Circular Economy

1 What is the circular economy?

The circular economy is an economic and industrial system which aims to keep products, their components and materials in circulation as long as possible within the system, while ensuring the quality of their use. As such, the circular economy contrasts with the linear economy, in which products and materials are disposed of at the end of their economic life.

This movie clip by Ellen MacArthur Foundation (2011) explains the circular economy in an accessible way.

https://youtu.be/zCRKvDyyHml

1.1 Assignment

To get a good introduction in the circular economy go through the learning path of the Ellen MacArthur Foundation (15 minutes) and answer the following questions:

- Why do we have to transform all the elements of the take-make-waste system?
- Explain the three principles of the circular economy in your own words and give an example.

1.2 Linear versus circular

A circular economy is fundamentally different from a linear economy. To put it simply, in a linear economy we mine raw materials that we process into a product that is thrown away after use. In a circular economy, we close the cycles of all these raw materials. Closing these cycles requires much more than just recycling. It changes the way in which value is created and preserved, how production is made more sustainable and which business models are used.

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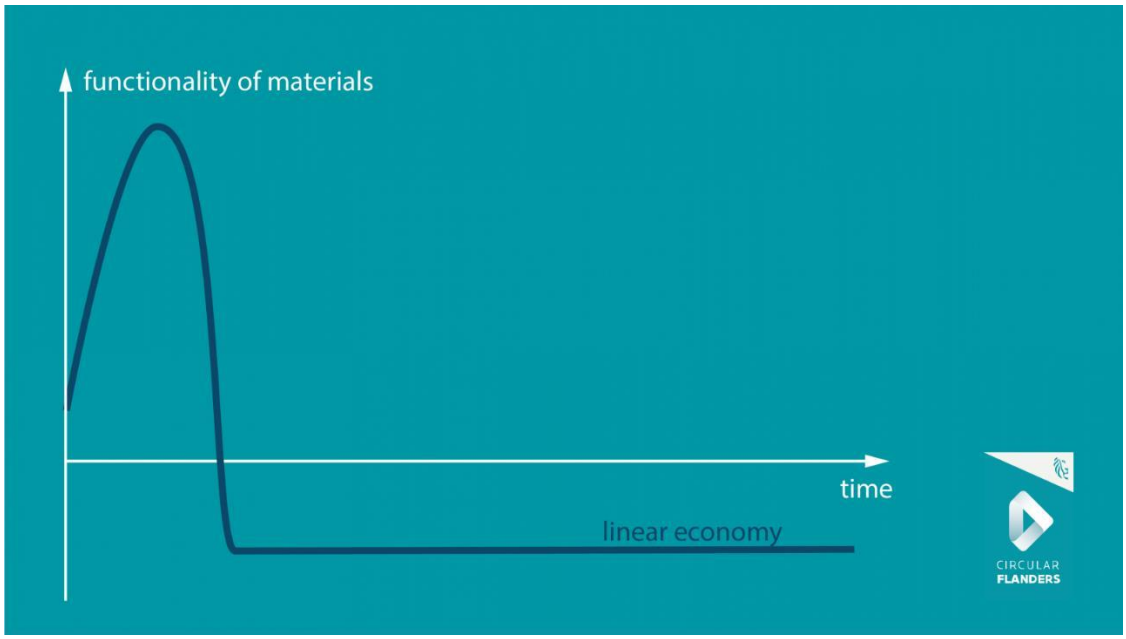
1.2.1 Functionality of materials

A linear economy traditionally follows the “take-make-dispose” step-by-step plan. This means that raw materials are collected, then transformed into products that are used until they are finally discarded as waste. Value is created in this economic system by producing and selling as many products as possible.

As soon as the product has been sold, the gross value of the products falls (the functionality of the materials decreases). This can even be to such an extent that they are given a negative value: you have to pay to get rid of them.

The graphic below shows that the value / functionality of materials increases throughout the production process, to the point of sale. Then a steep decline follows.

FIGURE 1 FUNCTIONALITY OF MATERIALS LINEAR ECONOMY



Numerous strategies are applied within a circular economy in order to continue to use materials and products in the economy in the most valuable way. They are repaired, have a high second-hand value, are upgradeable, can easily be disassembled and turned into new products, the materials are fully recyclable or biodegradable, etc.

The graphic below shows that the value / functionality of materials, even after the initial sale, returns again and again to a high level.

FIGURE 2 FUNCTIONALITY OF MATERIALS CIRCULAR ECONOMY

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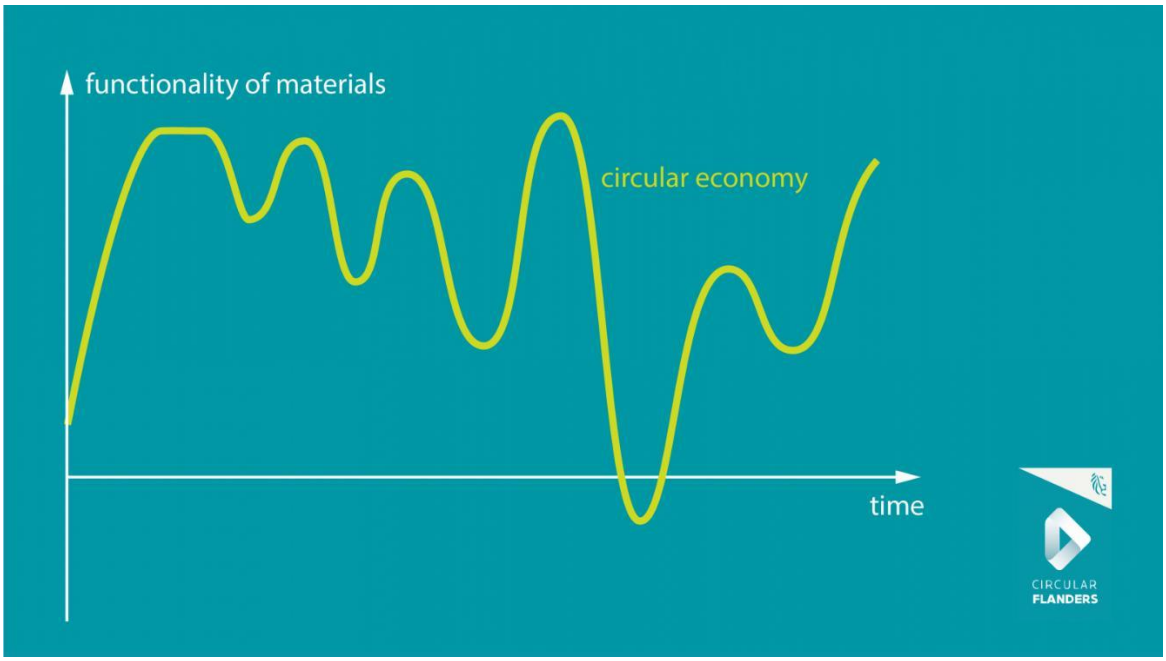

Source: https://vlaanderen-circulair.be/en/knowledge/what-is-it

1.2.2 From eco-efficiency to eco-effectiveness

The perspective on sustainability is different in a circular economy than in a linear economy. When working on sustainability within a linear economy, the focus is on eco-efficiency. This is to minimise the ecological impact for the same output. This will extend the period in which the system becomes overloaded (Di Maio, Rem, Baldï, and Polder, 2017). Within a circular economy, sustainability is sought in increasing the eco-effectiveness of the system. This means that not only the ecological impact is minimized, but that the ecological, economic and social impact is even positive (Kjaer, Pigosso et al. 2019).

This difference can be illustrated with the production of beef. Raising cows for beef results in emissions of methane gas, a strong greenhouse gas. In a linear economy, the production of beef is made more sustainable by changing the way cows are fed, so that they emit less methane gas for the same amount of meat. This makes production more eco-efficient. In a circular economy, production is made more sustainable by not making beef from cows, but by imitating it as a meat substitute. For the beef substitute, plants are grown that contribute to biodiversity, employment and landscape management. In this way, the ecological, economic and social impact of the same production of 'beef' is increased.

FIGURE 3 THE DIFFERENCE BETWEEN ECO-EFFECTIVENESS AND ECO-EFFICIENCY (EPEA GMBH, 2013).

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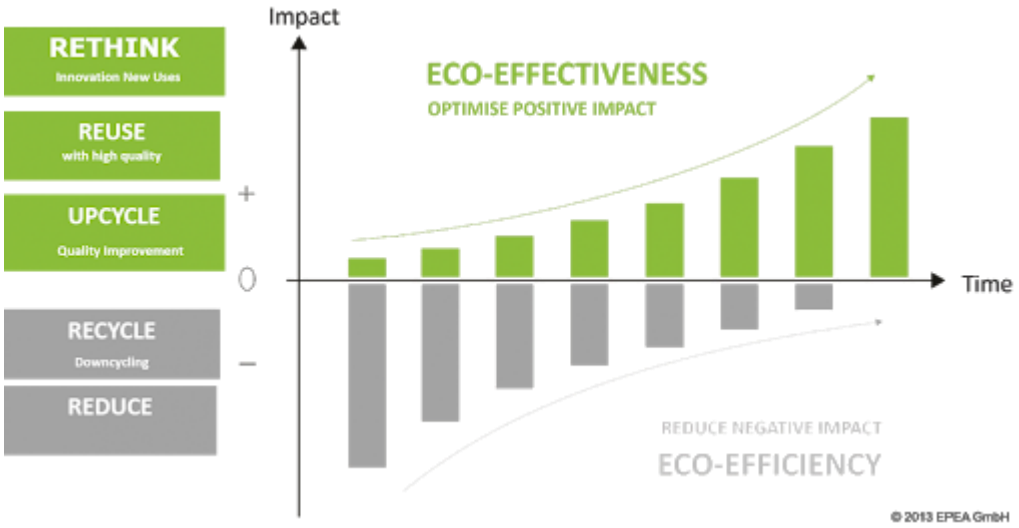

In order to achieve eco-effectiveness, residual flows must be reused for a function that is the same (functional recycling) or even higher (upcycling) than the original function of the material. As a result, the value is fully retained or even increased. For example: concrete is ground into granules that are used to produce the same or a stronger wall again. This is different in a linear economy. An eco-efficient system typically works on downcycling: a (part of a) product is reused for a low-grade application that reduces the value of the material and makes it difficult to reuse the material flow again. For example: concrete residues are processed in asphalt in the road surface (Bocken, Bakker & De Pauw, 2015; Ellen MacArthur Foundation, 2014).

1.3 How do materials circulate in a circular economy?

In a circular economy, materials circulate in two separate cycles: the bio-cycle and the techno-cycle. The distinction between these cycles helps to understand how materials can be used in a long-lasting and high quality way. A general rule of thumb is that the less process steps a material has to go through for reuse, the higher the quality of the material it can contain.

1.3.1 Technical and organic materials

Organic materials follow a different reuse process than technical materials. Technical materials are also called synthetic materials. Because of this difference in the reuse process, it is important that, after use, organic and technical materials can be properly separated from each other (see figure 1).

Technical materials such as fossil fuels, plastics and metals have limited availability and cannot easily be recreated. In the techno-cycle it is important that stocks of such finite materials are properly managed. In a circular economy, these materials are only used instead of being consumed. After use, materials are recovered from residual flows at their original value.

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Organic materials such as wood, food and water can be incorporated into the ecosystem and regenerated through biological processes. In the bio-cycle it is important to let the ecosystem do its work as well as possible. Consumption may take place during this cycle (fertilization, food, water) as long as the streams are not contaminated with toxic substances and ecosystems are not overloaded. Renewable organic raw materials can then be regenerated (Ellen MacArthur Foundation, 2015a).

FIGURE 4 THE BUTTERFLY DIAGRAM (ELLEN MAC ARTHUR FOUNDATION, 2015'A)

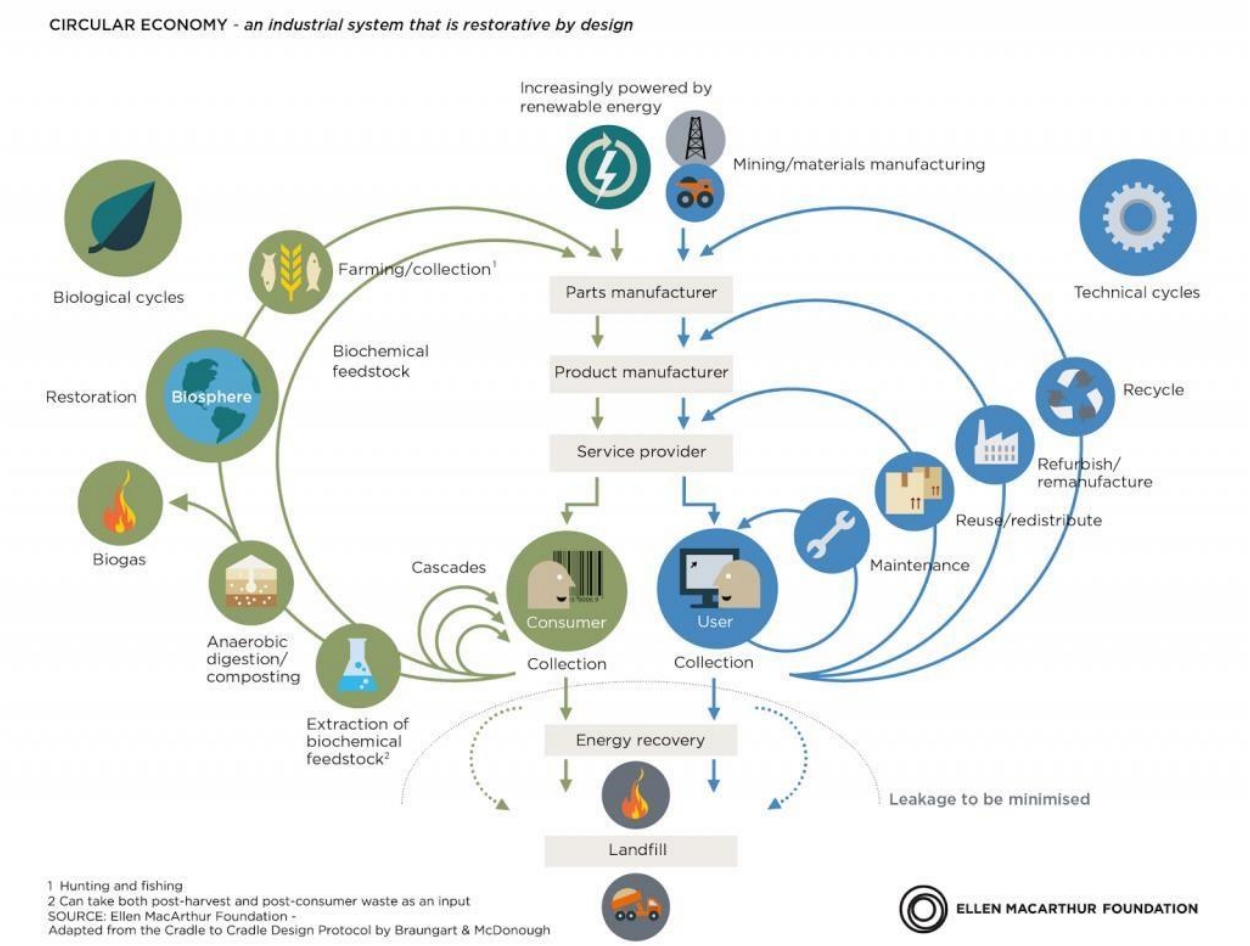

Figure 1: The Butterfly Diagram (Ellen Mac Arthur Foundation, 2015a)

1.3.2 The inner circle

Within the techno-cycle there are different levels of reuse (see the right side of Figure 1). The rule of thumb is that the smallest or inner circle is preferable to larger cycles, because these require less processing, labour, energy and new material to be of original value again (Ellen MacArthur Foundation, 2015a).

The different reuses within the techno-cycle are (see figure above):

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- Maintenance (& repair): Repair and maintenance during use to extend the lifespan.
- Reuse/redistribution: Direct re-use by re-marketing a product.
- Refurbish/Remanufacture: The thorough refurbishment and repair of a product by the manufacturer.
- Recycle: Retrieving parts or materials from the product for reuse.

1.3.3 Re-use in cascades

Within the bio-cycle, reuse takes place in cascades. Cascading means 'using (part of) a product for another application'. When a product is no longer able to perform its initial function, it is passed on for reuse. During cascading, the quality of the material is reduced and energy is consumed (Ellen Macarthur Foundation, 2013a).

Cascading differs from ordinary re-use and recycling in that it changes function and the extent to which the product is processed. A cotton T-shirt can serve as an example. When reused, a worn T-shirt is sold in a second-hand shop. When recycled, the T-shirt is shredded into cotton fibres, which are then spun into new yarn. Cascading is the use of old T-shirts as cushion filling.

1.3.4 Long-term cycles

For both the bio-cycle and the techno-cycle, the lifespan of a product must be made as long as possible. The lifespan of products can be extended by:

Ensuring that a product is used longer, thereby 'slowing down' the process, for example by focusing on emotional attachment to a product, lasting fulfilment of a need and adaptability of the product, so that it can keep up with the times.

To ensure that multiple consecutive cycles of direct reuse are followed, by facilitating the interchangeability of products and by properly maintaining products so that they can be used for a long time without repair (Ellen MacArthur Foundation, 2015a; Bocken, Bakker & De Pauw, 2015).

1.3.5 Pure flows

For both the bio-cycle and the techno-cycle, residual flows that are not contaminated with other materials are the easiest to collect and re-use. By ensuring that materials are easily separated from each other after use and that residual flows are collected in such a way that they are not contaminated with toxic substances, residual flows are the most useful (Ellen MacArthur Foundation, 2015a).

Within the bio-cycle, orange peels can serve as a good example. The company PeelPioneers collects orange peels from catering establishments and extracts essential oils from them. If there

is food residue in the peelings, the essential oils are polluted and can no longer be used for cosmetics, so the value decreases. Within the techno-cycle, plastic toys can serve as a good example. If the toy is completely made of polyethylene, it can be completely melted down and reused. If the toy also has polyester components, these must first be separated before the toy can be recycled at high quality (Peelpioneers, 2019).

2 Why do we need a circular economy?

2.1 Raw materials are not infinite

Since the Industrial Revolution, our economies have been running on a model in which resources are turned into products that are thrown away after they're no longer useful – a linear model that is based on the supposition that resources are abundantly available, easy to get, and can be cheaply thrown away. But this model has reached its limits.

The global middle class is expected to increase by three billion people in the coming decades. China and India, for example, will double their income per capita 10 times as fast for 200 times as many residents than England did during the Industrial Revolution. So, the demand for resources will only continue to grow at a time in which finding and extracting new resources will be growing increasingly more difficult. The direct consequence is that resource prices will fluctuate significantly. In the long term, certain crucial, raw resources will probably become scarce and expensive. And we haven't even covered the environmental impact of the extraction. This makes everything about our traditionally linear lifestyle unsustainable.

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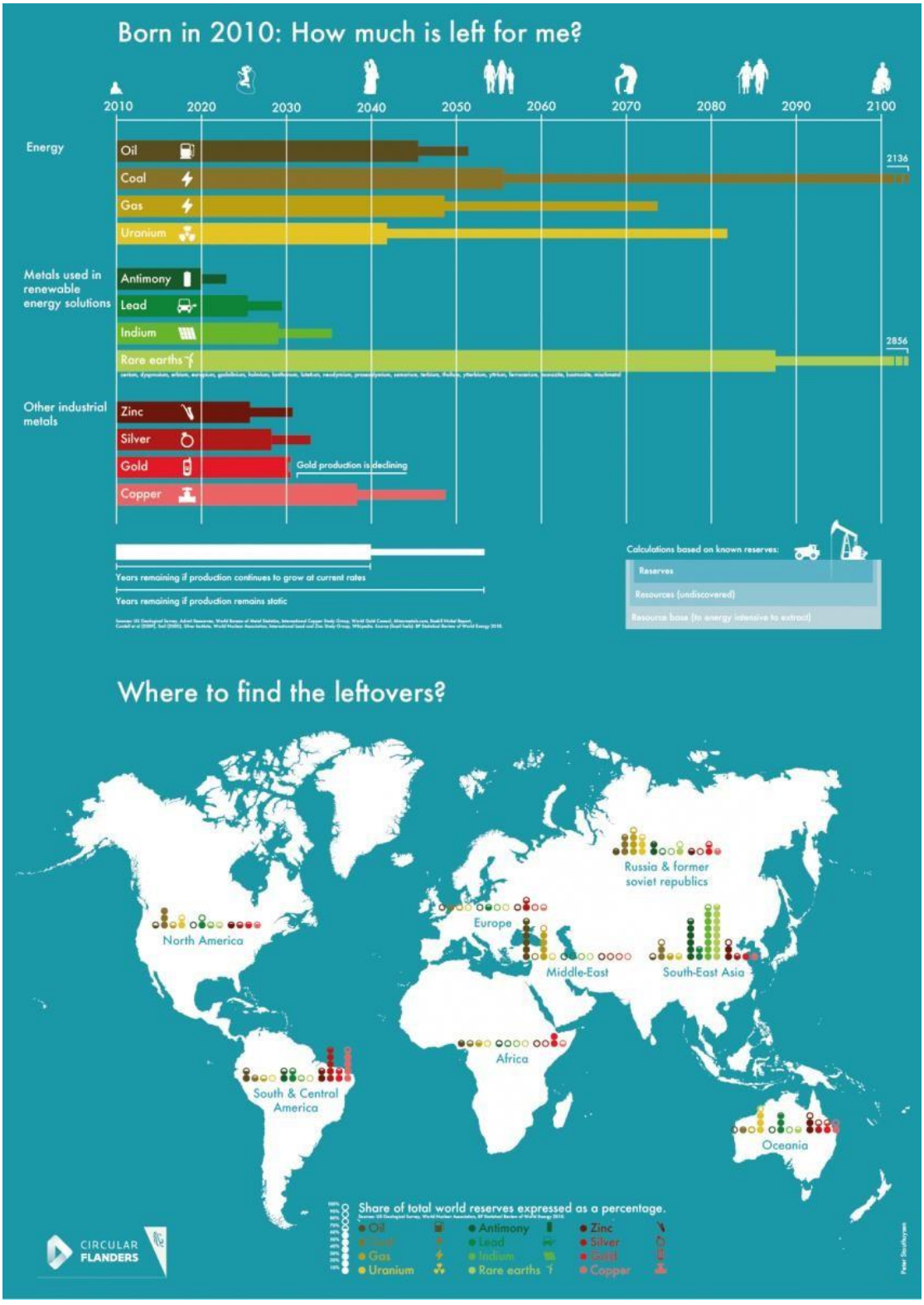
FIGURE 5 RESOURCE AVAILABILITY (VLAANDEREN CIRCULAIR, 2010)



Source: https://vlaanderen-circulair.be/en/knowledge/what-is-it

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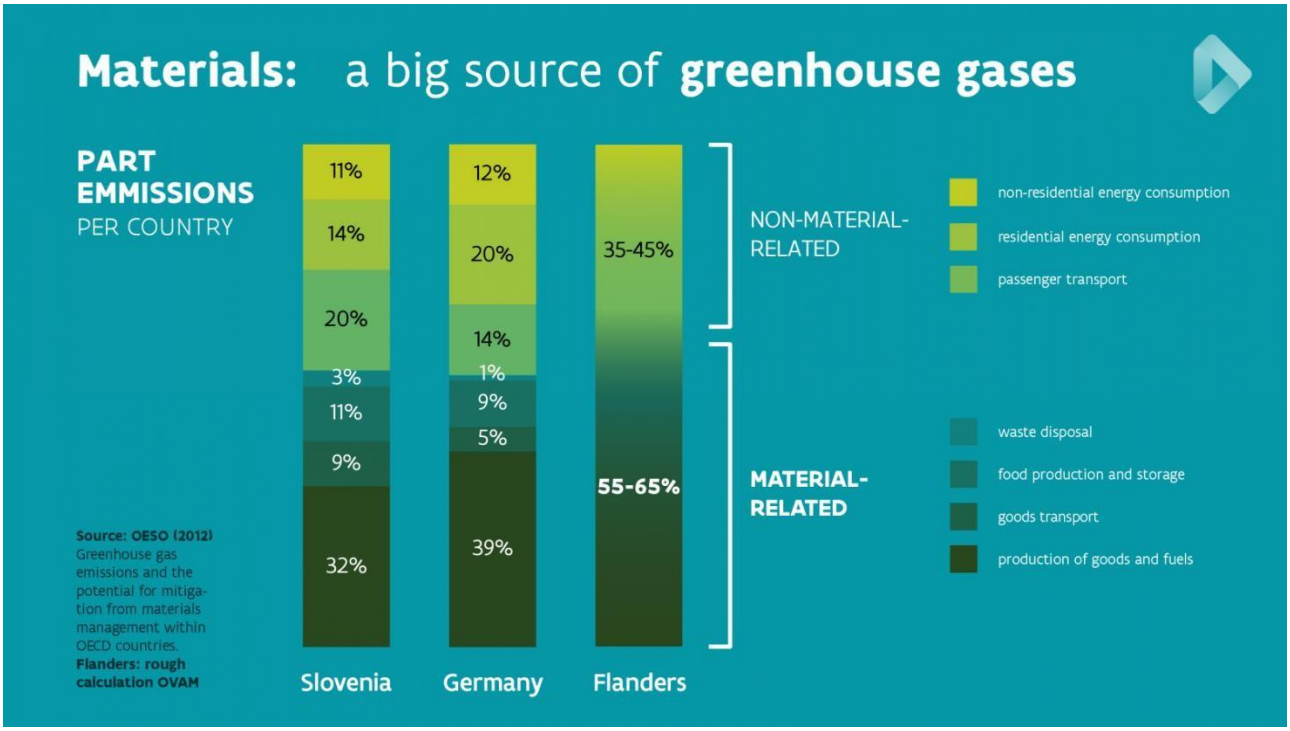
2.2 Our open economy is raw material-sensitive

Flemish manufacturing companies greatly depend on the import of raw materials. These account for up to 40% of their production costs. The availability of raw materials can quickly take a turn due to changes in goods flows or changes in trade policy. The European Commission adds to its list of critical raw materials (economically important but with supply issues) with each review. There are now 27 materials 'in the red'.

2.3 Materials and climate

The environmental impact of digging ever deeper and further for more fresh raw materials is enormous. Materials and energy are also two sides of the same coin: reclaiming and transporting materials and manufacturing goods from them has a high energy cost that is inevitably associated with CO2 emissions. Some two thirds of gross domestic energy consumption in Flanders can be attributed to material-related activities (production, transport, waste, and food).

FIGURE 6 MATERIALS AS A BIG SOURCE OF GREENHOUSE GASES



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2.4 Opportunities for innovation and new economic activity

Flanders is already in the lead when it comes to closing the material cycles. We can cash in on this leading position by further innovating in the circular economy: we can upscale our solutions and knowledge gained at home and abroad. The transformation to Industry 4.0 is also closely tied in with the evolution towards a circular economy for companies.

From a purely economic point of view, the advantages of the turn to the circular economy speak volumes. If we make the resources in the entire value chain more efficient, we can reduce the need for materials in Europe by an estimated 17 to 24% by 2030. The European business world could save 630 billion euros annually by using resources better. Services and value can increase the EU's GDP by 3.9% by getting rid of the materials costs and creating new products. This means that the circular economy could create 1.2 to 3 million extra jobs by 2030.

Indicative estimates of the economic benefits of the circular economy for Flanders points to a savings in material costs of 2 to 3.5% of the Flemish GDP and the creation of 27,000 additional jobs, ranging from high-tech to lower-skilled.

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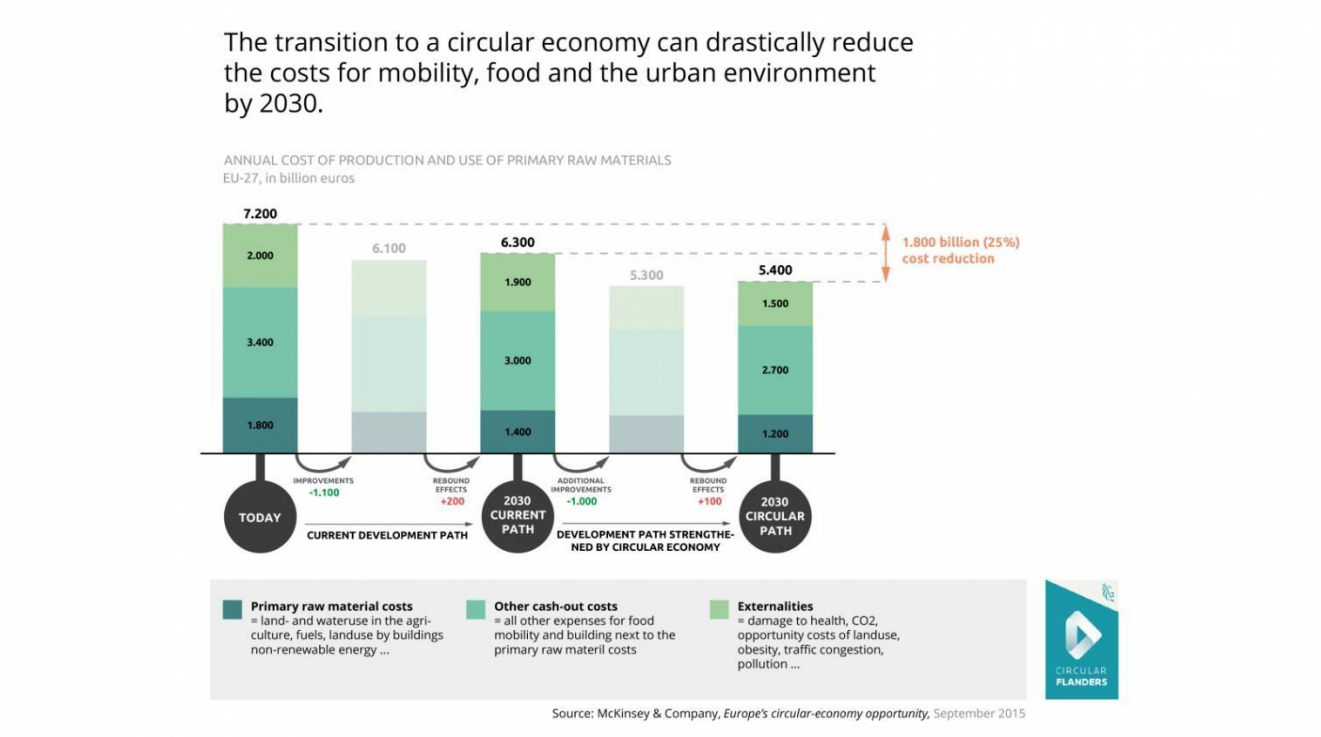
FIGURE 7 REDUCTION OF COSTS



2.5 Opportunities for new jobs

It is often forgotten that, in addition to the ecological and economic aspects, the transition to the circular economy also has significant social effects. An example is how the employment market will also (have to) change. This not only applies to the recycling sector, but also beyond it along the whole value chain.

Different studies show that the transition to a circular economy will provide extra jobs in different sectors. The projections differ depending on the focus area. For Flanders, SuMMa estimates 27,000 additional jobs in waste management in Flanders alone. No figures are yet available for the whole value chain in Flanders.

The Flemish Materials Programme (a precursor of Circular Flanders) commissioned exploratory research into the job impact of the circular economy. The research concentrated on a number of concrete case studies:

- biomass (frozen leeks);
- change-oriented construction;

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- electrical and electronic equipment;
- and new business models.

The study highlighted a number of new jobs, but also and particularly many changes to the nature of the work, many new skills, knowledge elements, and to a lesser extent attitude changes.

3 Doing business in the circular economy

At the core of the circular economy is the principle that nothing is lost: just like in the natural world, raw materials circulate endlessly in the system. This benefits all: the planet, businesses, and the people. The link between ecological and economic gain is the attraction of the circular economy: sustainability suddenly becomes an opportunity instead of something that just has to be done.

The number of companies that are seeing the advantages of the circular economy is increasing. Large companies are putting feelers out, bankers are studying their role, and start-ups are launching new concepts. The most innovative players fill a niche that is still small but no less important. They subject the circular principles that look so nice on paper to the harsh reality of the market. Does the consumer want to come along? Will we secure the financing? Is what we are doing actually more sustainable?

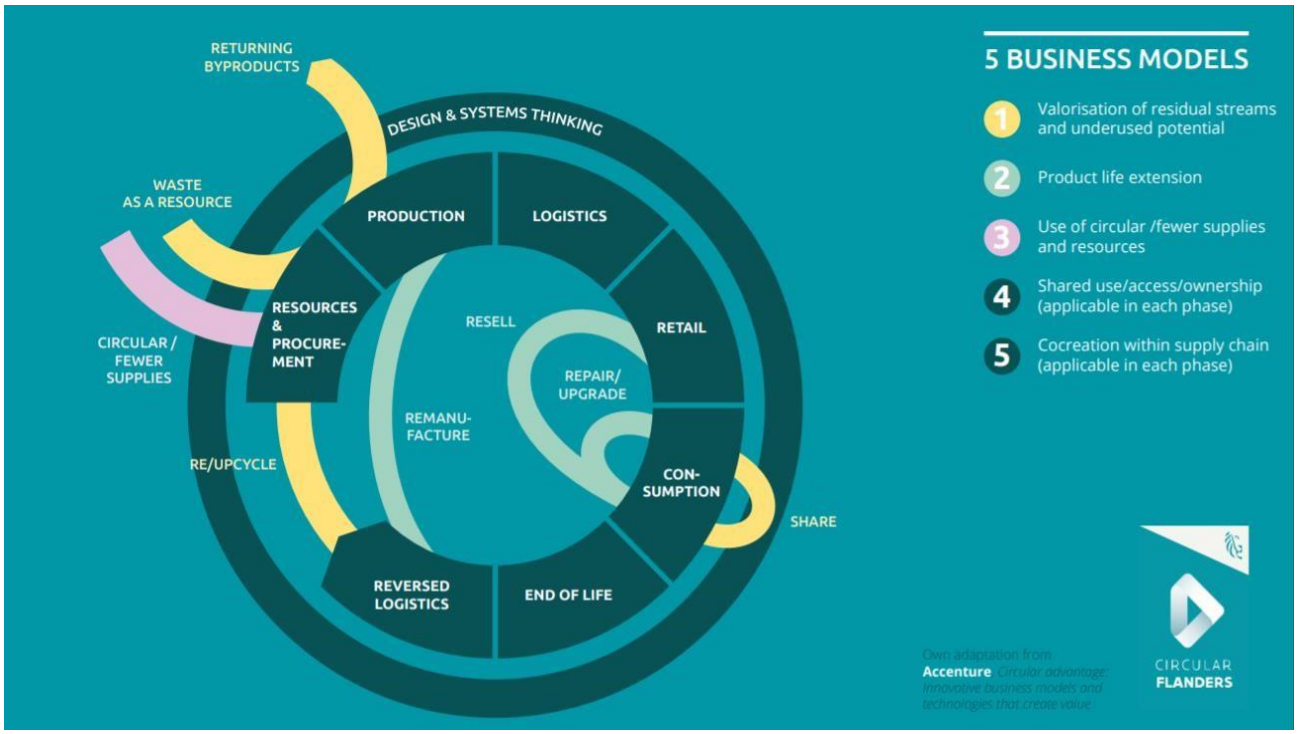
3.1 5 circular business models

Below we show how companies can take advantage of the circular economy in the real world. Each time, we give an example of a Belgian frontrunner. An enterprise can generally embark upon five routes towards more circularity:

1. Circular input
2. Raw materials recovery
3. Extension of working life
4. Sharing platforms
5. Product as a service

The figure below, borrowed from Accenture, shows the different business models. The thick ring in the middle represents the chain or life cycle of a product: from raw material to sale, to end of life and return. Different loops or extra circuits can occur along the chain. For example: a product that becomes defective during use/consumption can end up in the same phase of use after repair.

FIGURE 8 BUSINESS MODELS IN A CIRCULAR ECONOMY



3.1.1 Use of circular inputs

It all starts at the beginning: produce as much as possible using renewable energy and bio-based, biodegradable, or recyclable raw materials. Use less materials, dematerialise, or virtualise. Also buy circular.

Click here for some Belgian business examples.

Look up some international examples on the website of Ellen MacArthur Foundation.

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3.1.2 Raw materials recovery

Recovery of raw materials and/or energy from discarded products or auxiliary flows (often from a different circuit than one's own).

Click here for some Belgian business examples.

Look up some international examples on the website of Ellen MacArthur Foundation.

3.1.3 Extension of working life

Extend the functional life cycle of a product with repair, upgrading, and resale. Already calculate for the second and third life of a product in the design phase: choose a modular design, parts that can be removed, or parts that can be repaired easily.

Click here for some Belgian business examples.

Look up some international examples on the website of Ellen MacArthur Foundation.

3.1.4 Sharing platforms

Enabling more intensive use of products with shared use/access or ownership.

Click here for some Belgian business examples.

Look up some international examples on the website of Ellen MacArthur Foundation.

The circular economy has a special place for the sharing economy, or more generally 'use above ownership'. The idea that we do not always have to buy all the things we use ourselves can indeed contribute to a more circular economy. Indeed, many goods that we buy – a drill for example – spend most of their lives sitting in a cupboard unused. This is a waste of money and a waste of the energy and raw materials invested to make the products. So why not buy one drill

and share it with others? This idea is often expressed in witticisms such as “What I want is the hole, not the drill” or “I want to fly, not buy the aircraft”, or “I want light, not the lamp”. We would then potentially save money and raw materials. There is potential in any case, but the whole issue of environmental impact is obviously a complex one: there are, for example, the so called rebound effects (consumption increases due to lower costs of sharing) and moral hazard (the user takes less care because of the move away from ownership). Good preconditions and analyses are essential.

3.1.5 Product as a service

This entails offering access to a product while keeping ownership to enjoy all the benefits of a closed circuit.

Click here for some Belgian business examples.

Look up some international examples on the website of Ellen MacArthur Foundation.

3.1.5.1 Manufacturers change their revenue model

When manufacturers aim their products and revenue model towards this idea of use above ownership, we have product-service systems. Performance economy and functionality economy are synonyms. At the heart is the service around the product (the light, mobility, climate) and no longer the product (the lamp, the car, the heating installation). The focus shifts to the function of the product.

The manufacturer achieves turnover from selling the use of its product. The more robust it makes the products it offers as a service, the lower the maintenance costs it must pay, so the greater the profit left over. Result: in an ideal scenario, we get products that consume less material and last longer.

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3.1.5.2 Certainty for the user

For their part, the user buys certainty. The user only pays for the result, not the product; if the product breaks, the manufacturer has to have it mended at its own expense. So, we have a maximal service, healthy customer relations, and no unpleasant surprises.

3.1.5.3 Similar interests

So, both parties have the same interests with product-service systems: a product that continues to work as well as possible for as long as possible. This is contrary to the linear economy where most manufacturers like to supply products that will soon have to be replaced.

Watch this TedTalk of Thomas Rau. He is the founder of Turntoo and RAU Architects, two of the first companies in the Netherlands dedicated to the circular economy, created some of the original examples of circular economy concepts and business models including: the Light as a Service ("pay per lux") contract, which he developed together with Philips in 2010; a model for renting out washing machines on a performance basis with Bosch in 2012; the first circular building as a raw materials depot in the municipality of Brummen in 2013 and the first circular net energy positive building for network provider Liander in 2015.

- Explain the difference between the performance cycle and the lifecycle of a product.
- Explain briefly the three steps of the turntoomodel
- Why is a performance model much more sustainable than the linear way of consuming?