

POLY PRO BLEM

PLASTICS AND THE
ENVIRONMENT

Challenges, actors and perspectives



Published by

Röchling Stiftung GmbH
Richard-Wagner-Straße 9
68165 Mannheim
+49 621 4402 232
info@roechling-stiftung.de
www.roechling-stiftung.de

Wider Sense GmbH
Monbijouplatz 2
10178 Berlin
+49 30 24088 240
info@widersense.org
www.widersense.org

Editorial staff

Julia Oestreich, Anna Wolf, Gabriele Störmann (Wider Sense),
Julia Bettina Eberhardt, Uwe Amrhein (Röchling Stiftung)

Design and typeset

ds.DTP – Detlef Scholz and Simone Schubert

Translation

Malte Forstat, Freelance Translator

Photos

- p. 12/p. 14 Ellen MacArthur Foundation
- p. 12/p. 22 Plastics Europe Deutschland e.V.
- p. 13/p. 28 Oak Foundation
- p. 13/p. 32 Zero Waste Europe
- p. 12/p. 38 Fraunhofer UMSICHT
- p. 12/p. 44 Ocean Conservancy
- p. 13/p. 52 UNESCO-Weltaktionsprogramm: Bildung für nachhaltige Entwicklung © DUK
- p. 13/p. 58 OECD

CONTENT

1.	HYPE OR REVOLUTION?	4
2.	FACTS AND FIGURES ON PLASTICS IN THE ENVIRONMENT	6
3.	VOICES OF EXPERIENCE	12
	Ellen MacArthur Foundation	14
	Circular economy	18
	SIDE NOTE: collective impact initiatives	20
	PlasticsEurope Deutschland e.V.	22
	Recycling	25
	Oak Foundation	28
	Upcycling	30
	Zero Waste Europe	32
	Avoidance	34
	Alternative materials	36
	Fraunhofer UMSICHT	38
	Extended service life	42
	Ocean Conservancy	44
	Cleanup	48
	SIDE NOTE: Insufficient waste management systems	50
	UNESCO Global Action Programme: Education for Sustainable Development	52
	Education for Sustainable Development	56
	OECD	58
4.	ACTORS AND THEIR AREAS OF ACTION	62
	Civil society	66
	Political sphere – transnational actors and government agencies	69
	Private sector – industry, retail and industry associations	70
	Science	71
5.	WHAT NEEDS TO HAPPEN NEXT	72
6.	ABOUT THE AUTHORS	78
7.	FURTHER REFERENCES	80
8.	LINKS TO THE ORGANISATIONS MENTIONED	88
9.	LIST OF SOURCES	90

1. HYPE OR REVOLUTION?

Living without plastics, spectacular concepts for cleaning up the oceans, banning single-use plastics... are these all a flash in the pan or are we on the cusp of a global transformation when it comes to producing and using plastics? The impact of plastics on the environment, either already proven to be harmful or not sufficiently researched, is of concern to people all over the world. Along with climate change, the emission of plastics into the natural environment can be seen as the most pressing ecological challenge at this time. There is a strong willingness to take action. But to act decisively requires an overview and orientation. And providing a better overview and orientation is the goal of the Issue Handbook Plastics and the Environment.

One thing is clear: The problem is too large in scale and too complex to address it with a variety of disparate activities. It will take well-coordinated actions by public institutions, civil society, the private sector and academia, that is to say actions that are not limited to short-term stop gap projects, but are rooted in long-term cooperation.

However, and especially in light of the situation being as complex as it is, fostering actually impactful involvement, which furthermore complements the actions of others, is hard. This is exactly what characterises extremely complex social and ecological issues, and what often results in either action for its own sake or resignation.

The combined issues of plastics and the environment is such a highly complex problem. It has a wide range of very different causes that will require a multitude of measures to cope with it. The causes include the utilisation of highly durable plastics for short-duration consumables. Then there is the lack of sufficiently effective systems for gathering and treating waste – specifically

and ironically in countries with a large population that are catching up to our level of consumption. Yet another cause is an insufficiently established circular economy and the wrong economic incentives – even in industrialised countries.

These causes of the problem are faced by equally complex levels of action and investment opportunities. The media repeatedly paint a highly dramatic picture of the situation. Meanwhile, non-profit organisations as well as the private sector are engaged in initiating a variety of projects. These range from spectacular concepts towards cleaning up the oceans to educational programmes on waste prevention. Policy makers – from the United Nations down to the municipal levels – are putting together extensive funding programmes. A few first national governments and the European Union are banning single-use consumables made of plastic. Almost daily, scientific institutions are launching new research ventures. And last but not least, an increasing number of companies are looking into a more sustainable use of products made from plastics.



But what specific goals are they pursuing? Some are dreaming of a world free of plastics, while others are invested in innovative and more recyclable materials. Yet others are working on removing plastic waste from the environment, in spite of some people taking this as merely an attempt to mitigate the symptoms. Which of these assertions do we follow? What sort of alliances are we willing to form to that end? And most of all: What should our contribution be in order to achieve the greatest impact?

This Handbook was commissioned and funded by the Röchling Foundation and put together by Wider Sense. The goal was to collaborate towards a guide on the issues of Plastics and the Environment. With it, we hope to make it easier for actors from a variety of sectors to better grasp and differentiate the multidimensionality of this global challenge, and subsequently to come up with actions of their own.

To that end, we have interviewed international experts from public institutions, civil society, the private sector and academia. They will have their say as part of the chapter Voices of Experience, in order to share their specific perspectives with the readers and to give them an opportunity to reflect on their own involvement.

Building on these individual views of experts from a variety of sectors, the chapter Actors and their Fields of Action provides an overview of dif-

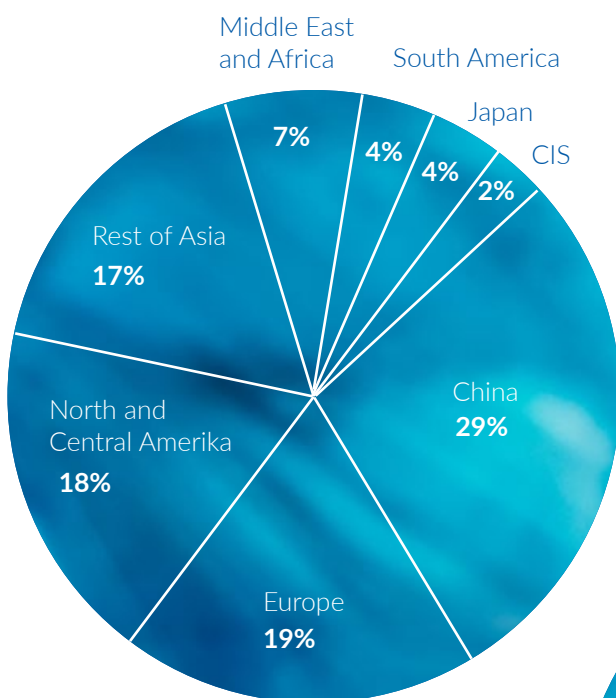
ferent levels where action is possible and what intervention can achieve. Each of these is associated with actors from civil society, the private sector, academia and the political sphere. The choice of actors in no way reflects the relevance of the respective initiative. That was not within the scope of the investigation. Nor do we make any claims for this research to be exhaustive, which, given the complexity of the issue under consideration, would be impossible. Rather, we aim to reflect as diverse an image as possible.

One thing we are committed to with this Issue Handbook Plastics and the Environment: Based on solid research and the expert interviews, we wish to show where civil society, academia, the private sector and policy makers stand when it comes to dealing with this global challenge and what urgently needs to happen in order to meet it even more purposefully and most of all with greater concentration. That is why the chapter Future Issues points the reader towards key issues that, according to the experts, have so far been neglected. Additionally, in the section Further Reference, we provide foundations and companies with assistance on their first steps towards the issue of plastics and the environment.

The very strong level of public attention is so far not matched by adequate, integrated and meshing solutions. Is it all a hype or a real revolution? This will soon be decided.

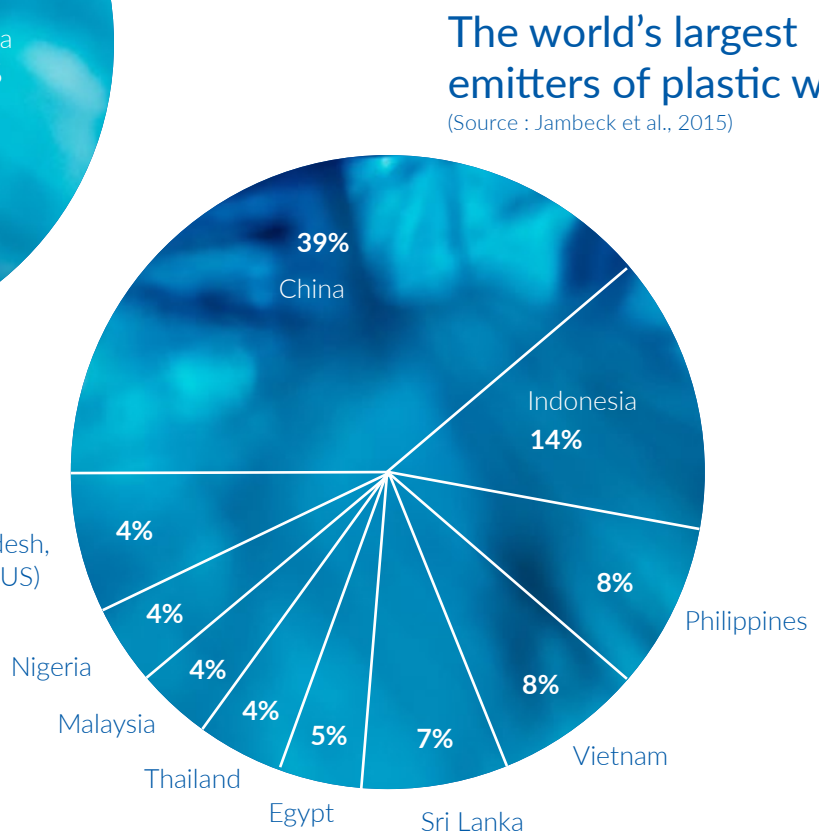
2. FACTS AND FIGURES ON PLASTICS IN THE ENVIRONMENT

In the 1950s, due to a number of scientific advances, plastics became a universal material for industrial mass production, rather than merely a substitute for traditional materials. It is used, among others, to manufacture packaging, textile fibres, paints and glues as well as tyres and upholstery. At 40 per cent, the packaging sector is the largest area of application in Europe.¹



Shares of global plastics production, by region

(Source: PlasticsEurope, 2017)



The world's largest emitters of plastic waste

(Source : Jambeck et al., 2015)



Kunststoff or Plastics?

German has two terms for plastics: 'Kunststoff' and 'Plastik'. Kunststoff tends to be more the technical term, while Plastik is generally used more often in everyday speech. Also, Plastik has recently gained a bit of a negative connotation. This English version of the handbook will generally use the word plastic(s), and polymer only where necessary.

What is plastic?

There is a wide range of different forms of plastic. Based on their properties if heated, they can be distinguished into two main groups of polymers: thermoplastics and thermosetting polymers.² Furthermore, this study will also include the elastomers (rubber) among the plastics. In scientific circles, this practice is already well-established. Industry still treats plastics and rubber separately, omitting to include the share of rubber in the official industrial statistics. The same is true for synthetic fibres such as Nylon. Put together, these two make up about 20 per cent of the volume of produced plastics.⁴

What is plastic waste?

The Issue Handbook Plastics and the Environment defines plastic waste as those plastics that are emitted beyond their area of application into the regular system of waste disposal or the natural environment, thus becoming a problem because they can either not at all or very poorly be retrieved, or are extracted from the environment by actors that were not responsible for the emission in the first place.

² PlasticsEurope (2018a)

³ PlasticsEurope (2018b)

CHALLENGES

One
rubbish lorry's worth

of plastics currently end up in
the oceans **every minute.**

If nothing is done about this, by 2050
the oceans will be home to
**more plastics
than fish.**

“Plastic is not
the problem, the
problem is what
we do with it.”

(Erik Solheim, Head of
UN Environment).

Of all of the plastics ever produced in the world⁴:

Total	9%	12%	79%
	of plastic waste was recycled	of plastic waste was incinerated, partly to generate energy	of plastic waste was deposited in landfill or has already been emitted into the natural environment
Year 2013 ⁵	14%	14%	72%

And considering the amount of annual plastics production worldwide, the result is also sobering.⁵

The **approx.
8.3bn tons of plastics**
produced globally until 2015, coincide
with **approx. 6.3bn tons of
plastic waste** generated
in the same period.

Single-use products,
e.g. plastic carrier bags,
are **only used** for an
average of
15 minutes.⁶

Plastics are
estimated to remain in
the natural environment
for
450 years.⁷

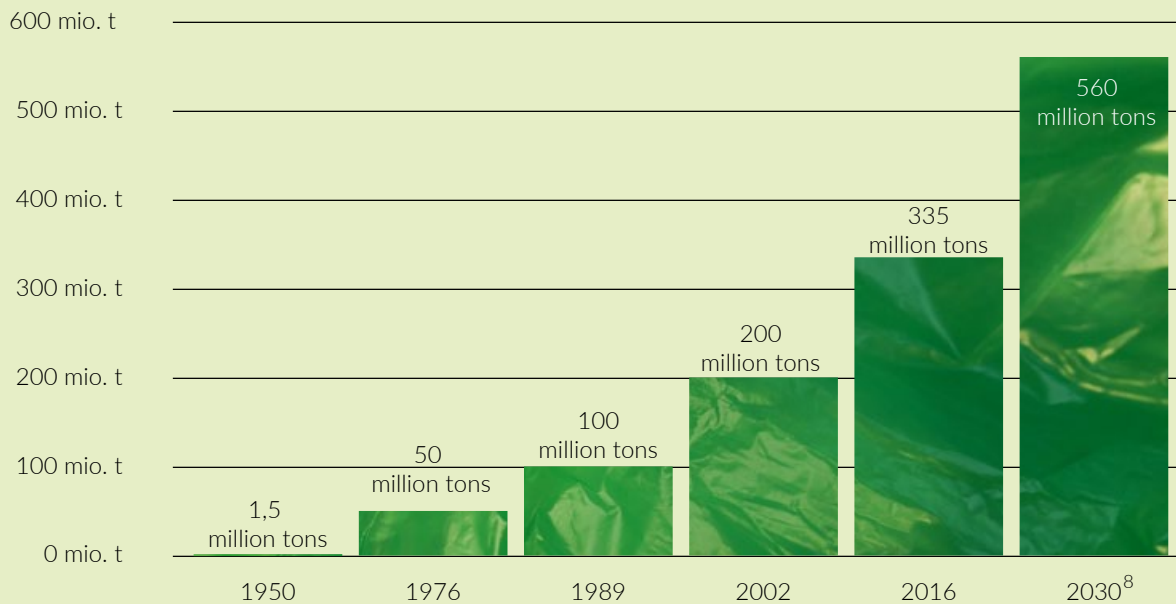
4 Projection until 2015 (World Economic Forum, Ellen MacArthur Foundation, McKinsey & Company, 2016)

5 The year in question is 2013 (Ellen MacArthur Foundation, 2016)

6 Ellen MacArthur Foundation (2016)

7 So far, it is only possible to estimate how long plastics can persist in the natural environment: between 400 and 1,000 years, depending on the type of plastic.

Massive increase in the production of plastics continues



Developments in global plastics production since 1950 in million tons (PlasticsEurope, Statista)

More than **90%** of plastics are produced from petroleum.⁹

The global plastics producing industry is currently responsible for between four and six per cent of the world's crude oil consumption. This is exactly the same share as the amount of oil consumed by the aviation industry. If the forecast of a massive increase in the production of plastics by 2050 turns out to be true, 20 per cent of oil consumption and 15 per cent of greenhouse gas emissions will be the result of plastics production.

According to initial uncertain estimates, about eight million tons of plastic waste make their way into the oceans via rivers, the wind, effluent etc., 80 per cent of which originated on land. 20 per cent of these emissions were caused by the fisheries and tanker accidents.¹⁰

⁸ Forecast 2030: McKinsey & Company

⁹ Rettet den Regenwald e.V., last accessed 9 November, 2018

¹⁰ World Economic Forum, Ellen MacArthur Foundation, McKinsey & Company (2016)

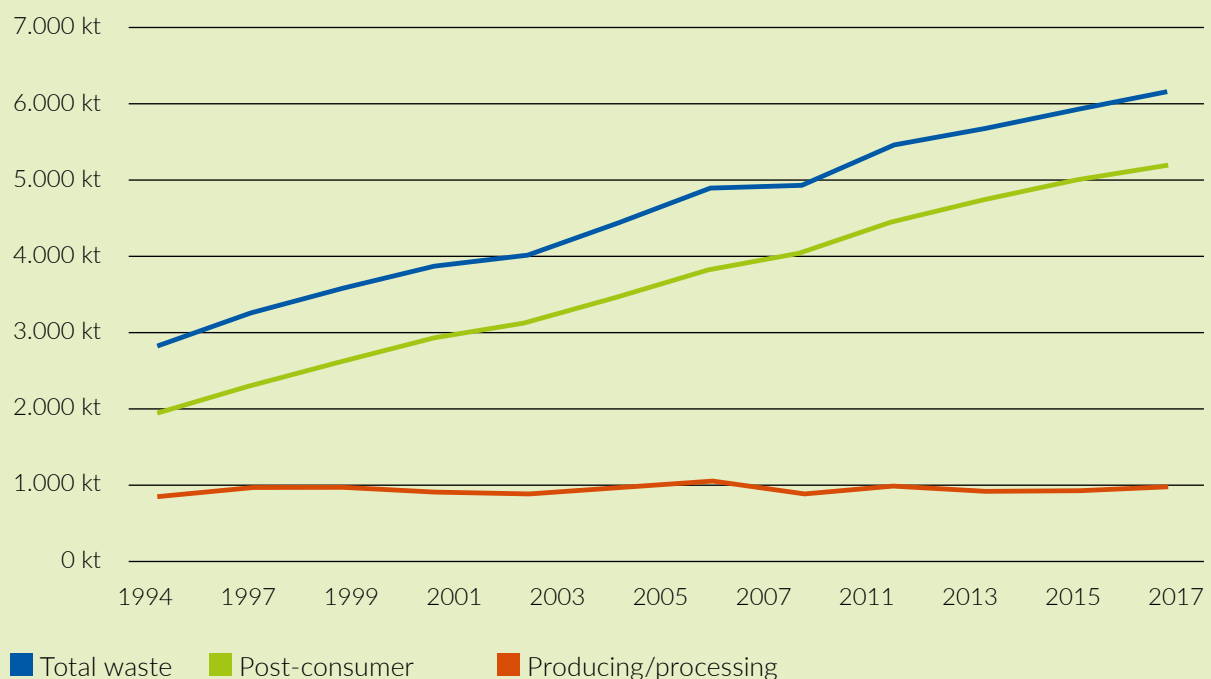
Focus on Germany

In Germany, a total of **5.2 million tons** of **plastic waste** were produced in 2017, **3 million tons** of this was from **plastic packaging**.¹¹

Per capita, Germans produced about **37.6 kilograms of plastic packaging waste** in 2016. That makes Germany the **third-largest** producer of plastic packaging waste in the EU, after Ireland and Estonia.¹²

However, at **99%**, Germany has a high **recovery rate** for plastic waste: 47% is recycled and 53% is used to generate energy.¹³

Since the 1990s, the amount of plastic waste has doubled, caused mostly by an increase in the post-consumer segment¹⁴:



¹¹ Bundesverband Sekundärrohstoffe und Entsorgung e.V. (2018)

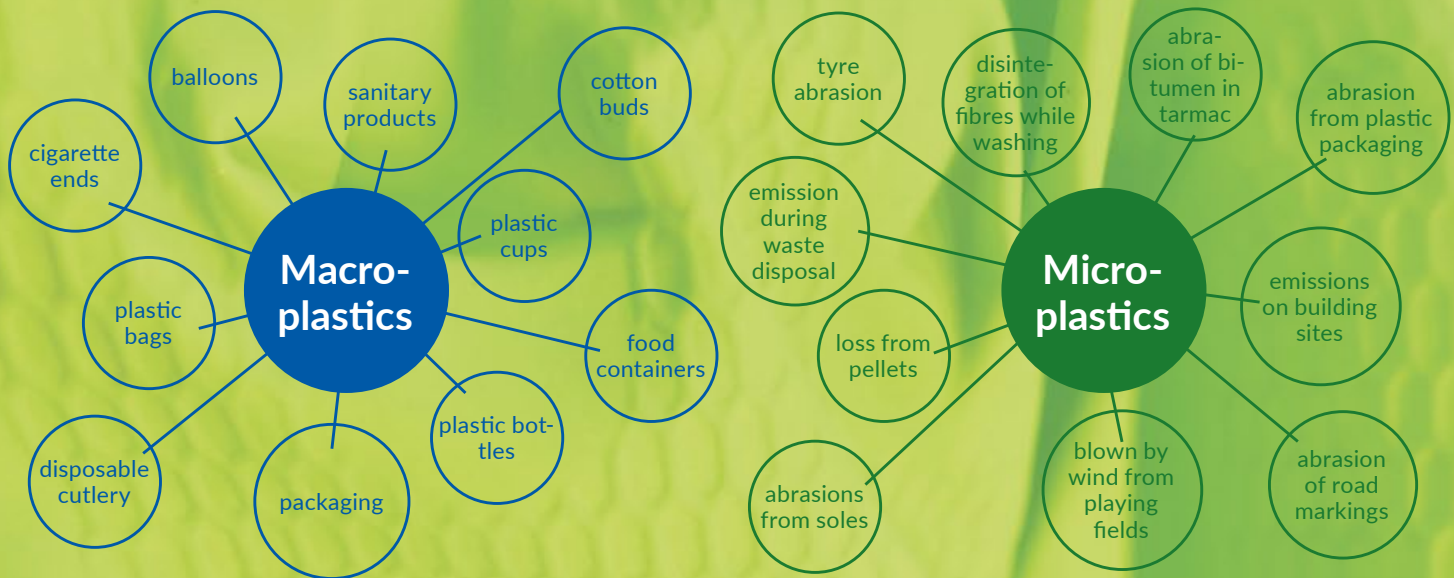
¹² Institut der deutschen Wirtschaft, last accessed 9 November, 2018

¹³ Bundesverband Sekundärrohstoffe und Entsorgung e.V. (2018)

¹⁴ Post-consumer plastics waste is waste that is created by private or commercial end consumers rather than in the process of manufacturing another product.

Sources of macro- and micro-plastics emissions into the environment

Plastics waste is classified into macroplastics as well as primary and secondary microplastics.¹⁵ While the term microplastics encompasses solid and insoluble plastic particles that are smaller than five millimetres, any plastic particles and products that are larger than five millimetres are classified as macro-plastics.¹⁶ The main sources include:



Insufficient or lacking waste management systems in many countries in Asia are partly responsible for the majority of the macro-plastics in the oceans.¹⁷ In countries where the waste management systems are working well, particles of microplastics that are created during usage are suspected to be a key source.¹⁸

About 74 per cent of the plastics emissions in Germany are microplastics and about 26 per cent are macro-plastics.¹⁹

Additives in plastics are a potential health risk for animals and people alike

As part of the production process, so-called additives are employed to give certain properties to plastics products, such as flame retardants, stabilisers, fillers, pigments or softeners. In terms of their toxicology, experts say, such additives pose a greater risk to human and environmental health than the plastics per se.²⁰

15 Latest studies suggest a further subdivision into type A and B primary microplastics emissions. Type A microplastics are already generated during the production process (e.g. friction particles in cosmetics or plastic pellets). Type B are generated during use, e.g. from tyre wear or when washing clothes made from synthetic fabrics. Secondary microplastics come from the deterioration or fragmentation of macroplastics in the natural environment. ((Bertling, Bertling, & Hamann, 2018)

16 Ziebarth (2018)

17 McKinsey & Company, Ocean Conservancy (2015); Interview with Emily Woglom, Ocean Conservancy, 11 July, 2018

18 Bertling, Bertling, & Hamann (2018)

19 Bertling, Bertling, & Hamann (2018)

20 Galloway (2015)

3. VOICES OF EXPERIENCE



Interview:
Ellen MacArthur
Foundation p. 14
Circular economy p. 18
SIDE NOTE: collective
impact initiatives p. 20



Interview:
Plastics Europe
Deutschland e.V. p. 22
Recycling p. 25



Interview:
Fraunhofer UMSICHT p. 38
Extended service life p. 42



Interview:
Ocean Conservancy p. 44
Cleanup p. 48
SIDE NOTE: Insufficient
waste management
systems p. 50



Interview:
Oak Foundation p. 28
Upcycling p. 30



Interview:
Zero Waste Europe p. 32
Avoidance p. 34
Alternative materials p. 36



Interview:
UNESCO Global Action
Programme: Education
for Sustainable
Development p. 52
Education for Sustainable
Development p. 56



Interview:
OECD p. 58

INTERVIEW

ELLEN
MACARTHUR
FOUNDATION

“We throw
things away –
but there’s no
such thing as
away”

Jon Ely,
Philanthropic
Lead,
Cowes




The Ellen MacArthur Foundation was established in 2010, to speed up the transition to a circular economy. With their New Plastics Economy initiative, the foundation wishes to contribute to breaking the systemic blockages in the global plastics sector that any single actor would never be able to tackle. The initiative promotes a new way of thinking that sees plastics as an effective material flow within a circular economy. The initiative strives for change at the global level, and is thus seen as a global point of reference when it comes to a circular economy of plastics. Industry, NGOs and governments equally see the Foundation as a trustworthy hub and accept that it has a unique role in catalysing transformation in this sector.



Why did the Ellen MacArthur Foundation decide to focus on plastic packaging?

Given that it is cheap, convenient and has a number of useful properties, plastic packaging is an indispensable part of today's economy. Its low weight and the excellent barrier properties allow a reduction in carbon emissions and food waste. So plastics is essential as a packaging material, which is also reflected in the volume of the plastic packaging industry. 78 million tons of plastic packaging material was sold in 2013 (about 26 per cent of the total global plastics production), worth a total of 260 million US dollars. By 2020, the volume is projected to be up to 108 million tons.


But because the industry generally adheres to a linear model, the current way of doing business in plastics packaging is seriously detrimental. Large quantities (about one rubbish lorry's worth per minute) end up in the oceans every year. Circular concepts such as re-using (less than one per cent), recycling (about 14 per cent) and biodegradation (less than one per cent) have rates of adoption per year that are too low. Also, plastics almost exclusively rely on fossil fuels as a raw material. The linear approach results in both the waste of valuable materials and in massive environmental damage. While beach clean-ups, banning plastics and fishing plastics out of the sea are certainly necessary, these measures only deal with the symptoms of the problem rather than the root causes.



What is the objective of the New Plastics Economy Initiative?


Our goal here is to stimulate the establishment of a plastics economy that works sustainably and is based on the principles of a circular economy. All unnecessary plastics would be removed from such a system, and what remains would be designed in such a way as to keep the plastics in circulation through re-use, recycling and composting. Such an approach goes to the root causes of the problem, and that is the only way to ensure that the plastics do not end up in the natural environment.

The initiative brings together key stakeholders such as companies, academics, political decision makers, product designers and innovators to reimagine and reframe the future of plastics – starting with the largest field of application for plastics: packaging.



What are the key elements of the initiative?

In the first three years we were primarily involved in successfully integrating the stakeholders, promoting innovation and improving the factual basis. These efforts were supported by a growing understanding of the key building blocks that are needed to bring about a systemic transition. These include framing a shared vision, gaining a deeper understanding of how to challenge the current practices and the mobilisation of key actors, including corporate and philanthropic.



From the word go, our goal was to find exponential solutions to exponential problems. The initiative is on the right track for achieving this. It convened a group of influential actors that have come up with a shared vision, gained widespread recognition for their global position of leadership and were already able to achieve concrete results.

Why is the initiative mostly targeted at companies?

The challenge of plastics contamination is a global one and thus also requires global action. We have to fundamentally change the way we currently use plastics, and that will require a reconsideration of the way we design, produce, utilise and re-use them. That is why we are convinced that companies should be supported in their efforts in this matter. They not only have a lot to gain, but are also the key to many of the necessary measures that need to be taken. They are in a position to drive this transition in terms of its scope and its momentum.

Nevertheless, I should stress that anyone who is directly or indirectly involved in the plastics industry can make a contribution to this transition, so that eventually no more plastics end up in the natural environment. The industry cannot achieve a systemic transition on its own – the political sphere, academia and philanthropists also have a crucial role to play here. The New Plastics Economy is a major example for an excellent cooperation between all involved, which in the end is the key to its success.

What specific actions has the initiative taken so far?

The first report published by the New Plastics Economy revealed the sobering forecast that, unless we take action, there will be more plastic than fish in the oceans by 2050. However, that same report also presents a vision based on the principles of a working circular economy. The following year, the initiative published a second report that elaborated on how this vision could be implemented.

We initiated a two-million-US dollar innovation award to generate important momentum by rewarding innovative solutions in the packaging sector. The award ceremony reached over 100 million people and inspired some into organising similar and even greater initiatives. Furthermore, those awarded are part of an accelerator programme to get their inventions to market at a large scale.

Last year we saw 15 large international companies – that together make up about ten per cent of the global plastics market – implement the initiative's vision and made the ambitious commitment to have all of their plastic packaging be re-usable, recyclable or bio-degradable by 2025. And we were able to also make strides in the political sphere, including EU Strategy on Plastics in the Circular Economy and the French road map for a nation-wide circular economy. In these instances, our foundation was asked to advise the political decision makers.

The background of the page is a blurred image of a globe with various pieces of plastic waste, such as bottle caps and fragments, scattered across its surface. The globe is centered, and the plastic waste is in sharp focus, creating a visual metaphor for global plastic pollution.

Furthermore, we co-founded the UK Plastics Pact which is headed by the UK charity WRAP with the support of the British government. It unites 58 companies that have made ambitious commitments by 2025, including: abolishing problematic and unnecessary packaging, recycling or composting of 70 per cent of all plastic packaging as well as utilising 30 per cent of recycled materials in plastic packaging. We are working on establishing more such Plastics Pacts all over the world. A second one will shortly be worked out in Chile.

What characteristics does a foundation need to have in order to be successful in such a venture?

In promoting the transition to a circular economy, philanthropy has a decisive role to play. Four main areas can be distinguished here:

Funding – a collaborative approach to funding initiatives has proven very successful.

Expertise – foundations can offer a profound understanding of certain issues that can be of great value as part of a wider cooperation.

Networking – an unprecedented cooperation is vital to the structural transition, which is why the high-quality networks of foundations and their ability to bring together and engage with actors across sectors is so valuable.

Systemic approaches – complex challenges always require complex solutions, and these are best supported by a sound yet flexible financing structure, which ultimately promotes an entrepreneurial approach. To a certain extent, foundations have to be willing to take risks.

What are the plans for the future of the New Plastics Economy initiative?

Over the next seven years, the New Plastics Economy initiative will build on their past successes and enter into a critical phase from 2019 to 2025. Our current approach of fostering a systemic transition will remain at the heart of the initiative's strategy, which aims at influencing the key parts of the value chain using a distinct combination of vision and ambition.

The initiative particularly focusses on increasing the involvement of companies, which includes actively influencing and monitoring the progress in implementation. It will also get governments more involved into developing solutions that are suitable for industrial application. Lastly, and in collaboration with key civil society actors, it will also aim to raise greater public awareness for the scope and quality of the solutions that are necessary to achieve real impact.

In the short term, we intend to create an unprecedented coalition between companies and governments, that will come together behind the world's most ambitious commitments to a circular economy, in order to combat plastic waste.

CIRCULAR ECONOMY



The circular economy is an alternative concept that is fundamentally opposed to the conventionally linear form of economic activity. While the conventional model is based on a linear progression of manufacture, use and disposal, the circular economy is set up in such a way that the materials involved are retained in a closed loop and valued as a resource at the end of a product's usefulness, thus keeping them in that loop of manufacture, use and re-use for as long as possible.

The objective of a virtually perfectly closed loop takes into account that plastics, but also other recyclable materials, play an important role in our lives and have even become indispensable in many sectors. As of now there is no perfectly functioning circular economy, and especially when it comes to the recycling of plastics, we still have a long way to go. This is clearly illustrated by a global recycling rate at only nine per cent²¹.


Important prerequisites for realising a truly closed-loop economy for plastics are certain quality standards when it comes to the recyclates as well as a high degree of recyclability for end-products. Key factors to achieving this are the utilisation of plastics that are as homogenous as possible and contain no additives, a consistent system for collecting and separating waste as well as efficient waste management including sophisticated recycling systems.

The Ellen MacArthur Foundation holds the view that simply reducing the negative impact of our current linear economy will not be enough. What is required is a systemic transition that results in long-term resilience and provides opportunities for a strong economy, while simultaneously generating both ecological and societal benefits²².

With its "EU Strategy For Plastics in a Circular Economy", the European Commission has also pledged to implement this more sustainable

21 World Economic Forum, Ellen MacArthur Foundation, McKinsey & Company (2016)

22 Ellen MacArthur Foundation (2018a)



Learn to appreciate the recyclable – rather than just the product

model. The EU Commission is aware of the need to expand and upgrade recycling facilities in the EU in order to achieve the adopted goals. At the same time, like leading civil society initiatives and international companies, it calls for a reconsideration of product design in order to increase the recyclability of plastics.²³

The latter requires companies to modernize their core competencies. For an economically successful product design in the sense of a closed-loop economy, companies must consider, among other things, the selection of materials, criteria for simplified end-of-life sorting, separation or re-use of products. In addition, companies should give thought to possible practical ways of using their by-products and waste.²⁴

The Cradle to Cradle design concept developed by Michael Braungart and William McDonough in the 1990s, for instance, shows how companies can implement such a rethink. As the name

suggests, “from cradle to cradle” stands for a safe and potentially infinite supply of materials and nutrients within the cycle. With this concept, the developers have introduced a quality framework for the certification of products according to the standards of their recyclability. In addition to Cradle to Cradle, there are numerous other eco-design tools and suppliers, such as the RAL gGmbH's Blauer Engel (Blue Angel).

In 2010, the Cradle to Cradle Products Innovation Institute was founded to scale this concept globally. It manages the publicly available Cradle to Cradle Certified™ product standard, which provides designers and manufacturers with criteria and requirements for the continuous improvement of the design and manufacture of their products. The Cradle to Cradle Certified™ label gives consumers, regulators, employees and industry peers transparency and validation on the sustainability of a product and the commitment of its manufacturer.²⁵

²³ European Commission (2018a)

²⁴ Ellen MacArthur Foundation (2018b)

²⁵ Cradle to Cradle Products Innovation Institute (2018)

SIDE NOTE: COLLECTIVE IMPACT INITIATIVES

There are just a few collective impact initiatives for resolving the issue of plastics in the environment. The **New Plastics Economy** of the Ellen MacArthur Foundation currently must be the best-known. Together with companies such as



Coca Cola, Danone and MARS, but also with political and civil society actors such as the MAVA Foundation and the Oak Foundation, they are working on the implementation of a circular economy for plastic packaging.

OTHER COLLECTIVE IMPACT INITIATIVES THAT FOCUS ON DIFFERENT ASPECTS OF THE PROBLEM, CURRENTLY ARE:



The Plastics Solution Fund is an international alliance of nine supporting foundations. Together they are working towards the goal of discontinuing the production of plastic products that are not absolutely necessary or toxic, while increasing the re-use and recycling rate of the remaining plastic products. To achieve this, the Plastics Solutions Fund supports projects that sensitise and mobilise consumers as well as projects that put a certain amount of pressure on companies and governments. This is a sector-specific alliance with its own team and governance structure.



The Trash Free Seas Allianc currently consists of 30 companies (mainly from the consumer goods industry), civil society organisations and academic institutions. The Alliance is committed to the short-term reduction and medium-term prevention of ocean pollution through product and service innovation. The NGO Ocean Conservancy is responsible for coordination. A first joint project is an Impact Investing Fund, which aims to promote the establishment of waste management and recycling systems in Southern Asia.

According to John Kania and Mark Kramer, collective impact initiatives display the following characteristics:²⁶

1. A common agenda and goals of the actors
2. A shared and standardised metric for assessing progress and impact
3. Mutual support in each actor's activities, i.e. differentiated areas of expertise and activity according to the individual strengths in combination with close coordination
4. Consistent and open communication is needed across the many players to build trust, assure mutual objectives, and appreciate common motivation
5. Shared and centralised infrastructure with highly motivated members providing coordination and support

Collective impact approaches are based on the understanding that solving many global problems requires a fundamental change in traditional social systems, which can only be achieved through a joint effort of the political sphere, private sector and civil society. While ordinary networks are less formal and all actors pursue their own goals, collective impact initiatives are often cross-sectoral, formalised, institutionalised, with the actors involved working collaboratively to solve a specific problem.



²⁶ Kania & Kramer (2011)

INTERVIEW


PLASTICS
EUROPE
DEUTSCHLAND E.V.



Michael
Hillenbrand,
Berlin Liason Office

“Higher recycling
rates require
better-quality
plastic waste”

PlasticsEurope Germany e.V. is the association of plastics producers in Germany. It represents the political and economic interests of its member companies. PlasticsEurope brings together a total of 100 member companies under its aegis. They produce more than 90 per cent of plastics in the EU. In the last few years, PlasticsEurope has been campaigning at the European level for uniform quality standards for waste streams containing plastics, in order to support an increase in the recycling rates.




Why does the current recycling rate still fall short of what is technologically possible?

There are many reasons for this and they cover almost the entire plastics material cycle. Depending on the application, a wide range of additives is used in plastic products. Although these additives make a product particularly rigid or fire-resistant, they also reduce its recyclability. In addition, composite materials²⁷ are increasingly being used, whose complex material composition makes it more and more difficult for existing recycling technologies to separate them.

Incorrect disposal by consumers or retailers is another challenge if, for example, plastic packaging ends up with the general rubbish rather than with the recycling or when supermarkets dispose of plastic packaging together with the meat that has gone off. All this results in a lower quality of the waste streams containing plastics and thus in poorer material recycling.

The more pure the plastic waste, the better the recyclability. For this reason, we work closely with political and economic representatives to improve the quality of waste collection and subsequent waste processing.



What will it take for the recycling of waste streams containing plastics to improve in Germany?

In spite of the challenges just mentioned, Germany is well positioned in terms of recycling and recovery compared with other countries. Sorting facilities in Germany are already very good at detecting different substances, thanks to the best available technology, e.g. using infrared. In this way, recycling can now be significantly improved by so-called plastic type separation. Today, the remaining waste is used to generate energy in modern power plants.

Nonetheless, the new packaging law ratified by the German government stipulates, among other things, that the recycling rate for plastics must increase from currently 36 up to 69 per cent by 2022. If we want to achieve this goal, intensive efforts are needed both when designing products containing plastics and when sorting plastic waste. To put it plainly, this means, on the one hand, that plastics processing companies must take into consideration as early as the product development stage how these products can best be returned to the material cycle. On the other hand, consumers must be even better informed about proper waste separation than before.

27 Composites are packaging materials that consist of at least two different materials fused together over their entire surface area which cannot be separated by hand (Lumitos AG, 2018)

In addition, uniform standards are needed to ensure that the quality of waste collection and processing continues to improve.

What is the situation at the European level?

With regard to the European Union, we see two main challenges. On the one hand, there is still no comprehensive ban on disposing of high-calorific municipal waste in landfills. In its latest amend-

ment to the waste legislation package concerning recycling management, the EU has decided that waste disposal in landfills will be postponed until 2035, and in some cases even until 2040. This thwarts all efforts towards recycling and recovery.

Secondly, there is a need for a European internal market with defined quality standards for products of recovery processes, both from recycling and from energy recovery. Currently, there is a patchwork of different standards at the national level.

RECYCLING



Within the context of this study, plastics recycling refers to the material recycling of plastic waste. Used plastics are mechanically processed by shredding, cleaning and sorting, and then processed into new products. In waste management²⁸, recycling is one of the five stages of the waste hierarchy. The EU Waste Framework Directive (Directive 2008/98/EC) sets out a sequence of priorities for the prevention and management of waste, which can be represented by the following pyramid.

With about 79 per cent, the majority of all plastic waste generated globally has so far ended up in legal and illegal landfills or in the natural environment. 12 per cent of all plastic waste was incinerated and partially recycled to generate energy. In energy recovery, the materials involved in the incineration process are used to generate power such as electricity or steam. Combustion of plas-

tics causes additional CO₂ emissions – unless they are plastics made from renewable raw materials. Many actors therefore take a critical view of this form of recycling. Individual civil society organisations are campaigning against the incineration of plastic waste. Only nine per cent of the plastic ever produced worldwide has so far been recycled.²⁹ The current global annual recycling rate is around 14 per cent. This low rate is partly due to a lack of waste management systems, especially in developing and emerging-market countries, partly due to a lack of sorting accuracy of plastic waste and the quality of recyclates³⁰ (also referred to as secondary raw materials) as well as a lack of standards in Europe and North America.

Many plastic products currently fail to meet the high demands placed on input quality by material recycling because they consist of composite materials, various types and layers of plastic.

28 Waste management refers to all activities and tasks relating to the collection, transport, recovery and disposal of waste, including the supervision of these operations, the maintenance of disposal facilities and the actions of companies that buy, sell, or recover and dispose of waste for others. (European Union, 2008)

29 Geyer, Jambeck, & Law (2017)

30 Recyclates refer to recycled plastics from post-consumer waste. (Ecoplast, 2018)

FIVE STAGES OF THE WASTE HIRARCHY

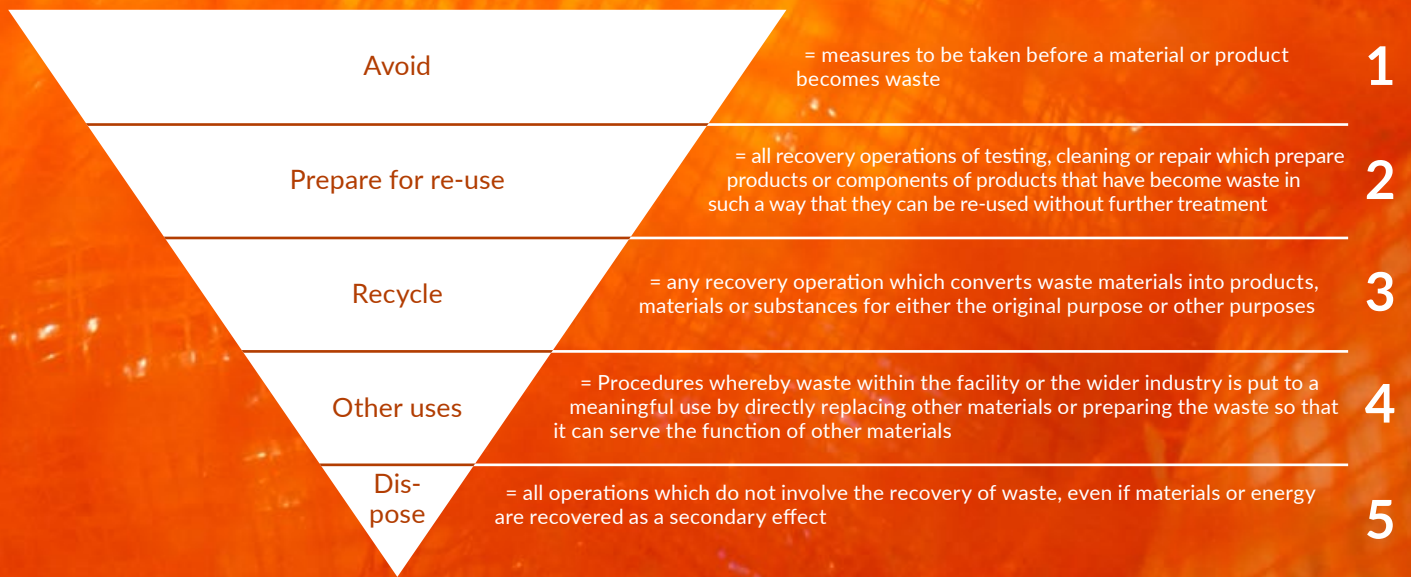


Illustration by Wider Sense based on the European Parliament's and Council's Directive on Waste and the Repeal of Certain Directives (2008/98/EG) of 19 November, 2008. (European Union, 2008)

Recycling, on the other hand, requires the clean collection of old plastic components and their easy dismantling into sorted fractions. It remains clear that the so-called “end-of-life phase” is often not given any consideration in product design³¹.

A particular obstacle to greater use of recycled materials is the increasing number of additives. These make it more difficult for sorting facilities to separate plastic waste into pure fractions. Some additives are advantageous for the recycling process because they are also needed in the recycled product (e.g. stabilisers, hardeners, plasticisers etc.).³² Nevertheless, the concentration of certain additives and the carry-over of substances can be problematic, especially if they are permissible in some sectors (e.g. construction) but not in others (e.g. food packaging). Furthermore, additives that were allowed in the past and are no longer accepted today, such as lead and cadmium stabi-

lisers³³, are also a challenge. The industry has already recognised this and has started to replace some of these additives.

The plastics processing industry can only use recycled materials in its finished products, if they are of a certain quality and the composition of the recyclates is known. Due to the lack of uniform regulations, this currently is only the case to a limited extent, which makes the use of recyclates considerably more difficult for end producers.³⁴ Many producers therefore resort to the primary raw material³⁵, i.e. newly produced plastics, as this results in significantly lower costs for obtaining information on the origin, properties and quality of the input materials.³⁶

As mentioned at the beginning, the majority of the plastic waste generated in Central Europe is not recycled but used to generate energy. The

31 Wilts & von Gries (2016))

32 Pfaendner (2006)

33 Wilts & von Gries (2016)

34 Interview with Michael Hillenbrand, PlasticsEurope Germany, 2 July, 2018

35 Primary raw materials are produced from unprocessed raw materials and secondary raw materials through recycling. (Deutscher Naturschutzring, 2018)

36 Interview with Jürgen Bertling, Fraunhofer UMSICHT, 9 July, 2018

Green Paper of the European Commission speaks of the “vacuum cleaner effect” of energy recovery³⁷, because due to the existing overcapacities and the associated economic incentives to accept plastic waste at thermal waste treatment plants, recycling companies often lack a sufficient quantity of plastic waste for recycling. This further reduces profitability.³⁸ However, it can be assumed that the Chinese import restrictions on plastics from abroad, which came into force in January 2018, will slowly but surely make this problem less relevant.³⁹

Not only on the part of the plastics processing and plastics recycling industry are there obstacles to higher recycling rates. The lack of appreciation and the resulting careless handling of plastics by consumers is also seen as an important hurdle.⁴⁰ On the one hand, the lack of appreciation leads to plastic waste being disposed of improperly, and on the other hand, unlike recycled paper, consumers are not yet prepared to pay more for recycled plastics. In many cases, it is not communicated to customers if secondary plastics had been used.⁴¹

Numerous civil society initiatives and politicians, as well as the plastics-producing industry, are striving to increase recycling rates and are using

their leverage to facilitate the transition to a recycling economy.

In late May 2018, the EU Commission adopted a package of measures for the realisation of a closed-loop economy for plastics. Among other things, this package stipulates that by 2030 all plastic packaging on the EU market must be recyclable or re-usable. In addition, it aims to achieve a recycling rate of 55 per cent for plastic waste. This is to be accomplished above all through changes in product design (e.g. no use of additives or paints) and improved technologies for the collection, sorting and recycling of plastic waste.⁴² To finance the development of more recyclable plastics and more efficient recycling processes, the EU intends to provide an additional 100 million euros.⁴³

With their Vinyl2010 initiative (since 2000) and its successor Vinyl Plus (since 2011), industrial clusters such as the European PVC industry have been working in the 28 EU countries and Norway to increase recycling rates for PVC. The initiative is a voluntary commitment with specific, verifiable targets and deadlines. One of Vinyl Plus' targets is to recycle 800,000 tonnes of PVC per year by 2020.⁴⁴

37 European Commission (2013)

38 Henkes (2010)

39 Bundesverband Sekundärrohstoffe und Entsorgung e.V. (2018)

40 Bertling, Bertling, & Hamann (2018)

41 Wilts & von Gries (2016)

42 European Commission (2018)

43 Abele & Bethke (2018)

44 Vinyl Plus (2018)

INTERVIEW


OAK
FOUNDATION

“We cannot
recycle the
problem away”

Stephen Campbell,
Campaigns Leader
of the Environment
Programme, Genua




The Oak Foundation is a family-run foundation established in 1983. The foundation now has 11 different programmes. As part of its environmental programme, it has been actively campaigning against the dumping of waste on the world's oceans since 2014. Together with 20 NGOs, the Oak Foundation founded a network in 2015, which among other things led to the emergence of the international movement #breakfreefromplastic. This movement is globally committed to a massive reduction in the use of disposable plastic products.



The Oak Foundation has been involved in this area for four years. How are you different from other actors?

We don't think we can solve the problem by just trying to increase the recycling rates of plastic waste. If you look at the current plastic production forecasts, which predict an increase to about 600 million tonnes in 2035 compared to 380 million tonnes in 2015, and the current global recycling rate of 9 per cent, it is hard to believe that recycling alone will solve the problem.




What else will it take, do you think?

The Oak Foundation is committed to systemic approaches. On the one hand, we are convinced that there is a need for a differentiated narrative around the topic, which results in significantly less plastic being produced and consumed. This is why we support campaigns led by NGOs, such as #breakfreefromplastic, which specifically raise the awareness of consumers and companies that the large amounts of plastic in the environment pose a danger and therefore make a reduction unavoidable.

But we also specifically work with companies that are open to changing the way they use plastic.

Here we are talking primarily to manufacturers and retailers of consumer goods. The chemical industry is an important group that is still very cautious at the moment. Among other things, we support the New Plastics Economy initiative of the Ellen MacArthur Foundation.

We think it takes both: external pressure, e.g. from #breakfreefromplastic as well as collaboration with companies through approaches like New Plastics Economy.



How does the Oak Foundation assess whether their activities have been successful?

Our main goal is protecting the oceans. To find out how successful we are, we need to know if less plastic waste gets into the oceans. This is no easy task, but for us it is the ultimate indication that we and our partners are on the right track. To determine this, we are working with an Australian research centre, the Commonwealth Science and Industrial Research Organisation (CSIRO). A validated baseline is currently being developed to measure whether the ongoing efforts of different civil society actors are resulting in significantly less plastic waste ending up in the oceans

UPCYCLING – A MATTER OF PERSPECTIVE



In order to reduce the production of primary plastics, a return to re-usable products such as beverage bottles, yoghurt containers and the like is increasingly being advocated. Upcycling can be described as a special form of recycling. It changes the material cycle by using plastic waste as the starting material for the manufacture of higher-quality and more durable products. This method of recycling therefore enhances the material value.

For instance, designers and producers of spectacles such as Norton Point (US) or Sea2See (Spain) produce their collections using 100 per cent plastic waste collected from the oceans.⁴⁵

With the project titled “Upcycle PET”, the Fraunhofer Institute for Structural Durability and System Reliability is working on ways of using collected waste from short-lived plastic products such as PET bottles to produce long-lived products, for example for the automotive industries, rather than again turning them into bottles. Disposable plastic becomes material for long-term use.⁴⁶ This form of upcycling on an industrial scale can significantly enhance material flows.

In plastics production, a distinction is made between standard plastics, engineering plastics and high-performance plastics. Standard plastics

⁴⁵ Nortonpoint, last accessed 17 December, 2018

Sea2see, last accessed 17 December, 2018

⁴⁶ Schöneberger (2018)

New material flows: Extending the second life

are plastics for use in simple applications, such as the production of packaging material. Engineering plastics are more complex polymers that are used for higher quality and longer life applications. High-performance plastics are high-grade plastics with special properties for special purposes, for instance in systems engineering.

The aim of upcycling is to upgrade recyclates from standard plastics to engineering plastics.

This promising and demanding research should therefore not be confused with the popular term upcycling, which is generally understood to mean the manufacture of new products from waste.

INTERVIEW

ZERO WASTE
EUROPE

“Generate
political
pressure”



Joan Marc Simon,
Executive Director,
Brüssel


We are a European organisation consisting of members from 26 countries and are ourselves a member of a global movement called GAIA. It encompasses over 1,000 organisations working towards reducing not only plastics, but also waste in general. We see ourselves as ‘policy makers’. Among others, we coordinate a Brussels-based network of about 400 municipalities, assisting them in implementing zero-waste plans. That gives us a pretty good perspective on what is happening at the local levels as well as an awareness of many interesting pilot projects.



What is Zero Waste Europe?

We are a campaigning organisation. For instance, we initiated the Plastic-Free Day more than seven years ago. The fact that the EU has recently been regulating single-use plastics, is a result of years and years of effort. Also, we coordinate the global campaign Break From Plastic for Europe as well as the also Brussels-based Rethink Plastic Alliance in order to generate political pressure.

Even until a year ago, the common view was that the only problem was that too much plastics was discarded in the natural environment and that all it took was gathering and recycling it. We do not see recycling as the solution to the problem. It is about more than that: We need a policy of prevention, i.e. of reducing waste. That is why we support alternative business models such as edible drinking straws, alternatives to single-use nappies or reusable delivery systems by drawing attention to and presenting them to political and economic decision makers as exemplary.



How do you support a policy prevention?

Ten years ago we opened the first packaging-free shop in Europe; today there are thousands.

What is important is to look at the problem from a higher perspective and to recognise the root causes. The petrochemical industry keeps pro-

ducing more plastics, because that makes them more money than selling oil. We need to understand these kinds of situation and the economic incentives in order to find an approach as a society.

That ties into the debate surrounding a plastics tax in the EU. The practical elaboration has to be about creating incentives to member states to produce less new plastic and recycle more. At the same time we urgently need common and internationally recognised quality standards for plastics in terms of their recyclability. There needs to be industry-wide agreement on which polymers and additives to use in order to raise the recyclability in general.

At the level of civil society, what is striking is that in the US and Europe there are a number of networks and collaborative initiatives, while there are no cross-organisational platforms in Asia and Africa, even though the problem is most severe there. The global North put together studies on the problems in the global South and as a result exclusively come up with North-oriented solutions.

To suggest building 500 waste-to-energy plants in Southeast Asia is fairly pointless, if you have not included local initiatives and do not understand the situation in the towns and cities. Such edification can even be counterproductive.

It would be better to support platforms where local initiatives, government and the private sector themselves work out suitable solutions.

AVOIDANCE



A number of civil society organisations are increasingly calling on consumers and companies to avoid plastic products. To this end, they initiate campaigns and movements that are frequently joined by a variety of other NGOs at the national or international levels.

The internationally observed Plastic Bag Free Day was launched in 2009. Under the auspices of the international movement [#breakfreefromplastic](#), several thousand organisations carry out campaigns once a year to call upon people to do without plastic bags. Companies are also involved in actions.

The “Beat the Microbead” campaign is directed at companies and the political sphere and advocates

against the use of micro-plastic particles in cosmetic products. It is led by the Plastic Soup Foundation and supported by 95 NGOs from 40 countries and regions. Provided that intentionally added plastic micro-particles are consistently and comprehensively avoided in all cosmetic products, these campaigns can, for example, contribute to the reduction of micro-plastic waste. Currently, however, the effect is limited to voluntary commitments by companies in the cosmetics industry and to isolated national measures (UK, Italy, Sweden, New Zealand and Canada) banning micro-plastic beads in peeling or abrading products.

Consumer campaigns to avoid specific products usually have a targeted character, but can have a

Winning by giving up: grassroots pressure

major impact on individual products, as companies are very concerned about the image of their products. Such initiatives are particularly effective when they exert additional pressure on industry or policy by mobilising the population to bring about fundamental changes or legislative initiatives, i.e. a long-term socio-cultural change in consumption and production patterns.

However, doing without plastics is not always the best solution. Initial projections suggest that substituting glass or paper for plastic can have a greater negative impact on the environment. A study published by Trucost in 2016 estimates that replacing plastic in consumer goods and packaging with alternatives that perform the

same function would increase environmental costs from 139 billion dollars to a total of 533 billion dollars. This is primarily the case, because on average more than four times the amount of alternative materials (such as glass or aluminium) would have to be used to make the same product performing the same function. For example, a typical plastic soft drink bottle contains 30 grams of plastic. However, if it is replaced by a balanced average mix of alternative materials currently used on the market, a US-equivalent capacity bottle would require 141 grams of alternative materials such as glass, tin or aluminium.⁴⁷

ALTERNATIVE MATERIALS

One important strategy is to enhance plastics as such. Improved recyclability, higher resistance to weathering and abrasion as well as biologically based⁴⁸ and biodegradable⁴⁹ plastics are important developments in this respect. Research institutes, product designers and social enterprises are driving this trend.

Numerous research projects deal with biodegradable plastics, which are produced from fossil and biological raw materials and, at the end of their life cycle, are degraded by biological and physical processes in industrial composting facilities. A common example are plastic bags made from cereals, maize or potato starch, which are now widely used by European food retailers. They can only be composted industrially, i.e. they decompose into carbon dioxide and water when heated to at least 60 degrees Celsius. In addition, biodegradability is not a solution to the environmental chal-

lenge of plastic waste and the problem of microplastics. The latter is mainly due to the fact that the conditions for the degradation of biodegradable plastics, e.g. in the deep sea, are much worse than in household compost. Furthermore, possible impacts on other sectors, such as loss of raw materials and nutrients for agriculture and food production, have to be considered, especially if these types of plastics are not recycled or are not recyclable.⁵⁰

Another area of research concentrates on making CO₂ usable for the production of plastics or converting non-recyclable polymers into raw materials from which new plastics can be produced. These last two routes are very attractive for the recycling of mixed fractions and contaminated plastics. In the past, however, they have failed primarily due to being expensive in terms of technology and energy as well as being associated with high costs and lacking positive environmental benefits.

48 Biobased plastics are polymers that are partially or entirely made from renewable resources. (European Bioplastics, 2018)

49 DIN EN 13432 defines biodegradability as "a material [that] must have degraded by more than 90 percent to water, carbon dioxide (CO₂) and biomass after a specified time under defined temperature, oxygen and humidity conditions in the presence of microorganisms or fungi. However, biodegradable plastics are not necessarily made from renewable plant or animal resources; there are also plastics from fossil, non-renewable resources that are biodegradable. Biodegradability therefore does not depend on the raw material but on the chemical structure of the material and its ability to transform itself into naturally occurring metabolic end products through biological activity." (Beier, 2009, p. 3)

50 UN Environment (2018)

The American organisations Full Cycle Bioplastics, Elk Packaging as well as Associated Labels and Packaging have jointly developed a completely compostable packaging material consisting of wood fibres, vegetable waste and agricultural by-products that can be processed into new packaging after use.⁵¹ The material is efficient and durable, and suitable for packaging a wide range of products, from cereal bars and crisps to detergents. The innovation was honored by the Ellen MacArthur Foundation as part of the Circular Materials Challenge.⁵²

The Indonesian start-up Evoware designs food packaging (e.g. for instant coffee) from an algae-based material that can be dissolved or digested.⁵³

Another area of development is research into the degradability of conventionally manufactured plastics through microbiological processes (biodegradation). Several research institutions and

scientists are looking into this topic, in particular a Japanese research group led by Shosuke Yoshida. In Europe, Federica Bertocchini and Paolo Bombelli have made promising observations on wax moth larvae that may be able to decompose certain plastics such as polyethylene. However, further research is necessary to clearly identify a biochemical process. There are different findings on the exact processes of decomposition. The results of the research group led by Professor Till Opatz of the Johannes Gutenberg University in Mainz are particularly noteworthy in this context. The research group was able to show in control experiments that the published spectra lack certain signals that are particularly important for the unambiguous detection of ethylene glycol.⁵⁴ Financially and strategically supported by the Röchling Foundation, Federica Bertocchini is currently continuing her research into the biochemical decomposition of plastics and possible practical applications of this method.

51 Full Cycle Bioplastics, last accessed 9 November, 2018

52 New Plastic Economy, last accessed 9 November, 2018

53 Evoware, last accessed 9 November, 2018

54 Johannes Gutenberg-Universität Mainz, last accessed 14 November, 2018

INTERVIEW


FRAUNHOFER
UMSICHT

“Every car
journey
produces micro-
plastics”

Dipl. Ing. Jürgen Bertling,
Deputy Head of the
department of Sustainability
and Resources Management
at the Fraunhofer Institute
UMSICHT,
Oberhausen




Fraunhofer UMSICHT has a part in shaping the energy and resources sector. In this context, the institute has been, for the last five years, actively involved in researching the manufacture and utilisation of plastics in a variety of fields.



Mister Bertling, why is the Fraunhofer UMSICHT involved in plastics and the related challenges?

The Fraunhofer UMSICHT takes an active part in the energy and resource economy. In this context, we have also been involved with the production and use of plastics in various fields for about five years. We have been doing this because we see a clear need for innovation in coping with the challenges posed by the issue of plastics.

Among other aspects, our work focusses on bioplastics as well as plastics recycling. That made it a logical next step to get together with commercial partners and implement a meta-study: "Plastics in the Environment: Micro- & Macro-plastics – Causes, Quantities, Environmental Destinies". As the title indicates, our intention was to make the scope of the entire problem more open to scientific enquiry.




Where do you currently see the greatest challenges?

What is at stake is reducing the emissions while also creating conditions more favourable to a functioning circular economy. Both require focussed regulatory measures. Those measures that are currently being proposed often only address one particular area. Take the tax on plastic

waste discussed by the EU Commission: On the one hand, it will divert more plastic waste away from incineration and towards recycling, but it will not contribute to a reduction of plastics emissions.

In the area of plastics emissions, we see microplastics produced by wear or weathering during use as one of the major challenges. So far, everyone has always focussed on microplastics produced deliberately, such as what can be found in cosmetics. Our study has shown that one of the key sources of microplastics emissions is tyre wear particles.

The data situation currently is also problematic. So far, it is impossible to truly quantify and reliably rank the chief sources of plastics emissions – and microplastics emissions in particular. However, that is necessary to be able to take appropriate measures for reducing such plastics emissions.



In your opinion, what kind of approaches would be necessary?

It will take design innovations to reduce microplastics emissions. Most of all, we are calling for improvements in the quality of materials, which will also make them last longer. For example, if one extends the service life of a tyre, that would result in lower emissions of tyre wear particles.

The same is true for outside paint, where significant regulatory measures are in place, but so far only at national levels, for instance in France and Sweden, rather than at the EU level.

Who do you see as mostly being responsible for solving the challenges you mentioned?

We have to realise that this is a problem where the responsibility is shared. It is of concern to a number of spheres: the political and municipal, the scientific community and the private sector, citizens as well as urban water management and refuse management. Each one of these groups of actors needs to do their part.

What role could the plastics budget proposed by you play in this context?


If we intend to reduce plastics emissions long-term, we need to set a goal that we as a society can work towards. The plastics budget is a first, rough attempt at a solution in that direction.

As a first step, we defined a level to which plastics emissions would have to be reduced so that no more plastics is released into the environment than is already in it. In the future, the rate of

emission of plastics into the environment should not exceed the rate of removal. Based on a number of assumptions we came to the result that plastics emissions would have to be reduced by roughly a factor of 27 in order to achieve this goal. Each of us will have to cut our plastics emissions from an annual 5.4 kilograms down to 200 grams. This ambitious goal highlights the great importance of reducing the amount of plastics that we release as part of our daily consumption of products. This is the only way to prevent the situation from getting worse.

But what influence would such a per-capita budget have?

Only having a benchmark to aim for enables us to quantify the usefulness of specific measure towards achieving the goal. As an example: You could decide that you wanted to reduce the amount in the clean water outflow of water treatment plants from 50 particles down to five per a given amount of water. But considering the overall amounts and the possible ways of dealing with them, you might realise there are other places to be tackled first. In other words: The budget helps in setting priorities.




What do you see as having highest priority?

We should definitely not start with filtering the oceans. Even though there are impressive images of machinery and collection facilities out there, this will not work. It is much more effective to take action further upstream.

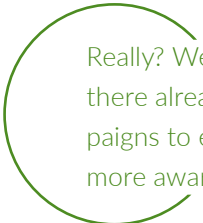
You had mentioned the shared responsibility of the political, scientific, civil society and industrial spheres. Would you say that more coordination and interconnectedness is required overall?

No. Interconnectedness is great if you are actually taking action together. Many of these networks and clusters are self-referential and often leave very little time and resources for actually doing something and developing necessary solutions. I do not think that enough is being done. However, I do think that there are enough networks and initiatives. The way I see it, more energy needs to be invested into finding concrete solutions. I am a friend of funding small-scale measures that produce actual results.



What is the best way that funding bodies – such as foundations, companies or even ministries – to invest if they wish to make a contribution to solving the problem?

First, it would make sense to support work on specific research queries, for instance research into how the wear and weathering for various types of plastics and products can be reduced. A second area would be supporting the involvement of civil society for a change in people's behaviour. We have to come up with clever ways to get people to simply not throw away certain things.



Really? We are under the impression that there already are quite a number of campaigns to encourage consumers to be more aware in how they consume.

True, there are many initiatives. But that begs the question if they are the right ones. Giving up plastics – even for four weeks: What I see in places verges on the absurd. These people get everything mixed up and demonise plastics as this toxic material. It would be better to create a greater awareness among people that we have here a valuable material that can be used to make wonderful things, but that should not end up in the natural environment.



EXTENDED SERVICE LIFE



In Germany, 26 per cent of plastics emissions consist of macro-plastics and 74 per cent of micro-plastics. A large proportion of micro-plastic originates from the use of products, for example through abrasion and weathering. This type of micro-plastics in turn fragment into nano-plastics, while the time scales on which this process takes place in the environment is not even remotely understood.⁵⁵ Nanoparticles are then absorbed by plants via the roots and reach the leaves.⁵⁶ Plastic thus reaches our food chain not only through fish and seafood, but also through agricultural products. In the form of a fine dust, nano-plastics can also be inhaled, similar to pollen.

In order to reduce emissions from micro-plastics and thus also the formation of nano-plastics, first efforts are being made to develop innovative and high-quality materials that both increase the service life and reduce abrasion at the same time. This

applies, for example, to clothing that releases synthetic fibres while being washed, paints that are exposed to weathering or the abrasion of shoe soles and tyres.

The largest sources of micro-plastics are currently found in buildings, transport and infrastructure. Especially in these fields, material and product innovations for the longevity of materials need to be stimulated in order to reduce the quantities emitted. This could be accompanied by legal provisions for significantly extended warranty obligations or repair guarantees. In addition to the plastics industry, the rubber industry would also have to be involved.

The search for new materials is also driven by the fact that until now the usability of plastics has been achieved primarily through the use of additives. This is particularly true for materials in the

⁵⁵ So far, there is no clear definition for nano-plastics. Different studies set the upper limit of the particle size at either 1,000 or 100 nanometres. (Gigault et al., 2018)

⁵⁶ Machado, Kloas, Zarfl, Hempel, & Rillig (2018)

That fatal greed for novelty

construction industry, as they are often exposed to the weather and can only survive for longer periods of time if they are treated with appropriate additives.⁵⁷ In order to reduce the release of additives into the environment, completely new and innovative materials must be discovered and developed in the long term.

Other important components in the debate on extending the useful life of plastic products range from fashion trends to psychological or planned obsolescence as well as upgradeability. For instance, electronic devices are used for much shorter periods than they were ten years ago. The waste generated as a result and the higher material consumption have detrimental effects on the environment. The main reasons for this are that equipment breaks down more quickly (planned obsolescence), that consumers dispose of fully functional equipment for a newer model

(psychological obsolescence), that repairs are too expensive compared to purchasing new equipment or that there is no compatible software for older hardware (upgradeability).⁵⁸

In a study of 2016, the Federal Environment Agency identified lifestyle requirements and standardisation as important overarching strategies against electronic devices becoming old too early or going out of fashion.⁵⁹ In practical terms, this refers to measures that oblige manufacturers to develop innovative service models and to guarantee certain minimum requirements for software as well as improved repair capabilities. In addition, consumers must also be better informed. However, the responsibility of the consumers themselves should not be neglected in this context, as careful use of electronic equipment can extend its service life.

57 Bertling, Bertling, & Hamann (2018)

58 Wilts & von Gries (2016)

59 Wilts & von Gries (2016)

INTERVIEW

OCEAN
CONSERVANCY



Emily Woglom,
Executive Vice President
Washington D.C.

“We need
a shared
architecture”


Since it was founded in 1972, US-based Ocean Conservancy has tackled some of the greatest conservation challenges to the ocean. Since then it has been committed to a variety of aspects of marine conservation, with the topic of plastics and the environment naturally playing a major role. The organisation became known worldwide through the International Coastal Cleanup, a global day of action in which several hundred thousand volunteers take part every year. With the Trash Free Seas Alliance®, Ocean Conservancy has created one of the most respected networks with a high level of industrial participation.



Ocean Conservancy has been campaigning against plastic waste since as early as 1972. What has changed since then?

For many years we have been organising the International Coastal Cleanup. Groups from all over the world collect garbage on the beaches on a certain day. But they not only collect garbage, they also record what they find. So we know pretty well how the composition of garbage in the oceans is changing. In 2017, for the first time, all ten of the most frequently found objects were made of plastic. In all the years before, we also found glass and other materials among the top ten. Now it is practically just plastic.

Recognizing that the solution to ocean trash must go beyond beach clean-ups, we turned to tackling it at its source. So we put together a scientific working group at a world renowned ecological think tank, the National Center for Ecological Analysis and Synthesis. Their work led to the much-quoted 2015 Science article "Plastic Waste Inputs from Land into the Ocean," in which it was reported for the first time that eight million tons of plastic waste ends up in the sea every year and that 50 percent of this comes from five countries.



What came out of this realisation?

Concurrently, we established the Trash Free Seas Alliance®. This is an alliance of industrial companies, environmental organisations and scientists working together to find solutions. This collaboration was built in partnership with some of our long-time International Coastal Cleanup sponsors, including Dow and Coca-Cola, who shared our sense that we need to do more than collect garbage once it has reached our beaches and waterways.

The work of Dr. Jenna Jambeck and the team of scientists that worked on the 2015 Science paper made us understand that most of the plastic in the oceans comes from countries that are experiencing rapid economic development. Countries such as China, Indonesia, Vietnam, Thailand or the Philippines, where the consumer goods industry is developing strongly, but the disposal infrastructure is not keeping pace with this development. The Trash Free Seas Alliance® wants to focus on this problem.



How does the Trash Free Seas Alliance® go about this?

We have analysed the financial, technical, legal and political barriers to waste management in these regions of the world. The result of this analysis is a new impact investment fund that was launched together with Closed Loop Partners (which was subsequently spun off to form the investment firm Circulate Capital now manages this fund). The goal is to invest 150 million dollars in waste management solutions in South-east Asia. The money is to flow in the form of subsidised loans and investment grants.

We believe that multiple strategies are going to be needed to solve this problem. The zero-waste movement is working to reduce plastic use overall. Others are working on the design of materials and products to make them more recyclable. We, on the other hand, believe that in the face of an acute crisis with the equivalent of a lorry dumping garbage into the ocean every minute, one of the greatest and fastest impacts can be achieved by installing collection and recycling infrastructure in Southeast Asia.



What are the greatest challenges in this?

A major challenge is the cost-effectiveness of such a system for the people involved. The value of recyclable material is simply not high enough. If a garbage collector picks up easily recyclable PET bottles for a day, he can earn three to four dollars from them. If he collects material that is difficult to recycle at the same time, such as thin films, he only receives 50 cents. So a larger market for recyclable material has to emerge.

We must therefore ask ourselves how in Asia collecting waste can become more attractive than throwing it away. Does it require a municipal tax on certain products to pay for collection? Or should the state set high quotas for recycled content in packaging and thus increase the value of the recovered material? At the moment, we believe that new policy tools are necessary to find the right allocation of these costs.



Are you seeing any particularly successful solutions?

To be honest, energy and the financing of activities are currently well ahead of solutions. This is unusual, because for many other societal challenges there are good solutions, but limited money and little awareness. The opposite is true for plastics and the environment. The World Bank, the G7, the G20, the United Nations, numerous national governments and companies are making this a priority, but we are still pretty much working to develop solutions.

Companies and foundations want to see actions and projects, but the problem is too immense to try out some pilot projects here and there. We need sustainable political and financial conditions to make a recycling economy possible in the first place. It is more effective for us to work on the foundations for such a system than to run individual projects.

Overall, it is the complexity of the problem that poses the greatest challenge. There is no single solution to the environmental pollution caused by plastic. We need action on several fronts at the same time. Political action must go hand in hand with the development of new business models and new technologies.



Will it take greater coordination among the individual initiatives to achieve that?

Yes and no. There is already a lot of communication and coordination between the actors. We talk to our industry partners. Some of them are part of the network World Business Council on Sustainable Development. The World Economic Forum is also stepping up to the plate.

When it comes to coordination across sectors and organisations, however, it must be considered that there are two groups of actors with a different logic of action. We believe the private sector needs to be part of the solution, and we work with leaders there who are committed to solving the problem to develop implementable solutions. There are others in the NGO community that work on public campaigns to push industry act. Both play an important role, but this difference can be hard to bridge when it comes to coordinated activities

We are currently talking to a number of relevant actors about improved cooperation mechanisms. It is not so much a question of whether projects should be carried out together but rather of whether and how it is possible to access a shared architecture – for example, evaluation results or a common set of basic data. That would help more than meeting in a room every month.

CLEANUP



Systematic actions for rubbish collection are commonly referred to as clean-ups in the international context. Numerous civil society organisations, for example, have been campaigning for clean coastal areas and beaches for years by calling for and mobilising the population to take part in regular clean-up campaigns. Today, many of these actions combine the collection and removal of rubbish with the collection of data on where it is found, products found, product components and their properties. As a result, clean-up activities are increasingly becoming Citizen Science projects⁶⁰, actively involving the public in the collection and analysis of data on the environment.

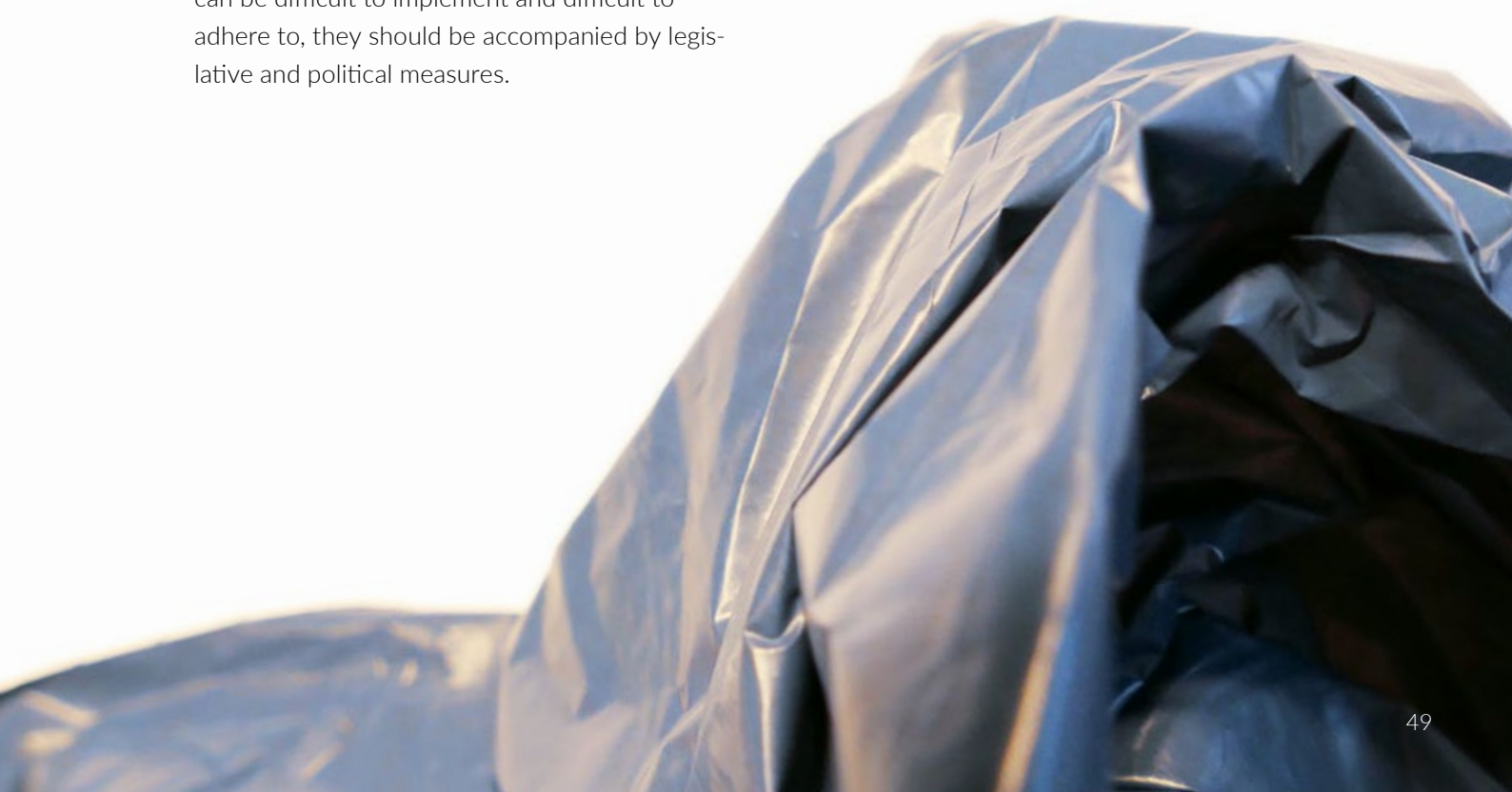
Clean-ups usually focus on coastal regions and the oceans themselves. They generally have a corrective and short-term effect. Some civil society actors therefore do not regard clean-up activities as part of a systemic solution to the problem of plastic waste. Nevertheless, over the years these activities have helped to raise public awareness of the problem and make it part of the agenda of actors from business and the political sphere.

Sustainable consumption requires educated and responsible consumers. Educational projects for young people can make a significant contribution

⁶⁰ Citizen Science is the collection and analysis of data from a variety of areas of research, such as science, technology or sociology, by the general public. This often happens in cooperation with a professional scientist (based on the definition in https://en.oxforddictionaries.com/definition/citizen_science, 1 August, 2018). Through the use of digital technology, the public can participate in research regardless of their physical location. In order to coordinate the information from an increasing number of different Citizen Science projects and make it more usable, the international Data and Metadata Working Groups of the American Citizen Science Association and the European Citizen Science Association ECSA, have, among others, developed a joint design model.

Cleaning up does not take care of the problem – but brings it to light

to this, as long as care is taken to ensure that as many children and young people of the same age group as possible participate in these projects and that parents and adults also apply the practices learned in everyday life. Since voluntary changes in behaviour, even for problem-aware consumers, can be difficult to implement and difficult to adhere to, they should be accompanied by legislative and political measures.



SIDE NOTE:

INSUFFICIENT WASTE MANAGEMENT SYSTEMS IN DEVELOPING AND EMERGING ECONOMIES – ONE OF THE MAJOR SOURCES OF PLASTICS IN THE OCEAN

In many developing and recently emerging countries in Asia and Africa there is still no basic infrastructure for professional waste management. Although activities in the informal waste sector (individual and informal collection of waste and recyclables) are widespread in most of these countries⁶¹, there is a lack of funding and appropriate political standards to establish formal and professional waste management systems.⁶² According to a study published by Ocean Conservancy, about 60 per cent of plastic waste in the ocean comes from only five Asian countries: China, Indonesia, Thailand, Vietnam and the Philippines.⁶³ This is

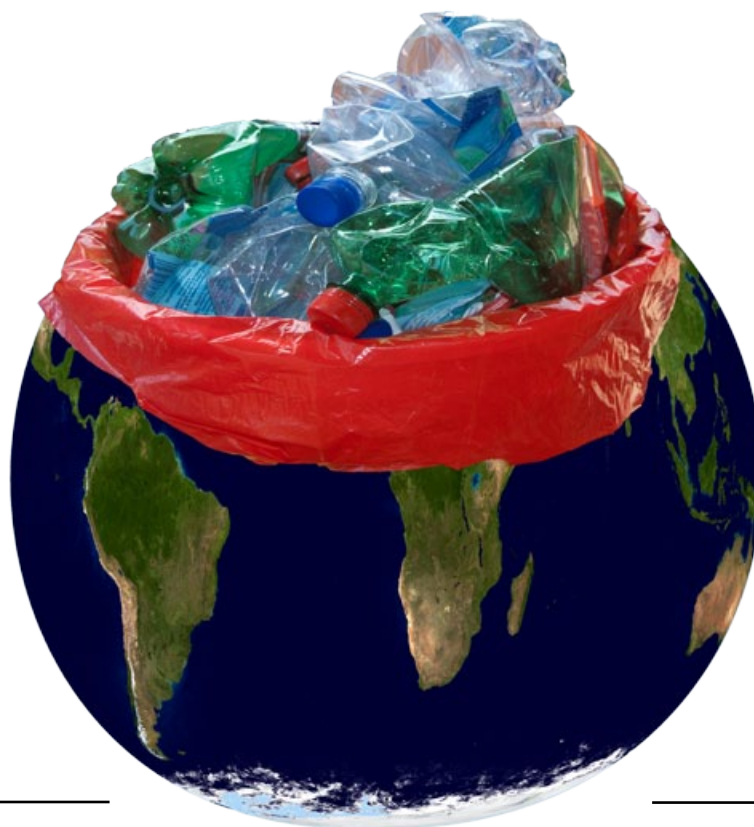
why public and private investors, in cooperation with the respective national governments, promote the establishment and expansion of waste management systems in these countries.

In 2017, Circulate Capital, together with the Trash Free Seas Alliance, launched an Impact Investment Fund to promote the establishment of waste management and recycling systems in Southeast Asia. A total of 150 million US dollars are to be contributed by corporate partners such as 3M or Coca Cola to finance infrastructure projects on the one hand and to support young com-

61 An estimated 15 to 20 million people work in the informal waste sector and more often than not, that is how they earn a living (GIZ 2018).

62 Interview with Emily Woglom, Ocean Conservancy, 11 July, 2018

63 McKinsey & Company, Ocean Conservancy (2015)



panies in their development on the other. These and similar initiatives and funds are now managed by the spin-off company Circulate Capital.⁶⁴

Another important actor in this field is the World Bank. It finances and consults solid waste disposal projects with a wide range of financial products. Since 2000, the World Bank has provided over 4.7 billion US dollars for solid waste management. The projects financed cover the entire life cycle of waste – from generation, collection and transport to treatment and disposal. In early 2018, the World Bank granted Indonesia a 100 million US dollar loan for a national programme worth a total of one billion US dollars. This programme aims to transform the waste management practices of about 70 participating cities affecting a total of 50 million people.⁶⁵

The introduction of waste management systems can help to reduce plastic pollution, especially in emerging countries where industrialisation is generating large amounts of plastic waste that is not disposed of in an environmentally sound way. Cultural, economic and political conditions in the target countries should be taken into account.⁶⁶ Professional and formal waste management requires the active support of the population and their willingness to collect their waste and separate it appropriately. In addition, possible negative impacts on the informal waste sector, which is an important source of income for many people in emerging countries, must be taken into account. Moreover, in order for waste management systems to be economically viable, they should not relate exclusively to plastics, but to all household and commercial end-user waste.⁶⁷

⁶⁴ Circulate Capital, last accessed 16 November, 2018

⁶⁵ The World Bank (2018)

⁶⁶ Interview with Joan Marc Simon, Zero Waste Europe, 19 July, 2018

⁶⁷ Interview with Emily Woglom, Ocean Conservancy, 11 July, 2018

INTERVIEW

UNESCO GLOBAL
ACTION PROGRAMME:
EDUCATION FOR
SUSTAINABLE
DEVELOPMENT

“Change also
needs a new
point of view”


Bianca Bilgram,
Head/International
Relations at the
German UNESCO
Commission e.V.,
Bonn





What part does the issues of plastics and the environment play in the UNESCO's Global Action Programme on Education for Sustainable Development (ESD)?

A major one. Most of the projects that we award prizes to are concerned with plastic avoidance and disposal. We notice that there are more and more projects about the avoidance of plastic. We are, of course, no implementers of initiatives, but we are in exchange with many initiatives, some of which we also award prizes to. We participate in events and make our expertise available. The award-winning initiatives can then also be found on the ESD portal as part of a map of actors. In addition, there are of course many initiatives in Germany that focus on plastics and the environment, including the UNESCO project schools located in the UNESCO Biosphere Reserves.



What do you see as the greatest challenges for educational programmes in the area of plastics?


A key challenge is bridging the gap between non-formal and formal education. School and extra-curricular education programmes for sustainable development are usually considered and developed separately. This needs to be interconnected.

One constant challenge is, of course, the funding of education projects so that they can be implemented in the long term.



Where is the issue being addressed too little?

We are currently experiencing a lot of change here, especially as the topic of microplastics is very much represented by various studies at the



moment. Of course, this also applies to the initiatives and educational activities at schools and universities. However, we see potential for development above all in the area of avoidance or the question of the future role of plastics and their sensible use. This discussion is important in order to develop alternatives, especially with regard to everyday consumer goods.

In addition, it is important that ESD initiatives in this area do not focus solely on school children and young people. There is no question that this target group plays an important role, but it is also important to specifically address how we enable lifelong learning. It would therefore make sense to also look at opportunities for in-service training and in one's own industry.


The Federal Institute for Vocational Education and Training (Bundesministerium für Berufsbildung – BIBB)⁶⁸ is a good point of contact for this. The BIBB has already undertaken several pilot projects in various branches of industry in which innovations in in-company vocational education and training are developed, tested and prepared

for transfer. However, plastic has not yet been part of this process.

Where is the potential of ESD when it comes to plastics?

ESD as an educational concept aims at enabling people to change their perspective. ESD can contribute to a critical reflection on the global issue of plastics and plastics disposal in Germany and internationally. ESD as a concept is intended to facilitate good solutions for the balance between economy, ecology and social aspects. It is central that the reflection process provides an experience of self-efficacy: Learners must be able to experience what the individual can contribute to the process of change.

A European comparison shows that the holistic consideration of the plastic problem – i.e. that it is not only a question of disposal, but also has to be considered beforehand in terms of use and avoidance – still has room for improvement in Germany. Some other countries have already made greater progress in this respect.



Take a current example: The ban of disposable plastic articles is a regulatory measure and at first glance has nothing to do with education. However, ESD must make it possible to take a critical look at the issue in order to develop solutions based on it.

Looking to the next five to 10 years: How would you position the issue of plastics in ESD and what role do other actors play in this?

Plastics are important for ESD and will remain so until the appropriate solutions are found. It seems very likely that the significance will grow even more. This also reflects the strong presence of the issue in the media. Especially with regard to the economy and specific questions of avoidance, production or use, ESD measures can have a meaningful effect in the sense of lifelong learning. Initiating an open dialogue with young people not only in the formal sphere, but also within the companies themselves, has an impact on corporate culture and on the business partners. Important stimuli can also be provided by foundations,

as they are in a position to initiate change by supporting pilot projects.

ESD was made the guiding principle for the Bundesministerium für Bildung und Forschung (BMBF) research series Research into Sustainable Development (FONA⁶⁹). Are effects of this official upgrade in status already apparent?

The research sector and the education sector are traditionally very self-contained areas. It always takes time for structures to change. However, we can see that the guiding principle is becoming increasingly effective, particularly with regard to the transfer of knowledge between research and education. ESD has so far mostly been thought of as an addition to scientific/academic research. This is currently changing. One example is the Hoch N² project, which deals with sustainability at universities. There certainly still is a lot of potential here, but FONA is still in its infancy in this respect.

EDUCATION FOR SUSTAINABLE DEVELOPMENT



Education for Sustainable Development (ESD) has been the World Programme of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) since 2015. Thus, educational programmes are regarded the world over as a central building block in actively addressing global challenges such as climate protection and biodiversity conservation. Last but not least, this formal upgrade has resulted in a tremendous variety of projects and programmes, which receive substantial financial support from the public sector and foundations.

The concept of ESD describes a holistic and transformative approach to education that takes into account what is taught, what results are achieved and what the learning environment is like. Teaching and learning should be designed in

an interactive way in order to enable research- and action-oriented as well as transformative learning.⁷⁰ The aim is to equip people to think and act in a way that is fit for the future. A crucial factor here is the interdisciplinary preparation of the topics and fields of action, taking into account the specific cultural backgrounds. That is the only way ESD can enable each individual to understand the effects of their actions on the world and to make responsible decisions.

Education and Research for Sustainable Development (ERSD) need to be considered as one. Although the two strands start from very different premises, a number of thematic, structural and process-related intersections arise, which should grow closer together in the continuation of the two programmes.⁷¹

70 UNESCO Weltaktionsprogramm Bildung für nachhaltige Entwicklung, BNE Portal, last accessed 17 December, 2018

71 FONA (2016)

A global programme for the forward-thinking

The World Action Programme's scientific support has shown that the strongly participatory approach of platforms for the exchange and promotion of Citizen Science projects holds great potential for identity-building and mobilisation.

Plastics in the Environment - Sources. Reduce. Solutions is the research programme of the FONA flagship initiative Green Economy and aims to grasp the problem of plastic waste in its entirety in a scientific way and thus close existing gaps in knowledge. In addition, approaches to reducing the amount of plastic waste emissions are to be identified and implemented.⁷² The individual research projects are supported by Citizen Science activities such as the Plastic Pirates⁷³ or the Citizen Science platform Citizens Generate Knowledge⁷⁴.

In spring 2018, the Executive Council of UNESCO decided that ESD should continue after the end of the Global Action Programme in 2019. In the next programme, the five priority fields of action (political support, transformational learning and teaching environments, skills development for multipliers, mobilisation of youth and promotion of sustainable development at the local level) will be further expanded.

72 Bundesministerium für Bildung und Forschung (2018), last accessed 9 November, 2018

73 Bundesministerium für Bildung und Forschung (2018), last accessed 9 November, 2018

74 Wissenschaft im Dialog, Bürger schaffen Wissen, last accessed 14 November, 2018

INTERVIEW


OECD

“It is simply a question of the political will”



Peter Borkey,
Senior Policy
Analyst,
Paris

The Organisation for Economic Cooperation and Development aims to promote policies that improve the economic and social lives of people worldwide. As a government supported think tank, their task is to develop comparative policy analyses and identify examples of good practice. These are then translated into recommendations for governments to take action. The OECD also plays this role when it comes to plastics.



Where do you see the greatest challenge when it comes to plastics and the environment?

We see completely different challenges in developing countries than in highly developed economies. In the developed OECD countries, we need to question how we use and consume plastics. We need to be more aware than before of which uses of plastics are not productive and simply not necessary. And we have to take much greater account of the fact that during the development phase of materials and products we can handle them more sensibly even at the end of their useful life.

In developing economies, the problem is much more fundamental. There, the use of plastic consumables is increasing immensely without suitable waste management systems being in place. These countries could probably avoid 90 percent of their plastic emissions into the oceans simply by establishing collection systems.

So we are talking about completely different initial situations, and our recommendations to governments vary accordingly.



Can you quote examples of sensible policy measures developed countries?

There are a number of problems that need to be addressed through political regulation. One of these is a problem of quality, which means that many plastic materials cannot be recycled or can only be recycled with difficulty. This is where policies can set targets. Another example is improvements in the separated collection of plastics. This is widespread in Germany, but not in other developed countries, including the US.

Beyond this, political measures are possible which increase the proportion of recycled plastic relative to newly produced material. This would require overcoming the current cost disadvantage of recycled material. We need to create a market in which industry has a significant cost advantage from using recycled materials over primary plastic. The demand for recycled material must increase. And then there are a number of softer measures such as the introduction of certification marks and standards

All of that does not sound very difficult. Why is it not happening, or only very slowly?

I think there just has not been enough awareness so far. That is changing rapidly at the moment. Someone once said that plastic in the sea is the new polar bear in environmental policy. Everyone can now see what is happening. Consumers become aware. This in turn has an impact on the industry. Companies like Nestlé run the risk of damaging their brands if they do not seriously look for alternatives to some types of packaging. This risk weighs more heavily on the companies than potentially higher costs. A lot has changed in a short time.

Let us return to developing countries. If what is necessary there is primarily the introduction of a waste management system, who should cover the costs for it? The respective governments? The private sector? The consumers? Or even the international community?

According to the OECD model, it is essential that consumers finance the majority of waste management via prices. This is the only way to create an incentive to produce less waste. Waste, especially plastic waste, is thereby given a value.

What do you think of the idea of a personal plastics budget to give people a greater awareness of how much they consume?

Not much. That would imply that plastic is generally bad and should be banned. In fact, plastic also has many benefits and the alternatives often have an overall worse ecological footprint.

Instead, we need to have better control over what happens to the material at the end of its useful life.

Do you see any solutions that actually work?

We were discussing the tool kit. It is only a question of political will and of funding, if it will be used or not.

What has to you been the most interesting policy measure so far?

The ban on disposable plastic articles in some countries is really interesting. But it is also a little dangerous because we still know relatively little about the long-term economic and ecological effects. You have to be careful not to replace the banned material with an inferior one. We see in France that the very thin bags for fruit and vegetables in supermarkets have been replaced by paper bags. Their production requires ten times more in materials and water. That simply delays the problem.

In your opinion, who is responsible for removing plastic waste from the environment? The public sector as well? Or the private sector? Or the start-ups that are currently proposing innovative ideas?

I wish there was such a magic technology that would allow us to clean up the ocean at a reasonable cost. Unfortunately, that does not seem to be the case. Municipalities will continue to clean up their beaches because otherwise there will be no more tourists. And maybe a niche will be created and some companies will pay a lot of money for plastic fished out of the ocean. But this will be a small drop in the big sea of plastic.

One last question: How can a foundation take a useful and effective position in this field, crowded as it already is? Are there problems that have so far not at all or not sufficiently been dealt with?

Yes, the field is extremely busy, especially when it comes to plastics in the oceans. Foundations and similar organisations can really make a difference in the general area of sustainable materials and product development. Our understanding of what this means for different products and sectors is still very limited. Investing in research into innovations and opportunities would be an effective form of engagement. And this is also the point where we as the OECD will focus our efforts.



4. ACTORS AND THEIR AREAS OF ACTION

Scarcely a day goes by without an item in the media on the environmental impact of plastic waste. In recent years, the growing attention paid to the problem has also led to an increase in the number of actors who want to actively contribute to solving this problem. While the challenge is multi-faceted, the actors' approaches are just as varied. This has set the plastics producing and processing industry in motion and increased the overall complexity of the issue. Nevertheless, a number of, albeit sometimes contradictory, approaches to action are emerging within the arena of actors. For those new to the field, the question arises as to how they can make a meaningful contribution. For experienced actors, the key is not to lose sight of the bigger picture.

As the preceding interviews have shown, there are various views on how the global plastic waste problem should be solved. They essentially encompass the following:

1. Establishing closed-loop material cycles and, if possible, a virtually completely circular economy
2. Avoiding and reducing (short-lived) plastic products
3. Innovations for improving the environmental characteristics of plastics and alternative materials
4. Increasing the service life of plastic products
5. Upgrading waste management systems, especially in developing and emerging economies
6. Increasing recycling rates
7. Clean-up actions

Each of these seven concepts is based on a series of further ideas and approaches. Their multiplicity shows that a skilful combination of the different approaches is required, along with in-depth research to identify particularly effective levers. Some even argue that there is a need for a common architecture that allows different actors to access a set of basic data in order to focus on the most effective and promising solutions.⁷⁵

Due to their diversity, it is hardly possible to capture the entirety of actors and initiatives. Based on observations from the conducted interviews and desktop research, the handbook *Plastics and the*

Environment endeavours to present the different actors by classifying them into sectors and describing their roles and connections. The organisations and initiatives mentioned and described here meet the following criteria:

- Their work, research or funding activities explicitly focus on addressing the goal of eliminating, reducing or avoiding plastics waste at a global scale.
- Their activities have at least national, if not international, reach or relevance (i.e. the organisations pursue their activities in more than one country or they have partner organisations in more than one country).
- They have a holistic approach to eliminating, reducing and/or avoiding plastics waste. In their considerations and activities, they involve
 - multiple stages along the value chain or the life cycle of plastic products.
 - Stakeholders and/or partners from more than one sector (political sphere, private sector, civil society).

Nevertheless, the following analysis can only be seen as a number of examples and is neither exhaustive nor complete.



CIVIL SOCIETY

FOUNDATIONS

Adressium Foundation
Ellen MacArthur Foundation
Global Alliance for Incinerator Alternatives (GAIA)
MAVA Foundation
OAK Foundation
Ocean 5
Plastic Soup
Röchling Stiftung
Schmidt Family Foundation
Stiftung VEOLIA
The Ocean Cleanup

NGOs

#break free from plastic
Global Ghost Gear Initiative
Greenpeace
Ocean Care
Ocean Conservancy
Ocean Recovery Alliance
One Earth – One Ocean
Plastic Pollution Coalition
Rethink Plastic
WWF
Zero Waste Europe

PRIVATE SECTOR

FOOD & BEVERAGE

Coca Cola
Danone
Nestlé
PepsiCo
Procter & Gamble

Cradle to Cradle Products

Plastics
Europe

RECYCLING INDUSTRY

International Solid Waste
Association (ISWA)
Terracycl
VEOLIA
Vinyl Plus

Planet or Plastic?

World Economic Forum

World Business Council for
Sustainable Development

World Palstics Council

ACADEMIA

Algalita Marine Research and Education

Fraunhofer Umsicht

College of Engineering –
University of Georgia

JPI Oceans

Plastik in der Umwelt (BMBF)

The Commonwealth Scientific and
Industrial Research Organisation (CSIRO)

The National Socio-Environmental
Synthesis Center (SESYNC)

The Spanish National Research Council

Wuppertal Institut

TRANS-SECTORAL NETWORKS

Plastic
Solutions Fund

Trash Free
Seas Alliance

New Plastics
Economy

The Plastics
Pact

POLITICAL SPHERE

Agence Française de
Développement

European Commission

European Investment Bank

Global Environment Facility

Kreditanstalt für
Wiederaufbau (KfW)

Organisation for Economic
Co-operation and Development (OECD)

The World Bank

UN Environment

RETAIL

Walmart

Circulate
Capital

Civil society

Through campaigns and actions, **Civil Society organisations** such as NGOs or non-profit foundations have raised awareness of the issues among policy makers and the business community. Foundations support basic research to gain a deeper understanding of how plastics enter the environment as well as the development of socio-ecological innovations. However, the latter has so far only been very limited, for example supported by the Ellen MacArthur Foundation with its Innovation Moonshots initiative or by the Oak Foundation.

By the 1980s at the latest, the first NGOs had taken up the issue of protecting the seas and oceans against increasing pollution with waste, and sensitised the public to the problem via campaigns and coastal clean-up actions. The Coastal Cleanup, launched by Ocean Conservancy in 1986, is today the world's largest voluntary action of its kind. Another initiative to mobilise consumers is the International Plastic Bag Free Day, an annual event of the international #breakfreefromplastic movement.

In addition to such selective consumer mobilisation initiatives, many NGOs have developed educational and awareness-raising programmes for young people, which are either integrated into school education or can be joined by students in their free time. The Plastic Soup Foundation's section PSF Junior devotes special attention to the presentation of important information to young people.

Outside pressure versus collaborative transformation from within

The activities of NGOs are not only aimed at consumers. Today, many NGOs campaign to put pressure on the consumer goods industry or policy makers to abandon certain product components or additives or to impose legal restrictions on the use of certain materials or products. The campaign Beat the Microbead mentioned in Chapter 3 can be given as an example. Zero Waste Europe, on the other hand, works closely with municipalities and regions to develop and implement solutions for sustainable and waste-free cities and communities.

In recent years, it has become generally accepted that a sustainable reduction of environmental pollution from plastics waste requires a systemic transformation for which actors and stakeholders from the various sectors (political, economic, civil society etc.) need to pull together. As a result, the first NGOs have launched initiatives and programmes that actively include economic and political actors instead of putting pressure on them. The aim is to develop requirements and standards for the design of plastic products together with companies from the consumer goods industry to facilitate re-use or recycling. The most wide-ranging initiative of its kind at present is the New Plastics Economy initiative of the Ellen MacArthur Foundation.⁷⁶

76 Ellen MacArthur Foundation (2018c)

Key civil society financiers

Funding for campaigns, initiatives and NGOs is often secured through a mix of membership fees, public grants and private donations.

Among the largest international civil society sponsors in the field are:

ACTOR	OVERVIEW	ACTIVITIES Year established
Schmidt Family Foundation http://tsffoundation.org/	Year established : 2006 Based in: Palo Alto, USA Goal: The Schmidt Family Foundation advocates the development of a sustainable and resilient society, specifically in the areas of nutrition, water and the environment.	Through the Wendy and Eric Schmidt Fund for Strategic Innovation, the Schmidt Family Foundation is, e.g. the main supporter of the Ellen MacArthur Foundation's New Plastics Economy Initiative.
MAVA Foundation http://mava-foundation.org/	Year established : 1994 Based in: Gland, Switzerland Goal: By providing funding, mobilisation and support to their partners and the conservation community, the MAVA Foundation advocates the preservation of biodiversity for the benefit of both people and the natural world.	The MAVA Foundation also funds the Ellen MacArthur Foundation's New Plastics Economy initiative, as well as the Plastic Solution Fund.
Oak Foundation http://oakfnd.org/	Year established : 1983 Based in: Geneva, Switzerland Goal: The Oak Foundation campaigns for solving ecological and social problems worldwide. In particular, the foundation works on human rights, the environment, education and access to affordable housing.	The Oak Foundation supports campaigns organised by NGOs, such as #breakfreefromplastic, that specifically aims to raise awareness of plastic waste in the natural environment among consumers and companies. In addition, they also support the New Plastics Economy initiative.
Adessium Foundation https://www.adessium.org/	Year established : 2005; Based in: Reeuwijk, the Netherlands Goal: The Adessium Foundation advocates a society that protects the environment, uses natural resources wisely and provides equal opportunities for all.	Together with other foundations, they initiated the Plastic Solutions Fund, which funds solutions-oriented projects by NGOs (e.g. by Zero Waste Europe or GAIA).

As this overview shows, some foundations are involved not only as sponsors but also in an operational capacity in the field. Like NGOs, they use their programmes to raise awareness and bring different actors together and encourage them to take action. An examination of the approaches and methods used by foundations and NGOs shows the use of a set of instruments that are intended to bring about changes in the production and use of plastics products. The instruments mentioned in this context are the following:

- Gathering data and knowledge through basic research on the ways in which plastics are released from the economic cycle and into the environment as well as on the effects of the released material
- Disseminating knowledge by publishing studies
- Creating awareness of the problem and mobilising actors from within the general public, the political sphere as well as from industry and retail via campaigns and advocacy work
- Educating young people to become responsible consumers acting sustainably through educational projects

- Promotion of product-related or methodological socio-ecological innovations through applied R&D, awards and/or support of promising start-ups in organisational development (incubation, accelerator programmes or scaling)
- Initial grants in the field of materials research
- Fostering close cross-sectoral collaborations between the private sector, the political sphere and civil society

Looking at the arena of foundations, it becomes clear that – compared to how many foundations there are and how enormous and pressing the challenges – surprisingly few of the foundations that exist are specifically focussed in this issue.

This is true for the international level, but even more so when looking at the German foundation sector with its approximately 22,000 foundations.



Political sphere – Prevent from BMZ, EU Changes

On the one hand, political actors react by initiating legislation; on the other hand, they initiate research and investment programmes for the further development of materials, waste management and recycling systems as well as specific sustainability strategies. For Example, in the European Commission's strategy for plastics in a circular economy that was released in December 2018, one of the measures for strategy implementation was to examine together with stakeholders the potential design features of a private-led investment fund to finance innovative solutions and new technologies that reduce plastic pollution in the environment.⁷⁷

While some people see the political arena as a driving force in the implementation of legislative frameworks for higher recycling rates or even a recycling economy, critical voices are of the opinion that the political arena only implements certain regulations once the industries concerned are ready to take these steps or the pressure from civil society is so great that the political arena must react.

At present, there is a worldwide increase in specific bans on the use of certain plastic products, especially disposables that are easy to replace.⁷⁸ As early as 2008, Rwanda was the first country in the world to introduce a legal ban on plastic bags, and countries such as Kenya and France are also following suit with laws against the use of plastic bags. Some ten years later, the European Commission adopted new regulations to ban or reduce the use of disposable plastic products and fishing equipment. One such ban was passed by the EU in March 2019 that will essentially elimi-

nate the use and distribution of 10 common, single-use plastics such as plastic cutlery and straws in Europe by 2021.⁷⁹

On the other hand, general conditions under waste legislation, such as the recently adopted amendment on landfill (European waste management package), provide mixed incentives. The law stipulates that plastic waste can still be deposited in landfills until 2035, and in some cases even until 2040, which may have a negative impact on recycling rates.⁸⁰

Transnational organisations and governmental agencies are at last getting involved in the debate

Most of the major transnational organisations and governmental agencies are now actively involved in the debate on plastics and the environment. These bodies develop and pursue strategies at different levels.

The World Bank, among others, provides financial support for the professional management of waste. It finances and consults solid waste management projects with a wide range of financial products and services, including conventional loans, results-oriented financing, development policy financing and technical advice.⁷⁹ Similarly, the Federal Ministry for Economic Cooperation and Development (BMZ) in Germany recently founded the PREVENT alliance together with Ghana, Indonesia and over 30 businesses, research and political organisations.

⁷⁷ European Commission (2018)

⁷⁸ Interview with Peter Börkey, OECD, 11 July, 2018

⁷⁹ European Parliament, Press Release 27.03.2019, last accessed July 5th, 2019

⁸⁰ The World Bank (2018)

⁸¹ OECD (2018)

The alliance aims to promote waste prevention, recycling and proper disposal in developing and emerging countries and thus promote knowledge and technology transfer in these areas.⁸²

At the end of May 2018, the EU Commission adopted a package of measures for the implementation of a closed-loop economy for plastics.

Also at the end of May of 2018, the OECD held a global forum on the design of plastic products with the aim of promoting a closed-loop economy. The main focus was on discussing possibilities for sustainable product design from a chemicals perspective.⁸³

The United Nations Environment Programme (UN Environment) promotes the implementation of sustainable development under environmental

aspects within the United Nations system. UN Environment disseminates information through studies and is inspired by the sharing of innovative best practices. It also runs its own campaigns, such as the global CleanSeas campaign of 2017, which has taken up the fight against micro-plastics in cosmetics and the excessive use of disposable plastic products.

While the implementation of this EU package of measures will be the responsibility of the national governments of the EU member states in the coming years, the British government, together with the NGO WRAP and under the auspices of the Ellen MacArthur Foundation, has already launched the UK Plastics Pact to implement a closed-loop economy for plastics. Companies throughout the value chain of plastic packaging have joined this pact.⁸⁴

Private sector – Alliance to End Plastic Waste

The initiatives currently being taken by industry are largely based on voluntary commitments by consumer goods and retail companies to make plastic packaging re-usable, recyclable or compostable and to increase the proportion of recycled materials in packaging (i.e. New Plastics Economy and UK Plastics Pact).

Even though packaging and disposable products are responsible for a large proportion of plastic waste, plastics are used in many other industries, such as the production of automotive parts, building materials, paints and tyres. To date, very few initiatives have been taken, particularly in the chemical and rubber industries, to find a sustainable solution to this problem. Although associa-

tions of the plastics-producing industry (Plastics Europe) and the waste management industry (in the form of the Federal Association of the German Waste Management, Water and Raw Materials Industry) welcome an increase in recycling rates, they also highlight the current poor quality of products from the waste management sector.

They advocate uniform European standards with regard to the qualities of products and materials yet to be recycled and once they have been recycled. To this end, they are in dialogue with political actors. Individual industry clusters, such as the European PVC industry, are also working on standards, but often only for their respective industry sector.⁸⁵

82 Prevent Waste Alliance, last accesses July 5th, 2019

83 World Economic Forum, Ellen MacArthur Foundation, McKinsey & Company (2016)

84 World Economic Forum, Ellen MacArthur Foundation, McKinsey & Company (2016)

85 Vinyl Plus (2018)



Others such as the Alliance to End Plastic Waste, made up of over 30 companies all over the world at all stages of the plastic supply chain have com-

mitted \$1.5 billion in the next five years, with the overarching goal of ending plastic waste in the environment.⁸⁶

Science – 100 Plastic Rivers Project

Through research projects and scientific publications, the scientific community can assist other stakeholders from business, politics and civil society to make evidence-based decisions on which initiatives can achieve the greatest environmental impact in terms of reducing plastic waste.

A major focus is currently on research into the ways in which macro-plastics (including plastic bags, plastic packaging etc.) are released into the natural environment. This is also due to the high presence of such plastic waste in the oceans. Not in all areas are the entry and exit routes of plastic waste uniformly recorded and evaluated. So far, little is known about how much plastic is released into the environment through the daily use and wear of plastic products and what effects these plastics emissions have. However, the University of Birmingham, for example, has recently launched the “100 Plastic Rivers Project” that was presented in April 2019. A key aspect of the project is the development of a standardized method for the sampling and analysis of microplastics in order to assess the plastic pollution of river networks. Thus, the University has come up with a toolkit, including detailed instructions and has teamed-up with the Clean Seas Odyssey citizen science project for a first pilot study to test parts of the methodology.⁸⁷

Additionally, the Institute Fraunhofer UMSICHT has conducted a joint study⁸⁸ to obtain an initial quantitative overview of microplastics emissions during the use phase of products. Research groups on plastics in the environment were established in 2017/18 as part of the Bundesministerium für Bildung und Forschung (BMBF) programme Research for Sustainable Development (FONA). These research groups are active in the areas of green economy, consumption, limnic systems⁸⁹, recycling as well as seas and oceans⁹⁰.

Cooperation between civil society organisations and research

Among other researchers, Ocean Conservancy has worked with Jenna Jambeck from the College of Engineering at the University of Georgia to quantify for the first time the amount of plastic waste that is released each year from land into waterways. The Oak Foundation, on the other hand, works with the CSIRO Institute in Australia to determine, in an evidence-based way, the impact of its activities. Founded in 2013 in the Netherlands, The Ocean Cleanup works with more than 70 engineers, scientists, researchers and programmers to develop new technological solutions to remove plastics from the oceans.

86 Prevent Waste Alliance, last accessed July 5th, 2019

87 Science Daily (2019)

88 Fraunhofer UMSICHT (2018)

89 Limnic ecosystems are ecosystems dominated by fresh water.

90 Wissenschaft im Dialog, Bürger schaffen Wissen, last accessed 9 November, 2018

5. WHAT NEEDS TO HAPPEN NOW

Over the past 10 years, civil society organisations have made every effort to raise awareness of the challenges posed by plastics (waste) among the general public, the business community and the political sphere. Thanks to the large number of initiatives, the problem has become a central issue in society. The issue of plastic waste in the natural environment is named by the population in the same breath as particulates, nuclear waste or greenhouse gases.⁹¹ The European Commission is proposing EU-wide rules to ban or reduce the use of certain disposable plastic products and fishing equipment.⁹² More and more large companies are committing themselves to recycling one hundred percent of their plastic packaging by 2025, or to using biodegradable plastics instead.⁹³

There are many indications that a critical mass has almost been reached in order to develop the plastics industry into a recycling economy in the medium term. In the coming years, the focus should be on building on existing knowledge about the main sources of plastic emissions and the main types of plastics that end up in the environment and developing concrete, interlocking solutions along the plastics cycle.

To that end, here are a number of aspects that warrant special attention:

1.

Previous policy measures do not go far enough – there are no policy measures that combine the reduction of plastics emissions with the idea of a recycling economy.

Current policy measures focus either on the reduction of plastics emissions, and on macro-plastics emissions in particular, among other things by banning certain disposable plastic products, or they try to steer plastic flows from energy recov-

ery to recycling, for example by the proposal of a levy on plastic waste made by the EU Commission.⁹⁴ The aim, however, should be to develop measures that reduce plastic emissions and at the same time contribute to the creation of a closed-loop economy.

⁹¹ Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB) (2017)

⁹² European Commission (2018b)

⁹³ Interview with Jon Ely, Ellen MacArthur Foundation, 18 July, 2018

⁹⁴ Zacharakis (2018)

2.

There are vast gaps in our knowledge of the main pathways through which (micro-)plastics are released and the possible effects of additives contained in plastics on animal and human welfare.

Previous studies on emission routes and main sources of plastic waste are based on rough projections. There is therefore still uncertainty as to which sources are mostly responsible for the emission of macro- but especially of micro-plastics into the environment.⁹⁵ Due to a lack of standardised methods of sampling, measurement and analysis, the comparability of the collected data is poor. In addition, current sampling and analysis methods can only detect micro-plastics particles up to a size of about 50 microns. Plastic particles smaller than 50 microns (often called submicro-plastics or nano-plastics) cannot yet be adequately studied due to a lack of analytical methods, although they are potentially harmful to health due to their properties.⁹⁶

The impact of many plastics emissions on human health has not yet been properly researched.⁹⁷ Although initial studies have shown that certain plastic components and additives such as bisphenol A, phthalates and flame retardants have detrimental effects on the human hormonal system⁹⁸, it is far from clear whether micro- and nano-particles that have been ingested, absorbed through the skin or the respiratory system, actually affect the human organism.⁹⁹

Although there is no doubt that measures and solutions must be implemented as soon as possible to prevent the continued release of large quantities of plastic waste into the environment, the current availability of data and poor comparability of data make it difficult to clearly identify and prioritise the main sources of plastics pollution.

3.

Too little attention is paid to reducing and avoiding micro-plastics emissions during use.

While campaigns such as Beat the Microbead have already resulted in greater awareness and the first bans on type A primary micro-plastics¹⁰⁰,

little attention is being paid to the challenges posed by type B primary micro-plastics during use, such as tire abrasion or machine washing of clothing

⁹⁵ Lassen et al. (2015)

⁹⁶ Interview with Daniel Stapel, Jülich Institut, 3 July, 2018

⁹⁷ Galloway (2015)

⁹⁸ Koushal, Sharma, Sharma, Sharma, & Sharma (2014)

⁹⁹ Interview with Jürgen Bertling, Fraunhofer UMSICHT, 9 July, 2018

¹⁰⁰ The latest studies suggest a further subdivision of primary micro-plastic emissions into types A and B. Type A primary micro-plastic emissions arise during production (e.g. abrasive particles in cosmetics or plastic pellets). Type B is caused during the use phase, e.g. by tyre abrasion or by washing clothing made of synthetic materials. Secondary micro-plastic emissions come from weathered and fragmented macro-plastic waste in the natural environment. (Bertling, Bertling, & Hamann, 2018)

made of synthetic fibres. Scientists consider this to be problematic because recent studies suggest that this type accounts for the greater proportion of micro-plastics in the environment.

Previous legal regulations for banning on disposable products, improving recyclability and increasing recycling rates remain ineffective here, as they only focus on the end-of-life phase of the products.

4.

A lack of focus on the longevity of certain plastics products results in emissions of micro-plastics.

Micro-plastics emissions caused by abrasion or weathering during use of a product can be counteracted by improving the longevity of the product. At present, however, this correlation receives little attention and there is a lack of innovative approaches to extending the service life of

products such as car tyres, clothing made of synthetic fibres or shoe soles. In such applications, the trade-offs resulting from improved abrasion or weather resistance need to be taken into account. Overcoming them requires technical innovation..

5.

Lack of uniform quality standards for plastics stand in the way of higher recycling rates.

End producers can only use recyclates (plastic processed from mechanical recycling) in their finished products if these are of a certain quality and the original components and the composition of the recyclates are known. There is currently a wide range of different and inconsistent standards, certifications and testing regulations in Europe that make the use of recycled materials considerably more difficult for end producers.¹⁰¹

Moreover, the number of composite materials used for plastic packaging has gone up in recent years. Due to their complex material composition, it is becoming increasingly difficult for existing recycling technologies to separate them. This complicates the transition to a closed-loop economy even further.¹⁰²

¹⁰¹ Interview with Michael Hillenbrand, PlasticsEurope Germany, 2 July, 2018

¹⁰² Interview with Daniel Stapel, Jülich Institut, 3 July, 2018

6.

Lack of or wrong economic incentives for inhibit a thriving market for recycled plastics.

Collecting plastic waste has so far been too expensive, making it economically unattractive to substitute primary materials with recycled plastic materials. The Canadian social start-up Plastic Bank is working on a remedy. It buys plastic waste from rubbish collectors in developing regions and sells it as 'social plastic' at a reasonable price to interested companies in the plastics and consumer goods industries. In this way, Plastic Bank seeks

to combat poverty and environmental problems at the same time.

Governments would have even greater leverage if they were to improve the market opportunities for secondary plastics through regulatory measures such as taxes and levies. A 'plastic tax' is being discussed in the EU. However, this would only be effective if it were levied exclusively on primary material.

7.

The plastics producing industry is not integrated well enough into international civil society efforts.

The cross-sectoral initiatives under consideration here have so far primarily involved companies from the consumer goods industry. It is striking that hardly any companies from the plastics processing industry are involved in such initiatives. If the recycling rates for plastics are to be increased in the medium term, the active involvement of

plastics processors would appear to be extremely important: A binding definition of uniform quality standards for plastics and recyclates that allow a significant increase in recycling rates has to be backed and actively endorsed by the plastics processing industries.

8.

The narrative is too one-sided.

Focussing too much on the amount of micro-plastic released into the oceans may result in the development of solutions for micro-plastic capture focusing too heavily on necessary measures in wastewater treatment plants or urban water management. However, tyre manufacturers and users who could contribute to a reduction of

micro-plastic emissions as a first step will not be held accountable.

A clear distinction between emission avoidance or reduction and retention/recovery as well as a holistic view of these different levels would, on the other hand, highlight all actors.

9.

A growing number of civil society actors taking part in the struggle against plastics in the environment raises the complexity of the situation and complicates coordination further.

It is to be welcomed that a growing number of civil society actors are devoting themselves to the topic of plastics in the environment. It confirms the hypothesis made at the outset that the time is right for a sustainable reshaping of the material cycle for plastics. At the same time, a

growing number of actors requires increased coordination among themselves in order to avoid the duplication of new, isolated initiatives with existing ones. Any effective use of additional resources in the field should consider incorporating or building on existing initiatives.

10.

In light of the forecast rise in the production of plastics and micro-plastics emissions, recycling cannot be the solution of all problems.

Recent projections suggest that the current plastics production output of 311 million tons will double over the next 20 years, partly due to developing and emerging countries catching up in their consumption. Not only laypersons will find it difficult to imagine how, with a current global recycling rate of around 14 per cent, it will be possible in 20 years to recycle not only a large part of the current production volume, but also

that of the future.¹⁰³ In addition, micro-plastics resulting from abrasion or weathering cannot be recycled. A functioning closed-loop economy cannot therefore be achieved solely by means of recyclable products and high-performance recycling systems. It is necessary to reduce the quantity of plastics produced, especially products that are proven to be the main sources of plastics in the natural environment.

11.

International solutions must take into account the economic and socio-cultural conditions of the particular country and enable cooperation on an equal footing in order to achieve a high level of acceptance.

The latest studies link the long-term and sustainable change of waste management systems with 'glocal' solutions. Only through cooperation between global and local initiatives can a systemic change in waste management be achieved in regions such as Southeast Asia and North Africa.¹⁰⁴ However, in order to understand the circumstances and conditions for a successful transfor-

mation, it takes more than a one-sided view of the problem. Rather, it is necessary to consider the interplay of international transdisciplinary research, development cooperation, the political arena, business and civil society. Previous measures in development policy have shown that good governance and capacity building are restricted if these changes do not occur intrinsically

6. ABOUT THE AUTHORS



The Röchling Foundation is dedicated to the issue of plastics and the environment. They support research projects and civil society initiatives that contribute to the responsible use of plastics as part of a sustainable circular economy. The Röchling Foundation does not see itself purely as a funding partner, but is above all interested in establishing new cross-sectoral cooperations and networks.

As was the case for this issue handbook, the foundation also initiates its own activities that contribute to a holistic understanding of and integrated solutions to the global challenge of plastics and the environment.

The Röchling Foundation was established by the Röchling family in 1990. The family also owns the Röchling Group, one of the leading international suppliers of advanced plastics for the automotive industry, industrial applications and medical technology.

www.roechling-stiftung.de

info@roechling-stiftung.de



Wider Sense provides customised consulting – from research to strategy to implementation – to help companies and foundations manage social change effectively. As of May 2015, Wider Sense is also a certified B-Corporation. In recent years, Wider Sense has generated expertise in CSR, philanthropy and social investment and established a global network of strategic partners. With its international reach and multidisciplinary team, Wider Sense has worked with more than 100 clients on projects in over 30 countries that have directly impacted more than 100 million euros in social change funds.

www.widersense.org

info@widersense.org

7. FURTHER REFERENCES

BASICS

The basic literature available on the subject of plastics and the environment is not only becoming more and more important, but is also growing in volume. This is not least due to an increasingly specialised approach to the topic from the various areas of activity and specialisations. The following publications are intended to give an initial overview of the subject matter.

Plastics in the environment – sources, reduction and potential solutions

This report, produced as part of the Bundesministerium für Bildung und Forschung (BMBF) FONA research programme for sustainable development, provides a clear insight into the range of currently funded approaches to research into plastics in the value chain, the freshwater cycle and the sea. Furthermore, the report points out possible fields of action and intervention for Germany.

**Bundesministerium für Bildung und Forschung (BMBF) –
Research for Sustainable Development (FONA)**

<https://bmbf-plastik.de/publikation/tagungsband-bmbf-forschungsschwerpunkt-plastik-der-umwelt-quellen-senken>

Plastics in the environment: micro- and macro-plastics

The authors of the study Plastics in the Environment managed to compile the current state of knowledge in a structured way and to make recommendations for action based on it. In addition to the systematic definition and delineation of the terms micro- and macro-plastics, which gives information on the scope of application, the chronological classification of the topic provides a good overview of the ever-increasing relevance of the issue. A detailed glossary also provides a good overview of the terms used in the field of plastics. Following the analysis of the sources, quantities, distribution and recovery of micro- and macro-plastics, the study deals with the resulting environmental impacts, evaluations, regulations and control measures. This is the focus and the strength of the study. In 23 concise conclusions, environmental and socio-political aspects are discussed and recommendations for action made.

Fraunhofer UMSICHT

<https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/publikationen/2018/kunststoffe-id-umwelt-konsortialstudie-mikroplastik.pdf>

CLOSED-LOOP ECONOMY

One of the most important strategies in dealing with waste and plastics in particular is closed-loop recycling. The model breaks with the traditional practice – producing, consuming, disposing – and integrates the recycling of waste as part of the entire life cycle of a product. Measuring the impact of recycling is still largely in its infancy. The first studies deal with the macroeconomic effects and the economic advantages and disadvantages of the circular economy.

direction and a common sense of responsibility to initiate this new wave of innovation and thus transform the value chain of plastics. The collective impact approach has been widely used, civil society initiatives as well as companies are increasingly adopting this understanding and are thereby working towards a systemic rethink.

Ellen MacArthur Foundation

<https://www.ellenmacarthurfoundation.org/publications>

The New Plastics Economy: Rethinking the Future of Plastics & Catalysing Action

The New Plastics Economy of the Ellen MacArthur Foundation is standard reading on the subject of recycling management. At its core is the vision of a global economy in which plastics do not become waste in the first place. The report provides a detailed concept of how this systemic shift can be achieved. An essential aspect here is a holistic,

collaborative and collective approach. It requires a common

Models for Analyzing the Dependencies between Indicators for a Circular Economy in the European Union

In this paper, Adrian Tantau's team analyses the indicators for the further development and implementation of a circular economy in the European Union in the years 2010-2014. The authors examine the effects of various factors such as resource productivity and domestic materials consumption, the recycling rate of materials, cross-sectoral expenditure on research, trade in recyclates and environmental tax revenues on the municipal circular economy. Using their statistical model, the authors show that resource productivity and domestic materials consumption in particular have a positive impact on

municipal environmental services. It is precisely its methodological approach that enables the study to provide an initial insight into the European circular economy landscape.

Adrian Dumitru Tantau, Maria Alexandra Maassen and Laurentiu Fratila

http://www.mdpi.com/2071-1050/10/7/2141?type=check_update&version=1

Are Exports of Recyclables from Developed to Developing Countries Waste Pollution Transfer or part of the Global Circular Economy?

This paper by Zhe Liu, Michelle Adams and Tony R. Walker deals with the question of a globally fair trade concept for waste in the context of circular economies and waste management. According to the paper, China in particular has been benefiting for years from imports of recyclable waste from industrialised countries for its domestic manufacturing industry. The authors argue that an effective and sustainable circular economy can only go hand in hand with a reduction in consumption by individual consumers. This requires government zero waste policies. Moreover, there is a need for a cross-border and coherent environmental strategy that focuses on global knowledge transfer. Finally, the authors state that, from a global perspective, greater accountability on the part of manufacturers is necessary in order to effectively manage a worldwide circular economy.

Zhe Liu, Michelle Adams and Tony R. Walker

<https://www.sciencedirect.com/science/article/pii/S0921344918301368>

The Place of Waste: Changing Business Value for the Circular Economy

The paper by Robert Perey and his team looks at how companies can derive business benefit from implementing a closed-loop economy. They show that there is no conflict of interest between resource-conserving actions by companies and economic profitability. The study identifies successful examples of business models in this area and analyses their strategic approach. The analysis shows that a systemic change in their concept of resources – and the associated value chain of their products and services – has significant positive effects on companies' business models. Moreover, this disruptive shift also has an impact on business partners and their actions. The article provides examples for the practical implementation of a circular economy and the systemic approach within companies.

Robert Perey, Suzanne Benn, Renu Agarwal and Melissa Edwards

<https://onlinelibrary.wiley.com/doi/pdf/10.1002/bse.2068>

The Macroeconomics of the Circular Economy Transition

The study examines the existing literature on the macroeconomic consequences of a change towards a circular economy. Existing models for improving resource efficiency are presented and compared. The research shows that the transition to a closed-loop economy can have a significant positive macroeconomic impact. Furthermore, the analysis presents the effects of policies aimed at supporting a closed-loop economy on different economic sectors. It becomes clear that the macroeconomic effects of introducing a closed-loop economy can vary. The study, commissioned by the OECD, covers a wide range of macroeconomic analyses of circular economies while at the same time offering considerations for further analysis of macroeconomic effects of the circular economy.

Andrew McCarthy, Rob Dellink and Ruben Bibas

<https://www.oecd-ilibrary.org/docserver/af983f9a-en.pdf?expires=1536160586&id=id&accname=guest&checksum=2677D87D3519CDB58C7D03FB490BC6F1>

MICRO-PLASTICS

Micro-plastics have a special significance in the plastics debate. Recent research and civil society organisations have been dealing significantly with the occurrence, extraction, avoidance, disposal and recyclability of micro-plastics. The results are still largely pending. Micro-plastics is at the heart of the BMBF's FONA programme. The available studies mostly offer subject-specific insights from biology and chemistry. Civil society organisations, on the other hand, try to promote the labelling and traceability of micro-plastics in consumer goods and provide information in this field.

Micro-plastics: developing a concept of environmental evaluation – initial considerations on the relevance of synthetic polymers in the natural environment

The publication by the Federal Environment Agency offers a comprehensive compilation of literature on the incidence and effects of micro-plastics in aquatic environments. Furthermore, the study critically discusses current analytical methods of sampling, sample preparation and analysis. This results in a first proposal for

evaluation scores for micro-plastics in surface waters and runoff from municipal wastewater treatment plants in Germany. An guideline for the interpretation and classification of findings of micro-plastics in the environment discusses a possible integration of the topic into existing systems of legislation and submits proposals for reduction measures.

German Federal Environment Agency

<https://www.umweltbundesamt.de/publikationen/mikroplastik-entwicklung-eines>

Instrumental Analysis of Microplastics Benefits and Challenges

The study by Sven Huppertsberg and Thomas Knepper discusses the predominant analytical methods in the investigation of microplastics and clearly shows their benefits and limitations. This article thus offers a deeper insight into the academic debate on the adequate observation and study of the field and is of interest to anyone wishing to take a look behind the scenes of micro-plastics research.

Sven Huppertsberg and Thomas P. Knepper

<https://link.springer.com/article/10.1007%2Fs00216-018-1210-8>

CLIMATE CHANGE

The exact contribution of plastics waste to the greenhouse effect is virtually unknown. Recent research has not just focused on the carbon footprint of plastic waste during production, but also during its disposal. Projects and ideas for the prevention and regulation of CO₂ emissions from plastics are primarily seen and discussed at the level of political regulations. In addition to the Fraunhofer study presented in the section Fundamentals, the following paper provides an insight into the topic.

Production of Methane and Ethylene from Plastic in the Environment

US researchers at the University of Hawaii have demonstrated that ethylene and methane are released when plastic that was previously in salt water is exposed to UV radiation. Methane, in particular, is a powerful greenhouse gas that is also released from landfills or natural gas production. In addition, the researchers found that the longer the UV exposure, the higher the emissions. This means that during the life cycle of plastics not only the emissions resulting from production and

thermal disposal have to be considered, but also those resulting from degradation in the oceans. The effect of plastic waste on climate change is clearly illustrated by this study.

Sarah-Jeanne Royer, Sara Ferrón, Samuel T. Wilson and David M. Karl

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0200574>

BIO-DEGRADATION

The research and discussion of bio-degradable plastics has been pursued with great intensity for many years. Biodegradable plastics are mainly found in consumer-level products, for example in the form of rubbish bags or cosmetic products.

Polyethylene bio-degradation by caterpillars of the wax moth *Galleria mellonella*

Polyethylene and polypropylene account for 92 per cent of global plastics production and are virtually non-biodegradable. Federica Bertocchini and her team discovered by chance that the larvae of the wax moth, the worm *Galleria mellonella*, are able to break down polyethylene. This discovery is part of an entire research series that focuses on the degradation of plastics by natural means. Three years ago, a group of Chinese and American researchers discovered that a butterfly was also capable of breaking down polyethylene. In 2017, a Japanese group of researchers discovered two bacteria that can biodegrade plastic. Even though the idea of using the caterpillars directly and in large quantities for disposing of plastic is not an option for Federica Bertocchini in order to maintain the natural equilibrium, further research will aim to find out how the biochemical decomposition process works and what implications this may have for disposing of plastic

Paolo Bombelli, Christopher J. Howe and Federica Bertocchini.

<https://www.ncbi.nlm.nih.gov/pubmed/28441558>

Can conventional plastics be degraded by microbes?

This article discusses the limits of bio-degradability of plastics from a biochemical, physiological and ecological point of view, considering previous research in this field. In doing so, studies already submitted by the author, but also research such as the aforementioned study by Federica Bertocchini and her

team are taken into account. This approach provides a sound overview of the current debate on the biological recoverability of plastics.

Dietmar Schlosser

<https://link.springer.com/article/10.1007/s12268-018-0932-7>

START-UPS IN THE SUSTAINABILITY SECTOR

Over the past few years, numerous start-ups have been founded worldwide, whose products and services contribute to solving the global plastic waste problem. These are both commercial and non-profit companies. New companies emerge every day – while some also have to give up – making it difficult to keep track of the sector.

A selection of start-ups active in the area of the avoidance and recycling of plastics waste

Landpack –eco-friendly insulating food packaging, www.landpack.de

Refurbed – online platform for reconditioned mobiles, tablets and laptops, www.refurbed.de

BioCellection – fundamentally innovative chemical processes for recycling plastics, www.biocellection.com

PlasticRoad – roads and bike trails made from recycled plastic, www.plasticroad.eu

TechCrunch is one of the largest and most prominent international online portals for technology and Internet start-ups (www.techcrunch.com). News on the latest trends and exciting business launches can be found here – also from the so-called green tech sector.

Global Goals Lab is an example of a platform specifically targeted at social businesses (www.globalgoalslab.eu/). Social enterprises and initiatives can qualify and network here if their products and services contribute to achieving the UN's 17 sustainability goals. The Global Goals Lab is a joint initiative of Deutsche Bank and Social Impact.



8. LINKS FOR THE ORGANISATIONS MENTIONED

Organisation	Acronym	Link
#breakfreefromplastic		https://www.breakfreefromplastic.org/
Adessium Foundation		https://www.adessium.org/
Algalita		http://www.algalita.org/video/plastic-pollution-a-serious-threat-to-the-environment-april-2013/
Associated Labels and Packaging		http://associated-labels.com/
Beat the Microbead		http://www.beatthemicrobead.org/
Bundesverband der Deutschen Entsorgungs-, Wasser- und Rohstoffwirtschaft	BDE	https://www.bde.de/
Circulate Capital		https://www.circulatecapital.com/
Collective Impact		https://www.fsg.org/publications/collective-impact
College of Engineering University of Georgia		https://jambeck.engr.uga.edu/
Commonwealth Science and Industrial Research Organization	CSIRO	https://www.csiro.au/
Cradle 2 Cradle Designkonzept		https://www.epea.com/de/cradle-2-cradle/
Elk Packaging		http://www.elkpackaging.com/
Ellen MacArthur Foundation		https://www.ellenmacarthurfoundation.org/
EU Strategy For Plastics in a Circular Economy		https://ec.europa.eu/commission/publications/documents-strategy-plastics-circular-economy_en
European Commission		http://ec.europa.eu/environment/waste/plastic_waste.htm
Evoware		http://www.evoware.id/
Fraunhofer LBF		https://www.lbf.fraunhofer.de/de/forschungsbereiche/kunststoffe.html
Fraunhofer UMSICHT		https://www.umsicht.fraunhofer.de/de/forschung-fuer-den-markt/kunststoffe-in-der-umwelt.html https://www.umsicht.fraunhofer.de/de/forschung-fuer-den-markt/mikroplastik.html
Full Cycle Bioplastics		http://fullcyclebioplastics.com/
Gaia Foundation		https://www.gaiafoundation.org/
Global Environment Facility	GEF	https://www.thegef.org/
Global Ghost Gear Initiative		https://www.ghostgear.org/
Greenpeace		https://www.greenpeace.org/international/act/lets-end-the-age-of-plastic/
JPI Oceans		http://www.jpi-oceans.eu/
MAVA Foundation		http://mava-foundation.org/
National Socio-Environmental Synthesis Center	SESYNC	https://www.sesync.org/
Nestlé		https://www.nestle.com/csv/what-is-csv/public-policy-advocacy/plastic-pollution
Norton Point		https://www.nortonpoint.com/
Oak Foundation		http://www.oakfnd.org/
Ocean Care		https://www.oceancare.org/de/startseite/
Ocean Conservancy		https://oceanconservancy.org/
Ocean Recovery Alliance		https://www.oceanrecov.org/
Oceans 5		https://oceans5.org/

Organisation	Acronym	Link
OECD		http://www.oecd.org/env/waste/global-forum-on-environment-plastics-in-a-circular-economy.htm
One Earth – One Ocean		https://oneearth-oneocean.com/
P&G		https://www.pg.co.uk/sustainability/environmental_sustainability/focused_on/packaging
Pepsico		http://www.pepsico.com/live/pressrelease/pepsico-to-more-than-triple-recycled-content-in-its-plastic-bottles-to-50-p-in-the-european-union-by-2030?sf196839220=1
Planet or Plastic - National Geographic		https://www.nationalgeographic.com/environment/planetorplastic/
Plastic Bag Free Day		https://www.plasticbagfreeday.org/
Plastic Bank		www.plasticbank.org
Plastic Soup Foundation		https://www.plasticsoupfoundation.org/
Plastics Solution Fund		http://plasticsolution.org/
PlasticsEurope Deutschland e. V.		https://www.plasticseurope.org/de
Plastik in der Umwelt - FONA		https://www.fona.de/de/plastik-in-der-umwelt-20982.html
Rethink Plastic Alliance		http://www.rethinkplasticalliance.eu/
Schmidt Family Foundation		http://tsffoundation.org/
sea2see		https://www.sea2see.org/
Stiftung Veolia		https://www.stiftung.veolia.de/projekte
Terracycle		https://www.terracycle.de/de-DE/
The Coca-Cola Company		https://www.coca-colacompany.com/stories/world-without-waste
The International Solid Waste Association	ISWA	https://www.iswa.org/
The New Plastics Economy	NPEC	https://newplasticseconomy.org/
The Ocean Cleanup		https://www.theoceancleanup.com/
The Plastics Pact	WRAP	http://www.wrap.org.uk/content/the-uk-plastics-pact
The World Bank		http://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management
Trash Free Seas Alliance		https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/trash-free-seas-alliance/
United Nations Environment Programme	UNEP	https://www.unenvironment.org/
UpcyclePET		https://www.lbf.fraunhofer.de/de/presse/presseinformationen/upcycling-von-pet-flaschen-wertstoffkreislauf.html
Veolia		https://www.veolia.de/positionspapiere
Vinyl Plus		https://www.vinylplus.eu/
Walmart		https://corporate.walmart.com/2016grr/enhancing-sustainability/moving-toward-a-zero-waste-future
World Business Council for Sustainable development		https://www.wbcsd.org/
World Economic Forum		https://www.weforum.org/reports/the-new-plastics-economy-rethinking-the-future-of-plastics/articles/
World Plastics Council		https://www.worldplasticscouncil.org/
Wuppertal Institut		https://wupperinst.org/das-institut/
WWF		http://wwf.panda.org/get_involved/banners/beat_plastic_wpollution_unenvironment.cfm
Zero Waste Europe		https://zerowasteurope.eu/

9. LIST OF SOURCES

- Abele, K., & Bethke, L. (2018). *Kommission legt europäische Plastikstrategie vor*. Abgerufen am 31. August 2018 von Europäische Kommission - Vertretung in Deutschland: https://ec.europa.eu/germany/news/20180116-plastikstrategie_de
- Beier, W. (2009). *Biologisch abbaubare Kunststoffe*. Umweltbundesamt.
- Bertling, J., Bertling, R., & Hamann, L. (2018). *Kunststoffe in der Umwelt: Mikro- und Makroplastik. Ursachen, Mengen, Umweltschicksale, Wirkungen, Lösungsansätze, Empfehlungen*. Fraunhofer Umsicht.
- BUND e. V. (2018). *Mikroplastik - kleine Gifttransporter aus dem Abflussrohr*. Abgerufen am 31. August 2018 von BUND - Friends of the Earth Germany: <https://www.bund.net/meere/mikroplastik/hintergrund/>
- Bundesinstitut für Berufsbildung (BIBB). (2018). *Bundesinstitut für Berufsbildung*. Abgerufen am 9. November von Bundesinstitut für Berufsbildung: www.bibb.de
- Bundesministerium für Bildung und Forschung (BMBF). (2016). *Nachhaltigkeit an Hochschulen (HOCHN) entwickeln - vernetzen - berichten*. Abgerufen am 10. Oktober 2018 von fona: <https://www.fona.de/de/nachhaltigkeit-an-hochschulen-hoch-n-entwickeln-vernetzen-berichten-21824.html>
- Bundesministerium für Bildung und Forschung (BMBF). (2018). *Hintergrund*. Abgerufen am 9. November 2018 von Plastik in der Umwelt: <https://bmbf-plastik.de/index.php/hintergrund>
- Bundesministerium für Bildung und Forschung (BMBF). (2018). *Plastikpiraten*. Abgerufen am 14. November 2018 von Plastik in der Umwelt: <http://www.bmbf-plastik.de/index.php/plastikpiraten>
- Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB). (2017). *Umweltbewusstsein in Deutschland 2016 - Ergebnisse einer repräsentativen Bevölkerungsumfrage*.
- Bundesverband Sekundärrohstoffe und Entsorgung e.V. (BVSE). (2018). *Statusbericht der Deutschen Kreislaufwirtschaft. Einblicke und Aussichten*.
- Conversio Market & Strategy GmbH. (2018). *Stoffstrombild Kunststoffe in Deutschland 2017*. Bundesverband Sekundärrohstoffe und Entsorgung e.V.
- Cradle to Cradle Products Innovation Institute. (2018). *About the Institute*. Abgerufen am 31. August 2018 von Cradle to Cradle Products Innovation Institute: <https://www.c2ccertified.org/about>
- Circulate Capital. (2018). *Circulate Capital*. Abgerufen am 16. November 2018 von Circulate Capital: <https://www.circulatecapital.com>
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2018). *Partnerschaften für die Recyclingwirtschaft*. Abgerufen am 1. August 2018 von GIZ: <https://www.giz.de/de/weltweit/15913.html>
- Deutscher Naturschutzring. (2018). *Rohstoffpolitik 2.0 - Primär und Sekundärrohstoffe*. Abgerufen am 3. September 2018 von DNR - Deutscher Naturschutzring: <https://www.dnr.de/rohstoffpolitik-20/glossar/grundbegriffe/primaer-und-sekundaerrohstoffe/>
- Ecoplast. (2018). *Econews - Was sind Rezyklate?* Abgerufen am 1. August 2018 von Ecoplast: <https://www.ecoplast.com/index.php/question/was-sind-rezyklate/>
- Ellen MacArthur Foundation. (2016). *The New Plastic Economy - Rethinking the Future*.
- Ellen MacArthur Foundation. (2018a). *Circular Economy Overview*. Abgerufen am 31. August 2018 von Ellen MacArthur Foundation: <https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept>
- Ellen MacArthur Foundation. (2018b). *Building Blocks of a Circular Economy*. Abgerufen am 31. August 2018 von Ellen MacArthur Foundation: <https://www.ellenmacarthurfoundation.org/circular-economy/building-blocks>
- Ellen MacArthur Foundation. (2018c). *Eleven Companies take major step towards a New Plastic Economy*. Abgerufen am 9. November 2018 von Ellen MacArthur Foundation: <https://www.ellenmacarthurfoundation.org/news/11-companies-take-major-step-towards-a-new-plastics-economy>
- Europäische Kommission. (2013). *Grünbuch zu einer europäischen Strategie für Kunststoffabfälle in der Umwelt*.
- Europäische Kommission. (2018). *A European Strategy for Plastics in a Circular Economy*.
- Europäische Kommission. (2018a). *Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and The Committee of the Regions*. Brussels.
- Europäische Kommission. (2018b). *Single-use plastics: New EU rules to reduce marine litter*. Abgerufen am 9. November 2018 von European Commission Press Release Database: http://europa.eu/rapid/press-release_MEMO-18-3909_en.html
- Europäische Union. (2008). *RICHTLINIE 2008/98/EG des Europäischen Parlaments und des Rates vom 19. November 2008 über Abfälle und zur Aufhebung bestimmter Richtlinien*.
- European Bioplastics. (2018). *Bioplastics Glossary*. Abgerufen am 8. November 2018 von European Bioplastics: <https://www.european-bioplastics.org/glossary/>
- Evoware. (2018). *Evoware*. Abgerufen am 31. August 2018 von Evoware <http://www.evoware.id/>
- FONA. (2016). *Forschung für Nachhaltige Entwicklung - FONA*. Bundesministerium für Bildung und Forschung.
- Fraunhofer Umsicht. (2018). *Kunststoffe in der Umwelt: Mikro- und Makroplastik*. Oberhausen.
- Full Cycle Bioplastics. (2018). *A Better Approach to Plastics*. Abgerufen am 8. November 2018 von Full Cycle Bioplastics: <http://fullcyclebioplastics.com/>
- Galloway, T. S. (2015). *Micro- and Nano-plastics and Human Health*. In M. Bergmann, L. Gutow, & M. Klages, *Marine Anthropogenic Litter* (S. 343-366). Springer International Publishing AG.
- Geyer, R., Jambeck, J. R., & Law, K. L. (2017). *Production, use, and fate of all plastics ever made*. *Science Advances*, 3. American Association for the Advancement of Science.
- Gigault, J., ter Halle, A., Baudrimont, M., Pascal, P., Gauffre, F., Phi, L., El Hadri, H., Grassl, B. & Reynaud, S.. (April 2018). *Current Opinion: What is nanoplastic? Environmental Pollution*, S. 1030-1034. Elsevier.
- Henkes, W. (August 2010). *Kirchturmdenken. Recycling Magazin*, 24-25.
- Institut der deutschen Wirtschaft (IWD). (2018). *Das Plastik-Problem*. Abgerufen am 17. Dezember 2018 von IWD: <https://www.iwd.de/artikel/das-plastik-problem-368426/>
- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., & e. a. (2015). *Plastic waste inputs from land into the ocean*. *Science*, 347 (6223), S. 768-771. American Association for the Advancement of Science.
- Johannes Gutenberg-Universität Mainz. (2017). *Mainzer Chemiker stellen Studie über plastikfressende*
- Raupe in Frage. Abgerufen am 14. November 2018 von Johannes Gutenberg-Universität Mainz: http://www.uni-mainz.de/presse/aktuell/2477_DEU_HTML.php

- Kania, J., & Kramer, M. (2011). *Collective Impact*. Stanford Social Innovation Review.
- Koushal, V., Sharma, R., Sharma, M., Sharma, R., & Sharma, V. (10. Februar 2014). *Plastics: Issues Challenges and Remediation*. *International Journal of Waste Resources*, 4(1).
- Lassen, C., Hansen, S. F., Magnussion, K., Hartmann, N. B., Rehne Jensen, P., Nielsen, T. G., & Brinch, A. (2015). *Microplastics - Occurrence, effects and sources of releases to the environment in Denmark*. Kopenhagen: Technical University of Denmark.
- Lumitos AG. (2018). *Verbundstoff*. Abgerufen am 31. August 2018 von Chemie: <http://www.chemie.de/lexikon/Verbundstoff.html>
- Machado, A. A., Kloas, W., Zarfl, C., Hempel, S., & Rillig, M. C. (April 2018). *Microplastics as an emerging threat to terrestrial ecosystems*. *Global Change Biology*, S. 1405-1416. Wiley Online Library.
- McKinsey & Company & Ocean Conservancy . (2015). *Stemming the Tide: Land-based strategies for a plastic-free ocean*.
- New Plastics Economy. (2018). *Full Cycle Bioplastics*. Abgerufen am 1. August 2018 von New Plastics Economy: <https://newplasticseconomy.org/innovation-prize/winners/full-cycle-bioplastics>
- Norton Point. (2018). *Norton Point*. Abgerufen am 17. Dezember 2018 von Norton Point: <https://www.nortonpoint.com/>
- OECD. (2018). *Global Forum on Environment - Plastics in a Circular Economy: Design of Sustainable Plastics from a Chemicals Perspective*. Abgerufen am 31. August 2018 von OECD: <http://www.oecd.org/env/waste/global-forum-on-environment-plastics-in-a-circular-economy.html>
- Pfaendner, R. (2006). *Additive heute und in Zukunft*. *Kunststoffe*, 64-71.
- PlasticsEurope. (2017). *Plastics - the Facts 2017*. Abgerufen am 17. Dezember 2018 von PlasticsEurope: <https://www.plasticseurope.org/de/resources/publications/395-plastics-facts-2017>
- PlasticsEurope. (2018a). *Wie Kunststoffe hergestellt werden*. Abgerufen am 6. November 2018 von PlasticsEurope: <https://www.plasticseurope.org/de/about-plastics/what-are-plastics/how-plastics-are-made>
- PlasticsEurope. (2018b). *European Plastics Industry Market Data*. Abgerufen am 13. November 2018 von PlasticsEurope: <https://www.plasticseurope.org/en/resources/market-data>
- Rettet den Regenwald e.V. (2018). *Hilfe, wir ersticken im Plastik: Die EU muss handeln*. Abgerufen am 9. November 2018 von Rettet den Regenwald e.V.: <https://www.regenwald.org/petitionen/1124/hilfe-wir-ersticken-im-plastik-die-eu-muss-handeln>
- Schöneberger, F. (2018). *Fraunhofer LBF*. Abgerufen am 10. Oktober 2018 von Upcycling statt Recycling: <https://www.lbf.fraunhofer.de/de/presse/presseinformationen/upcycling-von-pet-flaschen-wertstoffkreislauf.html>
- Sea2see. (2018). *Sea2see*. Abgerufen am 17. Dezember 2018 von Sea2see: <https://www.sea2see.org/>
- Szaky, T. (2014). *Outsmart waste: The modern idea of garbage and how to think our way out of it*. San Francisco: Berret-Koehler.
- The World Bank. (2018). *Solid Waste Management*. Abgerufen am 9. November 2018 von The World Bank: <http://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management>
- Tolinski, M. (2012). *Plastics and Sustainability: Toward a Peaceful Coexistence between Biobased and Fossil Fuel-based Plastics*. Hoboken, New Jersey: John Wiley & Sons.
- Trucost. (Juli 2016). *Plastics and Sustainability: A Valuation of Environmental Benefits, Costs and Opportunities for Continuous Improvement*.
- UN Environment. (2018). *Exploring the potential for adopting alternative materials to reduce marine plastic litter*. United Nations Environment Programme (UNEP).
- UNESCO. (2018). *A UNESCO position paper on the future of Education for Sustainable Development (ESD)*.
- UNESCO Weltaktionsprogramm Bildung für nachhaltige Entwicklung (2018). *BNE Portal*. Abgerufen am 17. Dezember 2018 von BNE Portal: www.bne-portal.de
- Vinyl Plus. (2018). *VinylPlus® Voluntary Commitment*. Abgerufen am 1. August 2018 von Vinyl Plus - Committed to Sustainable Development: <https://vinylplus.eu/programme/voluntary-commitment>
- Wilts, H., & von Gries, N. (2016). *Entwicklung von Instrumenten und Maßnahmen zur Steigerung des Einsatzes von Sekundärrohstoffen – mit Schwerpunkt Sekundärkunststoffe*. Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit.
- Wissenschaft im Dialog gGmbH. (2018). *Bürger schaffen Wissen - Citizen Science Plattform*. Abgerufen am 14. November 2018 von Bürger schaffen Wissen: <https://www.buergerschaffenwissen.de/>
- World Economic Forum, Ellen MacArthur Foundation & McKinsey & Company. (2016). *The New Plastics Economy – Rethinking the future of plastics*.
- Zacharakis, Z. (2018). *Lieber aus der Pappe schlürfen*. *Zeit Online*. Abgerufen am 9. November 2018 von Zeit: <https://www.zeit.de/wirtschaft/2018-05/plastikmuell-eu-kommission-verbot-nachhaltigkeit-kunststoff>
- Ziebarth, N. (2018). *Mikroplastik – kleine Gifttransporter aus dem Abflussrohr*. BUND e.V.

Weitere Interviews wurden mit folgenden Personen geführt:

Adessium Foundation, Martijn Meijer
Programme Manager People & Nature

MAVA Foundation, Holger Schmid
Program Director Sustainable Economy & Switzerland Programme

Jülich Institut, Daniel Stapel
Projekträgerschaft Ressourcen und Nachhaltigkeit

Wuppertal Institute for Climate, Environment, Energy, Dr. Henning Wilts
Head of Research Unit Circular Economy

