse print and adhesives remain



2. MOVE TO SINGLE LAYER FILM

- 2.1 Use only optimized MOPE
- 2.2 Switch to a surface print with inks optimized for clarity, machineability and bond strength
- 2.3 Add heat and scratch resistant layer
 - ▶ Outer layer has to protect prints from scratching. To reinstall that, a scratch resistant lacquer is printed on top of the inks
 - ▶ Heat resistance: PE melts easily. Need to make sure it does not melt too quickly in process (sealing accuracy)

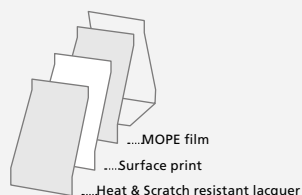


Figure 18: Creating a recyclable pouch with high functionality: Transition from a multi-layer/ multi plastic (PE, MetPET, OPP) to a single layer/ single plastic pack (MOPE)

Assessing ways of enhancing the ecological footprint of the company's inks with no loss of performance is one of Siegwerk's key R&D efforts since years already. The company is always looking into further opportunities to drive the development of eco-friendly and circular ink solutions.

Topics of increasing relevance for Siegwerk's R&D activities are amongst other mono-material packaging for an increased recyclability, renewable and reusable packaging to ensure an efficient use of non-finite resources as well as the further enhancement of deinkability to improve recycle quality. In all of these activities, the company sees great potential to significantly influence circularity by developing innovative inks and coatings concretely meeting the individual needs of a circular packaging solution.

With the combination of a functional and technical understanding of inks and varnishes with a strong partner network and integrated know-how along the packaging value chain Siegwerk is well equipped to individually support customers towards a more circular model.

*We never stop developing.
Get in touch with Siegwerk to discover how
we can make your packaging circular.
Contact us at ce@siegwerk.com*



6 NO TIME TO LOSE:

**Ready to shape the future
of the packaging industry?**



The developments of the last years clearly speak for themselves:

It is high time to act and shape the future of packaging and consequently the future of our planet.

Are we already able to build an economy that produces no waste?
The answer is "YES, BUT..."

YES, we have the principles, the tools and technologies in place and can already learn from first successful applications, BUT we need to speed up, become more ambitious to scale ideas and above all get ready to leave the "past normal" behind us to rethink the here and now.

We need to start thinking differently and use new design approaches for packaging, expanding opportunities and tackle transformation. It is time to break down silos, discover new ways of collaboration, and open the solution space as achieving a Circular Economy is not a single path route - it is more than just recycling.

We have the chance and responsibility alike to solve a problem that evolved over the past 70 years and is on track to grow exponentially. While the job ahead of us, seems daunting at times, we as an industry have the ability to transform and make a difference for the next generations. So, let's get started now.

Ready to shape the future of the packaging industry together? Then get in touch and join us in becoming a pioneer for the Circular Economy!

Contact us at ce@siegwerk.com for further information.



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