

DESIGNING PRINTED PRODUCTS FOR THE FUTURE

Creating competitive advantages
by defining a new level of quality.



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EPEA
The Cradle of
Cradle to Cradle



Healthy
printing!



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Coordinator: Martin Oldeland



The author of this study, EPEA Internationale Umweltforschung GmbH, was founded in 1987 by Prof. Dr. Michael Braungart.

As an international scientific research and consulting institute, EPEA works together with players from business, politics and science to introduce circular processes as well as product optimization and development.

Coordinator: Tom Koch



In early 2017, EPEA launched the Healthy Printing Initiative with the support of the DOEN Foundation. The aim of the initiative is to promote the use of healthy inks and printing chemicals, so that safer and more economical paper recycling systems can be realized. Paper is recycled on a large scale today, but is often heavily contaminated. This can cause problems in new products that contain recycled content.

Coordinator: Katja Hansen (EPEA)

About this study:

„Designing printed products for the future: Creating competitive advantages by defining a new level of quality.“

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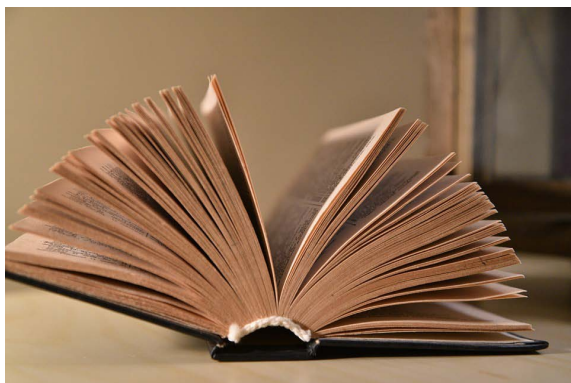
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Printed products are part of our lives

Humans are in daily contact with printed products. Books, magazines, cardboard boxes, packaging, printing inks, office paper and many other printed products enrich our everyday lives. Despite digitization, printed products remain indispensable for private life and work. Therefore, it makes sense to design those products to be suitable for high quality recycling and human contact.



Designing printed products for the future: Creating competitive advantages by defining a new level of quality.

This report analyzes the current market situation in the paper sector and the most relevant challenges for today's print products. Those challenges are used here to describe how print products must be designed in the future to achieve a new quality of recycling, and optimise paper as a valuable resource. Thus, both economic and environmental benefits can be created along the entire value chain, from the producer of paper and inks to the print shop to the customer.

1. The current situation

Because of the practical benefits of paper, the sector is one of the largest resource consumers in the world. One ton of pulp requires five tons of wood and 50-300 tons of process water. **More than 400 million tons of paper are produced each year, and about 77 million tons are shipped to Europe. The market is growing worldwide by approx. 1.5% annually.** In order to meet this growth, billions of tons of fresh materials are used and high recycling rates are targeted.¹

Considered by many experts to be an outdated model in the digital age, it was expected that paper consumption would decrease due to the digitization of work processes. But the total volume continues to grow due to demand from emerging economies and for example packaging from internet commerce. Another factor: paper materials are increasingly being used as substitutes for materials based on fossil raw materials (such as plastic), as in food packaging.

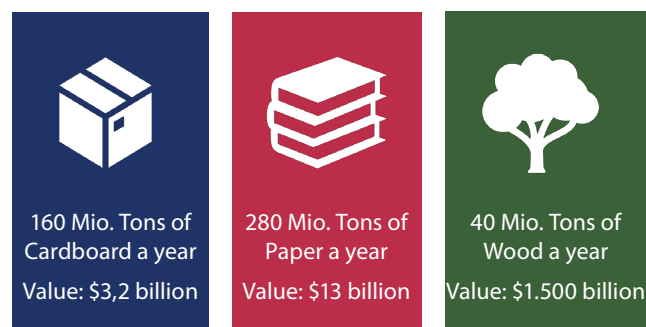
To meet steady demand, paper must come from fast-growing renewable sources and be as recyclable as possible. In theory, paper is an ideal biological product that can be returned to the environment after a 'cascade' of uses (see later section on cascades for description). However, looking at many paper products, this seems almost inconceivable – since after processing (such as bleaching, printing), safe recycling of the modified product in a biological cycle is highly unlikely.

By weight, additives such as coatings and inks form only a small portion of printed paper, but can significantly influence the quality of the product. Common examples of problems include news reports on health risks, such as the mineral oil contamination of food due to the use of recycled cartons.

Due to contamination of paper, **every year printed products such as boxes and paper worth about \$ 16.2 billion are thrown away and cannot be reused.**² The problematic ingredients in those products, which have not been optimized for circular reuse, cause higher disposal costs from a macroeconomic perspective than if they were used in effective recycling.

Regulators and NGOs are mainly focused on paper procurement and recycling, but little attention is paid to the thousands of additives that significantly affect 'recycled content' and have the greatest impact on human health and agriculture. In addition, only the fibers are recovered in paper recycling. So far, only a few approaches exist for reusing mineral components.

Figure 1: Value of annually burned paper products in US dollars



Source: GeneraCycle, "What we throw away every year" (2017)

Millions of tons of problematic sludge are produced globally each year resulting from the recovery of cellulose fibers from paper recycling. In the water-intensive, so-called deinking process, pulp containing additives that make up between 15 and 50 percent of paper volume are separated to be reused. As a result, sanitary paper designed to keep us clean and protect our health, often contains „recycled“ toxic materials that are harmful to human skin.³

To solve this, **the additives industry must be brought into optimising the recyclability of binders, bleachers, coatings, fillers, inks, smoothing agents, adhesives and many other chemicals that are used to process and print paper.**

Various eco-initiatives around the world are dedicated to paper, but there is no leading organization for optimising additives, coatings and inks to design paper for safe return to the biosphere:

The goal is to solve these challenges by finding organisations to take the lead in order to ensure healthy printing and safe paper processing.

Paper sector in Germany

Despite the increasing digitization of work, the relevance of paper products is not diminishing. **In Germany, the paper industry remains a high-tech industry with a future.**

Sales of paper products are very stable in Germany, with low growth in the last ten years. Thanks to state-of-the-art machinery, Germany is the world's fourth-largest producer of paper products and, in some areas, the world market leader.⁴ With exports of around 45 percent of paper products produced, Germany with its geographic position

in the heart of Europe plays a significant role.

Likewise, recycling is an important factor in Germany, as can be seen in the recycling rate for paper: around 75 percent of waste paper is used for recycling. However, the quality level is low, and too many high-quality white fibers are lost in the process. A further increase in the recycling rate is becoming increasingly difficult. Despite the high recycling rate, the problem is not solved; contamination of paper is still a problem that harms people, the environment and thus ultimately the economy.

Figure 2: Production volume (paper, cardboard and cardboard) in million tons

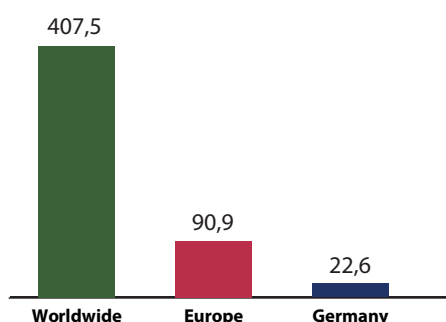
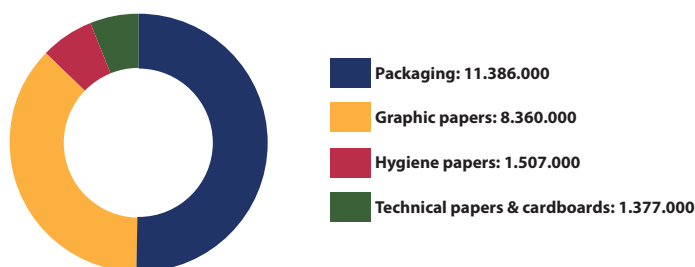
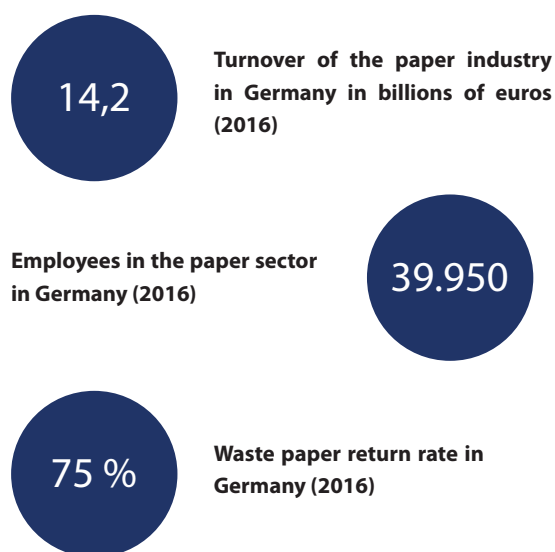


Figure 3: Production share in Germany in tons



Source: Verband Deutscher Papierfabriken, Papierkompass 2015/2016 (2017)

Figure 4: The paper sector in Germany at a glance



2. Challenges facing the paper industry

Paper recycling is a highly complex process: **in order to use waste paper in new paper, various cleaning steps and processes are necessary, in which fibers are lost or lose quality. Wood fibers in the paper can only be reused up to seven times, so new fibers must inevitably be added to the paper cycle.**⁵

There are five main challenges for the industry:

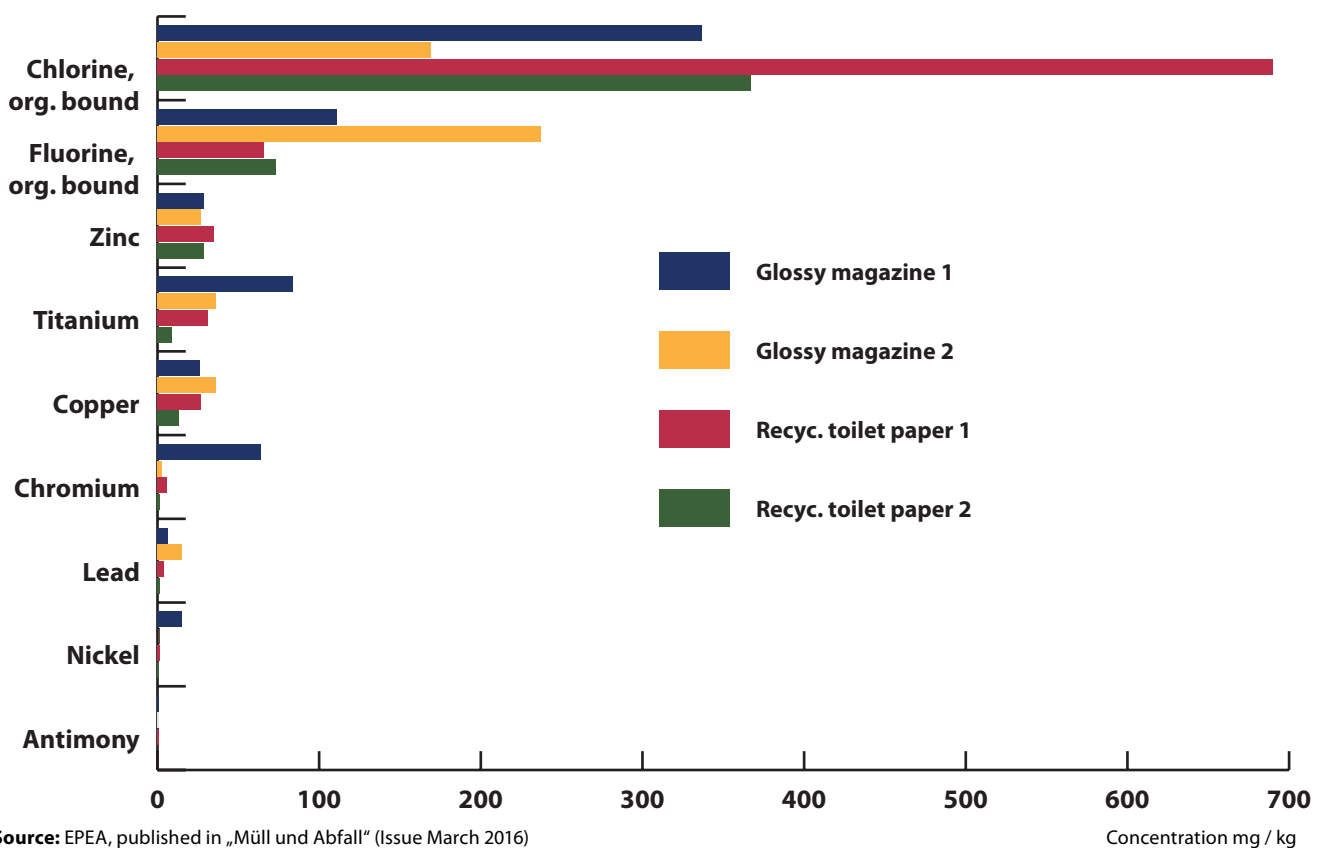
1. Contamination of recycled paper

The 'cascade' use of materials and the high variety of recycled materials can have negative effects, such as increased content of unwanted substances in wastepaper cycles. The cause of this is chemicals such as bisphenol A that adhere to paper fibers and are water-soluble.

Once paper is contaminated through household waste disposal, the material can no longer be used in paper production of food packaging because problematic substances could migrate into food via cardboard and paper packaging. Even if it is carefully separated, waste paper may still contain critical substances.⁶

So far, the quality of inks and printing processes has been determined solely by economic and visual parameters. Whether the resulting waste paper is suitable for subsequent recycling was not considered. For example, in paper used for two glossy magazines and recycled toilet paper, organic halogen compounds and heavy metals were detected (Figure 5). Due to this, one kilogram of toilet paper can contaminate five million liters of water, because traditional print products have never been made to be recycled as toilet paper.³

Figure 5: Organically bound halogens and heavy metals in two glossy magazines and recycled toilet paper



2. Migration of harmful substances

A poorly functioning circular economy for printed products can have negative effects on human health. These are shown by studies that detected residual ink from recycled cardboard packaging in food. A test published by the Stiftung Warentest on November 26, 2012, found mineral oil components in the chocolate of Advent calendars.⁷ In some samples, the testers were able to detect more than 10 milligrams of mineral oil per kilogram of chocolate.

The European Food Safety Authority (EFSA) had classified the uptake of these mineral oils by food as risky before this test and also the Federal Institute for Risk Assessment (BfR) stated that mineral oils should not actually migrate into food. In October 2015, an extensive laboratory analysis commissioned by Foodwatch finally caused quite a stir: 120 packaged foodstuffs from Germany, France and the Netherlands were examined for their mineral oil content and 43% of the products were contaminated with aromatic mineral oils (MOAH).⁸

3. Focus on increasing efficiency and compliance with thresholds

An indirect cause of such system failure is the focus on efficiency and minimising harmful content, rather than taking a healthy product design into account from the beginning.

Environmental and consumer protection directives set thresholds for substances and prescribe to what extent

they can be in contact with nature and people. The DIN standard for „compostable packaging“ also specifies thresholds for heavy metals allowed in printing inks.⁹

4. Low quality of “deinking” sludge

„Deinking“ sludge is used as fertilizer in many countries, which is now banned in Europe due to contamination with heavy metals. Legislation has been able to reduce the number of harmful substances contained in sewage sludge, but contaminants caused by printing inks (AOX, PAH, etc.) remain a challenge. The sludge is incinerated as a waste product or used in the concrete and brick industries. A pollutant-free sludge could create significant added value. However, due to contamination, problematic substances, e.g. from construction waste, can ultimately end up in the biological cycle through leaching or reuse of the waste. The result is not only a waste problem, but also the disruption of natural cycles, the depletion of raw materials and the loss of fertile soil.³

5. Lack of effective recycling methods

Existing recycling plants in Germany, won't achieve higher recycling rates without further advances in technology. Moreover, with today's conventional recycling processes, contaminants are not completely eliminated. At the same time, virgin fibers cannot fully meet the need for paper. Waste paper therefore remains a valuable commodity, which requires higher quality to ensure optimal reuse of resources.

3. Innovative printed products for a Circular Economy: Creating competitive advantages by defining a new level of quality.

3.1 Upgrading the quality of paper

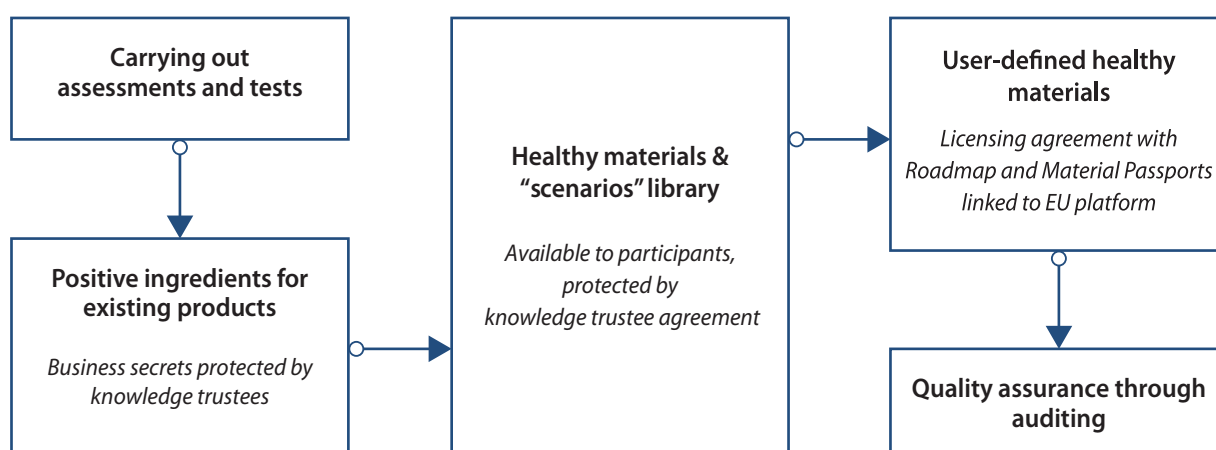
So the question is: how could printing inks and additives be optimised so they are really suitable for composting or food packaging?

EPEA has several decades of experience in healthy printed products, helping a variety of companies to identify and scale up safe printing substances. The collaboration is based on EPEA's Cradle to Cradle concept, which describes the safe and continuous reuse of healthy materials and nutrients in a biological or technical cycle.

Thousands of products and components have been optimized for recycling over the past two decades. In the printing sector, EPEA has been active since the 1990s, when EPEA scientists led the development of chlorine-free paper. Subsequently, hundreds of print and paper substances were evaluated and companies were supported in optimizing their products and offering them to the market. The protocol for the development, implementation, and verification of healthy ingredients (Figure 6) illustrates steps taken to optimize the industry.

Figure 6: Implementation of healthy ingredients

Protocol for the development, implementation, and verification of healthy ingredients



Source: EPEA (2016)

3.2 Optimizing the use of paper in a cascade

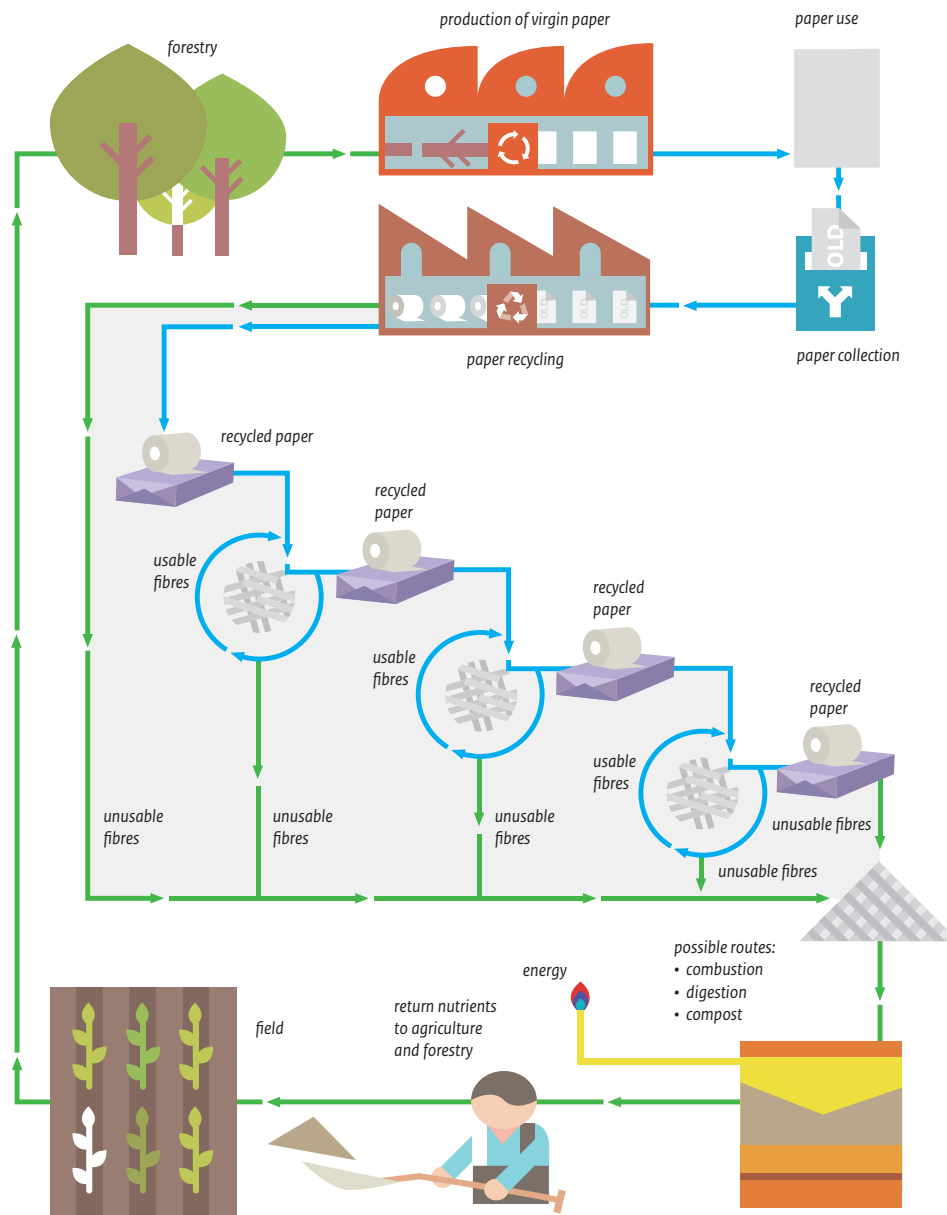
An important way to extend the use of wood components is healthy re-use of paper fibers and products in a cascade.

The model is based on repeated uses of paper fibers, through to their final use as soil components to grow new biomass for the production of paper. Paper fibers, which have become too short for reuse, return to the biosphere for example as ash that is used as a soil component, which results from safe combustion for energy generation. Hygienic papers are returned via the water cycle. Through new technologies, the organic material contained in paper sludge can be converted into bio-oil by pyrolysis and the minerals are recovered. The successful implementation of this cascade model depends on the materials that different users add to the paper fibers.

Companies from the chemical, printing, paper and board industries are capable of developing paper, printing inks, adhesives, process chemicals, etc. without problematic ingredients that are suitable for reuse within the cascade. This is where the Cradle to Cradle concept comes in.

Market leaders such as WEPA, Dekkers van Gerwen, Gugler, the Hubergroup and other innovative companies make it possible to implement the model in practice: all substances added to the paper fibers undergo rigorous toxicological testing and are well on the way to being optimized for the biological cycle.

Figure 7: Use of paper in a cascade



Source: NL Agency, Position paper – Usability of Life Cycle Assessment for Cradle to Cradle purposes (2011)

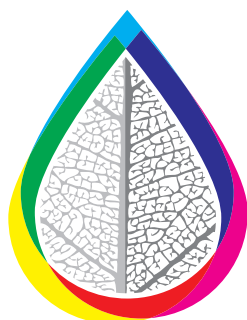
3.3 Achieving best quality through „Healthy Printing“

Nowadays many printing substances can already be classified as healthy, but awareness of them and their use in the market are still comparatively low. Other substances need further careful investigation, many should be completely removed from every printing process. **An optimized cascade use of paper is only possible if suitable printed products are developed and used.**

For this reason, and to improve food safety and reduce recycling costs, EPEA has launched the Healthy Printing Initiative with the support of the DOEN Foundation. This aims to increase the availability of healthy ingredients in printed publications and packaging, so that:

- Products are safe for high-quality recycling or use in the biological cycle.
- Sludge that inevitably occurs in recycling can be a safe resource for other uses.
- Standards for water quality and wastewater treatment in recycling can be improved.
- Products surpass legal requirements and are safe as measured by the highest standards for use and reuse.
- Products adversely affect neither humans nor food, air, water or soil.

Figure 8: Healthy Printing Initiative



Healthy printing!

Source: Healthy Printing Initiative (EPEA 2017)

A library of „best practices“ with a positive list of printing substances aims to promote healthy printing processes and products. Companies that lead the way in developing healthy printing products can thus strengthen their competitive position through the initiative.

For safe printed products, this means accelerating development of best practices across industries, while accelerating demand for healthy printed products by market-leading companies, NGOs and governments as customers.

Likewise, scaling up requires a network of companies and organizations along the supply chain - from packaging manufacturers to printers to ink suppliers. It is all about bringing the whole supply chain together with motivated stakeholders, so that cooperation and innovation lead to printed products for a beneficial Circular Economy with competitive advantages.

3.4 Healthy printing is characterized by and scaled up with the following aspects:

- Quality assurance for ingredients.
- Access to information about new innovations while protecting intellectual property.
- Separation of safe printed products from waste streams for high quality recycling.

One goal of the initiative is development of a Healthy Printing Charter, which includes implementing measurable roadmaps and pilot projects that facilitate healthy printing processes. Transparent communication between buyers and suppliers has been a major challenge in developing healthy and economical printing products. This gap is being filled by the initiative to enable healthy printing. The aim is to make printed paper an economic resource for recycling and composting.

3.5 What competitive advantages can be achieved through Healthy Printing?

As a driver for effectiveness and innovation, the Circular Economy has enormous economic potential. However, if you consider all of the materials in the printing sector as resources that could be reused, then the current approach, from a resource management perspective, is unprofitable. Many valuable and energy-intensive raw materials disappear forever.

A large part of the material value, created by complex processes (extraction, purification, coating and forming) is wasted, which significantly reduces the cost-effectiveness of those processes. On the other hand, systems are required where the usability of materials is not only maintained in continuous cycles, but can even be improved („upcycling“). Surveys show that sustainable packaging is one of the fastest growing segments of the printing and paper industry¹⁰ and creates a competitive advantage for various players in the industry:

- Retailers who sell products in printed packaging can meet the growing demand for safe and recyclable packaging.
- Printers meet the growing demand from publishers and packers for safe printed products. Additionally it is safer for their employees.
- For packaging manufacturers verifiable healthy printing products are a competitive advantage when sold to retailers who have environmental standards.

The development of a beneficial Circular Economy can create further competitive advantages, such as reduced price volatility in supplier / buyer networks or material savings in purchasing. An overview of the competitive advantages for different stakeholders is shown in Figure 9:

Figure 9: Competitive advantages through Healthy Printing



1. Advantages for paper manufacturers who mix recycled and primary raw materials

- Reduced waste management costs: Up to 40% of all paper fillers, binders and additives are processed into 11.8 million tons of sludge per year in Europe.¹¹ Often this is contaminated by problematic printing inks and is treated for € 30 to € 100 per ton or burned with expensive filters.¹² Waste management costs exceed 200 million Euros in the EU alone. These could be reduced if the sludge is biocompatible and suitable for high-quality composting and other products or is burned clean.
- Reduced sorting of raw materials: Today up to 15% of the raw material inputs are rejected due to contamination directly before the deinking process.¹³
- Improved quality of paper roll cut-offs: If these are biocompatible, they form a high-quality raw material for paper of the same quality or for hygiene and tissue paper manufacturers, which are looking for a safe starting material.
- Reduced liability and compliance costs for food packaging materials and for manufacturers using recycled paper in non-paper products (such as wall panels and other construction products).
- Reduced health risks for employees who work with recycled paper.



2. Advantages for printer, ink and pigment suppliers

- Meeting the growing demand of customers for defined and safe printing products.
- Reduced health risks for employees who work with printing additives.
- Cross licensing: benefits for healthy print suppliers sharing products and know-how.



3. Advantages for publishers

- Increased recycling quality of „returns“ and „scrap“, including unsold magazines, books, brochures and secondary packaging.
- CSR claim for healthy publications while promoting demand.



4. Advantages for retailers in the packaging sector

- Reduced contamination risks, compliance costs and PR risks with healthy packaging.



5. Advantages for large B2B customers using healthy printing products

- The paper user as a supplier of raw materials: Users and manufacturers can each benefit if the user returns the paper directly to the manufacturer instead of putting the high-quality raw material into partly undefined waste.



6. Advantages for waste disposal and packaging companies

- Economic incentive to introduce track & trace technologies for the separation of safe paper as demand for this share among manufacturers and users increases. These technologies are already being used in the marketplace today.



7. Advantages of integrated circularity - matchmaking as a service

- Higher efficiency and lower costs for participants in identifying sources and customers for healthy printing products.

Source: EPEA Business case for healthy printing & paper (2016)

4. Implementing innovation. Let's start!

Healthy Printing stakeholder networks are beginning to meet the demand for healthy ingredients and raw materials. Dedicated networks that let customers act as suppliers of raw materials by providing used paper directly to manufacturers already exist for office paper and packaging, and the challenge is to transfer those capacities to other market segments.

The Healthy Printing Initiative has a business case for every company in the industry:

1. Paper that is treated with safe chemicals is more economical to process - it is recyclable and safe in the biological cycle.
2. Safe printing chemicals help to recover fibers and residues as raw materials and to reuse them before they return to the biological cycle.
3. Recycled products become more competitive and people who work with printed paper or packaging are better protected.

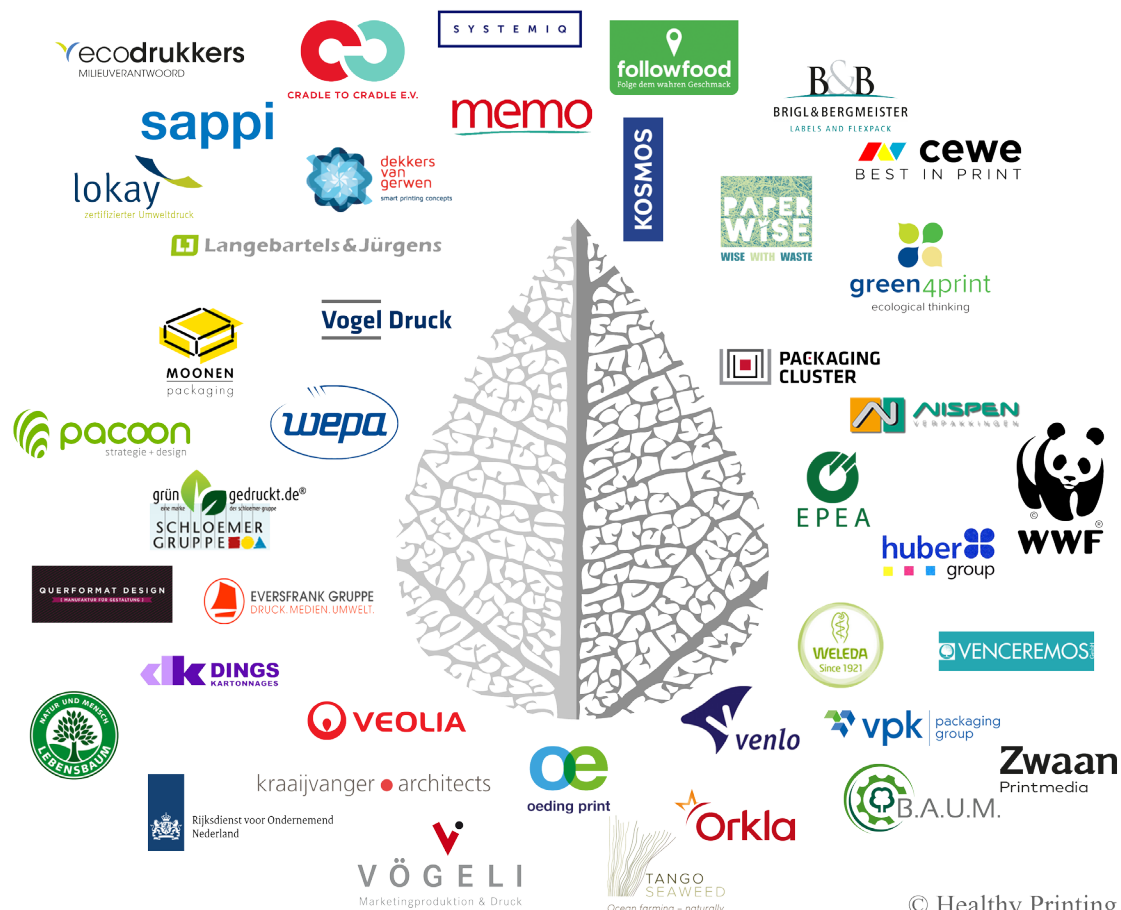
4.1 How can I become active?

Participation in the Healthy Printing Initiative requires no membership fee at this time, thanks to the support of the DOEN Foundation. Only in the case of consultancy or optimization of printed products are investments required.

Customers for printed paper who join will receive a list of questions to ask your printing company, to help identify opportunities for improvement. If your printer wants to know more, we can provide them with information on how to work together with ink suppliers to pave the way to circular printing products.

As a printing company or manufacturer of printing inks, coatings and paper, you will get examples of best practices to optimize your processes and products, and work with your suppliers. In addition, you get support in acquiring new customers, expanding your business, retaining existing customers and being competitive in acquiring new customers.

Figure 10: Members of the Healthy Printing Initiative (June 2018)



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Contact

Visit www.healthyprinting.eu for more information on the DOEN Foundation, current events, existing healthy printing products, and an overview of participating Healthy Printing members.

B.A.U.M. members can contact B.A.U.M. directly if they are interested in the Healthy Printing Initiative; all other interested parties are welcome to contact EPEA at the following address:

Save the Date

Healthy Printing Symposium:
Designing printed products for the future
When: 14 September 2018
Where: Lüneburg, Leuphana University
More informationen:
www.healthyprinting.eu/symposium

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List of references:

- (1) **Forest Industries** (2017) / **FAO** (2017): Statistics pulp and paper industry.
<https://www.forestindustries.fi/statistics/pulp-and-paper-industry/>
- (2) **GeneraCycle** (2017): What we throw away every year. <http://www.generacycle.com/>
- (3) **Braungart, M.** (2016): Von der Wiege zur Wiege – Abfall als Qualitätsproblem. Veröffentlicht in „Müll und Abfall“, Ausgabe März 2016
- (4) **Verband Deutscher Papierfabriken** (2016): Vorurteil und Wahrheit. <http://www.vorurteilundwahrheit.de/startseite.html>
- (5) **Veolia** (2017): Papierrecycling.
<https://www.veolia.de/unsere-leistungen/unsere-leistungen/ressourcen-loesungen/papierrecycling>
- (6) **Umweltbundesamt** (2016): Altpapier.
<https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/altpapier#textpart-1>
- (7) **Stiftung Warentest** (2012): Adventskalender mit Schokoladenfüllung: Mineralöl in der Schokolade.
<https://www.test.de/Adventskalender-Mineraloel-belastet-Schokolade-4471436-0/>
- (8) **Foodwatch** (2015): Mineralöle in Lebensmitteln: Ergebnisse des foodwatch-Tests.
https://www.foodwatch.org/fileadmin/Themen/Mineraloel/Dokumente/Testergebnisse_Mineraloele_in_Lebensmitteln.pdf
- (9) **Verband European Bioplastics** (2000): EN 13432 – Nachweis Kompostierbarkeit. <http://www.bioplastics.ch/EN-13432.pdf>
- (10) **Packaging Outlook** (2017): 2017 Packaging Outlook Report. Veröffentlicht in Packaging Strategies NEWS,
<https://www.packagingstrategies.com/articles/89474-packaging-outlook-2017>
- (11) **Pivnenko, K., Eriksson, E., & Astrup, T. F.** (2015): Waste paper for recycling: Overview and identification of potentially critical substances. Waste Management, 45, 134-142. DOI: 10.1016/j.wasman.2015.02.028
- (12) **European Parlement** (2017). Towards a circular economy – Waste management in the EU.
[http://www.europarl.europa.eu/RegData/etudes/STUD/2017/581913/EPRS_STU\(2017\)581913_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2017/581913/EPRS_STU(2017)581913_EN.pdf)
- (13) **Morawski, Clarissa.** „Understanding economic and environmental impacts of single-→stream collection systems.“ Container recycling institute (2009): 3.