ENSURE

EntrepreNeurs for plasticS'circUlaR Economy

IO1 – Training Course Material

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Plastics and Circular Economy. Opportunities and Challenges

4.1. Overview

When we think about the opportunities and challenges of plastics and the circular economy, there are many areas, issues, actors and questions that can arise. To make these more transparent and visual, it can be helpful to create a mind map with your class or team.

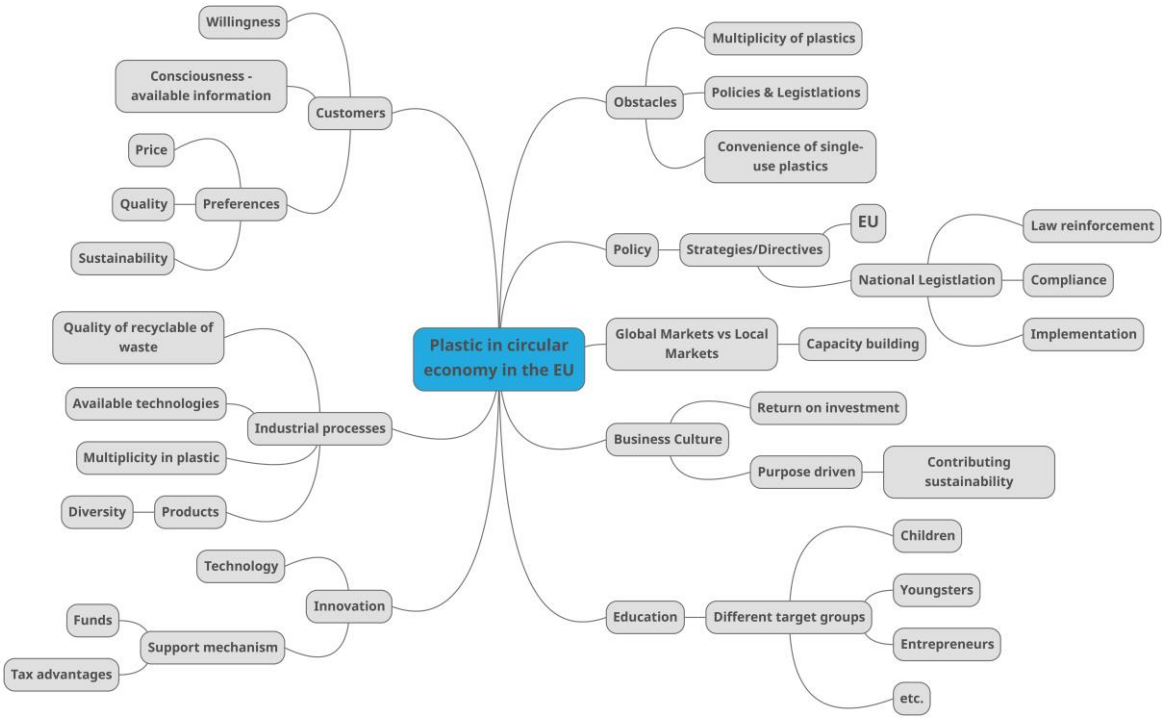

Figure 1: Mindmap of plastic in circular economy

In our example we tried to grasp this topic through 8 different areas, that can be also interconnected, so there is no particular hierarchy in the following order:

- ✓ **Policy** contains the different strategies, directives and legislation on EU and national level. They play a key role in the implementation, because they gave the legal and strategical framework of CE in the European Union and the member states. Therefore, they should become a catalyst of economical and attitude change.
- ✓ Therefore, policies and legislation also can be **obstacles** of change. The other main obstacles are multiplicity of plastics (see details in further chapters) and convenience of single-use plastics from the consumer side.
- ✓ Without trying to pass on the whole responsibility to the **consumers**, it is unquestionable that our everyday choices can make a change.
- ✓ Therefore, we need proper **education** and attitude change**.** Not just in schools or the formal education system but in everyday life of the population, entrepreneurs and companies.

- ✓ On the economic side it is really important to change and extend the good old fashioned "business as usual" **business culture** with more conscious, responsible, purpose driven thinking.
- ✓ Continuous **innovation** is essential for this change. Not just on the technological side but also in the support mechanisms (e.g. funds, tax advantages).
- ✓ In technology, the circularity of **industrial processes** are really challenging but also crucial.
- ✓ Last, but not least in our globalized, unsustainable economy, **local markets** should be more supported.

4.2. Global scale issues

In the followings we discuss why plastic pollution is a problem nowadays and what are its consequences on nature, human environment, and human health. Further, we list possible solutions from governments, companies, and some bottom-up initiatives that can help us to in mitigation and adaptation to the climate and biodiversity crisis we are living in. Partial solutions are also listed bearing in mind that they might be key factors in formalizing the global answers that humanity can give to the global scale issue.

4.2.1. Context and definitions

What is garbology?

Garbology is the study of modern refuse and trash[1]. As an academic discipline, it is a major source of information on the nature and changing patterns in modern refuse, and thereby, human society. Producing waste is coeval with human history, however, the amount of waste humanity produces significantly grew since the '50. Compounds of refuse and trash have been changing over the years as well. Initially, paper made up bigger part of household waste, but nowadays the plastic component is more important.

What are plastics?

Plastics are a wide range of synthetic materials that use polymers as a main ingredient[2]. Most modern plastics are derived from fossil fuel-based chemicals like natural gas or petroleum. Their plasticity makes it possible for plastics to be moulded, extruded or pressed into solid objects of various shapes. Plastics are highly adaptable, plus a wide range of other properties, such as being light weight, durability, flexibility has led to its widespread use.

Why plastic pollution is a problem nowadays?

Plastic products brought solutions to humanity in various fields and made our life easier in many aspects. However, single-use plastics – such as PET bottles, plastic bags and other wrappers – cause more damage than benefits.

- ✓ Petroleum is a non-renewable resource that means the Earth's petroleum storages will end one day.
- ✓ Plastic waste is not compostable it will stay with us for thousands of years if do not treat it adequately. Moreover, not all the plastic types are recyclable. about it in a later chapter.
- ✓ Macroplastics are visible; they come from mismanaged waste disposal. Every day, around 27,000 tonnes of plastics leak into the ocean. That is equivalent to almost 10 million tonnes per year, a quantity that is expected to double in the next decade if no action is taken[3].

[1] https://en.wikipedia.org/wiki/Garbology
[2] https://en.wikipedia.org/wiki/Plastic
[3] Geyer et al., 2017; Jambeck et al., 2015, https://www.iucn.org/news/marine-and-polar/202103/high-impact-small-scale-marplasticcs-projects-results-circular-economy-work-fight-against-plastic-pollution

- ✓ Microplastics are sometimes invisible; they are the fragments of any type of plastic less than 5mm in length. Their sources are cosmetics, industrial processes, use or washing synthetic clothes or from tyre and road wear particles.[4]

4.2.2. Consequences

What are the consequences of plastic pollution?

- ✓ Untreated plastic waste goes to landfills or incineration, therefore the loop is not closed, it is a one-way and unsustainable method, which leads to the Planet's exploitation.
- ✓ Macroplastics seriously damage ecosystem and harm wildlife. Pictures of trapped turtles and birds are more shockingly go viral on internet.
- ✓ Untreated macroplastic leakage carried by ocean currents created three "islands" of debris in the Pacific Ocean.
- ✓ Microfibers and microplastics enter to the food chain and undermine human health. Degraded plastic waste directly effects human health through direct consumption (i.e. in tap water), indirect consumption (by eating animals) and disruption of various hormonal mechanisms.
- ✓ Exposure to chemicals such as bisphenol A (BPA) has been correlated with disruptions in fertility, reproduction, sexual maturation, and other health effects. BPA often acts as an antiandrogen or as an oestrogen, which can cause disruptions in gonadal development and sperm production.

4.2.3. Solutions

Solutions and partial solutions

- ✓ Ban of single-use plastics in the EU

The European Commission adopted guidelines on single-use plastics products (Cotton bud sticks, Cutlery, plates, straws and stirrers, Balloons and sticks for balloons, Food containers, Cups for beverages, Beverage containers, Cigarette butts, Plastic bags, Packets and wrappers, Wet wipes and sanitary items). Where sustainable alternatives are easily available and affordable, single-use plastic products are banned from July 2021, when the ban on certain single-use plastic products enters into force.[5]

- ✓ Ban of micro particles in cosmetics

In January 2018, the European Commission initiated a restriction procedure on microplastics in cosmetic products. France has, as the first EU Member State, implemented a restriction on the use of microplastics in certain cosmetic and personal care products, the so-called rinse-off products for exfoliation or cleansing.

[4] Boucher &Friot, 2017, https://en.wikipedia.org/wiki/Microplastics

[5] https://ec.europa.eu/environment/topics/plastics/single-use-plastics_en

- ✓ Cooperation in global society level, interwoven systems

The pandemic situation caused by COVID-19 has shown us how much common and aligned efforts can ease or strengthen the situation on the entire population level. Similar initiatives, when a new, healthy, sustainable habit of a group of people becomes viral, widespread, accepted and even followed, is the crucial point to reach a critical mass. Only with human cooperation, we can arrive to a next level of consciousness and sustainable lifestyle on long term.

- ✓ Coastal and riverbed clean-ups

Typically starting as a bottom-up initiative, thousands of organisations, individuals, schools, environmental and nature clubs started aligned action on beach cleaning. Its popularity comes from the fact that the result is tangible and immediately visible, creates cohesion in the community and it is a well-defined goal that is easy to join to. More and more local governments and global institutions support these initiatives. See examples among best practices. However, the fact cannot be unseen, that this is still an "end-of-the-pipe" solution, it would be a much healthier world if those waste releases would not even happen.

- ✓ Circular economy?!

What if we "close the loop" and recycle and reuse as much as we can? This learning material you are reading now is about circular economy models, focusing mainly on plastic, but treating many other topics relevant to this field. Keep exploring the further chapters, it is also about how to make it applied in your (future) business.

- ✓ Production of long-lasting products, long term usage

This might be the most powerful solution to sort the question out, but probably the most difficult to execute as well. Eradicating *Planned obsolescence*[6] goes against the current, mainstream economic system that is based on generating the continuously increasing demand for new products. Hopefully, humanity finds a balanced solution – such as the circular economy or other new economical models – that will help ensuring a sustainable way of living on Planet Earth.

Read more about this topic:
https://www.un.org/sustainabledevelopment/sustainable-consumption-production/
https://www.iucn.org/theme/marine-and-polar/our-work/close-plastic-tap-programme/marplasticcs/knowledge-products
https://social.shorthand.com/IUCN_Water/3yJeDF7iKx/plastic-from-source-to-sea
https://petkupa.hu/hu_HU/tudastar
https://www.researchgate.net/publication/329047871_An_EU_ban_on_microplastics_in_cosmetic_products_and_the_right_to_regulate/link/5bf357204585150b2bc28862/download

[6] https://durabilitymatters.com/planned-obsolescence/

4.3. Models of circular economy

What is a circular business model?

A business model describes how a company is creating, offering and delivering value in an economic, social or cultural context, via products or services, to a broad range of stakeholders (customers etc.). A business model is essential, as it helps a company to understand the value over a long period of time. Nowadays, a business model is seen as a tool for systemic analysis, implementation of organizational units as well as a strategic asset for a competitive advantage and firm performance. A business model is aiming to foster on answering the questions WHAT (value proposition – What are you bringing to/ offer the customer), HOW (value creation – How are you creating that value), WHO (value delivery – Who is your target customer/ delivering value to?) and WHY (value capture – Why is profitable).[7]

Circular business models are described as a sustainable model that applies circular economy strategies while minimizing ecological and social costs and creating, offering and delivering a long-term sustainable value while considering a proactive multi-stakeholder engagement. The figure below illustrates that different circular business models drive circular supply chains through different loops: intensifying resource loops, dematerializing resource loops, closing resource loops, slowing resource loops and narrowing resource loops.[8]

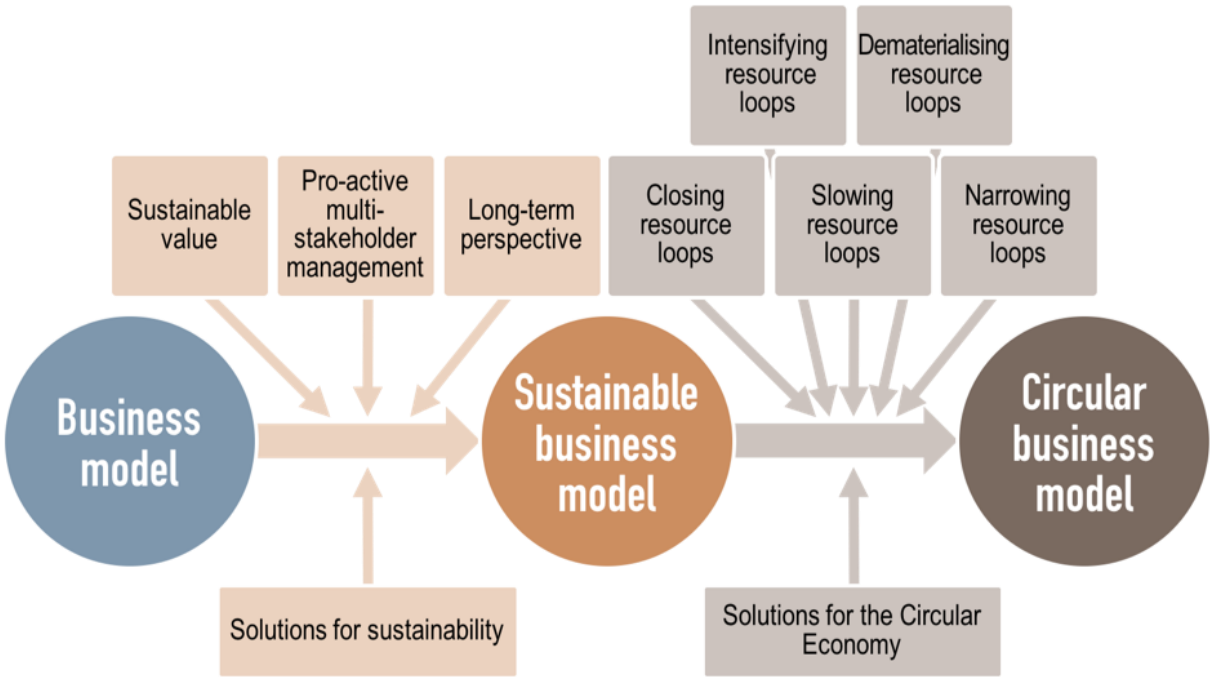

Figure 2: Circular business model, from Sustainable business models

When a company is adapting a circular business model, a broad range of new business opportunities emerge. For example, the possibility to enter a new market or to reduce costs and risks while future-proofing the business. In addition, companies can create the potential to align with public expectations

[7] https://youtu.be/IL8h0JJe2oQ
[8] https://www.sciencedirect.com/science/article/pii/S0959652618318961

and delivering greater customer value while retaining and attracting new talents and triggering new innovation capacity.[9]

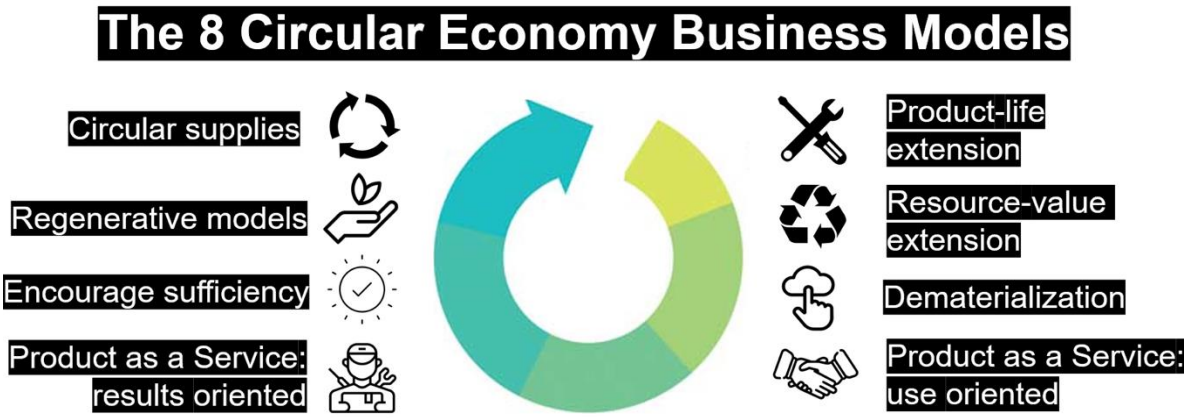

Figure 3: The 8 Circular Economy Business Models, Tomas Santa Maria

As it can be seen in figure 3 "The 8 Circular Economy Business Models", published by Tomas Santa Maria from the University of Graz, there are 8 circular economy business models for businesses, which are described in detail below. Those business models are the way how companies nowadays have the possibility to put the concepts of circular economy (refuse, reduce, resell/reuse, repair, refurbish, remanufacture, re-purpose, recycle, recover energy, re-mine) into practice.

- ✓ Circular suppliers

The business model of circular suppliers aims that a company is supplied by recycled or recyclable (technical) materials or recovered components and therefore using secondary materials for their products. The focus should lie on source cascades - using of a substance over several stages. In addition, this model is focusing on renewable and/ or compostable bio-based materials, being powered by renewable energy, eliminating toxins from the value chain and engaging in industrial symbiosis.

An example for a circular supplier is *Ecovative Design*: the company is producing compostable packaging from mycelium agriculture subproducts with a cost reduction of 75%, compared to synthetic alternatives.

- ✓ Regenerative models

Regenerative models are focusing on restoring and improving the delivery of biological ecosystem services and solving an environmental issue with profitability while offering a net-positive environmental impact. Furthermore, the concept of regenerative models lies in returning recovered bioresources to the biosphere, eliminating toxins from the value chain and being powered by renewable energy.

As an example, the company *Interface* offers a net-carbon positive carpet line, that absorbed more carbon than it emitted during its production phase.

[9] https://youtu.be/IL8h0JJe2oQ

- ✓ Encourage sufficiency

The purpose of the business model Encourage sufficiency is to encourage customers to moderate consumption through service, durability, upgradability, warranty, repairability and a non-consumerist marketing approach.

For example, *Patagonia* has repeatedly encouraged customers not to buy something they don't need, to repair it if it is broken, to use or to recycle their long-lasting apparel. Every time they amplified this social mission, their sales have increased.

- ✓ Product life extension

The model Product life extension aims to extend the lifecycle of products or components by strategies like repairing, maintenance, upgrading, resale, refurbishing, remanufacturing or component-harvesting and offering long-life products designed for physical and emotional durability.

For example, *Fairphone* is producing modular phones, which are aimed for a long-life, easy to repair and upgrade. The phones produced have 30% less CO_2 embedded than regular phones and alternatives.

- ✓ Resource value extension

This model has its focus on the exploitation of the residual value of resources through recovery, cascading as well as upcycling and recycling plus engaging in industrial symbiosis.

For example, *General Motors* is operating 152 landfill-free facilities worldwide, generating 1 billion $USD per year in recycling sales. 97% of the materials are reused or recycled and 3% goes to W2E (wind to energy).

- ✓ Dematerialization

The concept of the business model Dematerialization is to shift physical products, services, or processes into virtual services and to manufacture locally or on demand.

For example, the company *remarkable* is producing a paper-like feel tablet and therefore avoiding the use of paper.

- ✓ Product as a service: use oriented

The aim of the use-oriented product as a service model is to deliver access rather than ownership and optimize underutilized capacity through collaborative consumption, renting, leasing, sharing or pooling of products by applying pay-per use.

As an example, the company *FLEXE* is providing online marketspace for warehouse space, where warehouse space costs 20-70% less than alternatives. Another example are car-sharing programs.

- ✓ Product as a service: results oriented

The aim of the results-oriented product as a service model is to deliver functionally rather than ownership by applying performance-based contracts or activity-engagement.

For example, *Philips* is providing pay-per-lux lightning services implying ownership retention and incentivizing use of efficient, durable, repairable lightning products. The energy efficiency covers 35-75% less compared to previous services.

How to implement a Circular Business Model (CBM)?

To implement a CBM, four ways have been identified and are described in figure below very briefly:

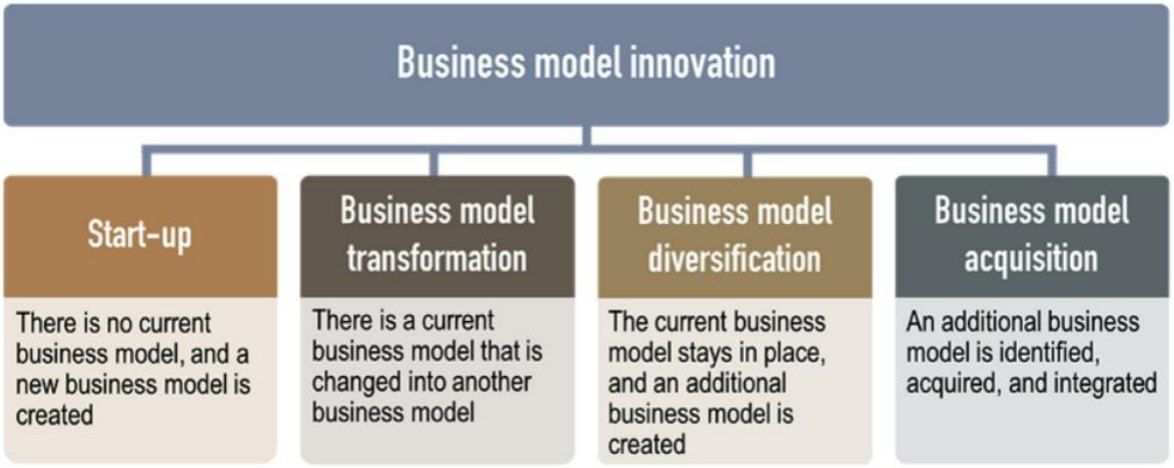

Figure 4: Types of business model innovation, Source: Sciencedirect

4.4. Focus on prevention and reuse

The following chapter deals with the overall statement "LESS IS MORE", focusing on waste prevention in waste, waste management and in the packaging industry.

What is waste?

According to the European Waste Framework Directive, waste "means any substance or object which the holder discards or intends or is required to discard".[10]

Following the Austrian Waste Management Law, waste is a moveable object/ material:

- ✓ the holder wants to get rid of / the holder has gotten rid (subjective waste term) of
- ✓ where the collection, storage, transport and treatment of waste is necessary in order not to harm public interests (objective waste term)[11]

Not considered as waste is an object that is new or in use of its intended purpose.[11]

What is waste management?

Waste management includes activities and actions required to manage waste from its beginning to its disposal as well as the collection, transport, treatment and disposal of waste. Furthermore, waste management is dealing with monitoring and waste management regulations, waste-related laws, technologies and economic mechanisms.[12]

The benefits of waste management are a better environment, the reduction of pollution, the conservation of energy, the creation of employment and the opportunity to make a difference.[12]

What is waste prevention?

Waste prevention, also called source reduction, means using less resources in order to create less waste and stopping waste from ever happening in the first place. Waste prevention is the highest ranked, preferred option in the European Waste Hierarchy, published along with the European Waste Framework Directive, which lays down some basic waste management principles.[13]

According to the European Commission, preventing products and materials from becoming waste for as long as possible and turning non-avoidable waste into resources are the key steps to achieve a greener, more circular economy.[14]

The prevention of waste is covered in one of the three principles of circular economy, published by the Ellen McArthur Foundation. The first principle *"Design out waste and pollution"* is stating the question, *"What if waste and pollution have never been created in the first place?"* and therefore directly addressing the concept of waste prevention.[15]

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705
[11] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20002086
[12] https://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php
[13] https://archive.epa.gov/epawaste/conserve/smm/wastewise/web/html/prevent.html
[14] https://ec.europa.eu/environment/green-growth/waste-prevention-and-management/index_en.htm
[15] https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy

The concept of waste prevention is offering environmental benefits and cost savings of high relevance. Businesses and organizations are able to force waste prevention by, for example, eco-design/ circular design as well as optimal use (long-lasting, modular, separable, durability, repairable), new business models (product as a service, product life extension or dematerialization) and through the establishment of cooperation and networks (Public Private Social Partnership or Social Circular Value Chain Cooperations).

In addition, there are five different approaches to waste prevention:

- ✓ Quantitative waste prevention: focusing on reducing the amount of waste
- ✓ Qualitative waste prevention: focusing on reducing the hazardousness of waste.[16]
- ✓ Reuse (e.g. buying second hand)
- ✓ Avoidance of harmful effects of waste on the environment and health
- ✓ Reusable packaging

What is reuse?

After prevention, the process of reusing covers the most value. The process of reusing helps reducing waste generation as well as the need for resource extraction and the need for energy use. The term reuse refers to reusing items more than one time and as often as possible. Some approaches for reusing items are for example, refilling water bottles before throwing them away and buying a new bottle or not using plastic bags but using environmentally friendly, reusable bags.[17]

Circular Economy and waste prevention

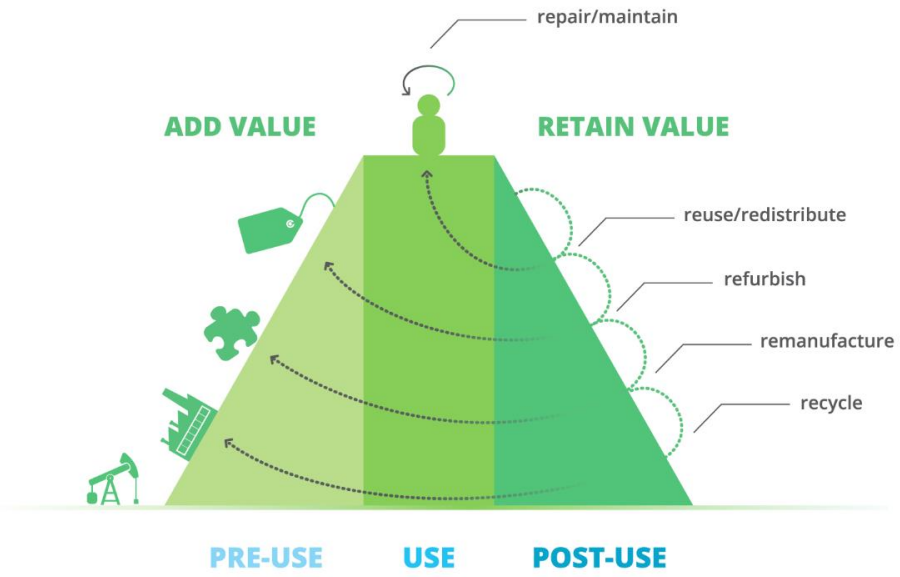

Figure 5: Value Hill Model, ©Saundra Stix, based on E. Achterberg et al.

[16] https://www.wien.gv.at/umweltschutz/abfall/vermeidung/#:~:text=Neben%20dem%20%C3%B6kologischen%20Nutzen%20bringt,zur%20Verbesserung%20der%20Lebensqualit%C3%A4t%20bei.
[17] https://www.epa.gov/recycle/reducing-and-reusing-basics

Keeping products at their highest value as long as possible is the concept of the Value Hill Model and a guiding principle for waste prevention. According to the Ellen McArthur Foundation, the idea of a circular economy is inspired by eco-systems in which the waste of one system is the food for another. Circular Economy aims to retain a product's value for as long as possible, preventing it from becoming waste. The figure above shows the Value Hill Model, with on the left hand the uphill where value is added during the pre-use phase from the primary material to the product. On top of the hill, the value of the product has to be retained for as long as possible by repairing and maintaining. When a product is, in the end, starting the downhill journey, this post-use phase should happen as slow as possible, so that the useful resources still can bring value to other products. The Value Hill Model is illustrating that the technological cycles like reusing/ redistributing or refurbishing contain higher value then strategies like remanufacturing or recycling. Especially recycling represents the lowest level of a circular economy.

Packaging

The right approach to packaging and packaging waste is through prevention in the first place and in the next step through reuse packaging. According to the latest study on reusable vs single-use packaging, published by Reloop & Zero Waste Europe in December 2020, reusable packaging is greatly preferable over single-use plastic. The results have been stated after analysing and evaluating 32 Life-Cycle-Assessments of different types of packaging (beverage packaging, buckets, bulk dispensers, carrier bags, crates, cups, drums, food containers, jars, kegs and transport packaging).[18]

What is reusable packaging?

Following the EU Directive Reusable packaging can be defined as packaging which is conceived, designed and placed on the market with the purpose of multiple trips or rotations within the life cycle. Approaches to fulfil this definition are for example refilling or reusing items for the same purpose it was conceived.[18]

According to the Reusable Packaging Associations, the following criteria must be fulfilled so that packaging is considered as reusable:[19]

- ✓ "The packaging is designed for reuse in the same or similar application, or for another purposeful packaging use in a supply chain.
- ✓ The packaging is highly durable to function properly in its original condition for multiple trips and its lifetime is measured in years.
- ✓ During its useful life, the packaging is repeatedly recovered, inspected, repaired if necessary, and reissued into the supply chain for reuse.
- ✓ The packaging operates in a system that prevents it from solid waste, and a process is in place for the recovery and recycling of the product at its end of life."[19]

[18] https://zerowasteeurope.eu/wp-content/uploads/2020/12/zwe_reloop_report_reusable-vs-single-use-packaging-a-review-of-environmental-impact_en.pdf.pdf_v2.pdf
[19] https://www.reusables.org/what-is-reusable-packaging/

Some approaches for packaging are:

- ✓ Reusable dishes for food delivery – for example dishes made out of bamboo or wood
- ✓ Refilling stations, for example refilling stations for water bottles in cities or shopping centres
- ✓ Transport packaging, food packaging, reusable drink packaging (reusable milk packaging)
- ✓ Reusable boxes

4.5. Myths around recycling, greenwashing

There are several common misconceptions about recycling, that usually are rooted in a lack of information, everyday cognitive distortions or the misleading marketing of big manufacturers and companies. Before explaining the topic in more detail, it is worth clarifying some concepts.

4.5.1. Key concepts

What is sustainable?

According to the Bruntland Commission report, Our Common Future, sustainable development is a *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (United Nations General Assembly, 1987, p. 43).

With its complex approach, it simultaneously takes into account

- ✓ the environmental expectations,
- ✓ the social needs,
- ✓ and the needs of economic development.

Figure 6: Sustainable development

In this approach the natural environment determines the structure and functioning of society, and the economy must conform to this.

In the light of all this we call the development "sustainable" if:

- ✓ the emissions (what we release into the environment) do not exceed the capacity of the environment to receive / process them
- ✓ what we extract from the environment does not exceed the ability of the environment to reproduce it
- ✓ the rate of use of non-renewable resources do not exceed the rate at which we can replace them with renewable resources

For more information about sustainability please visit: sdgs.un.org

What do we call "greenwashing"?

In recent years, sustainability and environmental protection have become increasingly common in marketing campaigns for various brands, products and politicians. Despite that, in our globalized consumption society it is always justified to raise a sceptical eyebrow when you hear organizations (e.g. corporations, governments) make claims of their environmental friendly, sustainable and responsible practices. According to Cambridge Dictionary's definition, greenwash is **"an attempt to make people believe that your company is doing more to protect the environment than it really is."** Therefore, greenwashing is a form of marketing spin in which public relation (PR) and marketing is deceptively used to persuade people that the organization's products, aims and policies are sustainable and environmentally friendly. While this deception is not necessarily intentional (it can also be caused by a lack of information), **people and future entrepreneurs need to be informed properly to make conscious decisions.** Read more about this in point *"How to identify greenmisleading?"*.

Life Cycle Assessment (LCA) – "Cradle to the Grave"

As a conscious producer (or a consumer as well) if we want to make sustainable solutions, **we should change our old way of thinking and apply the "cradle to grave" approach**. If we want to examine the real environmental impact of our product or service, it is not enough to consider a single phase (e.g. production or consumption), but all stages of the life of the product or service (from cradle to the grave, or even from cradle to cradle) must be taken into account.

Life Cycle Assessment (LCA) or Life Cycle Analysis is a methodology that measures the environmental impacts of a product or service with all the stages of the life-cycle. (It is included in the ISO 14000 series of environmental management standards.[20])

The methodology is based on 4 main phases:

1. **Goal and scope**

   The first phase contains the goal and methodology of the study, e.g. the intended application, reasons of the study, the audience (target groups), and how the results will be used in a comparative assertion.

2. **Life Circle Inventory (LCI) analysis**

   LCI phase contains data collection and the calculation procedure for the quantification of inputs and outputs (e.g. energy, raw material, waste, emissions) of the studied system.

3. **Life Circle Impact Assessment (LCIA)**

   In this phase LCI results are associated with environmental impact categories and indicators through LCIA methods (classification, characterisation, normalisation, weighting).

4. **Life Circle Interpretation**

   Finally, LCI and LCIA are interpreted in accordance with the stated goal and scope.

[20] https://www.iso.org/iso-14001-environmental-management.html

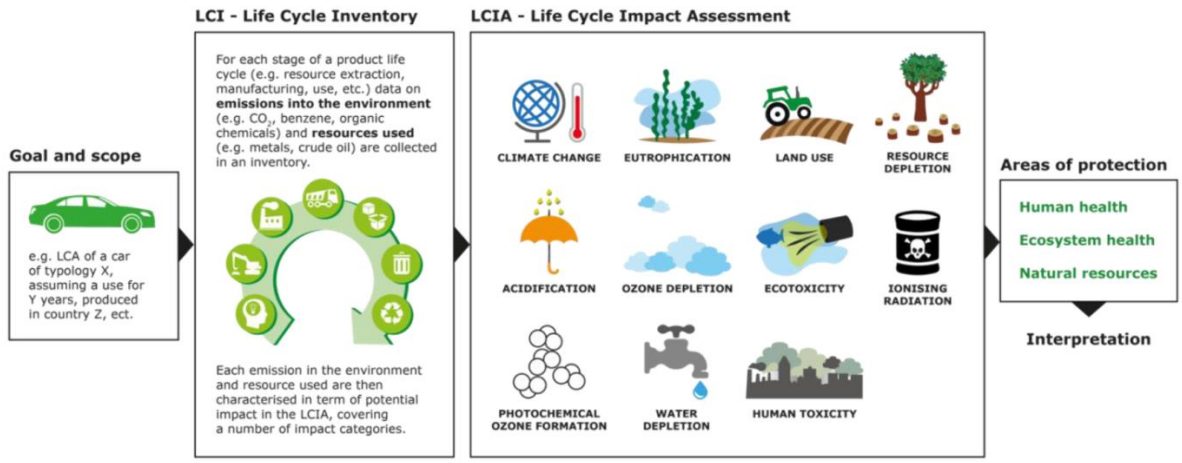

Figure 7: Life Cycle Assessment steps (Sala et al., 2016)

For more information, please visit the European Platform on Life Cycle Assessment:

https://eplca.jrc.ec.europa.eu/lifecycleassessment.html

Waste Hierarchy/Pyramid

The EU Waste Framework Directive aims *"to minimise the negative effects of the generation and management of waste on human health and the environment"* and reduce *"the use of resources, and favour the practical application of the waste hierarchy"* in EU Member States in waste management. (Directive 2008/98/EC of the European Parliament and of the Council)[21]

The waste hierarchy is a five-step preference order for managing and disposing of waste in EU waste management, in which preventing waste is the preferred option, and sending waste to landfill should be the last resort.[22]

1. **Prevention**

Preventing and reducing waste generation: e.g. using less material in design and manufacture, keeping products for longer, or using less hazardous material.

2. **Preparing for reuse**

Reuse and preparation for reuse means to **give** products a "second life" before they become waste. It can include repairing, refurbishing or even creative reuse, such as upcycling or redesign, where the reused object gets a whole new function.

3. **Recycling**

It is based on proper selective waste collection, where the collected waste materials are reprocessed into new products and materials (for the original or other purposes). Recycling can save not only raw

[21] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008L0098
[22] https://ec.europa.eu/environment/topics/waste-and-recycling/waste-framework-directive_en

materials but also energy and water, but it is less environmentally friendly than prevention and reuse. Recycling includes composting but it does not include incineration.

4. **Energy recovery**

If waste cannot be prevented, reused or recycled, one solution is to recover the energy content of the waste during incineration. Although the volume of waste is reduced, this solution is not energy efficient at all (much more energy is lost during the incineration than can be produced) and it's extremely polluting (e.g. dangerous flue gases, fly ash and slag). In addition, incinerators must be "fed" continuously, so it is completely against waste prevention and competes with recycling for high quality materials.

5. **Disposal**

According to the hierarchy, the worst thing that can happen to waste is disposal. The most common methods are landfilling, and incineration without energy recovery.

+1: Illegal dumping

The list of hierarchies does not include the really worst case, illegal dumping, which discharges garbage directly into the environment.

Figure 8: Waste hierarchy (ec.europa.eu)

4.5.2. *Recycling in the European Union*

EU waste policy and legal framework called **The Waste Framework Directive**[23] aims to protect the environment and human health and help the EU's transition to a circular economy. It sets objectives and targets to

- ✓ improve waste management,
- ✓ stimulate innovation in recycling,
- ✓ limit landfilling.

According to the data of Eurostat, in 2018, **2 317 240 000 tons** of waste were generated in the European Union (EU-27). The largest emitters are construction (36,0%), mining and quarrying (26,2%), and manufacturing (10,6%). These three economic activities are responsible for three quarters (72,8%) of waste generation. See graph below.

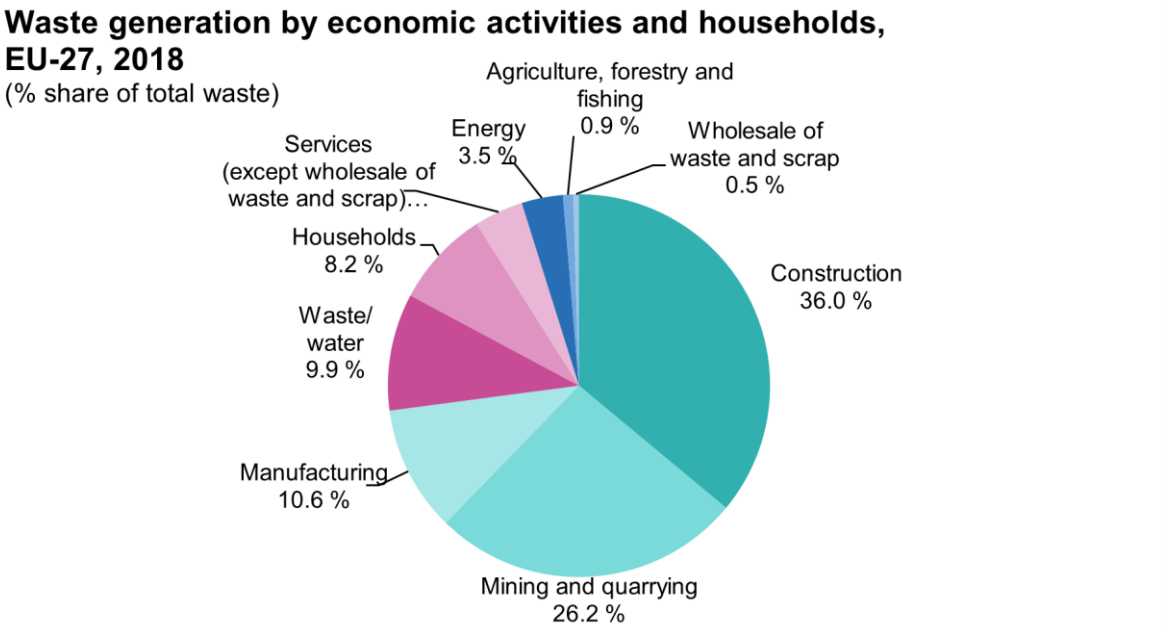

Figure 9: Waste generation in the EU, in 2018 (Eurostat online data code: env_wasgen)

In 2018, **2 149 million tonnes** of waste were treated in the EU-27.[24] From this 38.7 % of waste were landfilled and 38.1 % were recycled.[25] According to the definition of Waste Framework Directive *"recycling means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of*

[23] https://ec.europa.eu/environment/topics/waste-and-recycling/waste-framework-directive_en
[24] This doesn't include exported waste but includes the treatment of waste imported into the EU-27. The reported amounts are therefore not directly comparable with those on waste generation.
[25] More than a half of waste (54.2 %) was treated in recovery operations: recycling (38.1 %), backfilling (10.1 %) or energy recovery (6.0 %). The remaining half (45.8 %) was either landfilled (38.7 %), incinerated without energy recovery (0.7 %) or disposed of otherwise (6.3 %).

organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations."

As the below figure shows there are significant differences between the Member States concerning the use they made of these various treatment methods. From the partner countries Italy, Belgium, France, and Hungary had the three highest recycling rates, while Austria is on average in the EU-27.

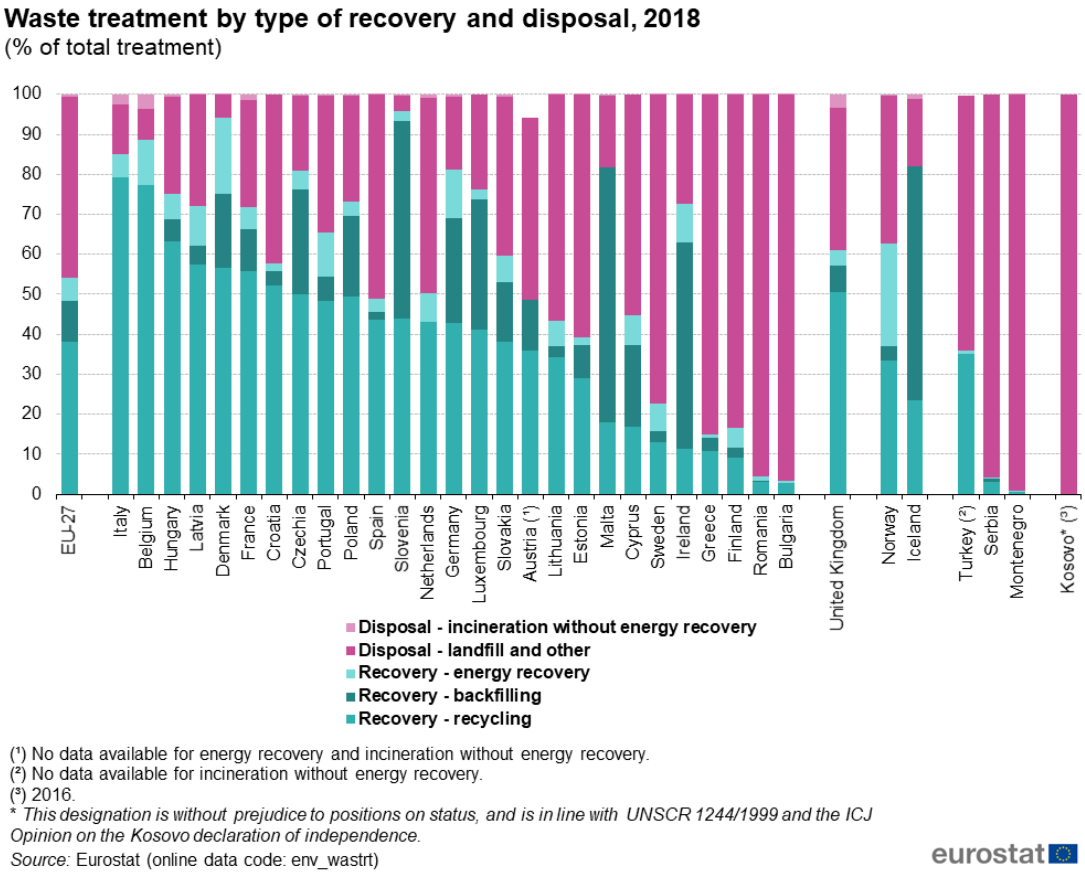

Figure 10: Waste treatment in 2018 (Eurostat online data code: env_wastrt)

For more information visit:

https://ec.europa.eu/environment/topics/waste-and-recycling_en

For more waste statistics visit:

https://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics#Waste_treatment

4.5.3. Most common misconceptions

Usually, when people hear the word "sustainability", one of the first things that come to their mind is "recycling". "*I recycle, so I live sustainably*." But is it enough to recycle? Are all plastics recyclable? Is it a sustainable solution at all?

Is plastic recyclable?

It is a wrong question. **There are many types of plastics with different properties and compositions.** They can be used in various products and applications. But **not all of them are recyclable.** Resin identification codes (RIC) are used to classify the different types of plastic. The EU's identification system for packaging distinguishes 6 types of plastics.[26] The table below shows the codes, the recyclability and areas of use of the different plastics. See the table below and for more technological details go to chapter 4.6.

Code	Abbrevation(s)	Material	Common uses	Recyclable
1	PET or PETE	Polyethylene Terephthalate	Polyester fibers, soft drink bottles, food containers	Yes
2	HDPE or PE-HD	High-Density Polyethylene	Plastic milk containers, plastic bags, bottle caps, trash cans, oil cans, plastic lumber, toolboxes, supplement containers	Yes
3	PVC	Polyvinyl Chloride	Window frames, bottles for chemicals, flooring, plumbing pipes	No
4	LPDE	Low-Density Polyethylene	Plastic bags, Ziploc bags, buckets, squeeze bottles, plastic tubes, chopping boards	Yes
5	PP	Polypropylene	Flower pots, bumpers, car interior trim, industrial fibers, carry-out beverage cups, microwavable food containers, DVD keep cases	Yes
6	PS	Polystyrene or Styrofoam	Toys, video cassettes, ashtrays, trunks, beverage/food coolers, beer cups, wine and champagne cups, carry-out food containers, Styrofoam	No
7	N/A or Other	Other Plastics (e.g. polycarbonate, polyctide, acrylic, acrylonitrile butadiene, styrene, fiberglass, nylon)		No

Table 1: Types of plastics

The solution is also complicated by the fact that **less than half of the plastics are recycled. In the EU,** an estimated 41.5% of plastic packaging waste was recycled in 2018.[27] The highest recycling rate of plastic packaging waste was recorded in Lithuania (69.3%), ahead of Slovenia (60.4%, 2017 data) and Bulgaria (59.2%). In the partner countries these rates are: Italy (43.8%), Belgium (42.4 %), Austria (31.9%), Hungary (30%), France (26.9%).

[26] https://eur-lex.europa.eu/eli/dec/1997/129/oj
[27] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210113-1

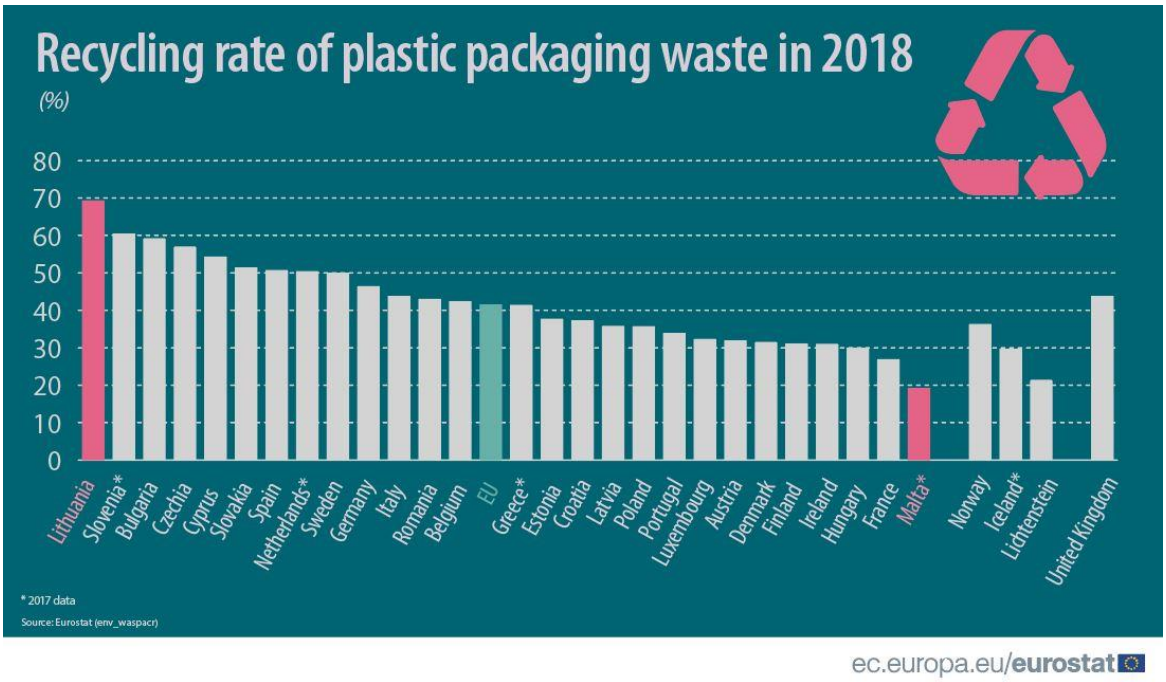

Figure 11: Recycling rates of plastic packaging waste in 2018 (Eurostat online data code: env_waspacr)

Recycling is by no means the best solution, it takes only the 3rd place in the waste hierarchy. It is a much better solution than recovery or disposal but **an environmentally friendly producer / entrepreneur should focus on prevention and re-use.**

Why is "biodegradable" not equal to "compostable"?

Nowadays, we can hear more and more about **"bioplastics", which includes bio-based plastics and biodegradable plastics.** Although they are made from bio-sourced materials, it does not mean that they degrade naturally. **Most bio-based plastics are non-degradable, non-compostable** (bio-polyethylene, bio-PET) or only under industrial conditions (PLA) which requires a separate collection and sorting system that makes selection extremely difficult. Not to mention oxo-degradable plastics, which are deceptively fragmented into microplastics by light due to the metal salt additives, which is particularly harmful to wildlife and thus to humans (through our food supply chain), such as petroleum-based plastics. The term "bio" is therefore extremely misleading, as it suggests, that they are naturally degradable, environmentally friendly packaging materials. **The only real solution is to use sustainable alternatives instead of "single use" or "throwaway" plastics.**

What are the alternatives to single-use or throwaway plastics?

Single-use plastics are always going to be throwaway plastics, regardless of whether a company is able to recycle a percentage of them. **To truly tackle the plastics crisis, companies and entrepreneurs need to fundamentally rethink how they bring products to people.** That could include **refill and reuse systems** (e.g., returnable cans and bottles), **plastic-free packaging, a combination of approaches or totally new delivery and provisioning systems.** There are also innovative researches around the world on **developing bio-plastics from organic waste streams** (crop residues, agri-food by-products, sewage sludge, etc.) **seeking to enter a circular economy concept.**[28] There are plastic alternatives that are

[28] https://www.frontiersin.org/articles/10.3389/fnut.2018.00121/full

becoming more prevalent around the world, but to bring about change at the scale needed, corporations are going to have to innovate as only they can afford to do.

For good practices for food waste reduction, please visit: http://maradeknelkul.hu/wp-content/uploads/2020/01/MN_good_practices_food_industry_2.pdf

4.5.4. Whose responsibility?

The good news is that people are increasingly recognizing the side effects of our western consumer culture and would be willing to change their lifestyle. But as environmental issues become more prevalent, it is also becoming more common that the **most pollution companies try to pass on the whole responsibility to the consumers** e.g. with greenwashing. But do we really only cause the problem?

As shown in the figure above, EU households directly (!) are responsible for 8.2% of the generated waste. Although we can do a lot for the environment on an individual and household level, by itself, people cannot be expected to change overnight. (Moreover, the current supply does not even allow most people to shop with a clear conscience.) Therefore, **to initiate real change governments and companies have the greatest responsibility.** The most polluting companies themselves are not interested in change (they are interested only in growth), that is why **the transition toward a circular/sustainable economy cannot take place without proper regulations.** It's up to decision makers and companies that produce this waste to come up with a better system. The individual consumer can certainly make informed decisions about what they buy, but companies must do better if they want to maintain customer loyalty.

The European Union has already recognized the huge problem of plastic pollution and accepted an EU directive to reduce single-use plastics from 2021.[29] **The most effective thing people and conscious companies can do is to call on decision makers to take action as soon as possible for a plastic pollution free future.** If your country or company is thinking of replacing single-use packaging (e.g. plastic bags), it is a good idea to first conduct a Life Cycle Analysis (LCA) and carefully select the most environmentally friendly solution.

[29] https://eur-lex.europa.eu/eli/dir/2019/904/o

4.6. Technological Background

4.6.1. Waste management hierarchy

The EU waste directive defines that waste should be dealt in accordance with different hierarchies. The recycling of plastics fits into the waste hierarchy as an efficient and sustainable use of material resources. The plastics industry also supports reduction and reuse measures.

The figure below shows the aforementioned hierarchy of waste management.

Figure 12: Waste management hierarchy

- ✓ **Prevention**: reducing resources used in manufacture, ensuring products last for a long time and using less material
- ✓ **Preparing for reuse**: repairing, cleaning, refurbishing, and checking
- ✓ **Recycling**: reprocessing waste into new material
- ✓ **Other recovery**: incineration to produce energy, anaerobic digestion, gasification, and pyrolysis to produce either fuel, heat, or electricity
- ✓ **Disposal**: landfill or incineration without energy recovery

We will focus mostly on recycling which represents one important step toward circularity.

4.6.2. Background on the use of plastic from the past to now

Plastic appeared in the 1930s thanks to Scotch and Nylon. Between 1950 and 2018, plastic production increased from 2 million tons to nearly 450 million tons. Plastic is a considerable material in the global economy as it comes in 3rd place after cement and steel, relegating glass, wood, cardboard, and paper far behind. Originally designed as a tough, long-lasting material, plastic is now widely used for one-time, single use with a very short life of use.

Between 1950 and 1970, the production of plastic increased by twenty and exceeded 25 million tons. The production was concentrated in Western countries: with 8 million tonnes in the United States, 4 in Japan and England, 1.3 in the United Kingdom, Italy and France. At this time, the USSR (still the world's second-largest economy) produced only 1.45 million tonnes. It was during these long periods of development and economic growth that plastic burst into our everyday life. Symbol of the "American way of life", "Tupperware" first appeared in 1946.

In 1968, the first plastic bottles appeared in Vittel, France. In 1980, the world produced 60 million tonnes of plastics, 187 in 2000, 265 in 2010 and 348 million tonnes in 2017, or an average growth of 8.5% per year since 1950.

Today, China is responsible for a third of the world's production of plastic. In total since 1950, 8.3 billion tonnes of plastics have been produced. The International Energy Agency, in a 2018 study, forecasts annual production of around 600 million tonnes by the middle of the 21st century.

A UN report estimated that 500 billion plastic bags are used each year, or 10 million per minute! Plastic consumption per capita is close to 100 kg (in 2015) in Korea, Canada; it is 80 kg in the United States, 60 kg in Western Europe, 45 kg in China but only 10 kg in India and 5 kg in Africa.

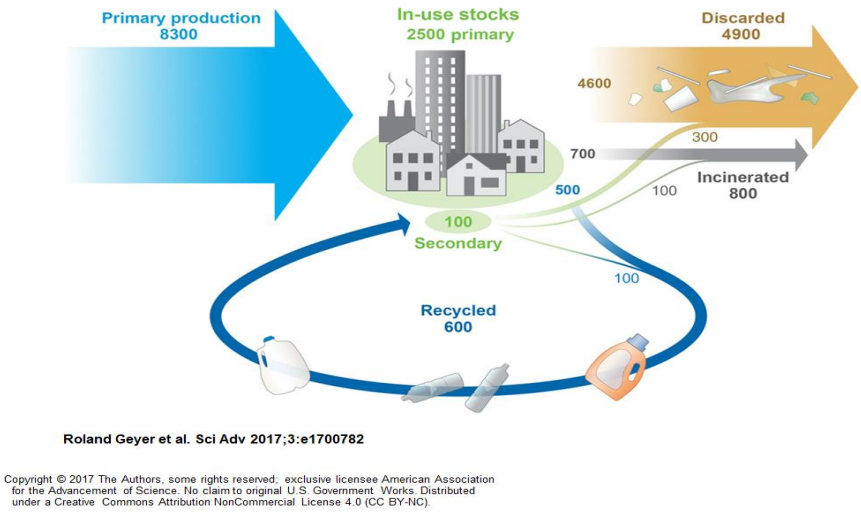

Figure 13: Global production, use, and fate of polymer resins, synthetic fibers, and additives from 1950 to 2015; in million metric tons

Collection and sorting are the weak link

The collection of waste, especially household waste, has reached a level of maturity in the (so called) developed countries, with increasingly selective collection; it is not the case with the rest of the world, which has represented the essential growth in demand for plastics over the past three decades.

In this context, a German study published in 2017 estimated that ten rivers in the world (eight in Asia and two in Africa) account for 90% of plastic discharges into the oceans, with the Yangtze discharging 15 million tonnes each year. The problem is coming from waste collection systems, whether formal or informal, and most of the waste is ending up in illegal dumps.

Even in Global North recycling remains extremely limited, and most of the waste is being incinerated due to a lack of sorting facilities and demand in recycling materials.

For example, the European Union consumes 49 million tonnes of plastics, and has a recycled material use rate of around 6%, or just under 3 million tonnes. The European Commission estimates that Europe generates nearly 26 million tonnes of plastic waste: 31% is recycled (in Europe or elsewhere, as in China, which imported waste until 2017), 42% is incinerated and 27% end up in landfills. But beyond the reduction in the consumption of plastics, the other strategy consists of collecting them better and recovering their waste.

In January 2018, the European Commission published its “plastics strategy”. The objective is to incorporate 10 million tonnes of recycled plastics in new products by 2025, and today only 3 tonnes of recycled plastics are reinjected in the loop. And we must consider the increase of plastic production.

Consumption of recycled plastics

Virgin plastic remains largely present along the chain of value of plastic as shown in the figure below. Virgin plastic is added in addition to recycled, to ensure good properties in the final product. For certain applications, such as food packaging where product standards are the most severe, producers will sometimes prefer virgin resin to avoid any risk of contamination of the recycled material.

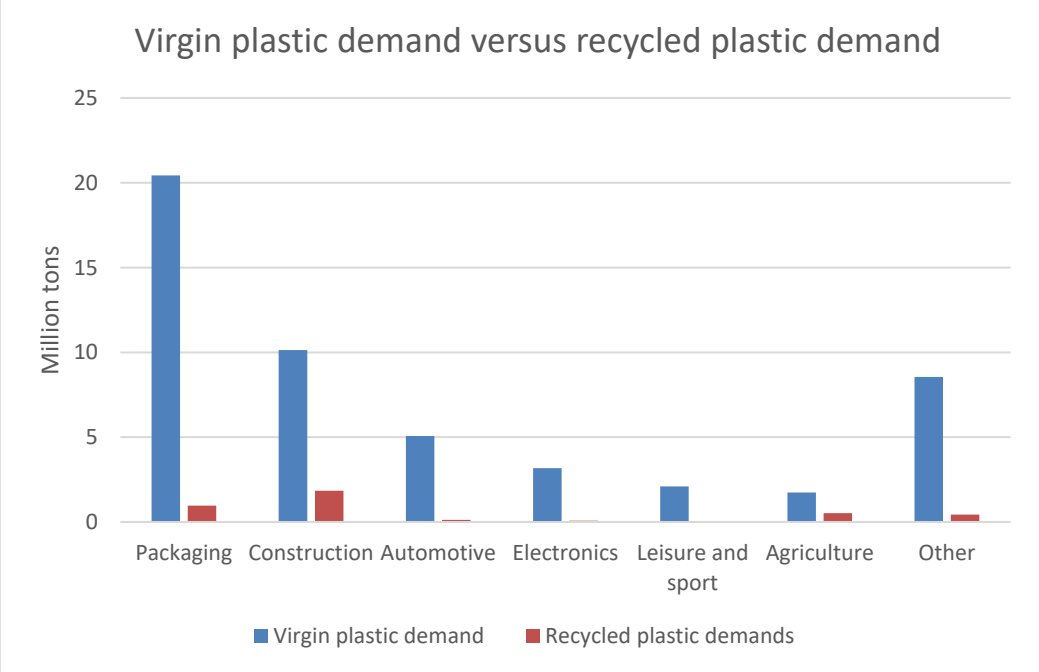

Figure 14: Use of recycled plastics[30]

The consumption of recycled plastics is still low in European industry, compared to the volumes of virgin resins used. The share of recycled plastics in European plastics consumption is 7%, all sectors combined. The main application is in the agriculture sector (23% incorporation) and construction (15% incorporation). When plastics cannot enter the industrial cycle, they will end up in the environment, in the form of emissions (with or without energy recovery) or in the form of solid waste (in a supervised, or “illegal” landfill).

If plastic has now become a social and a large environmental problem, some of its uses have demonstrated its competitiveness, not only economic but also environmental (in terms of carbon footprint). It has the undoubted advantage of lightness, of its ability to replace products that are admittedly more "natural" (wood, paper, metals) but in general more expensive and whose carbon footprint is often more important.

Several plastic products have come under attack and even regulation. These are generally single-use products and therefore disposable after use. In the first row, we find of course the bags now banned in France but also in Bangladesh or Rwanda. There are also PET bottles on which large companies like Coca-Cola have made very limited commitments.

Finally, plastic straws are receiving increasing attention. This use may seem marginal, but every day, in a country like France, 8.8 million are thrown away! From 2021, the European Union plans to ban ten single-use products such as straws, plastic cutlery and plates, cotton swabs… In France, there has also been talk of banning PVC windows and doors in the construction.

[30] http://www.bsi-economics.org/1270-l%EF%BF%BDeconomie-des-plastiques-note

The environmental and health challenges of plastics

Two main risks concern plastics: their chemical risks and their fragmentation into microplastics; and their risk to the climate.

Toxic risk: additives and microplastics

Certain chemical additives in plastics can migrate and accumulate in food, indoor air and building dust, and pose a health risk. More studies should be done on long-term exposure to these additives, as well as their migration conditions, to identify dangerous substances and uses. Thus, product standards could be adapted, in accordance with an eco-design with a view to recycling, which would also be facilitated by simplified chemical compositions.

It is estimated that about a third of the plastics produced each year end up in soil or inland waters. Spilled or buried in the environment, plastics fragment into tiny particles that can pass the barriers of living organisms and behave like magnets for toxic substances. Microplastics are found everywhere in our environment, up to the polar zones. In the oceans, bacteria that attach to their surface can become biological contaminants. In addition, soil pollution by plastic could be 4 to 23 times higher than ocean pollution, with an ecological impact that remains to be assessed.

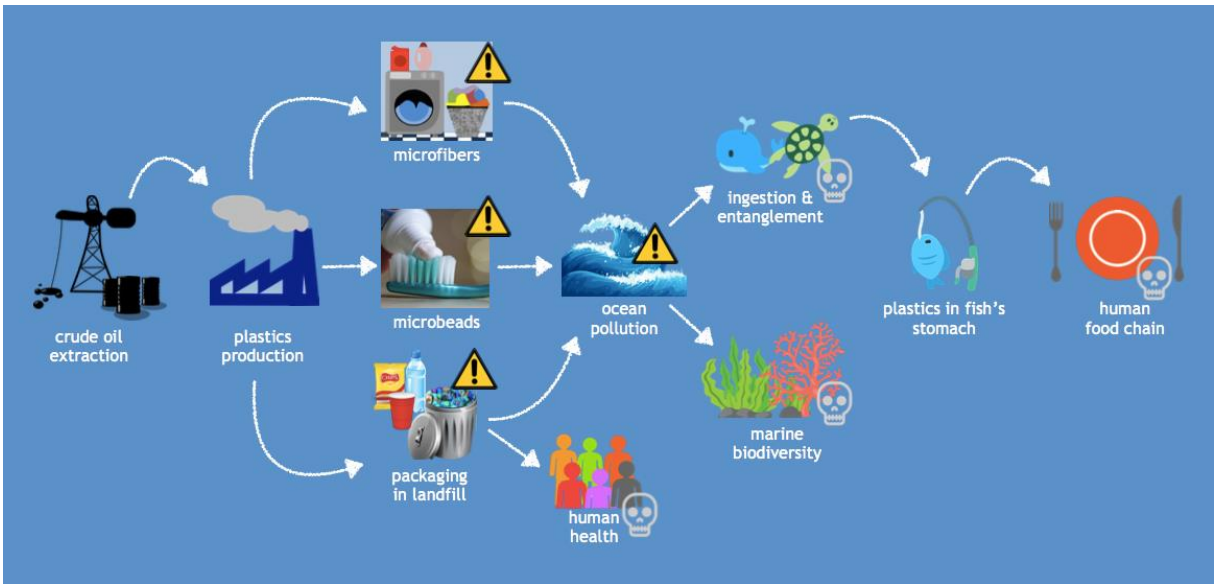

Figure 15: The chain of negative effects that plastics have on the planet and people[31]

Incineration of plastics: a risk for the climate

Plastic waste is often incinerated with energy recovery, due to its good caloric efficiency and recycling difficulties. In 2018, this treatment concerned 34% of plastic packaging in the EU. On the other hand,

[31] https://www.bepakt.com/plastic-problems/

once plastics have reached the limit of their recyclability, incineration (with or without energy recovery) seems the last option to avoid landfill.

The incineration of plastics, with or without energy recovery, poses a climate issue given that 90% of them are derived from fossil fuels. Thus, when burned, they release carbon dioxide (CO_2) which was fossilized in the soil, increasing the greenhouse effect. The Ellen MacArthur Foundation estimates that by 2050, plastics could represent 15% of our carbon budget .

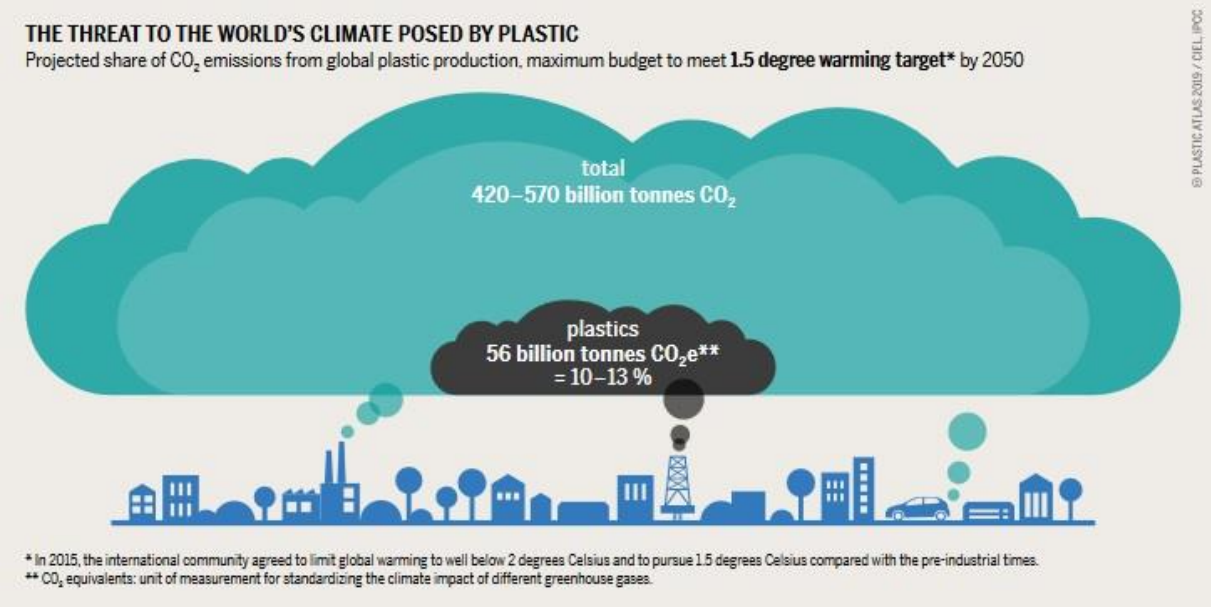

Figure 16: The impact of plastic on CO_2 emission[32]

4.6.3. The different types of plastics

Plastic material = polymer + additives

The properties of plastics depend on the different types of plastics considered. However, plastics have several interesting general properties which explain their great use for the manufacture of technical objects.

- ✓ They are light.
- ✓ They resist corrosion (rust).
- ✓ They can be shaped and molded by heat or pressure.
- ✓ They have excellent durability.
- ✓ They are good thermal and electrical insulators.
- ✓ They have great resistance.
- ✓ They are economical.

[32] https://fr.boell.org/sites/default/files/202003/Atlas%20du%20Plastique%20VF_0.pdf

Thermoplastic

Thermoplastic polymers soften at high temperatures and harden at low temperatures. They can thus be remelted and transformed without altering the mechanical properties of the material.

There are 7 main families according to the classification established by the Plastic Industry Society in the 1980s:

- ✓ Polyethylene terephthalate (PET)
- ✓ High density polyethylene (HDPE)
- ✓ Polyvinyl chloride (PVC)
- ✓ Low density polyethylene (LDPE)
- ✓ Polypropylene (PP)
- ✓ Polystyrene (PS)
- ✓ The others

Plastic recycling				
RIC number	Plastic name	Abbreviated name	Product use	New products after recycling
1	polyethylene terephthalate	PET or PETE	water, soft drink and juice bottles, carpet, polar fleece	food containers, carpet fibres, filling for jackets and cushions
2	high-density polyethylene	HDPE	milk jugs, bottles, shopping bags	bins, pipes, new containers
3	polyvinyl chloride	PVC	wrapping and packaging, pipes	pipes, traffic cones
4	low-density polyethylene	LDPE	plastic bags, squeezable bottles	rubbish bin liners, compost bins, outdoor furniture
5	polypropylene	PP	refrigerated food containers, dishware	tools, trays
6	polystyrene	PS	disposable plates, cutlery, protective packaging	light switches, packaging, mouldings
7	other	O	acrylic, nylon, composite plastics	low-grade bottles, outdoor products

Figure 17: The different families of thermoplastic[33]

[33] http://www.bsi-economics.org/1270-l%25EF%25BF%25BD+%C3%A9conomie-des-plastiques-note

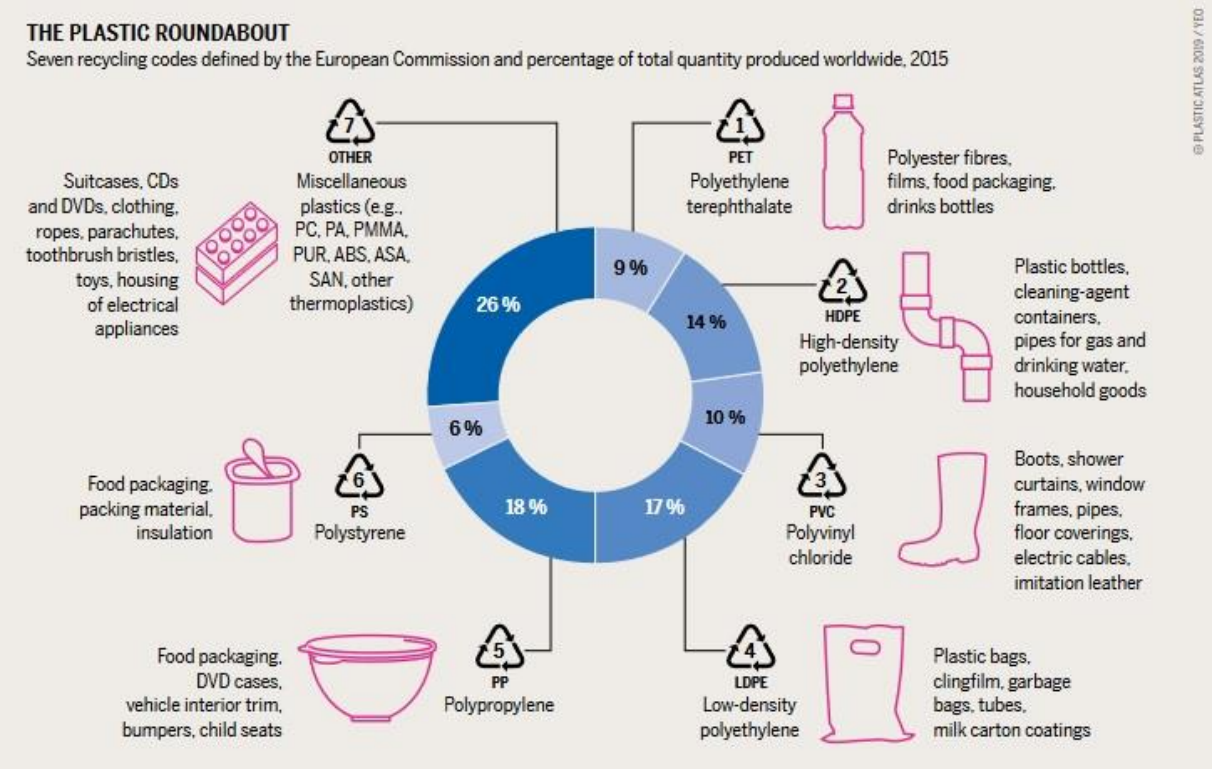

Figure 18: The different application of recycled plastics[34]

The name of the polymer is used to designate each category of plastic, as can be seen in the above figure, which presents the shares of each plastic in the global production of 2015. Within the same category, the additives used will therefore not be the same depending on the applications. The main plastic produced is polypropylene (PP), used for food packaging, but also banknotes and surgical masks.

Of the 438 million tons of plastic produced in 2017, the packaging sector used 158 million, construction and public works used 71 million, textile industries, 62 million; consumer goods, 45 million tons; transport, 29 million tons. 19 million tons of plastic were used for electrical and electronic devices, and 3 million tons for industrial equipment.

The figure above shows that plastics are mainly used for packaging (36% of total use), buildings (16%) and textiles (14%). For example, PET, gas and liquid tight, is particularly used for beverages. PP is resistant to high temperatures and can therefore be used for hot liquids. The building makes heavy use of PVC (rigid and durable) and HDPE for pipes.

Plastics, being light and insulating, also have many applications in electronics. Electrical and electronic equipment is made up of around 26% plastics on average (in terms of weight). It now seems difficult to imagine the digitization of the economy without plastics. Due to their resistance to vibrations and their durability, they are also used in transport (bumpers, seats, dashboards, etc.). Their lightness

[34] https://fr.boell.org/sites/default/files/2020-03/Atlas%20du%20Plastique%20VF_0.pdf

allows in particular to save energy compared to heavier materials. In the renewable energy sector, plastics also seem to be gaining ground in photovoltaic panels and wind turbines.

Single use plastic is also widely used in the medical sector, especially to reduce the risk of infection. In the United States, hospitals generate up to 3,500 tons of plastic waste per day. With the pandemic, this use extends to the population: the production of masks (FFP2 and surgical, in polypropylene) has multiplied by 30 in France.

Thermoset

A thermoset is a plastic material that always stays hard, even when heated. Its loss of elasticity is irreversible. Unlike thermoplastics which soften under the effect of heat, thermosets have lost this property during their manufacture. Thus, a thermosetting material retains the same rigidity under the action of heat until it reaches its decomposition temperature. Also, once produced, you can no longer modify the shape of a thermosetting material. Thermosets are difficult to recycle.

- ✓ Melamine Formaldehyde (FM) (Formica), (Plastic tableware, flooring, decorative panel),
- ✓ Phenoplast (PF), Box of various objects, panhandler, electrical and aeronautical insulation
- ✓ Polyester (UP): Boat hull, fishing rod, above-ground pool.

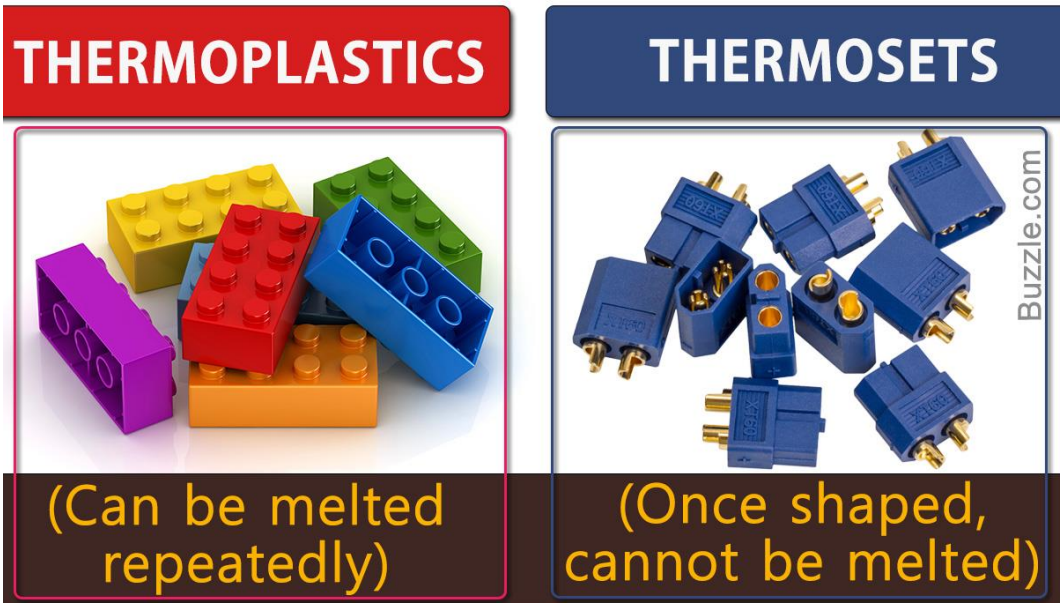

Figure 19: Difference between thermoplastics and thermosets[35]

Elastomer

An elastomer is a plastic material which has the properties of natural rubber, mainly high elasticity and high extensibility.

[35] https://sciencestruck.com/difference-between-thermoplastics-thermosets

A distinction is generally made between natural elastomers and synthetic elastomers. The first comes from the latex secreted by certain plants, for example by the rubber tree. They are however much less used than synthetic elastomers which are, in turn, produced in the laboratory thanks to the vulcanization process. This process consists of adding sulfur to the rubber, thus making it possible to reduce its elasticity, while improving its resistance. Despite their advantageous mechanical properties, elastomers have the drawback of being plastics that are difficult to recycle.

- ✓ Polychloroprene (CR): Adhesive, wetsuit, neoprene clothing
- ✓ Silicone elastomer: Thermal and electrical insulation used in construction.
- ✓ Butadiene-styrene rubber: Synthetic rubber, tire, elastic

Figure 20: Examples of elastomer use[36]

Bio polymers

Biopolymers are polymers derived from biomass, produced from plants, algae, animals, fungi, etc.

Bio-sourced does not necessarily mean recyclable and or biodegradable. Less than 20% of bioplastics were considered biodegradable in 2019. In addition, some will be considered biodegradable in industrial composting, but with difficulty in a natural environment, such as PLA.

[36] https://prepona.info/image-collection/thermoplastic-elastomer-examples

In order to produce plant resources, land must be freed up for cultivation. Increasing the pressure on land use and forests is difficult to sustain, in a context of increasing world population, climate change and the biodiversity crisis. Agriculture already uses five billion hectares, or 38% of the world's land area. The environmental impact of bio-sourced plastic will depend on the cultivation method. Monoculture, the use of phytosanitary products and deforestation will lead to a negative environmental impact. Notably, forests absorb much more carbon than corn crops. However, manufacturing bio-sourced plastics from plant waste could have a real advantage, since it will not change land use.

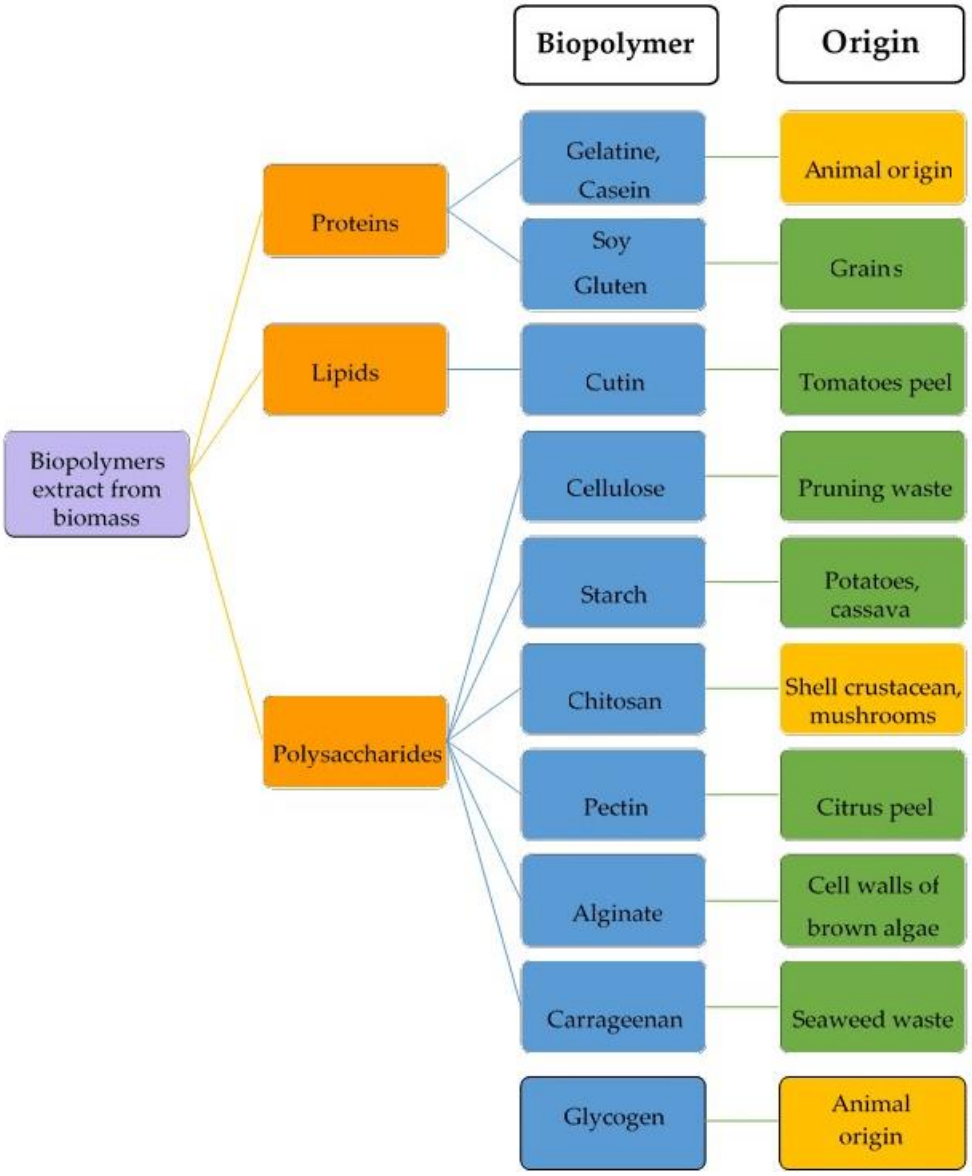

Figure 21: Different types of biopolymers obtained from animal and vegetable wastes[37]

[37] https://www.researchgate.net/figure/Different-types-of-biopolymers-obtained-from-animal-and-vegetable-wastes_fig1_339007591

4.6.4. *Value Chain of Plastic*

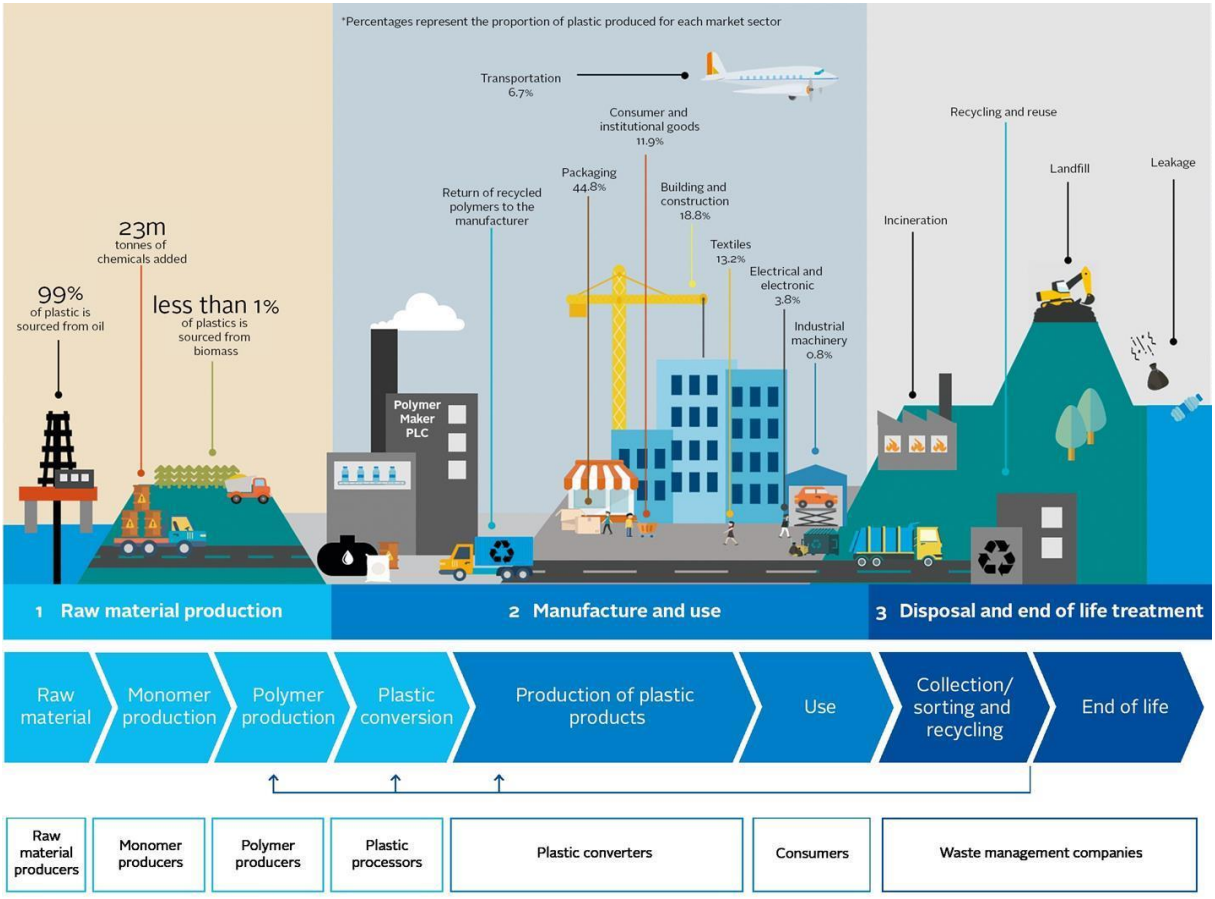

Figure 22: Value chain of plastic, Source: PRI

The plastic value chain is complex, touching most business sectors globally.

Plastic is essentially derived from petroleum (at the margin, with potatoes for biodegradable plastics and milk for anti-allergenic plastics). Specifically, it is made from naphtha, a transparent liquid obtained after the distillation of petroleum.

But the transformation operation does not stop there. This naphtha must then pass through the cracking box (an extreme and sudden hot-cold) giving it the shape of fragments of molecules. Then comes the polymerization phase, which binds these fragments together and thus forms what are called polymers, presented in the form of granules, liquids, or powders.

Last step of this long transformation: shaping by molding, injection or thermoforming which allows these polymers to pass from the resin state to that under which we know these famous plastics.

Read more here: https://www.paprec.com/fr/comprendre-le-recyclage/tout-savoir-sur-les-matieres-recyclables/plastiques/

Manufacture and use

1. Injection Molding

During this operation, the heated, compressed, and softened material in an injection molding machine is transfused into a mold which will give it its final shape. To do this, the resins are poured into a tank (a hopper), softened by heating, and sent under the pressure of a rotating screw (also called a plasticizing screw) to the closed and cooled mold, whose shape they will follow. by solidifying. At the end of these steps, the part is ejected.

As for injection blow molding, it is possible to produce hollow bodies (bottles, flasks) by combining - as the name suggests - injection and blow molding techniques. Preformed in an injection molding machine, the parts are expanded and pressed against the walls of a mold using a jet of compressed air. This mold will then be cooled, allowing the extraction of the final hollow body.

Commonly used, injection molding (also called plastic injection) therefore makes it possible to produce more or less complex parts in large series and intended for example for the automotive industry. The main plastics used for injection are polyethylene (PE), polypropylene (PP) and polyvinyl chloride (PVC).

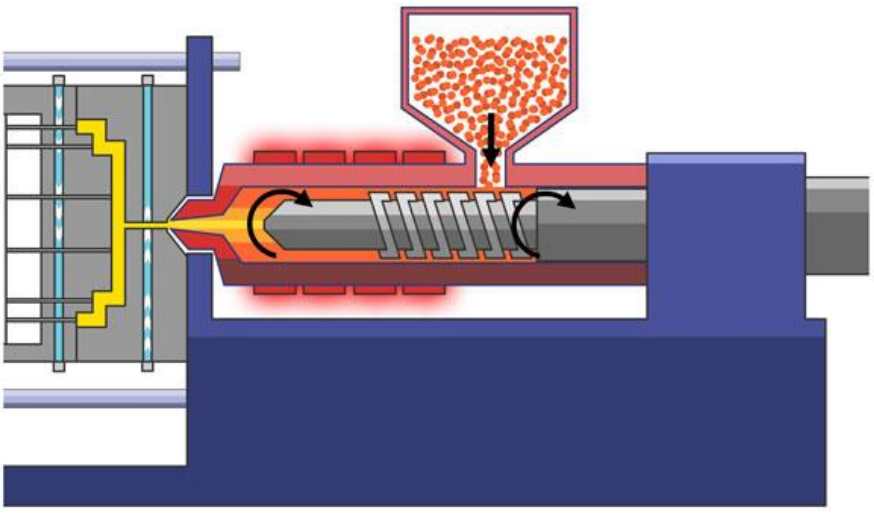

Figure 23: Injection molding[38]

[38] https://www.aireplastics.com/basic-injection-molding-process/

2. Extension Molding

During this plastic processing operation, mainly used to produce expanded polystyrene parts, thermoplastic resin balls are placed in a boiler, where, under the effect of water vapor, they can reach up to thirty times their initial size (expansion agents are added, such as pentane).

After being dried, these pre-expanded beads will be placed in a closed mold, where they will be homogenized and definitively expanded under the effect of a new injection of water vapor.

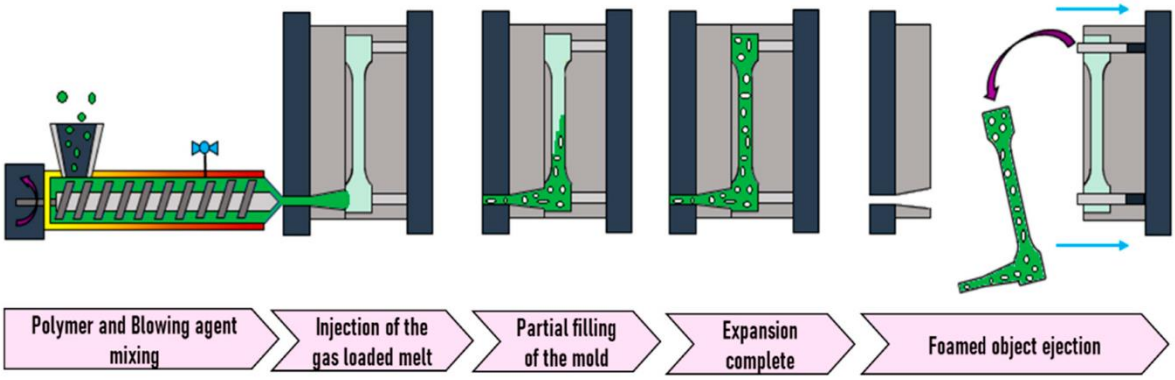

Figure 24: Extension molding[39]

3. Extrusion

Plastic extrusion consists of compressing a softened and homogeneous material (in a heated cylinder equipped with rotating screws similar to an injection molding machine) and pushing it through a die (rigid tool pierced with at least one hole) which will give it the desired shape. Then, the material expelled from this continuous die is then cooled and cut to the correct length.

Called extruders, these extrusion machines are well adapted to produce solid, hollow, or particularly long parts (tubes, pipes, profiles for doors or windows, cables, pipes, etc.) at high rates.

A variant of this system is extrusion-blow molding that also makes possible to produce hollow bodies, but by cutting a parison (an extruded plastic tube pierced at one end to allow air or compressed gas to pass) and placing this in a two-part mold, which will give it the desired shape. A blower rod will then inject enough air or compressed gas to press the material against the walls of the tube.

Another variant is extrusion-inflation, which involves injecting compressed air directly into the heated material leaving the extruder, and thus creating a vertical bubble, which will be flattened after cooling.

[39] https://www.mdpi.com/1420-3049/25/15/3408/htm

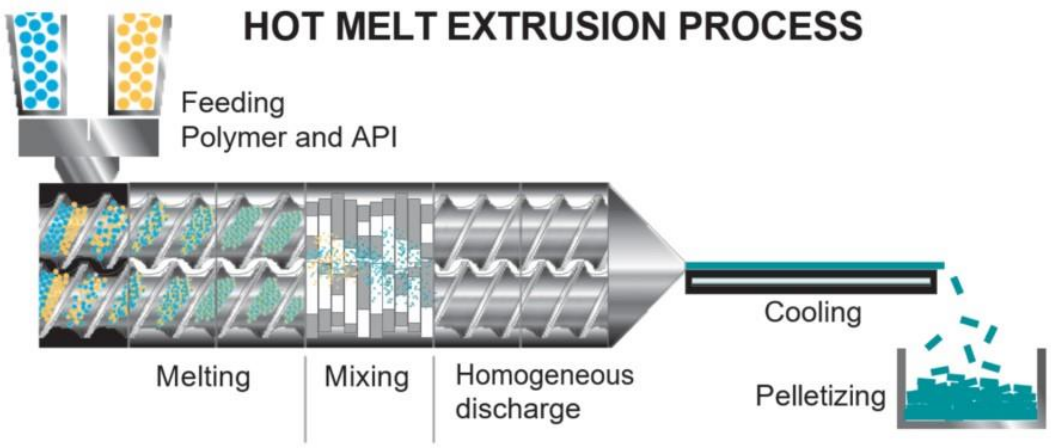

Figure 25: Extrusion[40]

4. Calendering

Calendering operations are used to produce plates, sheets, or films of various thicknesses by compressing the resin using rotating rollers called rolling mills. Once transformed into film, sheet, or film by these hot rollers, then they are cooled and stretched to the desired dimensions, the thermoplastic material is placed around an industrial reel. This process is used to manufacture flat and wide PVC products, but also coverings for furniture or leather goods.

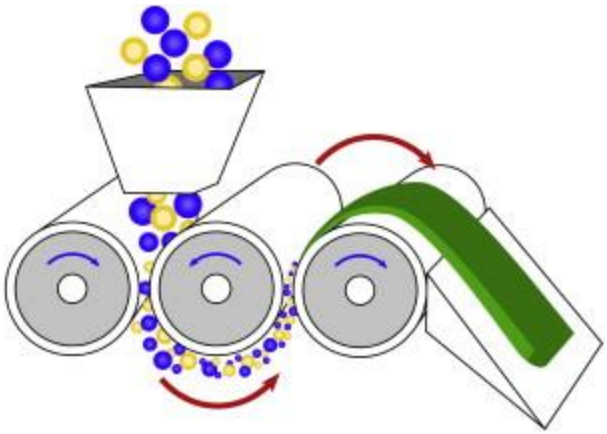

Figure 26: Calendering[41]

[40] https://fr.suurmond.com/products/extrusion-thermofusible-dans-les-industries-alimentaire-et-pharmaceutique/
[41] https://www.sciencedirect.com/topics/engineering/calenders

5. Coating

During a coating operation, the liquid material or the plastic solution is deposited on a substrate (a paper, fabric or aluminium support) and then sent to a drying oven.

This transformation makes it possible to produce, among other things, PVC floor or wall coverings, various PET films, and flexible industrial packaging.

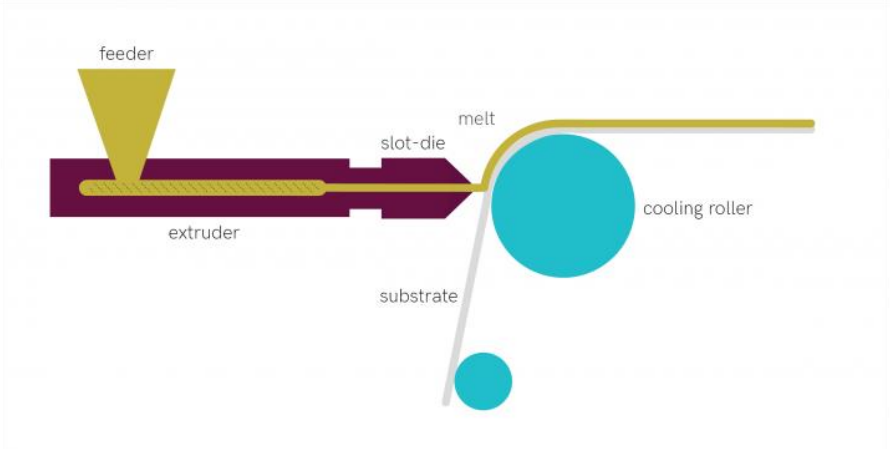

Figure 27: Coating[42]

6. Rotomolding

The treatment of plastic by rotational molding comprises the heating of a thermoplastic powder in a closed metal mold, rotating and removable, the transformation of the machinable plastic material by centrifugation in the heart of the mold, the cooling of the latter by means of water jets and / or cold air, and finally the demolding of the solidified part.

This is how certain hollow objects are made, such as canoes, windsurf boards, toys, vats, cisterns, or various pieces of furniture.

It should also be noted that the parts transformed by rotational molding are mainly recyclable plastics in medium and low-density polyethylene.

[42] https://www.centexbel.be/fr/plateformes-pilotes/plateforme-denduction-et-dennoblissement

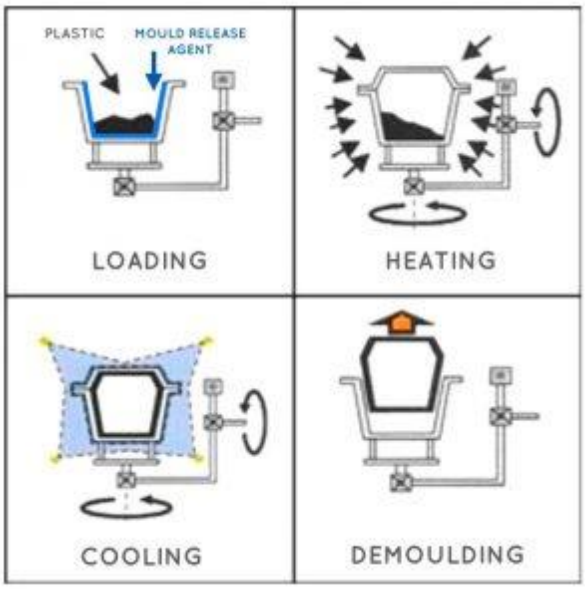

Figure 28: Rotomolding[43]

Collection and sorting of Plastic

Collection of waste from industrials

In France, industrial scraps represent around 30% of total recycled plastic waste. Various plastic wastes are generated such as low or high polyethylene density, PVC (like that of window fractions recovered from industrial carpenters), polyamides (PA), PET or polypropylene (PP).

The collected materials are usually clean. The plastics collected from professionals come in different forms: recyclable waste downgraded for reasons of non-compliance, poor workmanship, machine purges, films wound or not, injection cores (molded material which remains in the inlet channel of the mold of an injection press) and other materials used for the calibration of machines.

[43] https://concentrol.com/de/release-agents-for-rotomolding-process/

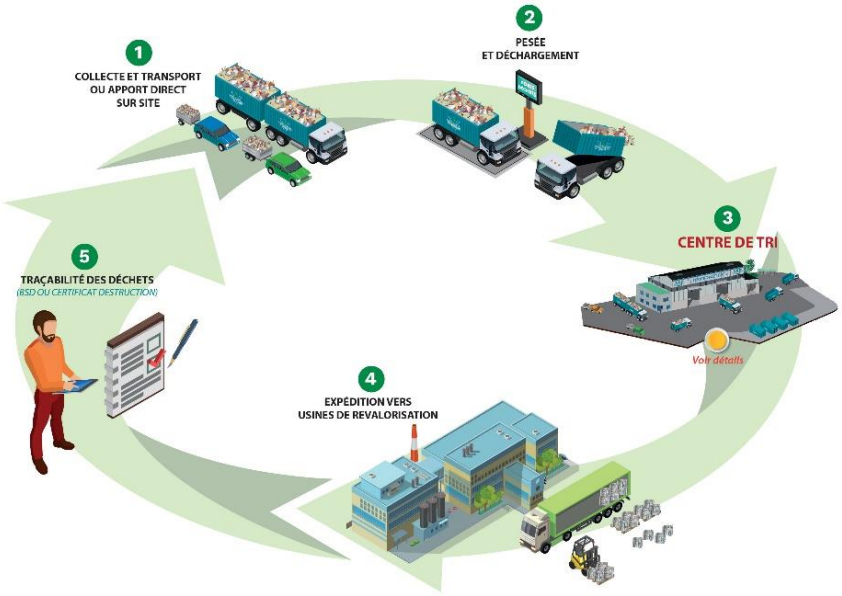

Figure 29: Waste management loop[44]

Collection from communities

The recovery of household plastic waste is increasing every year in France. In 2012, these materials represented just over 10% of total household waste collection, and 40% of post-consumer plastic waste.

In the same year, 6.73 billion bottles and other recyclable plastic bottles made of PET were collected for recycling. These materials are the main types of household plastic waste processed by recycling companies.

The recycling of household waste begins like paper and cardboard: an identified flow of materials (often placed in plastic collectors) are recovered by community providers from households, transported to sorting centres, baled, then recovered by recyclers, who will identify the materials, and ship them to factories specializing in waste treatment.

Two main streams of post-consumer treated plastics are identified: the clear stream (made up for example of soda, mineral water or sparkling water bottles) and that of opaque bottle-flasks (such as milk or milk bottles).

[44] https://www.negometal.fr/d%C3%A9chets-industriels.html

Figure 30: Household waste management[45]

Lifespan of plastics

Duration of use of different plastics depending on its use:

- ✓ Building and public works sector: pipes, windows, thermal insulation, external cables, floor coverings: lifespan 30 years and more
- ✓ Industrial sector: engineering plastics used for industrial equipment also have life spans exceeding 20 years.
- ✓ Transport sector:
- ✓ cars: 20% of the mass of a car is made of plastic (250 to 300 kg of plastic) for a lifespan of 9 years
- ✓ airplanes: 50% of the mass of an airplane is made of plastic for a lifespan of 25 years

Electronic sector:

- ✓ Lifespan of a smartphone: 15 to 18 months
- ✓ Laptop life: 3 to 5 years
- ✓ Lifespan of a washing machine: 11 years
- ✓ Lifespan of a refrigerator: 13 years

[45] https://slideplayer.fr/slide/4956613/

Textile sector:

- ✓ 2/3 of the sector use synthetic fibers for an average lifespan of 5 years but this duration decreases year by year. For example, Ademe estimates the average lifespan of a T-shirt at 35 days.

Packaging sector:

- ✓ the average duration of use of packaging is less than 1 month, or even a few minutes.

Cosmetics and hygiene sector:

- ✓ the average duration of use of plastics is a few months maximum.

In general, 81% of the plastics in circulation become waste after a year.

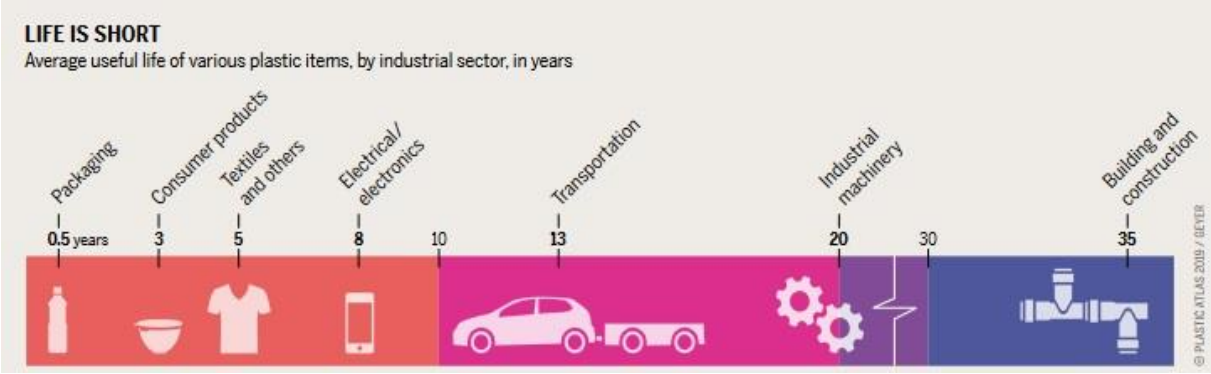

Figure 31: Lifespan of plastics[46]

[46] https://fr.boell.org/sites/default/files/2020-03/Atlas%20du%20Plastique%20VF_0.pdf

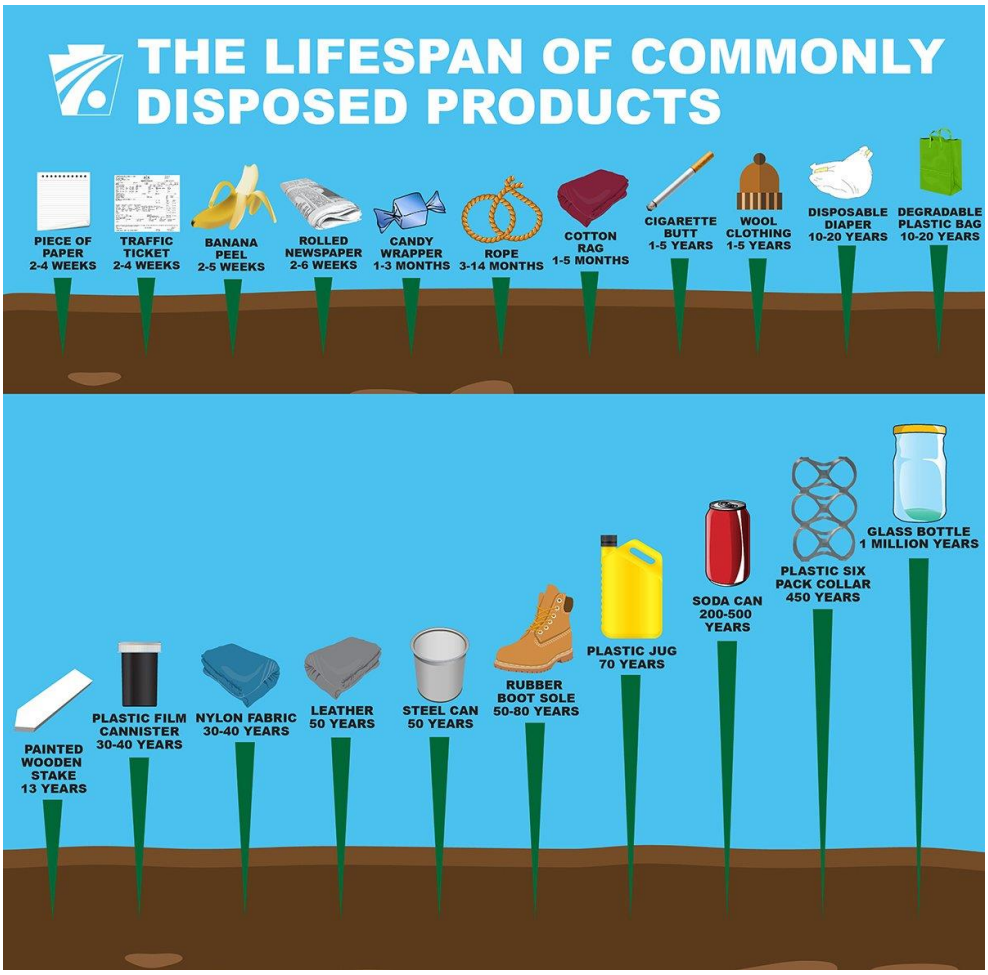

Figure 32: Lifespan of plastic disposed in the natural environment[47]

Read more about this topic here: https://www.unpri.org/plastics/risks-and-opportunities-along-the-plastics-value-chain/4774.article

4.6.5. Recycling Plastic

At the heart of the circular economy, recycling is the main contributor to saving materials and reducing pressure on non-renewable materials. Recycling helps prevent the waste of natural resources and energy, secures the supply of raw materials to industry, and reduces its environmental impact.

The incorporation of recycling raw material allows:

- ✓ lower consumption of energy, water
- ✓ less CO_2 emission

[47] https://www.penndot.gov/about-us/RoadsideBeautification/Pages/The-Great-PA-Cleanup.aspx

Recycling gives a real answer to face:

- ✓ industrial production as a result of waste management policies: recycling objectives, development of sectors with Extended Producer Responsibility
- ✓ the increase demand of plastic
- ✓ environmental and economic constraints

Extended Producer Responsibility (EPR) is a policy approach under which producers are given a significant responsibility (financial and/or physical) for the treatment or disposal of post-consumer products. Assigning such responsibility could in principle provide incentives to prevent wastes at the source, promote product design for the environment and support the achievement of public recycling and materials management goals.

The waste recycling industry is confronted with multiple challenges, products can consist of different layers of different types of plastic materials and can be presented in very small quantities.

On the other hand, industrial buyers are increasingly demanding top quality for raw materials in recycling.

Faced with this dispersion of the different plastics and the demands of users of plastic, significant progress has been made, in particular in the field of waste preparation and sorting with the increasingly important introduction of automated optical sorting technologies.

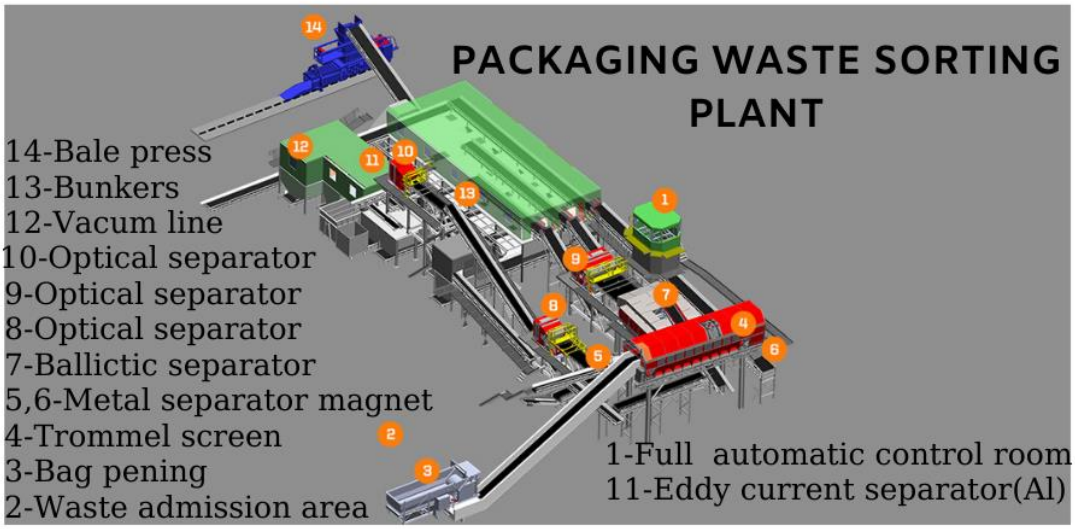

Figure 33: Packaging waste sorting plant[48]

[48] https://www.akfer.com/en/corporate-116-packing-waste-sorting-plant

The recycling plastic rate in Europe reach 30%, it is low compared to those of glass, scrap metal or paper and cardboard, this can be explained by the fact that:

- ✓ Plastic wastes are extremely diffuse, difficult to capture. In addition, products containing plastics are very varied and within the same product, several resins and materials are generally associated.
- ✓ Plastic wastes have a plurality of polymers which complicates recycling activities, in particular sorting.
- ✓ Waste trading and landfill compete with local recycling because these two alternatives can be more competitive in terms of cost per tonne, transport included.

Mechanical recycling

Mechanical recycling is the most widely used and least expensive technique but requires intensive sorting. It exposes the material to high temperatures, to remelt it, which accelerates its aging. The decontamination phase (removal of additives and impurities) is often not possible, which can prevent the plastic from returning to food grade. Thus, this recycling produces materials of often lower quality than virgin materials, and the number of times the material can be recycled is limited.

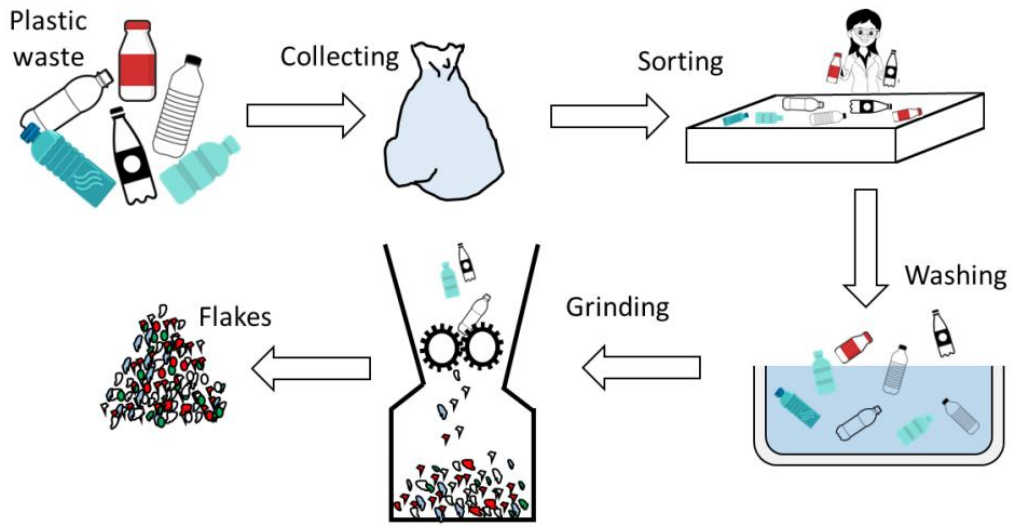

Figure 34: Mechanical recycling

Chemical recycling

Chemical recycling allows plastic to be transformed, for example to recover the monomers (depolymerization) decontaminated from the additives. In certain cases, it is therefore possible to produce, from the monomers, polymers which are completely identical to the virgin polymers. On the other hand, the economic model is sometimes difficult to apply on an industrial scale, and the environmental assessment, sometimes contested. Depending on the reaction temperatures required and the number of purification steps, this technology can be very energy intensive compared to mechanical recycling.

Not all plastics can be remelted (mechanical recycling), not all can be depolymerized, or recycled more widely. Thus, the most appropriate technique will be chosen on a case-by-case basis, depending on the waste to be treated (nature and quantity), while considering the economic and environmental cost, and the desired quality. One way to facilitate recycling would be to limit the diversity of plastics (in particular, additives used), to allow the development of more standardized techniques[49].

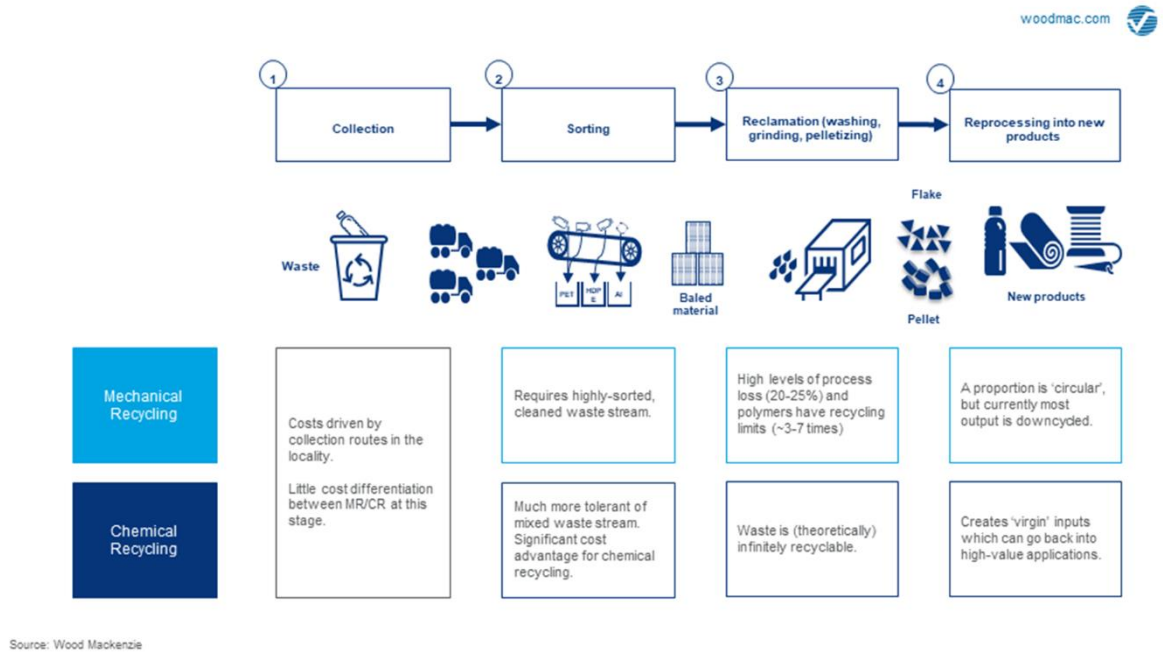

Figure 35: Difference between mechanical and chemical recycling[50]

Regeneration

Regeneration, also known as extrusion or granulation, is a plastic upgrading process that allows recyclers to produce high-end recycled plastic granules. Long processed, purified, homogenized, and ready to be mixed with virgin plastic granules or used as such, this secondary raw material (or compound) offers the highest possible level of quality.

The ground material is placed in a plastic extruder (that is to say a heating sleeve equipped with a screw, filtration systems and mechanical knives) to be softened there, free of residual pollutants by suction of the gases given off under the effect of heat, conditioned in the form of long pasty segments, cooled and finally cut by the knives to regain the size and structure of a virgin granule.

[49] https://www.paprec.com/fr/comprendre-le-recyclage/tout-savoir-sur-les-matières-recyclables/plastiques/re-generation-micronisation-et-broyage-des-plastiques/
[50] https://www.woodmac.com/news/opinion/can-chemical-recycling-make-plastic-more-sustainable/

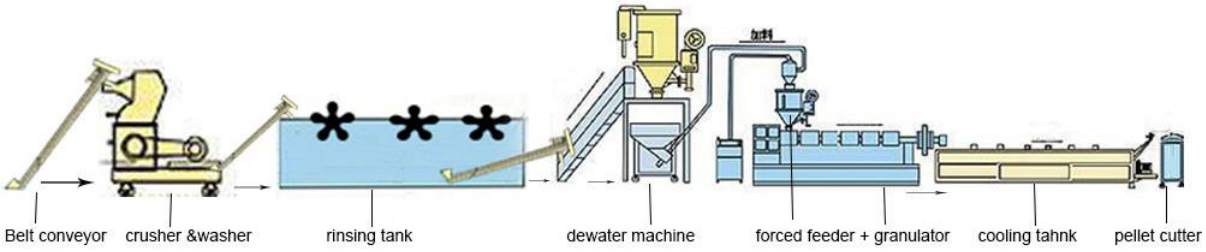

Figure 36: Regeneration of plastic[51]

Micronizing

Micronizing plastic involves of spraying the flakes into an extremely fine powder, which is generally considered of a lower quality than regenerated products (impurities not being removed, but simply reduced to a minimum size). Micronizing is practical, and more economical, it is very popular within the plastics industry. It is mainly used and mixed often with high-end materials to manufacture multi-layer products (an alloy of noble products for the upper layers, and micronized binders for the intermediate parts) resulting from plastic rotational molding.

New Products

There are many ways of reusing recycled plastics, and they vary depending on the type of plastic. They can be used to produce a large number of products, such as film, buckets or tools for low density polyethylene (LDPE), irrigation tubes, wheeled bins or bins from recycled plastic waste such as HDPE (high density), automotive parts, building materials or crawl spaces for recycled PP (polypropylene) plastic, joinery profile, induction tubes, adhesive tape or textile fibers for recycled PVC plastic, strapping (plastic band used to wrap packaging), fiber, thermoforming reels and preforms for PET, various injection or thermoforming parts for polystyrene, glazing for polycarbonate, and textile fibers or parts of automotive equipment for some polyamides (PA).

4.6.6. The challenges of recycling plastics

The problem with plastic lies with its end-of-life and the management of products made from it. Since 1950, only 9% of plastic used, has been recycled and 50% has ended up in landfill or dumped in the wild. Around 8 million metric tons of plastic waste ends up in the oceans. The lack of recycling represents a huge loss of value for local economies.

Read more here: https://journals.openedition.org/factsreports/5102

[51] http://www.plastic-machines.org/pp-pe-flake-products-recycling-and-pelletizing-machine

Once consumed, plastic objects become waste and their management is extremely variable from country to country. There are four types of profiles:

1. Developed economies with regulations that encourage recycling,
2. Developed economies that do not have incentives for recycling,
3. Developed economies with large industrial bases,
4. Developed economies with little industrial activity.

1. Developed economies with regulations that encourage recycling

Developed economies with regulations that encourage recycling tend to be rich countries, with modest growth, and good traditional waste management infrastructure with relatively high labour costs, like Western Europe and Japan. Regulations encourages recycling with a variety of incentives. Some organizations are created to finance some of the costs involved in collecting and sorting plastic waste. Funding generally comes from producers and retailers or is raised from consumers via green levies. This allows externalities relating to end-of-life management to be re-internalized into product pricing. In these situations, recycling depends on significant infrastructure for sorting and processing plastic waste by polymer type, capable of producing recycled plastic suitable for reuse by manufacturers. These countries also use measures to increase the cost of traditional processing solutions, in the form of taxes on landfill and incineration. Countries in this category can attain recycling rates in the order of 30%.

2. Developed economies that do not have incentives for recycling

In developed economies, like USA and Australia, without regulatory incitement, recycling remains underdeveloped and marginal due to its lack of competitiveness relative to other forms of processing. Less than 10% of plastic waste are recycled locally.

3. Developing economies with large industrial bases

Industrialized developing economies are generally characterized by inadequate waste management infrastructure. Collection is not systematic, and a large portion of household and industrial waste continues to be dumped at numerous unofficial and unregulated sites. Informal networks tend to be well developed and organized. Recycling develops primarily in reaction to the value of waste, driven by local industrial demand. This is the case in China, India and Brazil. Countries in this category can attain recycling rates in the order of 20%.

4. Developing economies with little industrial activity

Developing economies with a minimal industrial base have recycling rates close to 0%. A major portion of waste ends up in the ocean, often swept out to sea via informal dumps and rivers.

Mobilizing and aligning all stakeholders to redesign the plastics economy

A sustainable recycling sector can only emerge with an alignment of a very large numbers of actors in the ecosystem, at every stage of the product life cycle. This involves manufacturers that produce plastic products, petrochemical companies that produce raw plastic, retailers, consumers, waste managers, city authorities, governments, regulators, and NGOs.

Recycling develops local economy by re-internalizing employment within a territory. For example, a plant producing about 50,000 metric tons of recycled plastic will employ around 30 people. This is significantly more jobs than those generated by sending an equivalent amount of waste to landfill or incinerating it, or by the petrochemical industry synthesizing an equivalent quantity of virgin resins. Developing recycling also helps to deliver resource independence to countries with few oils or gas resources.

Setting up a system to recycle plastic waste allows a local industry to emerge and recover value from the recycled material. However, because plastic waste recycling systems are logistically more complex than traditional waste processing systems (separate collections, differentiated flows, etc.), this leads to higher waste management costs. This additional cost must be covered by producers and consumers of plastic goods through extended producer responsibility (EPR) as illustrated on the figures below.

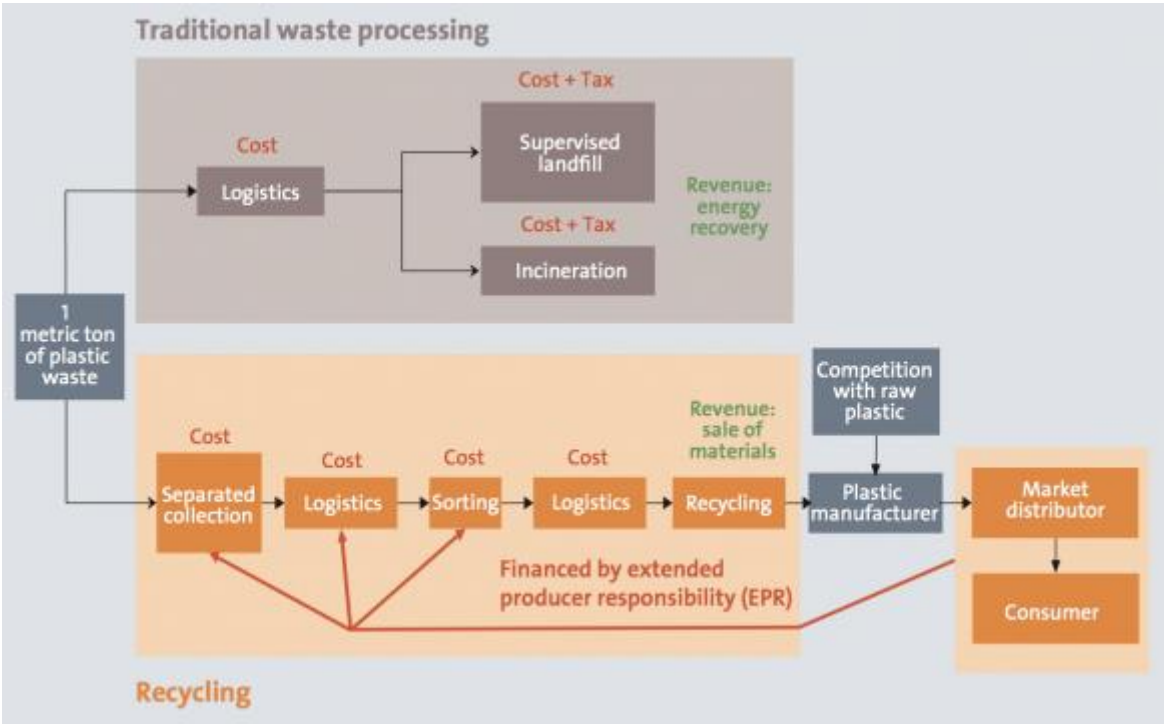

Figure 37: Traditional waste processing versus recycling (1)

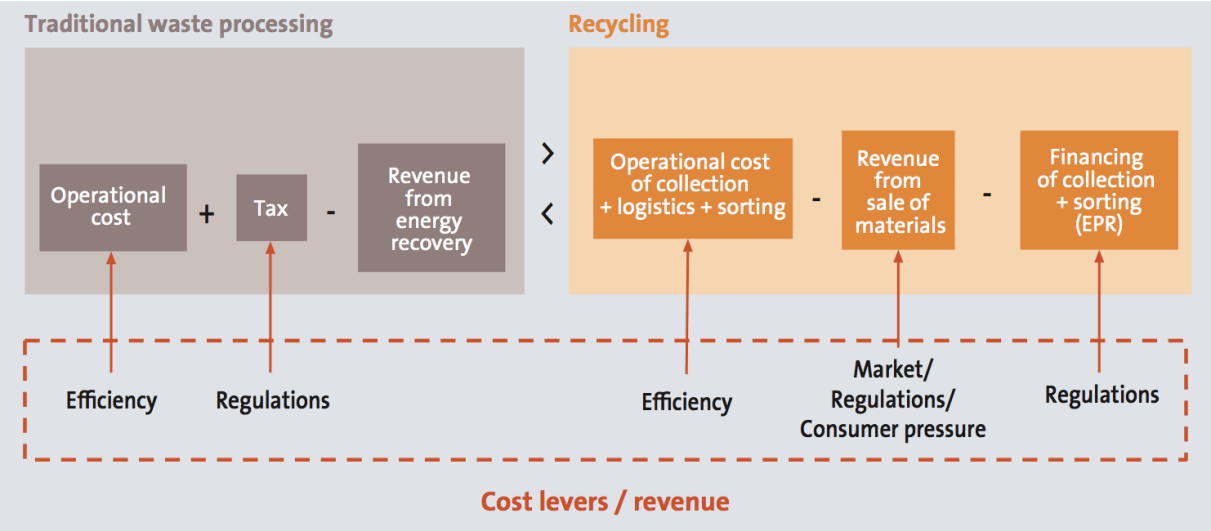

Figure 38: Traditional waste processing versus recycling (2)[52]

Lifecycle of products

Some factors are inhibiting the development of recycling at every stage of product life cycle: first on the product design, then during how the waste management is conducted, and finally how the recycled products are used.

Products can only be recycled in economically acceptable conditions if recycling is built into their design. For instance, using single-layer plastics facilitates recycling, and the use of multi-layer plastics with different polymers or materials complexifies recycling, and might be impossible. Furthermore, certain theoretically recyclable polymers are not recycled in practice because they appear in insufficient quantities in waste streams, and it cost too much to recycle them.

Recycled resins can often be hampered by problems of odour, colour, and quality. This means that it is difficult to offer an alternative that is exactly equivalent to raw resins. So, it is important to include these constraints during product development phases. Similarly, plastic manufacturers have to develop new eco-design to increase the amount of recycled material in the products.

Sustainability of recycling

The sustainability of recycling is also predicated on industrial demand for recycled material. Historically, it is cost factors that determine if manufacturers buy recycled plastic. Because of the correlation between the price of virgin plastic and that of crude oil, the plastic recycling sector is impacted by the variations in the price of Brent crude.

In order to protect the recycling sector from crude oil price volatility, measures could be taken to decouple the market for recycled plastic from the market for raw plastic. A requirement to include recycled plastic in products made from plastic would help to create a discrete market in recycled

[52] https://journals.openedition.org/factsreports/5102

plastic, one where raw plastic could not be simply used instead. In October 2018 the European Parliament voted to make it mandatory for beverage containers to contain at least 35% recycled plastic by 2025.

Innovations in sorting technologies can sort materials more efficiently with greater yields. Some of the latest sorting robots use artificial intelligence to improve their ability to recognize waste. The sector can also benefit from the scaling effect achieved by concentrating sorting and processing at centralized sites decreasing the production costs per metric ton of recycled plastic. Efficiency gains are possible in collection, sorting and processing.

Changes in final consumers' demands and behaviours is also important to encourage manufacturers to include more recycled plastic in their products. Pressure from consumers and civil society can push brands to increase the amount of recycled plastic in their packaging. Consumers have to take the responsibility for sorting their waste properly by properly following the guidelines, which has a direct impact on the quality of streams available for recycling.

4.7. Best practices in detail

4.7.1. Lessons learnt in plastic Circular Economy

What are market and regulatory obstacles in the European Union?

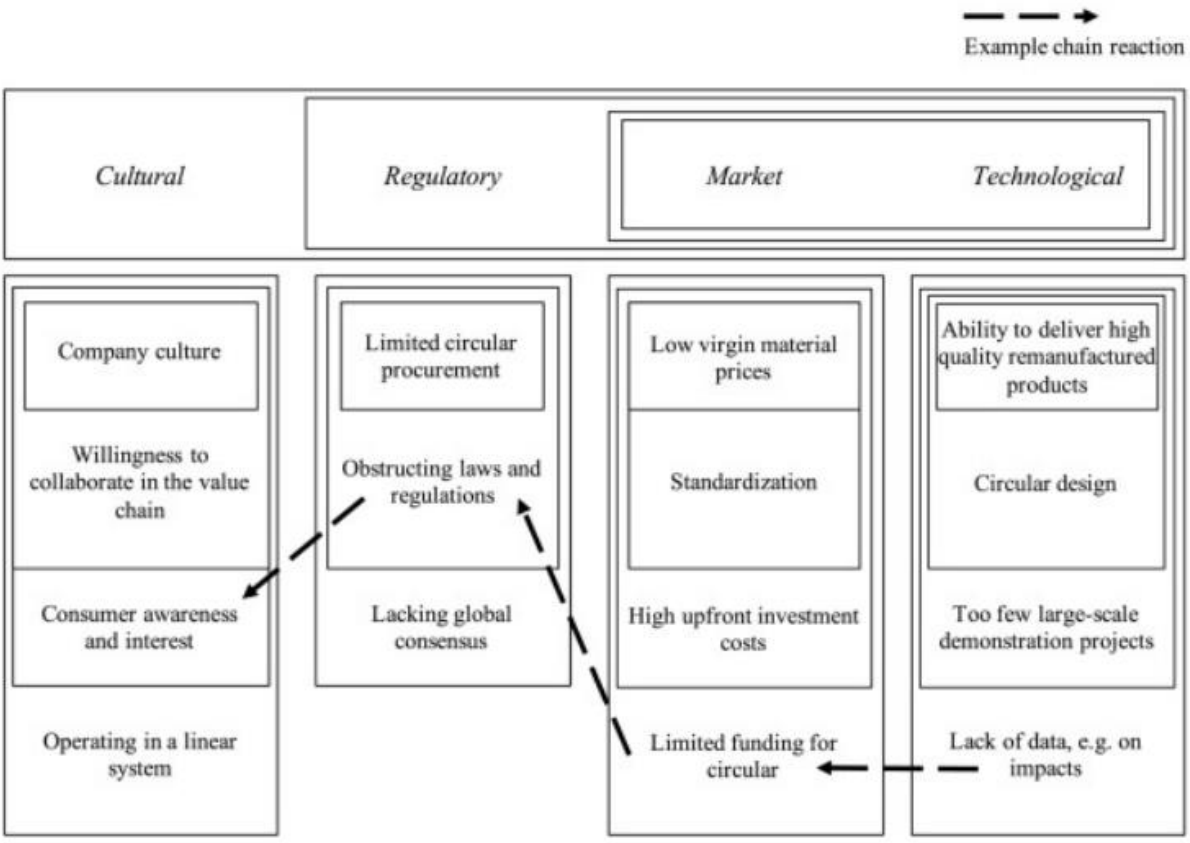

Figure 39: Barriers of circular economy, Sciencedirect

Barriers of Circular Economy can be divided into six different groups of obstacles:

- ✓ regulatory/ administrative barriers
- ✓ market barriers
- ✓ barriers related to lack of resources (financial and human)
- ✓ barriers related to the current way of managing waste
- ✓ cultural barriers (lack of consumer interest)
- ✓ technological barriers

Regulatory barriers

Regulatory obstacles refer to obstructing laws and regulations, lack of global consensus and limited circular procurement.[53]

[53] https://www.sciencedirect.com/science/article/pii/S0921800917317573?casa_token=gkycawtf7NEAAAAA:kAC6YNh7Y-hY6OYJg_QxHJ-88DNuRoL5Cww8ZkU9w7Lv8aLuWdNJAUajilM82ZFNS76xSQ

Regulatory barriers come from different, possibly conflicting regulatory objectives (e.g., public or animal health, environmental protection) which may be considered more important than the circular economy. In addition, the regulatory arrangements may be difficult or expensive to change as they can be part of a very complex system.[54]

According to a report focusing on "Regulatory barriers for the Circular Economy: Lessons from ten case studies", published by the European Commission, the key regulatory obstacles and barriers that hinder the realisation of the Europeans Circular Economy can be concentrated in the following 3 themes (the analysis covered the full product life cycle on the interfaces between the different steps of the value chain):[54]

1. **Collection of waste streams**

This barrier comes from a lack of specific legislation that would allow the collection and the pre-treatment of homogenous waste streams. Without this specific legislation, a lot of waste streams end up being mixed. This leads to the fact that reusing or e.g., high-quality recycling costs are higher than the income from the recycled materials (for example in the recycling of plastics).[54]

2. **Uptake of secondary resources**

During the production process, legislation is focusing on health and consumer protection, often undermining the opportunities and benefits of circular economy approaches. Another obstacle identified in this filed is the lack of harmonised EU legislation mandating specific quality requirements.[54]

3. **Design for reuse, repair or recycling**

This barrier is related to the lack of enforceable product requirements and concrete. The main example the report states is the problematic enforcement of the requirements of the WEEE Directive for or the recyclability of electronic products, especially concerning the disassembly of batteries.[54]

The report also highlighted a variety of different barriers:

- ✓ Focus of waste legislations on quantities (recycling targets and weight-based collection) than on qualities of recycled materials
- ✓ Inconsistencies between existing regulations, e.g., related to REACH or End-of-Waste criteria[54]

Another point when facing regulatory obstacles is the administrative framework. According to a research article, published by Garcia-Quevedo, firms consider the administrative procedure and the cost of meeting regulations of a highly important obstacle.[55]

[54] https://ec.europa.eu/growth/content/regulatory-barriers-circular-economy-lessons-ten-case-studies_en
[55] https://onlinelibrary.wiley.com/doi/full/10.1002/bse.2513?casa_token=cE2yA_AqymEAAAAA%3AuJJpZiLvAi-uSRnS5OSuj8LDzNfhiUXOrNIvV2GRkU9r57YNJE2ofr46CiZbGsh8AvySZSkfEmXY

Market barriers

An article published by Salemperä et. al. states that market barriers are related to low virgin material prices, high upfront investment costs, limited funding of circular business models and limited standardization.[53]

Low virgin material prices, prevent circular economy products to outcompete their linear equivalents. The article states that the recycling of materials often does not occur due to the fact that the production of virgin material is more economical for firms. In order to ensure the economic viability, circular economy strategies require financial subsidies, as frequently, circular economy initiative are stated as expensive. Furthermore, the article proposed that fossil-fuel plastic a way cheaper than bio-based plastics, influencing the affordability of the bio-based product.

High upfront investment costs appear as a relevant market barrier, as there is still a need for circular economy business learning curves. The first company to invest will probably lose money and then the second one will fortune money, therefore a lot of people waiting for each other.[53]

Lack of resources

In order to foster a technological push, green innovation and circular economy, physical, human and financial resources are required. If a firm is facing a lack of those resources, the possibility to foster innovation towards a circular economy is limited, as knowledge, human skills, provision and access to finance are essential for green innovation and a circular economy.[55]

Current waste management

The current waste management needs revising if material circularity is to increase. In order to foster a circular economy, more open and accurate data on waste is needed to boost business innovation. According to the article, there is a lack of operators enhancing the process of waste-based materials.[56]

Furthermore, the article is proposing that different actor groups do not share the same vision of barriers and that producers of circularity products would benefit from system thinking, as they primarily only recognise the barriers that a close to their own development activities. [56]

Cultural barriers

An article published by Kirchherr et al. in 2018 suggests that cultural barriers (especially consumer and company culture) refer to obstacles like a lack of consumer interest and awareness, a hesitant company culture, an operation in the linear system and a limited willingness to collaborate in the value chain.[53]

A lack of consumer interest and awareness especially refers to the limited consumer acceptance companies are facing, as consumers prefer new products. Furthermore, companies claim that consumers change their mind too fast, therefore it is difficult for firms to invest in durable, long-lasting products, which might last longer than the fashion trend.[53]

[56] https://www.sciencedirect.com/science/article/abs/pii/S0959652620343845?casa_token=Tx58N6gyUwcAAAAA:00FjcnSesL5bmUXK4uQTeOnphi-WUJu7iiagolvWYthz7GmBUJrW7nZQXsp_8Qr-QCNssZg

Related to the company's culture, the article states that circular economy is not integrated in the strategy, mission, goal, vision and key performance indicators of the firm. Therefore, companies have not mainstreamed to concept of circular economy yet. According to the article, the discussion of circular economy is often restricted to the corporate sustainability or environmental management department, not being a topic of discussion in operating or finances. It appears that circular economy is a niche discussion of professionals in a company. Moreover, the barrier of lack consumer interest is also influencing and resulting in the barrier of a hesitant company's culture.[53]

In addition, another cultural barrier is the operation within a linear model, as circular economy has not yet reached the mainstream. Companies face the obstacles that supply chains are not willing to apply a circular economy business model due to conservative thinking.[53]

Technological barriers

Technological barriers are limited to circular design (the design of the product is limiting the possibility to apply circular economy strategies), too few-large scale operation objects, lack of data (e.g. on impacts) and the ability to deliver high-quality remanufactured products.[53]

How to overcome market and regulatory obstacles?

Regulatory barriers

The report of the European Commission is proposing that many of the identified barriers are already focused on by the Commission. Additionally, the Circular Economy Action Plan is addressing these barriers by for example, the analysis of the interface between waste and chemical legislation or in the development of the plastic strategy.[54]

The government has to tackle the market barriers, for example via the elimination of fossil fuels subsidies or via the introduction of financial incentives for circular investments. Once those market barriers are handled, the government may be able to overcome the current chain reaction which is leading to the failure of a transition to a circular economy.[53]

Furthermore, ongoing exercise and plans of the program REFIT (= The European Commission's Regulatory Efficiency and Performance Program aims to ensure that EU legislation achieves its objectives for citizens in an effective, efficient and cost-effective manner) are also going to be informed about the results of the report.[54]

Market barriers

To overcome the barriers by the current waste management, findings of the study published by Salemperä et. al show that it can be promoted by:

- ✓ illustrating the economic benefits of the circular economy
- ✓ better sharing of waste related data
- ✓ increasing the dialogue and cooperation between key players
- ✓ harmonisation of regulations and their interpretations

- ✓ the waste management sector could take a more diversified role in the implementation of a circular economy (by providing waste processing services for the needs of the manufacturing industry)[56]

In addition, virgin material prices have to be higher in order to foster more affordable circular products. Those affordable products then have the ability to encourage consumers awareness, as consumers are indicated as very cost-conscious, when they are making a decision on what to purchase. As a positive effect, this would motivate more companies to focus on circular products.[53]

How to achieve positive changes in consumer behaviours?

For people to change, three conditions are necessary: MOTIVATION (people need a reason to change), ABILITY (people require skills, knowledge and confidence to change) and OPPORTUNITY (people require the resources, relationships and environmental conditions).[57]

Figure 40: Conditions for change, Source: NBS

According to McKinsey and company as well as the website "Network for sustainability", the following approaches can help to change the consumers behaviour:

1. "Reinforce positive new beliefs
2. Shape emerging habits with new offerings
3. Sustain new habits, using contextual cues
4. Align messages to consumer mindset
5. Analyse consumer beliefs and behaviours at a granular level"[57]
6. "Equip people with the right (environmental and sustainability) knowledge
7. Help people process information
8. Leverage the leaders
9. Make actions easy and enjoyable
10. Allow participation
11. Take on step at a time
12. Pause rewards"[58]

[57] https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/understanding-and-shaping-consumer-behaviour-in-the-next-normal
[58] https://www.nbs.net/articles/how-to-motivate-people-toward-sustainability

1. **Reinforce positive new beliefs**

The beliefs of a consumer are psychological and the set of beliefs a consumer holds about the environment is a key influencer of the consumer behaviour. Those beliefs might be so deeply rooted that they don't evaluate existing alternatives and therefore maintain to their existing habits and routines. If those beliefs are ignored or challenged, it is like fighting and uphill battle.

For example, the Covid-19 crisis has forced consumers to change their habits and routines. The new experiences made during the pandemic has caused humans to change their beliefs about a broad range of everyday activities (grocery shopping → grocery delivery, home exercises, socializing, etc.). Long-held beliefs can be changed if consumers are surprised or even delighted by new experiences, which is making the consumer more willing to repeat that new behaviour.

When trying to change a consumer's behaviour, an effective time to reinforce a new belief is during peak moments. A peak moment is a specific moment during a decision journey which the consumers remember the most, where the consumer reaction is the most. Those moments often include first-time experiences. Companies have to focus on, identify and optimize those peak moments. A moment is for example in a grocery store, when a consumer is discovering an exciting new product on the shelf. During online shopping a peak moment might be the unboxing of the product or an on-time delivery. Those positive experiences reinforce positive consumers connections to a certain product.[57]

2. **Shape emerging habits with new products**

Product innovation is another way to shape consumer behaviour. For example, the Covid-19 crisis has made consumers think more about their health, being fit, the environment or shopping locally. Therefore, innovate your product or service in a way that it is adapting to the new way of thinking and creating positive experiences with it. [57]

3. **Sustain new habits, using contextual cues**

When a consumer begins to associate a certain behaviour with a particular context, new habits can be formed. To shape those habits, it is crucial to identify the drivers of the behaviour (e.g., a particular task, time of the day, project placement, laziness, etc.).[57]

4. **Align messages to consumer mindset**

Heightened emotions and increased polarization (especially during the last few months) can drive lasting changes in consumers behaviour and shape long time preferences. Therefore, it is important to communicate to the sentiment of the consumers.[57]

5. **Analyze consumer beliefs and behaviours at a granular level**

It is important to conduct primary consumer insight work, focusing on changing consumer behaviour, beliefs, habits, motivators and norms. Therefore, you can get a comprehensive picture of the consumers decision journey.

As a precursor for quantitative research, qualitative and exploratory research plays a particular role. Vital tools to help understanding emerging behaviours and contextual cues are data-gathering and monitoring techniques (social media "listening, mobile diaries and artificial-intelligence-driven

message boards). Those gathered insights can generate new thinking within an organization, company etc. and be validated through larger-scale surveys. With the results and new findings, redefining product offerings and (marketing) messages can be placed accordingly.[57]

6. **Equip people with the right knowledge**

As the platform "Network for business sustainability" describes, in order to change the consumer behaviour, it is important to first of all equip consumers with the right knowledge. This means that people have to know why taking actions is required and how they can do it. Due to the fact that people can be hesitant sometimes when doing something that is unfamiliar, being able to try new actions in a small way can be reassuring. A great low-risk strategy are pilot programs.[58]

7. **Help people process information**

It is important to let a message sink it and repeat it multiple times. People are more affected by stories and positive messages because consumers absorb ideas and make decisions in specific ways than by abstract statements.[58]

8. **Leverage the leaders**

People are likely to follow when other people they like or respect do something. If those people endorse a behaviour their followers are likely to adopt them and deciding to act the same. Leaders can be from an organization, a work colleague or for example a public figure. Standards are also set by peer groups, therefore group activities can be a way to show that others are engaged as well.[58]

9. **Make actions easy and enjoyable**

The actions of people won't happen without practical support. This means that if for example a recycling bin is close by people will use it or if a product is not readily available consumer are not likely to buy it. According to the platform, social norms, positive messages and group activities can make sustainability more fun and bring it closer to people and their personal behaviour.[58]

10. **Allow participation**

Quiet often people want the possibility to contribute with ideas as they want to be involved in issues that concern them, not just receiving information. Allowing consumers to participate often leads to new innovative ideas.[58]

11. **Take one step at a time**

Consumers prefer by starting with one change of behaviour before trying another as they might get overwhelmed by a major change. Therefore, it is important to introduce gradually and connecting those changes to things that people are already familiar with.[58]

12. **Pause rewards**

Rewards are defined as an extrinsic motivation for people from the outside but they should be used carefully. Rewards tend to be effective while they continue but once stopped the behaviour might continue. It is more long-lasting to develop motivation that is more internally and rooted in their beliefs.[58]

4.7.2. *Successful business stories in plastic Circular Economy*

The waste management is considered to play a key role in the transition towards a circular economy, where making use of a design that eliminates waste, regenerate biological materials and the restoration of technological materials are the main principles.[56]

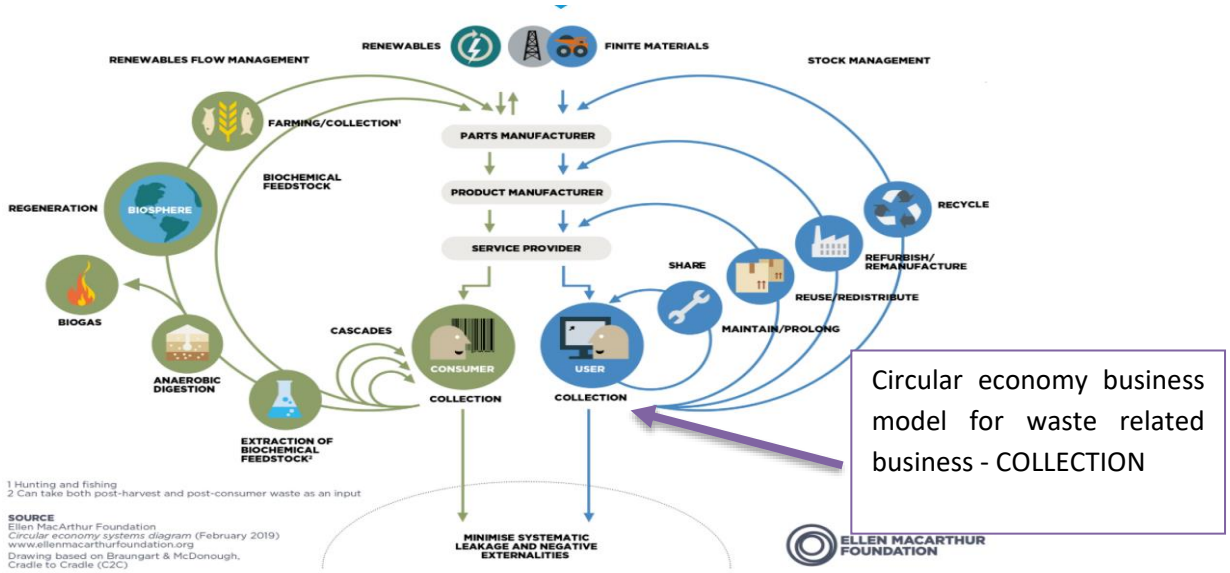

Figure 41: Butterfly diagram, Source: Ellen MacArthur Fundation

Following the butterfly diagram published by the Ellen MacArthur Foundation, a circular economy business model for waste related businesses is in the inner circle of the technological cycle: Collection. Below, some examples are presented, which follow a waste related business model by collecting and revitalizing waste or waste prevention in the first place.

The following section is describing successful business stories in the circular economy of plastics, for example the *Ocean Cleanup* as a worldwide non-profit organisation or the initiative *G'scheit feiern* based in Graz, as well as one example of a successful waste management story in a city. Further successful business stories are also *Das Gramm/ Das Dekagramm*, *Heidenspass*, *Carla shops*, *Revital* and *Graz repariert* from Austria.

Revital

An example for a waste related business model is the Public Private Social Partnership called *Revital* in Upper Austria. *Revital* is a Public Social ReUse Network with 240 employees. Reusable old goods are collected in a controlled manner via selected collection rails (in 111 collecting centres in Austria), their reprocessing is carried out in qualified facilities and the revitalized products are delivered to the sales outlets (23 reuse shops in every district in Austria) of the respective *ReVital* partners. These partners are predominantly employment-promoting organizations. In order to guarantee high standards to new owners, only those products are accepted that meet defined acceptance criteria and are complete,

undamaged and presentable. Quality on the second-hand market at reasonable prices. Therefore, *Revital* products are ecological, cheap and social.[59]

Carla Shops by Caritas

"*CARLA*" is the name of the re-use and second-hand shops of Caritas, a social aid and service organization of the Roman Catholic Church and a member of Caritas Internationalis. In these shops, used and well-preserved items that have previously been donated to Caritas by private individuals or companies are sold or are given out free of charge to people in need. The amounts of donated goods rise steadily every year, in 2019 it was 2.876 tons.

The basic philosophy is: "Everyone is welcome at Carla". Therefore, the shops are visited by people from different social backgrounds. Carla is not only the Caritas donation market, but also an employment project. People on the edge of the labor market find employment at Carla.

For many years, the *Carla* donation warehouses have been a hub for usable, intact goods donated by people who no longer need them. On the one hand, women, men and entire families are supplied with clothing, table and bed linen from this pool, and on the other hand, furniture, crockery, clothing, etc. are sold in order to finance aid projects with the proceeds.[60]

Das Gramm/ Das Dekagramm

Das Gramm and *das Dekagramm* (German word for decagram) are two packaging-free stores in Graz, which offer mainly regionally produced food from controlled organic cultivation, which you pay by weight. In addition to food, there are more non-food goods such as household and hygiene products, e.g. bamboo toothbrushes, dental floss, toothpaste powder, washable makeup removal pads, menstrual cups, solid hair shampoo, deodorant cream in a jar, ... but also home remedies for cleaning, such as baking soda, soda and citric acid. Products that need packaging are available in deposit jars or paper bags, in order to avoid disposable plastic as much as possible. The quantity required can be purchased according to need, thus they are taking action against food waste.

In addition, the gram offers workshops on environmentally relevant topics, sustainability, healthy food and much more to teach the conscious use of resources and other topics related to sustainability and zero waste (e.g. Do-It-Yourself laundry detergent). In addition, food from the store that threatens to expire is processed into meals in the in-store kitchen. Various other projects, activities and cooperation are the basis of the company's philosophy.

To act against global challenges such as the climate crisis, the "Das Gramm Academy" trains "Zero Waste Coaches" to teach them with expert knowledge on sustainability, fair business, zero waste and resource conservation.

Das Gramm additionally offers group tours to show how unpackaged shopping works, give tips on how to reduce waste, and provide insights into the entire product range and behind the scenes.

[59] http://www.revitalistgenial.at/header/englisch.html
[60] https://www.carla.at/

The primary concerns are environmental and social ones as the *Dekagramm* is not profit oriented. The company stands for fair trading conditions, fair wages and creating added value for our environment.

Heidenspass

The Graz-based work project *Heidenspass* has been active in the field of upcycling since the year 2000. *Heidenspass* is both an upcycling design workshop and a social work project. They develop and sell products made from used materials and in doing so offer work to young people between the age of 15-25 in difficult life situations in an unbureaucratic way.

Upcycling is the art of developing something new from used material with creativity and thus extending the product life cycle. Together with young people in NEET (Not in education, employment or training) situations, the team develops bags, backpacks and many other useful products from used materials.

The work project is following two principles, which can be seen as important success factors:

- ✓ "Work should always be fun! The success of the work project is the close contact with the adolescents.
- ✓ Financing: A first step is the establishment of a non-profit limited company, which is supported by the association. Beyond that the financing is to be extended on several legs e.g., over co-operation with enterprises. In this way, the own revenue is to be increased to 50%. With the size of the association, also the customers become more demanding, and the association becomes revenue-driven to not only be dependent on subsidiaries by the public sector. Still, as all the young people are disadvantaged the public sector has a lot of responsibility."[61]

GRAZ repariert (repair network)

Following the principle "Throwing away is not the only option! - Repairing instead of buying new saves the environment and resources" *GRAZ repariert*, the new repair network in the city of Graz sends a clear signal: repairing is more than just a trend! *GRAZ repariert* makes it easier to quickly find reliable specialized workshops that offer competent advice, transparent pricing and high-quality repairs in the immediate vicinity.

In Graz - as elsewhere - objects and devices that no longer function or are broken often end up in the trash, even though their repair would still be possible and make economic sense. Too often, a new purchase is preferred to a repair. This circumstance contributes to the fact that the waste stream, the consumption of resources, as well as the environmental impact continues to grow. *GRAZ repariert* wants to counteract this development by targeted information and awareness raising, to strengthen the idea of repair and thus to stop the trend to prematurely buy new (often short-lived) products. *GRAZ repariert* is a network of repair businesses from all sectors initiated by the City of Graz in cooperation with *ARGE Abfallvermeidung* – a waste prevention company located in the city of Graz.

In the member companies of the network, repair and customer service are top priorities! Professional advice, customer-friendly service, transparent pricing and many years of experience in the repair sector make the member companies competent partners of the network.

[61] https://www.heidenspass.cc/

R.U.S.Z washing machines

R.U.S.Z (repair and service centre) washing machines is a company in Vienna in Austria, with 19 former long-time unemployed employees. The company follows the principle "product as a service" and is offering the possibility to rent a washing machine with a one-time deposit and then a monthly rent. The offer includes one service per year, repair whenever it is needed and a replacement when the devices have served.[62]

The Ocean Cleanup

A successful business story in the circular economy of plastic is *The Ocean Cleanup* – "the largest cleanup in history". The non-profit foundation was founded in 2018 by the Dutch inventor Boyan Slat and consist of more than 90 engineers, researchers, scientists and computational modelers who are working daily to rid the plastic in the ocean. The foundation is developing advanced technologies to get rid of the world's ocean plastic. The developed cleaning method is using the natural ocean forces to cost-efficient and rapidly clean the oceans with a full feet of cleaning systems. Their aim is to clean 50% of the Great Pacific Garbage Patch every 5 years. In addition, the *Ocean Cleanup* has developed the first scalable solution to intercept plastics in rivers before it is reaching the ocean.

The *Ocean Cleanup* has recently launched their first product made from plastic of the Great Pacific Garbage Patch: sunglasses, where 100% of the proceeds goes towards the continuation of the ocean cleanup.[63]

4ocean

4ocean is a public benefit cooperation and certified B Corp committed to end the ocean plastic crisis. The non-profit cooperation is aiming to recover harmful marine debris that is polluting the ocean and educate people about the global crisis and empower them to end their use of single-use plastics.

On their website, 4ocean is selling products (bracelets, bags, accessories, drinkware, beach gear, single-use alternatives, etc.) which come with a One Pound Promise when purchased, meaning that one pound of trash is getting pulled out of the ocean rivers and coastlines after sale. Furthermore, every purchase supports a growing movement to end the worlds reliance on single-use plastic and helps funding their global cleanup operations. [64]

G'scheit feiern

The initiative "G'scheit feiern" in Styria is part of the network "Green Events Styria", promoting green events with focusing on green procurement, waste prevention, regional products and catering as well as on environmentally-friendly arrival and departure of the guests.

The team of "Gschei't feiern" consists of environmental and waste consultants of the Styrian waste management associations. Due to their core competence in the field of waste management, the experts help to avoid waste and support the separate collection of unavoidable waste for recycling. In

[62] https://rusz.at/
[63] https://theoceancleanup.com/
[64] https://www.4ocean.com/

addition, the waste consultants advise and support the use of regional, ideally organically produced, food. To this end, criteria were drawn up for the three focal points of waste and reusable materials, regional products and travel to and from the event, which are intended to ensure environmentally conscious celebrations and the associated quality. In order to be allowed to organize an event under "G'scheit feiern", organizers must commit themselves in writing to fulfil these criteria. The seal of approval may only be used on the occasion of a "G'scheit feiern - Event".

When planning an event, "G'scheit feiern" is facing the issue of waste prevention with serving reusable crockery, cutlery and glasses to avoid the use of single-use products. In the last 18 years, "Gschei't feiern" helped saving 4400 tons of waste for over 4 million years.[65]

BackCup Graz

BackCup is the reusable cup from Graz, which is easy to fill and return. Switching to reusable coffee cups is the environmentally friendly alternative to the conventional coffee-to-go cup. The City of Graz / Environmental Office, in cooperation with currently 45 partner catering establishments, has put 11,500 reusable coffee cups (BACKCUP) into circulation in Graz. If a customer want to use the concept of BackCup they simply have to get their cup filled and purchase it for a deposit of 1 euro. After drinking your coffee, the cup can get returned at a partner company and the customer gets the deposit back. Finding stores which offer this concept of reusable cups can be found via an app. [66]

A cup can be reused up to 500 times, bringing the current potential savings to over 5.5 million disposable cups. The BACKCUPs are available in 2 sizes (0.4l & 0.25l). They are produced in Germany and are bisphenol A free and recyclable. [66]

Ljubljana in Slovenia

A successful business story for the circular economy of plastic in cities is Ljubljana, capital city of Slovenia. The city can also be described as the most successful "Zero Waste Capital" in Europe. The capital is promoting campaigns for waste prevention and recycling since 2014. Sagna, the public company which is providing the waste management in Ljubljana has managed to reduce the amount of waste sent for disposal by 95% and to multiply its separate collection of organic waste. In order to manage those changes, Sagna followed three main waste management strategies:[67]

- "Introduction of a door-to-door collection system, specifically focused on the collection of organic waste
- Lower the frequency of collection for residual waste while keeping the collection of recyclables and organic waste the same
- Strong communication strategy focused on prevention and reuse to engage citizens."[67]

[65] https://www.gscheitfeiern.steiermark.at/
[66] https://www.umwelt.graz.at/cms/ziel/9274928/DE/
[67] https://zerowastecities.eu/bestpractice/best-practice-ljubljana/

After adopting those strategies, the total waste generation has been decreased by 15% in the last 14 years and the recycled or composed waste has gone up to 68%. Furthermore, as already mentioned, the amount of waste for landfill decreased by 95%.[68]

PET Cup - An inspirational initiative for clean waters

Waste pollution on river Tisza is a huge environmental problem. Tisza is the second biggest river of Hungary, that arrives from Ukraine through Romania and Slovakia; flowing towards Serbia to join the Danube. PLASTIC Cup, this non-profit, non-governmental initiative, was created to eliminate the problem of cross border environmental issue. This action contributes to clean river Tisza by organizing events, waste collection campaigns spanning several months, team-building activities, exhibitions and professional discussions throughout the year. The three main goals are: conservation of living waters, water sports promotion (kayaking, canoeing) and community building.[69]

Startup Plastic Surgery – Rethinking plastic

Focuses on fighting against climate change through complete life cycle recognition of plastic. The initiative launched in 2020, aims connecting climate innovators from different fields and committed to build a strong climate innovation community in Hungary. KIK provides a knowledge-sharing and networking platform which is open for individuals who are willing to change our future and contribute to tackle the challenges of climate change. Through the insight of our startup programmes, they help idea owners to transform their greentech ideas into climate-positive businesses. Since 2013 they supported more than 200 startups, provided more than 1300 mentoring hours and distributed more than €1 million among the best Hungarian greentech startups.[70]

Mare Vivu

Mare Vivu is a Corsican association founded in 2016 by 2 Corsican students. This association is specialized in the fight against plastic pollution in the Mediterranean, it is today engaged in low-tech research, local recycling experiments and the promotion of zero waste.

Each year, it organizes its scientific and educational eco-volunteering mission in a trimaran kayak, which crisscrosses the Corsican coast for a month in search of testimonies on the health of marine ecosystems: the CorSeaCare Mission.[71]

Healthy seas

Healthy seas was founded in 2013 aiming to tackle ghost fishing in order to avoid the useless death of marine animals. Based on volunteers and also maritime sector actors to do these actions.
Ghosts fishing nets are recovered, put out of the sea by Healthy seas in order to save marine lives and recycled into manufactures to sell nylon finishing into fashion and interior industries.[72]

[68] https://www.boell.de/de/plastikatlas
[69] https://petkupa.hu/eng/
[70] https://startup-plastic.hu/en
[71] https://mare-vivu.org/
[72] https://www.healthyseas.org/

Plastic Bank:

Plastic Bank is a startup founded in 2013 and located in Brazil, Indonesia, Haïti, and Philippines. They created some collection points in these countries where the population can bring their plastics wastes. With these wastes, they have the choice to sell, to save money or buy services with this "exchange". The collected plastics are recycled and sold to manufacturers which Plastic Bank signed partnership with. The idea is to treat plastic as an interesting money in countries in which there is a lack of public services in waste management.

Services can be as following:

- ✓ Buying electricity
- ✓ Credit for phone
- ✓ Wifi
- ✓ School fees

On the website, we can see that Plastic Bank have recycled 24,9 millions tons of plastics since the beginning of the creation of the company and 17,4 millions only in 2020.

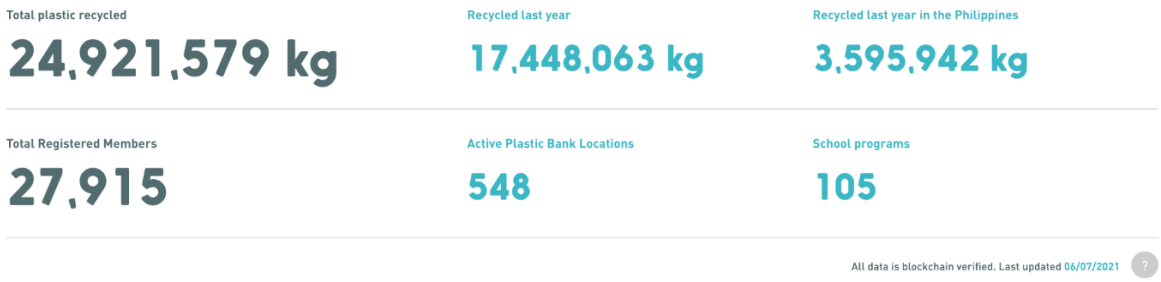

Figure 42: Source: PlasticBank

4.7.3. How to identify greenmisleading?

First of all, greenwashing or greenmisleading is defined as a misleading concept, to fool consumers into thinking that what they are buying is a more environmentally friendly, sustainable and healthier option. It is a practice used by companies of all sizes. Greenwashing is a communication and marketing strategy adopted by companies or other organizations to look "green" in front of the public – so it is about more marketing than actually committing. It means to put forward ecological arguments to force an ecological and responsible image for outsiders, although the communicated facts do not correspond with the reality: unecological or insufficient ecological practices. The term greenwashing was created in the 1990s by NGOs and is a combination of the words "brainwashing" and "green", with the aim to expose harmful practices of big industries. It became popular in the 2000s when the public started to care about ecological issues and companies realized that there impacts of their business is catching more and more attention of the population.[73]

Forms of greenwashing are for example the usage of packaging in earthy colours – like green or brown -, pictures of healthy fruit, nature photos, blooming flowers and trees or smiling people, or the use of vague terms like "natural", "sustainable", "responsibility" or "eco-friendly". Another example is

[73] https://youmatter.world/en/definition/definitions-greenwashing-definition-what-is-greenwashing/

companies using the wording that something is made “up to” 90% recycled materials – but only because it says “up to” does not mean that is 90%, it can also be way less (for example, think about someone claiming to give someone else up to 100€ - the person can give 100€, but also only 10€).[73]

The strategies of green image cultivation are always oriented towards the respective addressed public and target group. The methods used are therefore diverse and are not limited to conventional posters and advertisements. Here are some ways to identify if something is involving greenmisleading:

1. **No proof**

The first sign of greenwashing is if there is no proof: that means that there is no scientific evidence, no support or verification from third parties or no easily accessible supporting information. This kind of information can be found on the back of products, on the website of the company or included in the corporate sustainability reports (but it is also important to be aware of misleading information, as there are no binding guidelines – just voluntary standards).[74]

2. **“Hidden-trade-off”**

A “hidden-trade-off” is when a company is advertising a product as “green” or “sustainable” when there is only one attribute of the product actually sustainable and leaving all other attributes, which might actually be unsustainable, behind. An example given by the website “planA Academy” is when a company is labelling a product “made out of 30% recycled plastic” and leaving other attributes like carbon emissions, transportation method or energy use during the manufacturing process behind.[75]

3. **Vagueness**

As already mentioned, another sign of greenwashing is the use of vague terms and a “fluffy language” like “green”, “sustainable”, “all-natural” or earthy colours and “natural” pictures. Terms like this can mislead consumer into thinking that what they are buying is actually sustainable and environmentally friendly when it is not. A good example is the chemical element mercury: it is possible to advertise products made from mercury as “all-natural” as that is true because the element occurs naturally in the environment, but it is still poisonous.[76]

4. **No overall commitment**

When a product is communicating or advertising a single environmental claim, but the company is not committing to sustainability at all, is another form of greenwashing.[77]

5. **False labels**

Something that also occurs and can be defined as greenwashing are companies using false labels or certifications by third parties that are not sustainable, fake or simply don’t even exist.[78]

[74] https://www.ul.com/insights/sins-greenwashing
[75] https://www.ul.com/insights/sins-greenwashing
[76] https://www.sciencedirect.com/science/article/pii/S0959652618318961
[77] https://www.sciencedirect.com/science/article/pii/S0959652618318961
[78] https://www.ul.com/insights/sins-greenwashing

6. Fibbing

Another form of greenwashing are companies using false or not true slogans. For example, claiming to be “rainforest certified” when they are not. [79]

7. Irrelevance

A case of greenwashing occurs when companies claim that the products are for example CFC-free, when the usage of CFC is forbidden under the Montreal Protocol. That means the advertisement with facts that are simply not relevant or unimportant although they are the truth.[80]

8. Lesser of two evils

Products that are labelled with a fact that is true but distract the consumer from the real environmental problem and impact as a whole. An example for this case are organic cigarettes, which sound better than normal cigarettes but still do not solve the overall problem.[81]

Additionally, further examples or indications of greenwashing are institutions that form (alibi-)collaborations with environmental organizations or so-called “Astroturfs” (front organizations, which in the dress of a citizens' initiative and carry the wishes of their clients into the public) or cheer up and advertise marginal environmental projects to distract the public.[82]

There might be cases where institutions are greenwashing simply because they don’t know that they are greenwashing. They mislead themselves and consumer into thinking that what they do is the better, environmentally friendly option although it might be not. Therefore, it is important to always look at the whole cycle of the product: for example, the downcycling of products. When the products would be landfilled or might end up as a waste in the environment or in the sea, it is a good option to downcycle them and is still better than doing nothing. Otherwise, if the products would be collected and the upcycled, it is better to do it this way. In this respect, it is also of great importance to look at the given infrastructure.

In developing countries, the downcycling of products is still better than nothing or the products going to landfill. In developed countries, where there is already a better infrastructure implemented, downcycling would be the worse option and companies claiming to do that would be a form of greenwashing.

Last but not least, it is also important to look or be aware of, who might be behind some “environmentally friendly initiatives”.

[79] https://www.sciencedirect.com/science/article/pii/S0959652618318961
[80] https://www.ul.com/insights/sins-greenwashing
[81] https://www.ul.com/insights/sins-greenwashing
[82] https://www.lobbycontrol.de/wp-content/uploads/download/greenwash-studie.pdf

4.8. Policy, legislation, regulations of plastics and circular economy, on EU level. Evolution and impact in the sector

The EU is involved in the circular economy and is aware of the urgency of the matter. Such transition is the opportunity to transform the economy and think about new and sustainable competitive advantages for Europe.

The circular economy can boost the EU's competitiveness by protecting businesses against scarcity of resources, helping to create new business opportunities and innovative, more efficient ways of producing and consuming.

It should create local jobs at all skills levels and opportunities for social integration and cohesion. At the same time, it should save energy and help avoid the irreversible damages caused by using up resources at a rate that exceeds the Earth's capacity to renew them in terms of climate and biodiversity, air, soil and water pollution.

4.8.1. European legislation: Action plan for the Circular Economy

The legislative proposals on waste, adopted by the Commission include long-term targets to **reduce landfilling and to increase preparation for reuse and recycling** of key waste streams such as municipal waste and packaging waste. Further measures are proposed to make implementation clear and simple, promote economic incentives and improve extended producer responsibility schemes. **By stimulating sustainable activity in key sectors and new business opportunities**, the plan should help to unlock the growth and jobs potential of the circular economy.

It includes:

- ✓ Comprehensive commitments on ecodesign
- ✓ The development of strategic approaches on plastics and chemicals
- ✓ A major initiative to fund innovative projects under the umbrella of the EU's Horizon 2020 research program
- ✓ Targeted action in areas such as plastics, food waste, construction, critical raw materials, industrial and mining waste, consumption and public procurement

The actions proposed will be taken forward in line with **Better Regulation principles**, and subject to appropriate consultation and impact assessment. The action plan focuses on action at EU level with high added value. Making the circular economy a reality will however require **long-term involvement at all levels, from Member States, regions and cities, to businesses and citizens.**

The circular economy will also need to develop globally. Increased policy coherence in internal and external EU action in this field will be mutually reinforcing and essential for the implementation of global commitments taken by the Union and by EU Member States, notably the U.N. 2030 Agenda for Sustainable Development and the G7 Alliance on Resource Efficiency.

4.8.2. Policy of circular economy

A circular economy starts at the very beginning of a product's life. **Both the design phase and production processes have an impact on sourcing,** resource use and waste generation throughout a product's life.

1. **Product design**

Better design can make products more durable or easier to repair, upgrade or remanufacture. It can help recyclers to disassemble products in order to recover valuable materials and components. Overall, it can help to save precious resources.

It is an ecological and eco-responsible approach to the object. The aim is to limit the environmental impact of a product, while working on aesthetic aspects and optimal functionality. Design is the know-how that connects objects, spaces and premises.

Nowadays, issues such as reparability, durability, upgradability, recyclability, or the identification of certain materials or substances have to be systematically examined.

Figure 43: The benefits of Eco Design

2. **Production processes**

Even for products or materials designed in a smart way, inefficient use of resources in production processes can lead to lost business opportunities and significant waste generation.

Primary raw materials, including renewable materials, will continue to play an important role in production processes, even in a circular economy. In this context, attention must be paid to the environmental and social impacts of their production, both in the EU and in non-EU countries.

Industry has a key role to play by making specific commitments to sustainable sourcing and cooperating across value chains. Each industry sector is different when it comes to resource use, waste generation and management. Therefore, EU wants to promote best practices in a range of industrial sectors through the 'best available technique reference documents' (BREFs) that Member States have

to reflect when issuing permit requirements for industrial installations and promote best practices on mining waste.

In this field, it is important **to promote innovative industrial processes**. For example, industrial symbiosis allows waste or by-products of one industry to become inputs for another.

Industrial symbiosis creates an interconnected network which strives to mimic the functioning of ecological systems, within which energy and materials cycle continually with no waste products produced. This process serves to reduce the environmental footprint of the industries involved. Virgin raw materials are required to a lesser degree, and the need for landfill waste disposal is reduced. It also allows value to be created from materials that would otherwise be discarded and so the materials remain economically valuable for longer than in traditional industrial systems.

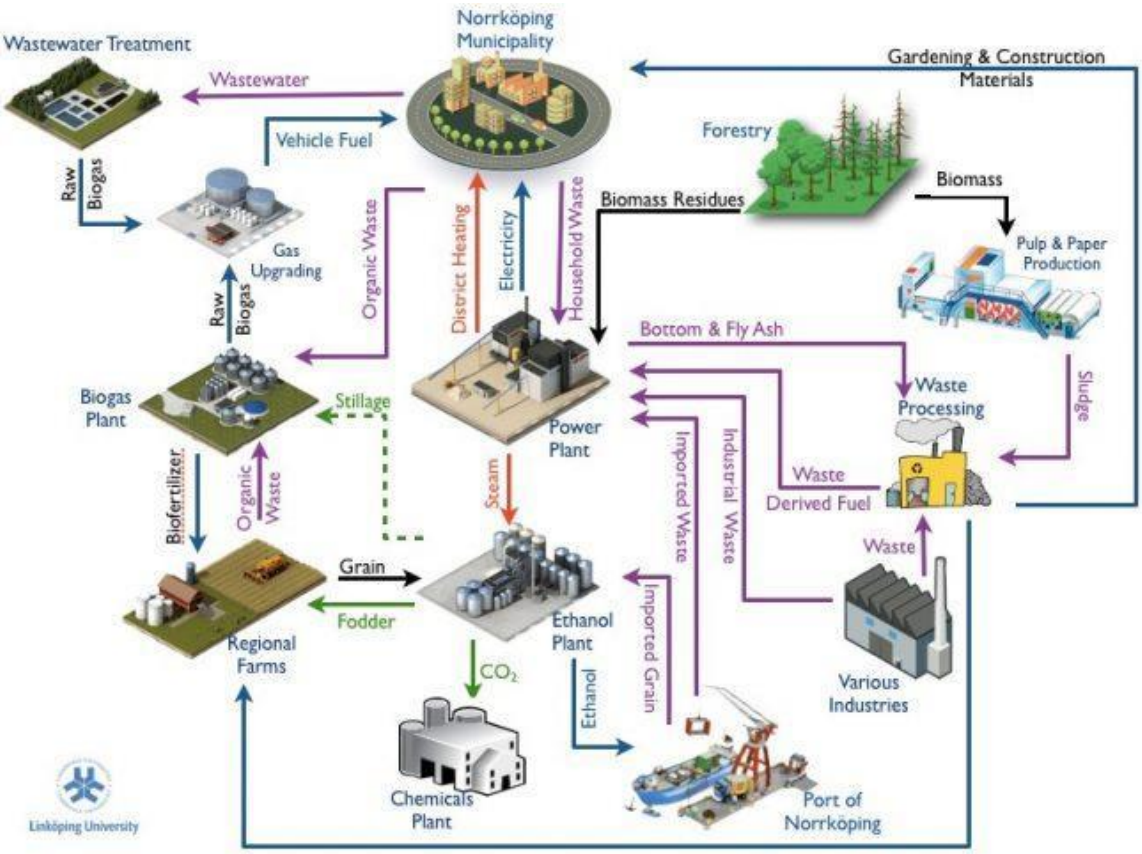

Figure 44: Industrial symbiosis. Source: [Linkoping University]

3. Consumption

The choices made by millions of consumers can support or hamper the circular economy. These choices are shaped by the information to which consumers have access, the range and prices of existing products, and the regulatory framework. This phase is also crucial for preventing and reducing the generation of household waste.

Faced with a profusion of labels or environmental claims, consumers often find it difficult to differentiate between products and to trust the information available. The labelling system for the energy performance of household appliances and other energy-related products is a good tool to help consumers choose the most efficient products.

Price is a key factor affecting purchasing decisions, both in the value chain and for final consumers. Member States are therefore encouraged to provide incentives and use economic instruments, such as taxation, to ensure that product prices better reflect environmental costs.

Once a product has been purchased, its lifetime can be extended through reuse and repair, hence avoiding wastage. The reuse and repairs sectors are labour-intensive and therefore contribute to the EU's jobs and social agenda. Currently, certain products cannot be repaired because of their design, or because spare parts or repair information are not available. Future work on ecodesign of products will help to make products more durable and easier to repair.

Planned obsolescence practices can also limit the useful lifetime of products. Through an independent testing program, it will initiate work to detect such practices and ways to address them. In addition, the revised legislative proposals on waste include new provisions to boost preparation for reuse activities.

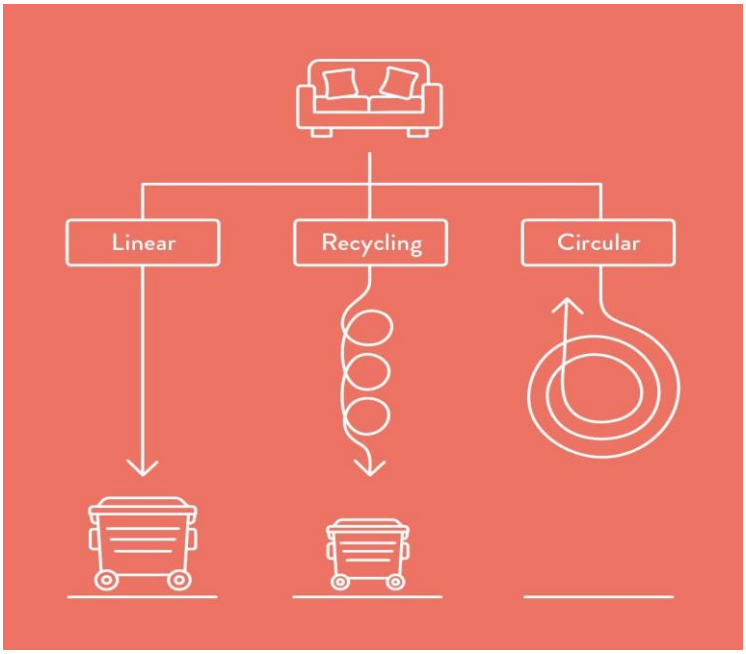

Figure 45: Planned obsolescence versus the circular economy. Source: frobes

Other actions can be taken to reduce the amount of household waste

This is often more effective at national and local level, where it can be better targeted: awareness campaigns and economic incentives (Such as incentive systems for municipalities or "pay-as-you-throw" schemes, where households, for example) pay according to the amount of non-recyclable waste that they throw away have proven particularly effective.

The EU promotes **waste prevention** and reuse through the **exchange of information** and best practices and by providing Cohesion Policy funding for projects **at local and regional level**, including interregional cooperation.

Innovative forms of consumption can also support the development of the circular economy, sharing products or infrastructure (collaborative economy), consuming services rather than products, or using IT or digital platforms. These new forms of consumption are often developed by businesses or citizens and promoted at all decision-making levels.

4. Waste management

Waste management plays a central role in the circular economy: it determines how the EU waste hierarchy is put into practice. **The waste hierarchy establishes a priority order from prevention, preparation for reuse, recycling** and energy recovery through to disposal, such as landfilling.

This principle aims to encourage the options that deliver the best overall environmental outcome. The way we collect and manage our waste can lead either to high rates of recycling and to valuable materials finding their way back into the economy, or to an inefficient system where most recyclable waste ends in landfills or is incinerated, with potentially harmful environmental impacts and significant economic losses.

To achieve high levels of material recovery, it is essential to send long-term signals to public authorities, businesses and investors, and to establish the right enabling conditions at EU level, including consistent enforcement of existing obligations.

Today, only **around 40% of the waste produced by EU households is recycled**. The Commission is putting forward new legislative proposals on waste to provide a long-term vision for increasing recycling and reducing the landfilling of municipal waste, while taking account of differences between Member States. These proposals also encourage greater use of economic instruments to ensure coherence with the EU waste hierarchy.

When waste cannot be prevented or recycled, recovering its **energy content** is in most cases preferable to landfilling it, in both environmental and economic terms. ‘Waste to energy’ can therefore play a role and create synergies with EU energy and climate policy but guided by the principles of the EU waste hierarchy. To that end, the Commission has adopted a 'waste to energy' initiative in the framework of the Energy Union.

For more information, please visit: https://eur-lex.europa.eu/legal-content/EN/

4.8.3. The plastic and the transition to a circular economy

A number of sectors face specific challenges in the context of the circular economy, because of the specificities of their products or value-chains, their environmental footprint or dependency on material from outside Europe. These sectors need to be addressed in a targeted way, to ensure that the interactions between the various phases of the cycle are fully taken into account along the whole value chain.

Increasing plastic recycling is essential for the transition to a circular economy. The use of plastics in the EU has grown steadily, but less than 25% of collected plastic waste is recycled and about 50% goes to landfill.

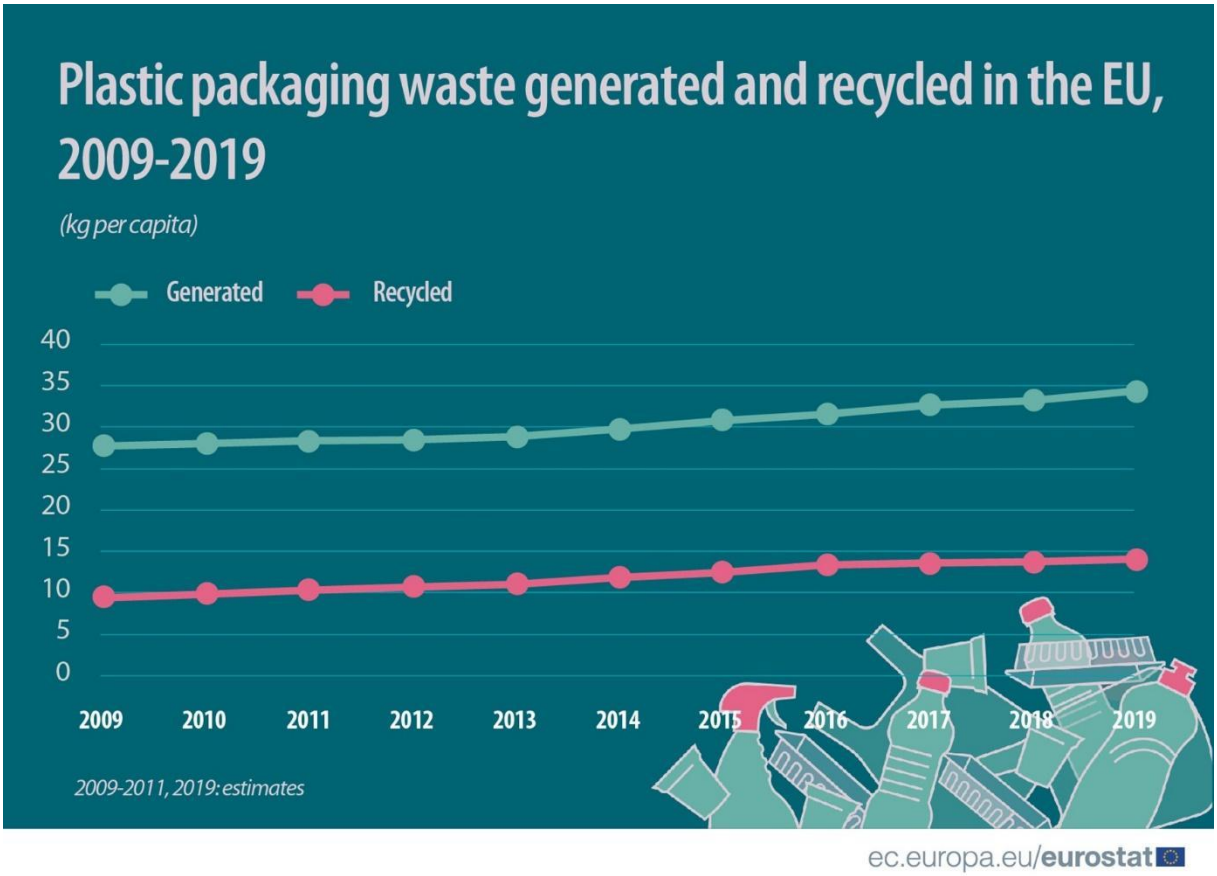

Figure 46: Waste in the EU in the past ten years. Source: env_waspac

Large quantities of plastics also end up in the oceans, and the 2030 Sustainable Development Goals include a target to prevent and significantly reduce marine pollution of all kinds, including marine litter. Smarter separate collection and certification schemes for collectors and sorters are critical to divert recyclable plastics away from landfills and incineration into recycling.

Figure 47: Example of the issue of plastic in Mediterranean Sea. Source: WWF

The presence of hazardous chemical additives can pose technical difficulties and the emergence of innovative types of plastics raises new questions, as regards plastics biodegradability. However, innovation in plastics can contribute to the circular economy by better preserving food, improving the recyclability of plastics or reducing the weight of materials used in vehicles.

A number of initiatives could help to increase plastics recycling, including ecodesign, an EU-wide target on recycling plastic packaging, quality standards and action to facilitate cross-border trade in recyclable plastics.

4.8.4. Innovation, investment and other horizontal measures

The transition to a circular economy is a systemic change. In addition to targeted actions affecting each phase of the value chain and key sectors innovation will play a key part in this systemic change. In order to rethink the ways of producing and consuming, and to transform waste into high value-added products, we will need new technologies, processes, services and business models.

In this way, many initiatives are emerging at different levels.

Below this strong example from the Commission in order to promote sustainable alternatives: **the 10 single-use plastic items most commonly found on Europe's beaches.** The impacts of this plastic waste on the environment and our health are global and can be drastic. Single-use plastic products are more likely to end up in our seas than reusable options.

The 10 items being addressed by the Directive (on single-use-plastics) are:

Figure 48: Most common plastic waste in the ocean. Source: European Parliamentary Research service

This applies also to cups, food and beverage containers made of expanded polystyrene, and on all products made of oxo-degradable plastic.

For other single-use plastic products, the EU is focusing on limiting their use through:

- ✓ reducing consumption through awareness-raising measures
- ✓ introducing design requirements, such as to connect caps to bottles
- ✓ introducing labelling requirements, to inform consumers about the plastic content of products, disposal options that are to be avoided, and harm done to nature if the products are littered in the environment
- ✓ introducing waste management and clean-up obligations for producers, including Extended Producer Responsibility (EPR) schemes

Monitoring progress towards a circular economy

In order to assess progress towards a more circular economy and the effectiveness of action at EU and national level, the Commission is working on the monitoring. A lot of relevant data already collected

by Eurostat can form a basis. In addition, the Resource Efficiency Scoreboard and the Raw Materials Scoreboard contain relevant indicators and analysis which will be particularly useful for tracking progress.

Further reading:

https://ec.europa.eu/eurostat/web/environmental-data-centre-on-natural-resources/resource-efficiency-indicators/resource-efficiency-scoreboard

On this basis, the EU wants to propose a simple and effective monitoring framework for the circular economy, designed to measure progress effectively on the basis of reliable existing data.