

Plastics

in circular economy

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Lately, plastics have become one of the hot topics both in the media and on various experts, scientists, decision makers and business forums. In most cases, the subject is presented very subjectively, both by opponents and supporters of this material. Unfortunately radicalism, populism and zero one treatment of the issue can be seen from all sides.

At INNOWO, we wanted to contribute to this discussion and look at the problem from a broader perspective. At the same time we want to show various shades of gray that are associated with this topic. We should avoid radicalism as hasty actions that seemingly solve one problem, can quickly create much greater threats.

The topic of plastic is a very difficult and complex one. Certainly there is too much plastic being currently used, often in a carefree way. We also lack systemic solutions that could facilitate its recycling. However, is the replacement of plastic with another material the right way out? For example, will replacing all plastic bottles with glass solve the problem? Certainly not, as this may cause further environmental threats, as the complex product life cycle and environmental footprint assessment proves.

In the report we embarked on a difficult mission to showcase both the benefits of using plastic - a virtually irreplaceable material for many sectors and industries, and the risks that are connected with its application. The publication also contains interesting innovative

solutions and good practices that are a step towards making the plastics industry sustainable. Additionally, we have created a mini guide for the consumers whose daily habits and activities are of great importance in reducing plastic pollution in the environment.

Already in the development of this publication, we came across many critics from both sides – the industry and environmentalists, who claimed that our view is overly pessimistic or, on the contrary – full of populism and wishful thinking. This shows how multidimensional and opaque this topic is. And so, with this report, we set on a journey to show this ambiguity.

As INNOWO, we want to use Polish Circular Hotspot initiatives and activities to systematically bring consumers and businesses closer, to cooperate with the aim to achieve a more responsible production and consumption of plastics.

In the meantime, I invite you to read the publication and draw your own conclusions!

dr Agnieszka Sznyk
Director of the Board
INNOWO





Sustainable usage of plastics

- Use reusable, permanent, colourless packaging, created from as few different types of materials as possible.
- Choose cosmetics and cleaning products in containers that can be refilled.
- Use reusable bags.
- Buy take-out coffee using your own reusable mug.
- Drink tap water and use reusable bottles.
- Avoid small portions items packed in mini sachets / small packages.
- Replace short-term products with products that you will want to use for a long time – aesthetic, repairable, modular, high quality.
- Before you throw away any device, check whether it can be repaired.
- Sell, give away or exchange unneeded or rarely used items.
- Do not litter.
- Sort waste according to applicable rules.
- Choose sellers / brands that minimize packaging or allow to buy food in bulk while ensuring a good level of hygiene.
- Avoid promotions that can cause waste.
- Don't be afraid to buy products in plastic packaging if you know they will prevent waste by extending food freshness.
- Try to give up take-away meals, deliveries and self-service kits for preparing meals.
- Use fresh and seasonal food.
- Stop smoking because, in addition to the dramatic health consequences, cigarette filters are one of the most common pollutants on beaches and in the marine environment.
- Buy recycled plastic products.



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REVIEWS



Fundacja PlasticsEurope Polska

www.plasticseurope.org

The circular economy concept is based on saving natural resources to the highest extent possible by minimizing their consumption and facilitating repeated use. From the beginning, plastics were developed to replace natural resources, including such rare ones as tortoiseshell, ivory or animal bones. Nowadays plastic is a part of everyday life, increasing its comfort, convenience and safety. Plastics, present in almost an infinite number of products and applications, help us save energy, reduce CO₂ emissions, decrease water and food consumption. Therefore, there is a reason plastics have been identified as one of five key areas (next to i.a. food and strategic raw materials) that determine the success of the whole circular economy concept. European legislators admit that plastics and products made of them are an indispensable attribute of today's economy and everyday life, but they also point to threats to resources and the environment in general, caused by the massive use of synthetic materials. In this study the authors have focused primarily on this last issue.

However, focusing only on the issues of waste management should not preclude a holistic approach that takes into account the importance for human health and for the product's entire life cycle – from production, through use, to the closure of the loop to reclaim its remaining economic value. When considering alternative solutions (e.g. the use of other materials, other business models or other lifestyles), human health must be an absolute priority, both to ensure food and drink safety (packaging must protect and preserve food), but also in all other areas where plastics are used (transport, medicine, sport, etc.). Analysing the the report's solutions

proposed in the consumer guide one should consider whether eliminating plastics from many areas of our lives is the right approach. Will our health and safety suffer in result? Additionally, considering the importance of plastics in the circular economy model, we should not neglect its role in reducing energy usage and counteracting global warming. By giving in to pressure to avoid plastics, which is often built on emotions and false information, we do not take into account actual reductions in greenhouse gas emissions that we can achieve using appropriate building insulation, saving fuel by transporting goods packed in lighter plastic packaging, or finally using renewable energy, the production of which requires plastic elements, such as windmill rotors. In their research in 2010, sustainability experts at the Austrian company denkstatt GmbH, considered the impact on energy consumption and greenhouse gas emissions of a hypothetical replacement of plastics with alternative materials. It turned out that such a conversion would cause a large increase in energy consumption (by 46%) and greenhouse gas emissions (by 50%). In addition, for about 16% of plastic products and those using plastic parts alternatives to plastic do not exist. Without plastics such products cannot be produced at all (e.g. electronic equipment, some car parts). Reduction of food losses thanks to modern plastic packaging, is also a very important element of fighting climate change. We do not only avoid greenhouse gas emissions occurring typically during biodegradation of discarded food, but also those that follow the production process burdened with big CO₂ emissions.

Although plastics have now become the object of mass criticism, after further considerations, most critics admit that they are not actually talking about a ban on use of plastics in general. They only express their opposition to the environmental pollution with plastic waste due to excessive and unreasonable use of cheap disposable plastic products and no waste management – these are the real problems. Thus, it is not plastic itself that is guilty of the pollution, but we are – users of plastic products littering the environment.

Proven solutions that we already have at our disposal require little effort from each of us: we should use no more than we need, all waste should be discarded to an appropriate container and above all, we should not litter.



Fundacja WWF Polska

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The circular economy is the first economy model to take natural resources into account. The previous linear model treated the environment as an inexhaustible set of resources that one can use freely. Today we know that this approach, in the near future, could lead to a catastrophe, not only environmental, but also an economic one. Our planet cannot renew its resources at a pace dictated by their usage. Europe uses resources comparable to those of two planets. Using them, European Union can provide a high standard life for 500 million people. This is the level of consumption which the developing economies, with billions of inhabitants, aspire to. Circular Economy is the only economic model that aims at ensuring a high quality of life, without having to give up the goods you need, and at the same time taking into account and highlighting the limited amount of natural resources.

According to the circular economy, all resources in economic circulation should be used as long as possible, with simultaneous maximisation of their value to the consumers. This applies to natural resources as well as those processed during manufacturing. There are many examples that corroborate the notion that plastics can replace natural resources. Furthermore, it is often the case that plastics employed in many products that we use on a daily basis are irreplaceable and cannot be substituted with natural resources.

An environmental footprint, measuring the impact of individual products throughout their entire life cycle, is a good indicator for deciding whether swapping plastic products to those made from natural raw materials is rational. It can answer the questions what product is “better” for environment: cotton bags versus reusable plastic bags, clothes only from natural fibers or those made from synthetic ones, etc.

Perception of plastics only as disposable products i.e. those that have significant impact on the environment, is unjustified. On the other hand, plastic pollution has already reached every corner of the earth – as the latest scientific studies show, we find it in the most inaccessible places, in our food, water and in organisms of hundreds of species of wild animals. It is time to take ambitious actions for the rational use of plastics. Everyday objects made of them end up in the environment as waste and will remain there for hundreds of years, exerting a negative impact on ecosystems and their inhabitants. Furthermore, we have just begun to understand their influence. That is why ensuring appropriate recycling and preventing the negative

environmental impact of waste generated from the use of plastic products, e.g. microplastics (highly harmful for the environment but also for human health), is crucial. For over 50 years, WWF protects the future of both people and the environment, combining global reach with solid scientific foundations. We are aware that we will not wake up tomorrow in a world without plastics and we do not urge the complete elimination of the material from our lives. Instead, let's make every effort to ensure that plastic will not reach our surroundings and nature. We don't want it there: in our seas, oceans, forests. Our slogan "No for plastic in the environment" supports the elimination of unnecessary plastic, its reasonable use and thoughtful management after it becomes waste. We are in favour of increasing plastic recovery and sustainable sourcing of raw materials for plastics' production. Creating a comprehensive plastic management system is an ambitious task requiring cooperation.



**Polska Izba Odzysku
i Recyklingu Opakowań**

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Contrary to the widely disseminated opinion, plastics have the potential to be a material in line with the principles of the circular economy. Information included in the report "Plastics in circular economy" clearly indicates that, not only producers but also consumers have a role in this process. Only joint action of all stakeholders will allow multiple use of resources contained in products. Furthermore, even with no regard to the material type used in the product. It should be emphasized, that the most important contribution of the publication is making everyone aware of their role in the newly shaped system of values. Products should not become waste any more, their retained value should enable the creation of new goods or services. That is why there is great potential in closing loops and plastic products, thanks to their properties, enable the introduction of such services or solutions, which currently are non-existent or constitute only a niche in the market. The examples included in the report are not a closed directory but an extremely valuable one, as they could inspire everyone to take further actions. That is how innovations arise and why both technological and social development is possible. Plastics, to a large extent, enabled the emergence of a consumer society. But maybe, what some facts seem to corroborate, they may contribute to the transformation towards a climate-conscious society. I encourage you to read the publication and cooperate on new solutions. There is already a necessity to take decisive steps, both at the national and international level, in economic as well as social terms.

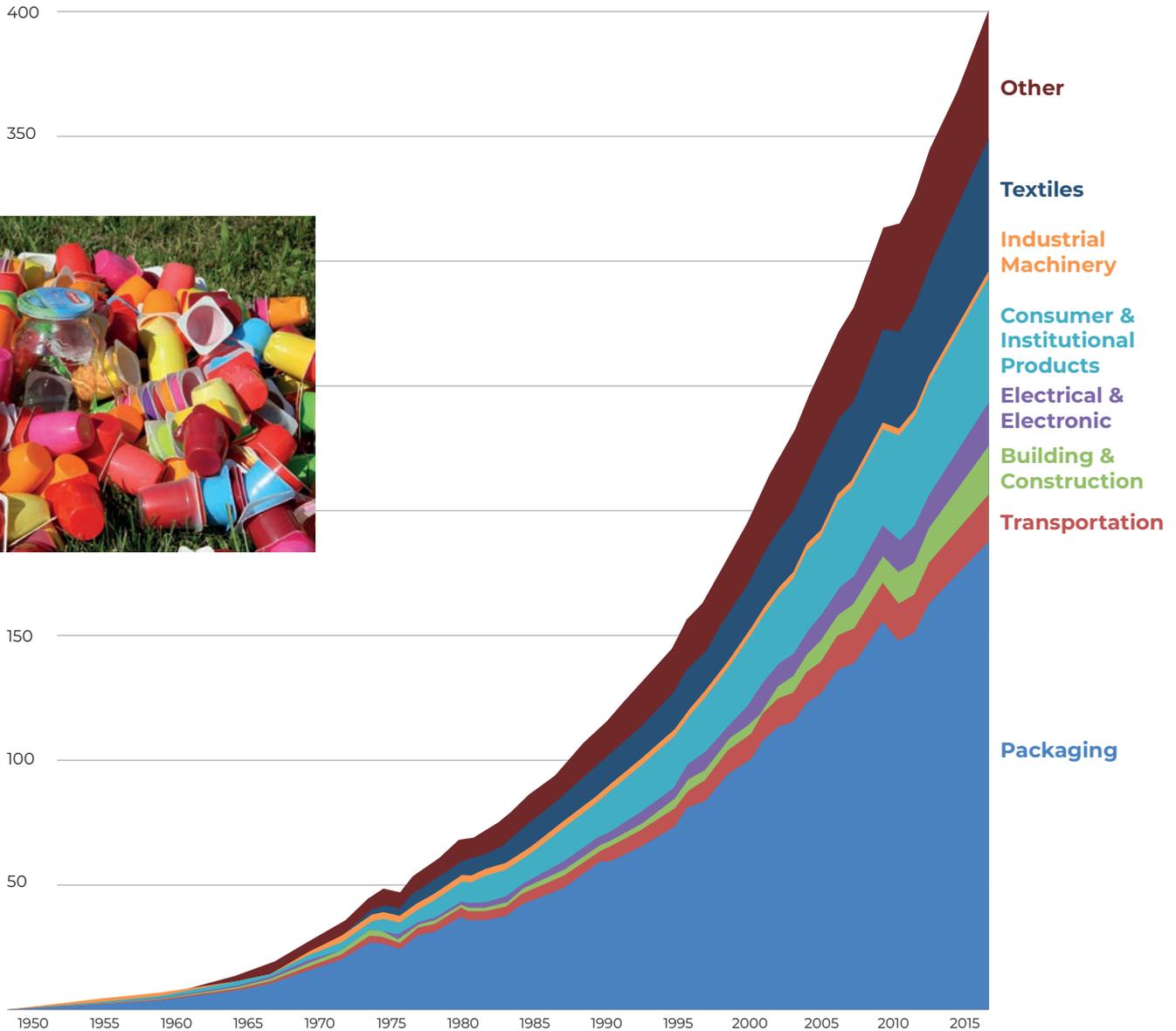
1 Introduction

Plastics allow for the production of original, practical items, light, durable and at the same time cheap. Considering all these advantages, their presence in most of the products that surround us is not surprising. Very fast increase in the use of plastics began in the middle of the last century, when technologies for the mass production of plastics from oil were developed. Chemists have found that in addition to natural substances that can be utilised to produce plastics, such as celluloid, one can use raw materials obtained during a controlled decomposition of oil to produce new materials – polymers with unusual properties and virtually endless applications.

Since then, plastics have changed our whole life and become its inseparable part. Their use is now so common and obvious that we often do not notice their role in improving the quality of our and previous generations' lives. Plastics revolutionized medicine, helped raise the level of hygiene in the world, provided access to drinking water in vast areas of the globe and have extended the shelf life of fresh food. In airbags, incubators, helmets, plastics saved millions of people's lives. Finally, they have reduced the weight of aircrafts and cars, resulting in saving fuel and reducing pollution in the transport industry and have had a role in the most prominent achievements of humanity – space travels.



Figure 1: Global primary plastics production (in million metric tons) according to industrial use sector from 1950 to 2015



Source: Geyer R., Jambeck J.R., Law K.L.; Production, use, and fate of all plastics ever made; Science Advances 2017, 3

However, plastics, hailed as a miraculous material in the middle of the last century¹, have become a real problem for the natural environment in recent years. This is a consequence of the deficiency of proper management of billions of tons of plastics produced since their development, specifically a result of their usual single-use application (see chart 2). Plastics litter our landscape, threaten the lives of many species of animals and plants, and in some cases even negatively affect people's health. Does this mean that we should abandon the massive use of plastics, simultaneously giving up our current standard of living?

The question of the effect of other materials, alternative to plastics, on our planet's environment remains. Unfortunately at the moment there is no definitive answer and no certain choice of environmentally-safe substances. Looking at the entire product life cycle, from the stage of obtaining the raw material, emissions arising during transportation and the end of the product's life, replacing plastics with glass, wood or other natural raw materials will definitely result in new threats to the environment.

If plastic packaging, for example in the beverage and ice segment, is replaced with alternative materials in the proportion currently observed on the market, each ton of plastics would should be replaced with a mix of:

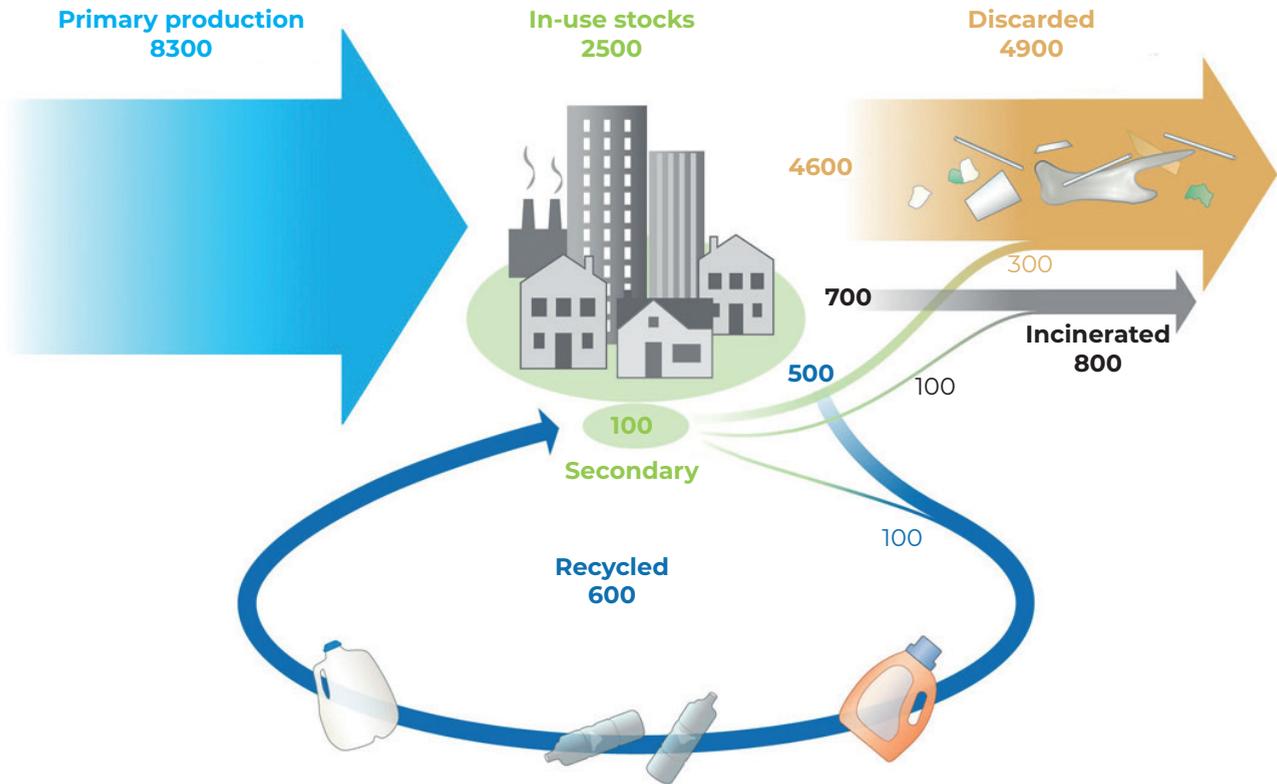
- **400 kg of metal,**
- **6.5 tons of glass and**
- **300 kg of paper and cardboard,**

which means that **13 million tons of beverage packaging would be replaced by approximately 94 million tons of other materials**

Unfortunately, due to the size of Earth's population, the amount of raw materials and products needed to meet the needs is huge, and by far exceeds the production and absorption capacity of our planet.

1. Chełmińska A., Czyżewski A. Kozłowski W. Petrochemia ma przyszłość, 2019

Figure 2: Managing plastics produced during 1950-2015 period, billion tonnes



Source: Geyer R., Jambeck J.R., Law K.L.; Production, use, and fate of all plastics ever made; Science Advances 2017, 3

However, there is a way to reduce both plastic production and ensure their more favourable management. The way out of this stalemate is to apply the circular economy model of maximizing the total economic value of assets in the long term, while adjusting the production volume to the resources of our planet. Meeting these two goals should result in a more rational and effective way of using plastics and, consequently, to continue to benefit from the various applications of this materials, without posing threat to the natural environment.

2

Plastics

– convenience or threat?

2.1. WHAT IS THE REASON FOR PLASTIC'S POPULARITY?

2.1.1. FUNCTIONALITY

Plastics are irreplaceable in virtually every sector of the economy (see chart 1). Manufacturers and consumers appreciate polymers for their functionality. Plastic items are durable, lightweight, easy to transport and can take a variety of forms depending on ones needs.

Polymers, widely used in agriculture and food industry, allow to raise production efficiency and increase product durability. Plastics decrease crop losses, reduce pesticides use and facilitate rational water management. Foodstuff wrapped in plastic materials can be stored for longer, which reduces food waste. At the same time, food manufacturers can reduce preservatives usage while maintaining the nutritional value and taste of products.

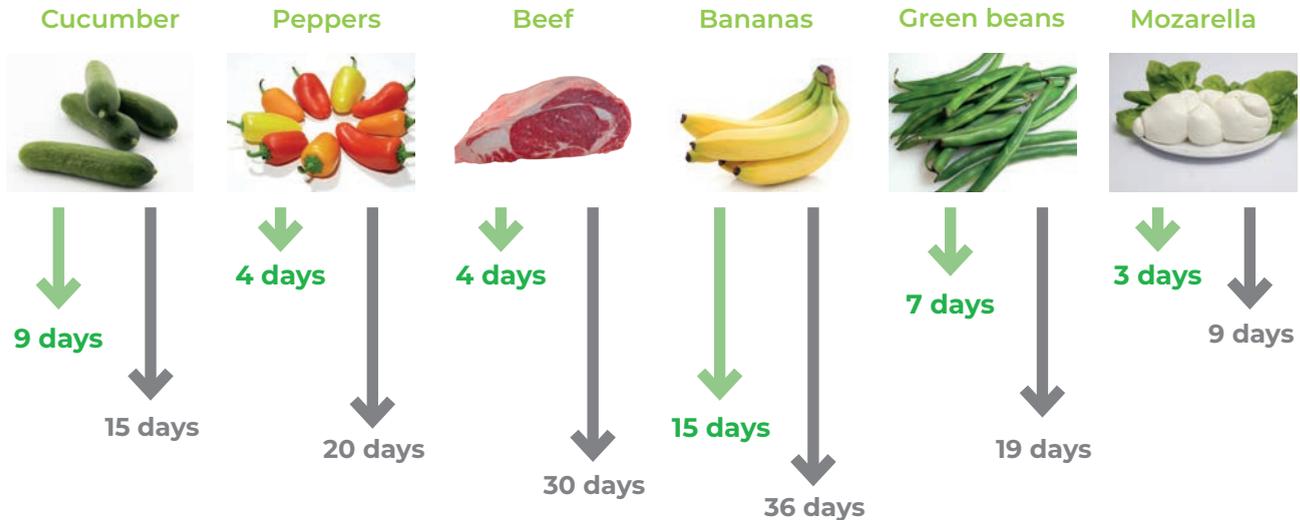


GOOD PRACTICE



Thin polyethylene films used by farmers to increase yields are difficult to collect. Soil compostable polymers that become nutrients for naturally occurring microorganisms can be an efficient solution. This type of compostable films are currently developed by companies around the world, among others Lublin's C2C.

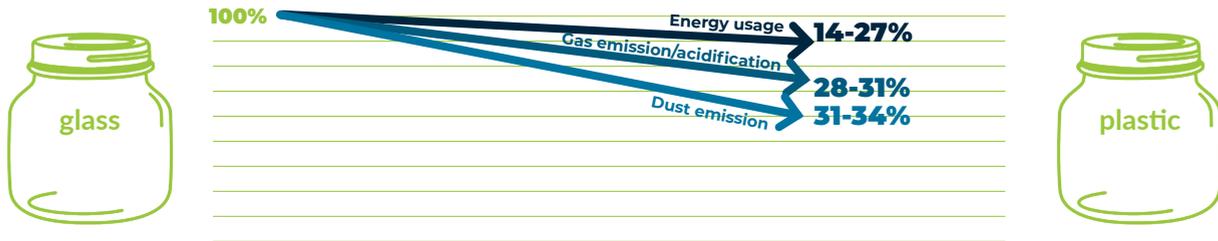
Figure 3: Possibility of lengthening eadibility period due to plastic packaging compared to selling in bulk



Source: dos Santos Pires, A.C., et al. "Development and evaluation of active packaging for sliced mozzarella preservation." *Packaging Technology and Science* 21.7 (2008): 375-383; Hailu, M. Et al. "Effect of packaging materials on shelf life and quality of banana cultivars (*Musa spp.*)." *Journal of Food Science and Technology* (2012): 1-17. Lucera, A. et al. "Shelf life of fresh-cut green beans as affected by packaging systems." *International Journal of Food Science & Technology* 46.11 (2011): 2351-2357. Sahoo, Nihar R., et al. "A comparative study on the effect of packaging material and storage environment on shelf life of fresh bell-pepper." *Journal of Food Measurement and Characterization* (2013): 1-7. McMillin, K. W. "Where is MAP going? A review and future potential of modified atmosphere packaging for meat." *Meat Science* 80.1 (2008): 43-65

The reduction of transportation costs due to plastics' low weight and high strength is the primary factor that encourages producers to use them in packaging . Plastics weigh less and usually take up much less space than alternative materials, which translates into fewer shipments. In result, fuel consumption as well as carbon dioxide and dust emissions are reduced (see Figure 4). In addition, due to the high mechanical strength and resistance to chemical agents, cases of product or packaging damage are also rarer.

Figure 4: The effect of limiting adverse externalities of using plastic instead of glass; example of baby food packaging



Source: Humbert S. et al. Life cycle assessment of two baby food packaging alternatives: glass jars vs. plastic pots: *Int J Life Cycle Assess* (2009) 14:95-106

The progress made in electronics in recent years would not have been possible without plastics. The relatively high mechanical strength combined with flexibility, extreme chemical resistance and fire resistance make these materials ideal for applications in electrical and electronic devices. These features, combined with appropriate electrical conductivity characteristics, have enabled the use of flat television sets, touch screens, more efficient computers and an ever-increasing miniaturization of devices.



GOOD PRACTICE

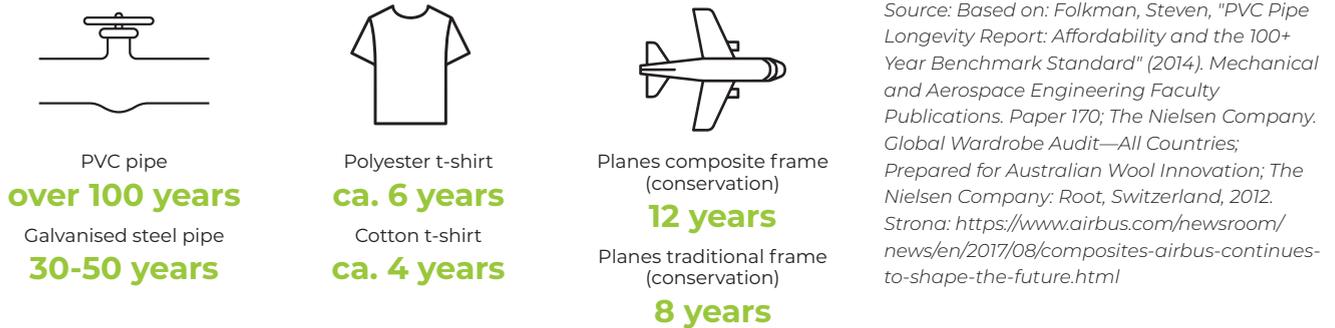


The ONYA company's offer includes air-permeable vegetable bags, bread bags (which ensure bread freshness for up to two days, freezing bread in them is also possible), multiple use packaging for sandwiches, backpacks. All products are made from recycled plastic.

2.1.2. DURABILITY

The durability of plastics is one of the most important features of these materials. The vast majority of polymers used in the production of plastic products is characterized by exceptional durability, which results from their chemical structure. Thanks to this structure, plastics are not subject to corrosion, they are resistant to weather, chemicals and microorganisms.

Figure 5: Selected plastic products and alternatives durability



2.1.3. SIMPLICITY OF THE PRODUCTION PROCESS

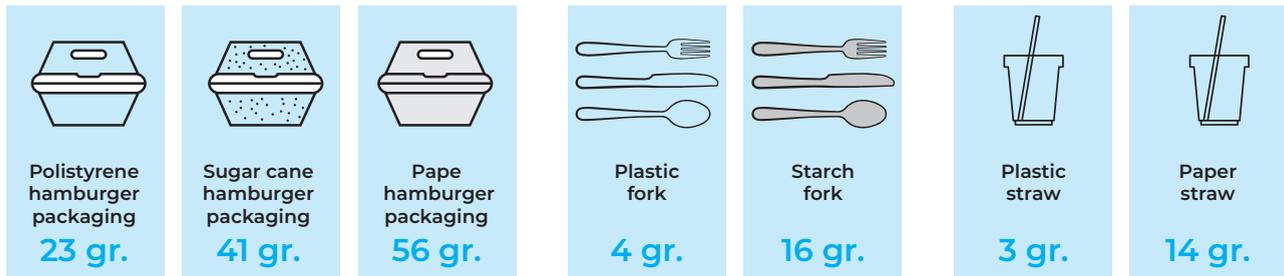
There are many processing options for plastics which allow to make the most of their properties. By appropriately fitting the production method, plastic items can be manufactured in virtually any shape, quickly and in large quantities, and at the same time material losses are relatively small. Compared to other materials, plastic processing is characterized by:



2.1.4. PRICE

The relatively low price of plastics is one of the reasons why these materials are so common. They allow the same or better functionalities at a lower cost. This is a consequence of relatively low prices of raw materials from which plastics are produced (primarily crude oil and natural gas) as well as the scale of production of both polymers and the products themselves. As a result, mass production using comparatively small amounts of relatively cheap material is possible. Consequently, plastic products are often unrivalled in terms of price; a fact that is most evident in the case of common, mass-produced goods.

Figure 6: Comparison of selected plastic products and their alternatives prices (100 gr. = 1 PLN)



Source: Based on: Gray R.; What's the real price of getting rid of plastic packaging; BBC
<http://www.bbc.com/capital/story/20180705-whats-the-real-price-of-getting-rid-of-plastic-packaging>

2.2. PROBLEMS CONECTED WITH PLASTICS' USAGE

2.2.1. COLLECTION ISSUES

In order to reuse plastics, it is advisable to separate them by type. Distinguishing between different polymers is quite a difficult task, often impossible for a human being. Therefore the waste and recycling industry use special technologies for the separation of individual types of plastics. Currently, taking into account the already large number of types of plastics, mixing of which may affect the quality of the resulting recyclate, the problem of distinguishing plastics remains significant, even with the use of increasingly effective separation technologies.



GOOD PRACTICE



Taylor Lane builds surf boards from cigarette butts that were collected from the beaches. To make one board as many as 10,000 cigarette butts, whose filters are made of plastic, are needed. The main goal is to reach the widest possible group of surfers and other people interested in this sport in order to increase people's awareness on littering and to reduce its adverse effects.

The small size of some plastic products, e.g. sweets, candy bars packaging, is an important problem. Their separate collection is so labour-intensive to an extent which makes the process unprofitable, and the optoelectronic sorters used in sorting plants cannot distinguish them due to their small size. As a result, waste that could potentially be a valuable economic resource is considered worthless.

2.2.2. DURABILITY

Durability, which is perceived by producers and consumers as an advantage, becomes a problem when the plastic item becomes waste. Depending on the type of plastic and the form of the product itself, the degradation process in the environment can last from hundred to several hundred years. As a result, the huge amounts of plastic waste that currently threatens the environment and human health will continue to pose threat for many centuries onwards. An ideal material - one that remains durable during use, but breaks down after usage is unfortunately impossible to produce.

Figure 7: Time needed for plastic products decomposition



Source: Based on: National Oceanic and Atmospheric Administration; U.S. Department of Commerce

2.2.3. ENVIRONMENTAL AND HEALTH IMPACT

Both, companies placing products on the market and consumers often use plastics in an irresponsible way. The former create products whose collection, segregation and reuse is unprofitable. The latter, litter our environment or limit the possibility of proper waste management in other ways.



While only a few years ago we thought that plastic waste was just an aesthetic problem, nowadays we are increasingly aware of the more serious consequences of their leakage into the environment.



According to some estimates, plastics are responsible for the deaths of millions of animals each year. The problem affects about 700 species of marine fauna alone, including endangered species². Some animals are strangled by abandoned fishing nets, others – from zooplankton to whales, devour plastic particles, consumption of which can have a significant impact on their health.

2. L. Parker; *We made plastic. We depend on it. Now we're drowning in it*; National Geographic; Czerwiec 2018



Polymers are not harmful themselves. However, it should be emphasised that in many plastics, apart from polymers, other substances are added - dyes, components that improve its properties or additives facilitating processing. A number of substances, currently known to be harmful, have been used in the past (e.g. dioctyl phthalate). Therefore, a careful approach to using additives in the production of plastics is very important to avoid possible adverse effects on human health.



GOOD PRACTICE



PLASTIC WHALE. DEALING WITH PLASTIC FROM AMSTERDAM'S CANAL.

Plastic Whale is a commercial company that collects plastic packaging from the Amsterdam canals and the Rotte River in Rotterdam. The goal of its founders was to clean canals of plastics and reuse the collected waste. Since 2011, 195 thousand bottles have been collected and 3.5 thousand bags have been filled with plastic waste. The collected waste was used to construct 11 boats and to create a line of high-quality Plastic Whale circular office furniture.

3

Handling plastic waste

The basic goal of the circular economy is the continuous increase in the value of products in the economic cycle. At the same time, an equally important assumption is to match the volume of production to the resources of our planet. The basic methods to fulfil these two complementary aspirations is to apply waste hierarchy principles.

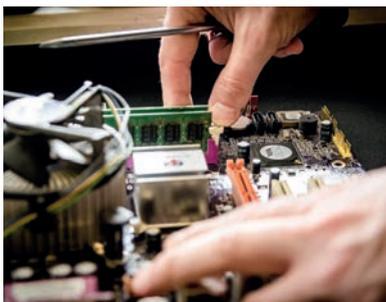
3.1. PREVENT

The first issue that every consumer should consider is to answer the question – do I really need another item? In most cases, one will find that:

- **the products we already have offer us similar functionality to the one we seek,**
- **the desired functionality can be achieved without purchasing the product,**
- **additional purchases will not significantly improve our quality of life.**

This approach does not mean that we should give up plastic goods for products made of other materials. We should strive to limit senseless purchases without distinction on the material from which the product was manufactured.

3.2. REUSE



In striving to reduce the consumption of resources, while constantly improving the quality of our lives, first and foremost, we should be guided by the possibility of long-term use of products. In other words, consumers need to pay attention to the durability of the product, the possibility of its repair, modularity and adaptability. We should think about each product not only in the perspective of our use, but also their future users, remembering to trade used products instead of discarding them.

In the context of plastics, this means, above all, giving up disposable products such as shavers, pens, etc. We can successfully replace them with permanent substitutes. They do not necessarily have to be made of materials other than plastics. As previously mentioned, in many cases plastics do not have alternatives in terms of functionality, longevity, and relatively low greenhouse gas emissions. Useful and aesthetic plastic products, that we or consecutive consumers will want to use, exist today.

In the future, plastic products should be designed and manufacture with a long shelf life and easy repair in mind. Additionally, packaging, especially food wrappings which by its very nature has a short product life span, requires a switch to reusable packaging. This of course concerns cases where it does not generate more food waste or environmental pollution. By replacing all types of plastics without prior analysis of the impact of such actions, one can eliminate a specific environmental challenge (e.g. littering in the environment) at the expense of another (e.g. deepening climate change).



photo: RataPlan

GOOD PRACTICE



Sale of used products (so-called second-hand) is becoming more and more popular in Poland and European countries alike. Currently, these types of stores offer used clothes, furniture, everyday objects, toys. Dutch chain store RataPlan offers the collection and repair of unwanted items from the customer.

3.3. REPURPOSE



The concept of the circular economy is often based on ingenuity, it facilitates the use of creativity during the design, usage and end-of-life phase. The products may find completely different applications than they were originally intended for. In the case of plastics, it is often possible to reuse them, benefiting from their extraordinary durability, mechanical and chemical resistance, insulation and fire resistance properties, for new applications.

This way, it is possible to preserve their economic value for longer and to a greater extent than in the case of employing lower levels of waste hierarchy. In some cases (so-called upcycling), by adding new functionality, it is even possible to increase the value of the existing product.



photo: Wikipedia

GOOD PRACTICE



The Terracycle company used popular carbonated drink bottles as a packaging for its product - a natural fertilizer for plants. This way, the company saved material resources and energy compared to using raw materials or recyclates.

3.4. RECYCLE



Few people are aware of the fact that, according to circular economy concept, recycling is relatively low in the hierarchy of most beneficial ways of handling waste. However, taking into account the current economic status quo where storage or incineration is often the only alternative to recycling, this process should be considered essential. It should be emphasised that standard mechanical recycling of plastics is an energy-consuming process, which in addition reduces the quality of the material by breaking the polymer chains (this can be countered by adding primary raw material).

The recycling opportunities obviously depend on the product properties. Therefore, eco-design, on top of extending product's life or increasing the possibility of its repair, should take into account the option of material recovery. Product designers and consumers should take this factor into consideration and give up products that combine many types of materials and use dyes as well as other additives excessively. Consequently, this could support the development of the recycle market, where we already face problems with insufficient supply.



photo: Synthos S.A.

GOOD PRACTICE



Expanded polystyrene (EPS) is an effective insulation material used in construction. However its recycling has been negligible so far. The PolyStyrene Loop technology enables the recovery of pure polystyrene (with simultaneous separation of impurities), which can be reused to insulate buildings, produce garden furniture, roofing and other everyday items.

3.5. RECOVER CALORIFIC VALUE

In case withdrawing from purchasing a plastic product, reusing it, utilizing in another functionality, and finally recycling are not viable options, there is one resort left to recover waste's economic value. For example, there is no possibility of recycling candy wrappers, but they still contain some calorific value. Current technologies are able to recover this value by using an incineration process to reclaim energy or to convert it to fuel. However, this way we give up on the possibility of reusing material if an appropriate recycling innovation arises. This also causes other issues to be dealt with, such as capturing harmful emissions and removing toxic ash from combustion. Energy recovery is nevertheless an option for waste that cannot be recycled because of its purity or composition, the unavailability of sorting technology, or market requirements for recycled plastics.



The lowest level of the waste hierarchy relates to the storage or incineration of waste without energy recovery. It is expensive, wasteful and harmful. Landfills unnecessarily occupy areas, emit harmful gases, and noxious substances escaping from landfills can penetrate into groundwater. Needless to say, such plastic waste management should not take place.



GOOD PRACTICE



Handerek Technologies has created a technology that converts non-recyclable plastic waste into diesel and gasoline. The process efficiency reaches 90%, while the technology does not generate useless waste (a by-product in the form of dry coal coke is sold). Producing one litre of fuel from plastics emits less carbon dioxide compared to using oil for fuel production. The process itself takes place under atmospheric pressure and at a low temperature.



4

Innovations

concerning sustainable usage of plastics

4.1. BUSINESS MODELS

The circular economy is a concept for improving the state of the environment and people's living conditions using a new economic model, that is nevertheless, as previously, based on supply and demand interactions. Closing economic cycles must therefore be profitable, and economic considerations must always be the starting point for this type of activity. Otherwise, it is difficult to imagine achieving a scale of activity that would significantly change the state of our planet. There are already several business models used on the market that are in line with circular concepts and employed by companies to generate revenue and improve competitiveness.



photo: Cosmetomat

GOOD PRACTICE



Cosmetomat is currently in the process of creating the first Polish network of vending machines for cleaning agents using their own containers. The machine will enable consumers to buy washing and cleaning liquids (e.g. for washing dishes, windows or floors), using its own packaging in the form of a bottle or jar.

4.1.1. PRODUCT AS A SERVICE

Never before has the saying “time is money” been more true than now. Nowadays, downtime in the production, transport or delivery of products and information causes enormous costs. Considering this, “selling functionality” instead of product ownership in many cases proves to be a very beneficial solution, not only in economic terms.

- **The manufacturer generates profit by providing solutions that are tailored to specific customer needs while minimizing inefficiency and maximizing the use of products.**
- **Payment for specific measurable results means that the producer has another reason, to extend the life of the product as much as possible.**
- **Due to the ownership of the product being left with the manufacturer, the return of the product and its handling at the end of its life cycle can be standardized and optimized.**
- **As a result, waste collection is easier and waste management is more efficient.**

Figure 8: Product as a service business model evolution



Source: Own elaboration



photo: Michelin

GOOD PRACTICE



The Michelin tire rental program can help maintain operational continuity, save fuel, and reduce costs with energy-saving technology. Thanks to the rates being settled by the kilometre, customers pay only for specific functionality and are not worried about tracking the need for tire replacements, carrying about risk reduction and optimizing performance.



photo: myreplenish.com

GOOD PRACTICE

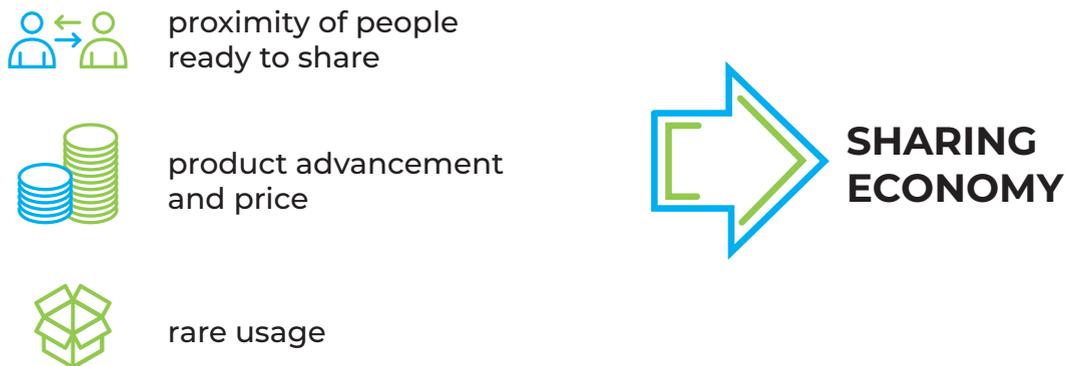


Replenish 3.0 is a universal platform for packaging detergents. The company offers reusable bottles and exchangeable containers with a detergent concentrate, e.g. dishwashing liquid. The system can be used on most packaged liquid goods, from cleaners to drinks. The user simply attaches the container with the concentrate and fills the bottle with water. Thanks to this solution consumption of plastic packaging with household chemicals is significantly reduced. Replenish sells both its own products, that are in 99% plant based as well as cooperates with other brands.

4.1.2. SHARING PLATFORMS

Many products in today's economy, including plastic ones, are hardly ever fully utilised. While the most basic ones are so widespread and often used that sharing them would be troublesome, there are a number of products that lie idle most of the time. The cost-effectiveness of sharing durable, rarely used and relatively expensive goods is often higher than for their ownership. Co-ownership would increase the utilisation of already existing products, thus reducing the total number of products needed, contributing to lower consumption of natural resources.

Figure 10: Factors supporting sharing economy



Source: Own elaboration

4.1.3. MANAGING BY-PRODUCTS

While sharing often concerns valuable products whose usefulness could be increased by more frequent, more efficient use of goods that are currently considered worthless is also possible. This applies in particular to by-products of the production process. Although they are only waste in one process, they can become a resource in another one. Energy, water, materials are often not fully utilised, although they could be used in another system within one organization³ or

3. It is estimated that 10-20% of "by-products" can be used directly at the producer's facilities by adding it to the primary raw material (Analysis of certain waste streams and the potential of Industrial Symbiosis to promote waste as a resource for EU Industry; European Commission; 2015).

by different entities (so-called industrial symbiosis). As a result, costs are reduced and additional revenue is generated. This solution fills the basic premise of the circular economy concept – it limits the use of available resources to the benefit of the environment and the standard of living of present and future generations.

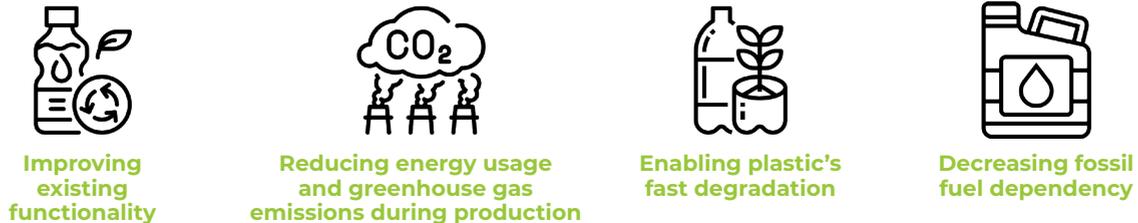


As part of the “EcoTowns” industrial symbiosis project in Kawasaki, plastic waste initiatives were created. The waste after segregation is managed by individual companies in different ways. New PET bottles are created from PET waste. Other type of plastic waste is used for the production of boards for construction applications. After twenty cycles of use, the energy value of the material is recovered from such elements.

4.2. TYPES OF PLASTICS

Currently there are many material technologies that improve the functionality of plastic products. They become even lighter, more resistant or have better insulation properties. These types of innovations improve our standard of living from year to year, and often also reduce their negative impact on the environment, even compared to alternative materials.

Figure 11: Basic direction of plastic innovation



Source: Own elaboration

Appreciating the positive effects of using new types of plastics, one should not forget about the waste hierarchy in accordance with circular economy model. In some cases, better than before material properties are the reason for more carefree behaviour, which is a direct negation of this hierarchy.



GOOD PRACTICE



Thirsty Pleasure creates unique, reusable gastronomic accessories using 3D printing technology. By using this method, products can be tailored to customer needs, all of which can be made of biodegradable polymers. The company is also working on composters for individual use, facilitating the management of used accessories.

According to some reviews⁴ this applies to biodegradable plastics used for the production of disposable items, such as packaging, shopping bags, pots, disposable cutlery, and even diapers. They may disintegrate quickly under appropriate conditions (temperature, humidity, oxygen supply, presence of living organisms, etc.), but careless handling may result in littering.

Additionally, the use of bio-based plastics, i.e. made from renewable resources, can influence consumers to consider their consumption to be neutral to Earth's resources. We should also remember that these types of plastics, despite constant technology improvement, are more expensive to produce and use arable land, plant protection products and other resources, the consumption of which has significant consequences for the natural environment.

⁴ GESAMP; Sources, fate and effects of microplastics in the marine environment - a global assessment.; GESAMP Reports and Studies Series. GESAMP (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection); 2015.



GOOD PRACTICE



Forbo reuses PVC waste (also obtained from other carpet manufacturers). Additionally, the new flooring products consist of 45% of processed material, renewable energy is used in production, and post-installation waste is recycled.

4.3. WASTE COLLECTION METHODS AND RECYCLING METHODS

Currently, the world is seeking new ways to manage the constantly growing amount of plastic waste. Waste sorting uses a variety of methods, from manual selection and removal of materials that impede recycling to the optoelectronic, gravitational, electrostatic and selective dissolution detection methods. The technology development has deemed automatic sorting much more efficient compared to the manual process. Different types of separators are used to recognize the material's properties - shape, colour, density, structure. The materials identified in this process are separated from the rest, which allows them to be reused.

Figure 12: Typical plastic recycling process



Source: Own elaboration



photo: Ioniga

GOOD PRACTICE



The Ioniga company from Eindhoven uses chemical recycling technology so that used PET bottles are utilised to produce material of the same quality and hygienic properties as the one produced from the raw resources. The resulting material is safe for food applications while its prices remain competitive.

Innovations in the area of sorting imply that more and more plastics will be recyclable, this concerns also those of smaller size or contaminated waste. However, it should be emphasised that consumers' handling of waste will always be crucial to this process.

The role of consumers in waste collection is particularly important, which is why creating effective and consumer-friendly collection management systems is of the essence. An example of such activities are deposit systems that employ reverse vending machines that sort and compress waste themselves. Currently the process of development of such machines, tailored to specific, usually high-quality products, such as used phones, is taking place. Keeping a record of waste generated, also at the level of a single household, is an important addition, as well as an incentive, to a more effective waste collection behaviour.



photo: Econit

GOOD PRACTICE



In the Czech municipality Prostřední Bečva, an intelligent system for records waste was introduced among households. After a year of operation, it turned out that residents began to segregate waste more diligently. 12% more plastics, 73% more glass, 90% more paper and 1860% more cardboard beverage packaging were collected.

5

Consumer guide



There are many small changes that each of us could implement to drastically reduce the problems associated with plastic waste and its management. What's more, it turns out that the answers to these dilemmas are also the key to a healthy, balanced lifestyle.

CHOOSE DURABLE PRODUCTS



AVOID SINGLE USE AND SMALL SIZE PACKAGING WHERE POSSIBLE

Choose cosmetics and cleaning products in containers that you can refill. Use reusable bags. In cafes and restaurants, use your own cup for take-out coffee. Use tap water and use reusable bottles. Avoid small-format items used, for example, for single portion ketchup or coffee. Take into account that small-format packaging enters the environment easier⁷ and has negligible recycling potential.

Interestingly, according to experts from the Danish Ministry of Environment and Food and the UK Environmental Protection Agency, the most ecological choice among all shopping bags is the repeated use of ordinary LDPE bags⁸. The worst choice was an organic cotton bag, which has to be used more than seven thousand times to balance its environmental footprint against the winner of this ranking. In contrast, the paper bag must be used more than 4 times so that its environmental cost equals the cost of a single use of a reusable plastic bag.

7. Together for our Ocean - International Coastal Cleanup 2017 Report, I.C. Cleanup, 2017, Ocean Conservancy; Washington, DC.

8. Life Cycle Assessment of grocery carrier bags; Environmental Project no. 1985; Ministry of Environment and Food of Denmark; 2018.



AVOID COMPLICATED PACKAGING

Modern packaging of meat or fruits often uses several thin layers of plastics to give the wrapper strength, stop gas permeability and act as glue. Most of these properties can also be provided by reusable packaging made of a thicker piece of material, which would facilitate separation and recycling. Therefore try to avoid flexible packaging and multi-layer materials.

Consider whether packaging with absorbers of moisture, oxygen, labels with an active date and antibacterial coatings are useful for you. Perhaps, thanks to the responsible planning of food purchases you will have a more beneficial impact on the natural environment by not using innovative packaging solutions.

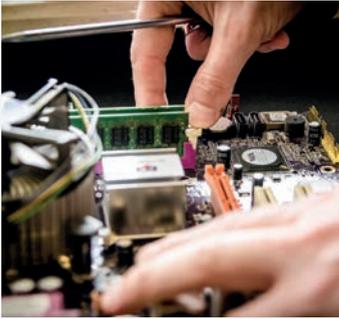


BUY PRODUCTS THAT YOU WOULD WANT TO KEEP IN THE LONG TERM

Disposable cutlery, plates, cups, straws are often thrown away after single use. Pens, lighters, flashlights, etc. are often disposed after emptying. Most cheap electronics, e.g. radios, dryers, small household appliances, usually serve us only for a few months. In case of malfunction repair is often impossible. Replace those products with the ones you would want to use repeatedly for a long period of time.

Therefore, pay attention to their aesthetics and quality, not necessarily the lack of plastic content. Check if the products can be easily repaired. If possible, choose modular products.

HANDLE WASTE PROPERLY



EXTEND PRODUCT'S LIFE

Try to repair all products that you own. Sell or give away unnecessary items.

If possible, share rarely used products with friends and neighbours (e.g. construction tools).



DO NOT LITTER

Apply this principle to all types of waste



USE RECLAIMED PLASTIC

Products made of recycled plastic are often similar in quality to products made from primary raw materials.



SORT WASTE APPROPRIATELY

Get to know the waste sorting system at your location.

AVOID WASTING FOOD



LIMIT PRACTICES THAT CAUSE WASTE

Some packaging practices with the sole aim of increasing sales (e.g. multipacks, „3 for 2“ campaigns) can result in an increase in food waste . Product grouping packaging limits consumer choice and forces larger purchases.

Therefore, buy no more than you need and be aware of the outcomes of such marketing practices.



USE REUSABLE PACKAGING AND STORE FOOD PROPERLY

Use reusable bags, jars and containers when shopping for food or keeping food at home. If you have time and options, choose sellers who allow buying food in bulk, provided that conditions for hygienic storage are met.



DON'T BE AFFRAID TO BUY PLASTIC WRAPPED FOOD IF IT REDUCES FOOD WASTE

Adjust the amount of food you buy to your needs and plan your purchases accordingly to reduce food waste. Very often, choosing the right item in the right packaging will reduce food waste.

MAINTAIN A HEALTHY LIFE



PREPARE YOUR FOOD AT HOME

Take-out services and meal deliveries provide convenience, but can also be very inefficient in terms of resources used and waste generated. Additionally, try to limit the use of self-catering kits.

According to one study, each such meal contains at least 24 packaging elements, often made of plastic⁹.



USE FRESH AND SEASONAL FOOD

Products such as pre-cut fruit and vegetables, packaged sandwiches, sushi are one of the fastest growing segments in the food industry. However, the combination of short shelf life, high packaging to product ratio, and cooling dependence mean that this type of goods should be given up completely.

In addition, food processing and packaging can cause additional hygiene issues.



GIVE UP SMOKING

Although tobacco addiction is difficult to combat, another motivation for doing so is the fact, that plastic cigarette filters are among the most environment polluting type of plastics (in fact, it is the most commonly found type of waste on beaches around the world).

⁹ Fink L., Roehl R., Strassner D.C.; UBA, Guideline: Prevention of food waste in the catering sector, 2016, Umwelt Bundesamt: Dessau-Roßlau.

6

Summary



In the present world, inhabited by more than seven billion people, we are not able to use technologies based only on wood, metals and aggregates. We need modern materials, among which plastics play a special role. Over the past hundred years, their contribution to raising the standard of living, and at the same time changing its style and mode is indisputable.

Nowadays, the perception of plastics is ambivalent. We notice that completely abandoning it would result in the decline in our quality of life. On the other hand, plastic is blamed for pollution, greenhouse gas emissions, and decline in biodiversity as well as population's health problems. Is there any way out of this stalemate?

The transformation towards circular economy could be a solution that decreases the negative effects of using plastics without reducing the convenience of our lives. The circular economy is an economic model based both on reconsidering our need for consumption and closing economic loops, that should replace the current approach of production – to use and then dispose of products as worthless waste.

First of all, it is important to properly manage plastic waste using the waste hierarchy. The extensive implementation of circular economy is a surefire way to reduce the negative aspects of using plastics, without giving up on its many popular applications.

Nowadays, the implementation of these assumptions is ever so plausible as more and more innovative circular business models emerge. For example, by selling functionality instead of product ownership, the manufacturer has an incentive to extend the product's life cycle, and will also take care of its collection and appropriate waste management. Platforms for sharing various products, as well as paying attention to the management of by-products within the organization or with business partners can also be of great importance. In effect more efficient use of products and raw materials is enabled.

In consequence of using the circular economy model plastics may become an ally of the environment instead of a threat. As climate change has become a reality, the lightness of plastics and the reduction of energy consumption during their use should be appreciated as never before. Plastics also allow the use of environmentally friendly technologies such as solar panels, lighter cars and planes that burn less fuel. These synthetic materials, used intelligently, may prove to be nature's protector. However, this change will not happen without modifying the ways plastics is handled. Through our daily decisions, primarily consumption, we can have an impact on better and more sustainable use of plastics. We must not forget about the proper management of waste, which could not be retained in the economic cycle.

It should be hoped for that the transformation towards a circular economy will allow us to continue to enjoy the benefits of plastics without endangering the natural environment and the lives of present and future generations.

