Product-Service Development for Circular Economy and Sustainability Course

Training Modules		
Introduction to the circular economy	Business models	Value chains
Processes and materials		Design and development
Radical innovation and collaborative design processes	Life cycle perspective	Communication

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Module Introduction to the circular economy

This module is part of the training materials developed in the KATCH_ e Project, Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education.

More information about the project, training materials and contacts, available at:

www.KATCH_e.eu

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Introduction to the circular economy

Contents

Learning objectives

- Understand the basic concept and principles of CE – including that there is not a single definition, but many variations
- Understand the differences between CE and sustainability and how the two concepts are related
- Understand how circular economy differs from a linear economy, and what kind of economic understandings (e.g. sharing economy) may be a part of CE
- Can discuss the potential values of CE for organizations in the furniture and the construction sectors and how the values are created
- Can discuss how CE is a part of a transformation of systems towards sustainability
- Understand major consumption patterns and market trends, and how these relate to the circular economy paradigm, specifically in the two target sectors

Previous knowledge

Basic understanding of sustainability. No knowledge on circular economy is needed.

What, who, where, when, why and how

What	Definitions of what CE means, circular economy criteria and evolution perspective that must be taken into account in order to adapt and carry out in the construction and furniture sectors. It also includes what these criteria mean to promote the transition from linear to circular economy, carrying out sustainable business models, including perspectives of sustainable consumption and the European policy framework.
Who	All KATCH_e sectors target groups: students, teachers and professionals who develop circular products, processes, materials or services from a life cycle perspective and with the purpose of supporting sustainability development.
Where	In any University, centre, company or institution that works in the topics and target KATCH_e sectors.
When	At the very beginning of the design process and even before, in the process of arguing and planning for circular economy solutions.
Why	To familiarize, students, teachers and designers to the concept of circular economy, and to provide the definitions of CE and Design for CE used in the KATCH_e project.

How	Having a good understanding of the strategies and how to apply them in the design and development process, in a holistic manner.

Questions the module addresses

This module is built around the following questions: Why circular economy, what is it about, and what is needed to work from a circular approach? The module answers the questions both from a conceptual perspective, a consumption and market perspective, and from a practical implementation perspective. The content is structured in eleven chapters with proposed assignments in most of them. To work on the assignments, one can use the provided background materials or do one's own research. The following table provides an overview of questions that are addressed within the contents as well as the assignments of the module.

Chapter 1: The global sustainability challenge and why we need a new approach	
Contents	– The global sustainability challenge – we are exceeding the carrying capacity of the earth – From linear to circular and the process of change
Assignment	– Argue for 3 main reasons for a transition from the linear business as usual
Chapter 2: Defining circular economy and the underlying principles and strategies	
Contents	– KATCH_e definitions of circular economy and Design for circular economy – Underlying principles and strategies for a circular approach
Assignment	– Discuss different CE definitions and which understanding of CE they represent
Chapter 3: Circular economy and sustainability	
Contents	– Relations between circular economy and sustainability – Life cycle thinking – Efficiency, eco-effectiveness and sufficiency

Assignments	– Give examples and related argumentation on, where circular solutions may not be sustainable – Give examples on how life cycle thinking in a circular economy may differ from life cycle thinking in a linear economy
Chapter 4: Design and innovation for a circular economy	
Contents	– What does it mean to design for a circular economy? – What is a circular product or product-service? – Design strategies for slowing, narrowing and closing loops
Assignment	– Design goes beyond the product. Discuss, eventually for a given product, what "designing" should include to create a sustainable, circular solution
Chapter 5: Circular economy requires new business models	
Contents	– Business models in a circular economy – the quality aspect – Developing new relations in the value chain
Assignment	– Discuss for a given product how you would expect a circular solution will affect the existing business model and the value chain
Chapter 6: Main challenges and drivers in shifting to a circular economy	
Contents	– Main challenges and drivers in shifting to a circular economy: Organization, market and society
Assignment	– Argue for what you see as the 3 main enablers and 3 main challenges for circular economy in the construction and the furniture sectors. How to address the challenges?
Chapter 7: EU policy and legislation for circular economy	
Contents	– EU understanding of circular economy – Initiatives supporting circular economy – The waste hierarchy – Linking CE initiatives to existing EU legislation
Chapter 8: Sustainable production and consumption	

Contents	– United Nations Sustainable Development Goals – EU focus on consumption in a circular economy – Slowing, narrowing and closing loops related to consumption – Consumer attitudes and choices
Assignment	– Think of your daily life at home, at school or in the office. Which other examples of consumption choises that are aligned with slowing, narrowing or closing loops can you come up with?
Chapter 9: Circular economy in the construction and furniture sectors	
Contents	– About the European construction and furniture sectors – Circular economy in the construction and the furniture sectors – Market trends in the European construction and furniture sectors – CE in the EU regulatory framework for the two sectors – Barriers for CE in the construction and the furniture sectors – Examples on CE initiatives in the two sectors
Assignments	– Select a number of trends mentioned in the market trends tables for construction or furniture that are relevant to the neighbourhood/town/city where you live. Based on a group debate, identify circular design specifications for a construction element (e.g. a wall) or for a piece of furniture at your choice – Discuss what you see as the potential outcomes of a CE approach in the construction or the furniture sector on a social and on a company level
Chapter 10: Tools for introducing the circular economy	
Contents	– KATCH Up! Game – Other tools
Chapter 11: The 10 Essentials of working with circular economy	
Contents	– Working with circular economy in practice: The Ten KATCH_e Essentials of circular economy to keep in mind when digging into the other KATCH_e modules
Assignments	– Brainstorm on questions you find relevant to consider for each of the 10 Essentials

Executive summary

Chapter 1 deals with the global sustainability challenge and why we need a new approach to production and consumption. Humanity is exceeding the Earth's carrying capacity and it can have severe consequences for our living conditions. This overexploitation of the biological system is partly a result of the increasing resource consumption linked with the linear economy or the take-make-waste paradigm.

Thinking circular can help to address many of these challenges. In essence, a circular economy represents a fundamental alternative to the linear take-make-consume-dispose economic model that currently predominates. This linear model is based on the assumption that natural resources are available, abundant, easy to source and cheap to dispose of, but it is not sustainable. So, we need a fundamental transition into a more sustainable production and consumption system.

Chapter 2: Since there is not one, common definition of circular economy, but a larger number with different foci, we have defined how circular economy and the underlying principles and strategies are understood in the KATCH_e project. Our definition, developed from a number of other definitions, goes:

Circular economy is a system that is restorative and regenerative by intention and design, which supports ecosystem functioning and human well-being with the aim of accomplishing sustainable development. It replaces the end-of-life concept with closing, slowing and narrowing the resource flows in production, distribution and consumption processes, extracting economical value and usefulness of materials, equipment and goods for the longest possible time, in cycles energized by renewable sources. It is enabled by design, innovation, new business and organizational models and responsible production and consumption.

Chapter 3: Circular economy can be seen as a tool to operationalize sustainable development principles through efficient and eco-effective use of reources. It is, however, not always obvious that a circular solution is sustainable. For example, if hazardous chemicals through recycling enter new product life cycles, and it is important to understand how life cycles of products are altered in circular solutions.

Design and innovation for a circular economy is the core of the KATCH_e materials. **Chapter 4** presents the main design strategies for a circular economy in our two target sectors – based on the principles of slowing, narrowing and closing material and energy loops. The strategies are further elaborated in the *KATCH_e **Design and development** module.*

Circular economy also requires new business models since it represents a new way of understanding value in the economic system. **Chapter 5** introduces some main aspects to consider when developing circular business models and related value chains, and the *KATCH_e **Business models** and **Value chains** modules* present methods and approaches for working with these aspects.

Circular economy as an idea and a concept is not new, and many companies have already come to know both challenges and enablers in shifting to a circular economy. **Chapter 6** gives an overview of the main types of the barriers and drivers on three levels: society, market and organization.

Legislation is both an enabler and a barrier for the transition towards circular economy, and the **chapter 7** highlights the main EU policies and regulation influencing the development. Moreover, market trends and the development in our consumption patterns are extremely important, also in the circular economy, and this is the topic for **chapter 8.**

Since the training materials are targeting the construction and furniture sectors, **chapter 9** presents the two sectors, the main market trends and circular economy aspects and challenges. The chapter also includes several examples on, how organizations in the two sectors deal with circular economy.

In **chapter 10,** tools that may support one's way into understanding and working with circular economy are presented, and the final **chapter 11** concludes the introduction by pointing at ten essentials of working with circular economy from a more practical perspective.

1. The global sustainability challenge and why we need a new approach

In the last hundred years, the shift of an increasing number of countries from low to high levels of industrial development has brought an unprecedented increase in natural resource use. Driven initially by economic development in Europe and North America, and subsequently elsewhere, world gross domestic product (GDP) has increased 25-fold since 1900, bringing a 10-fold rise in global resource extraction (EEA, 2016).

During the next 40 years, the world population is expected to rise from 7 to 10 billion people which will demand three times more resources than can be provided, unless resources are recycled (footprintnetwork.org; Population Reference Bureau, prb.org).

During the last 30 years, global material extraction has more than doubled from around 36 billion tonnes in 1980 to almost 85 billion tonnes in 2013, see figure 1 (Vienna University, 2016). Especially, industrial and construction minerals acquisition has increased significantly with more than 240% as a result of increasing material needs to build housing, energy and transport infrastructure in emerging economies (Vienna University, 2016).

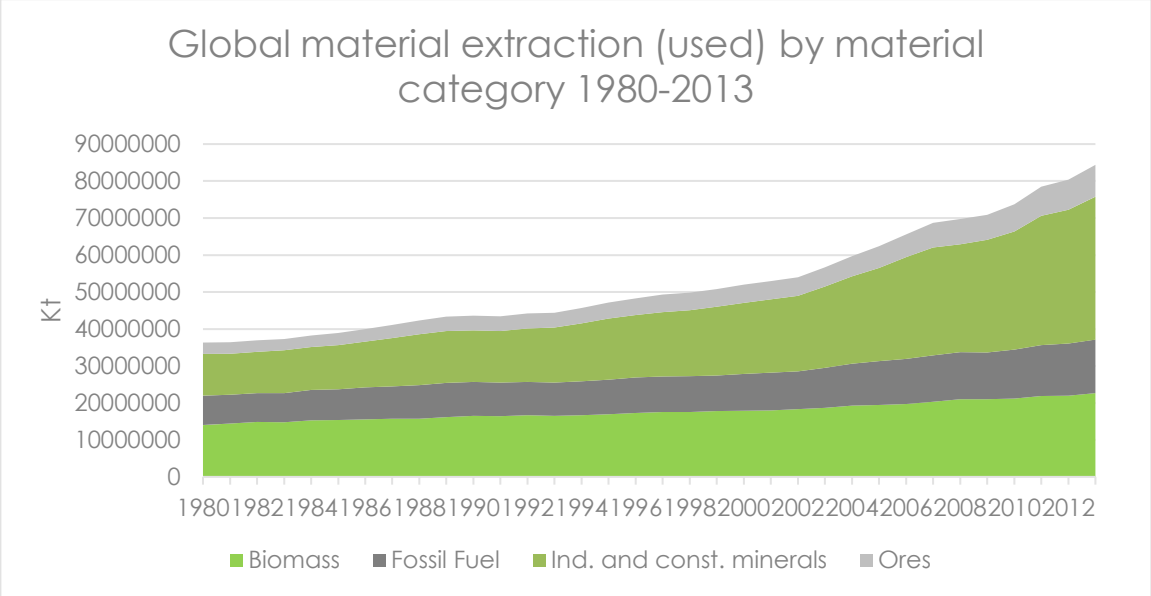


Figure 1: Global material extraction (used) by material category 2980-2013 (Global Material Flows Database, Vienna University, 2012).

The increasing material extraction rates seen during the last 30 years conveys the notion that the resources available on Earth are unconstrained. However, this is far from the truth. In fact, the Earth is a closed system and, with the exception of solar energy and wind power, the resources available on the Earth are constant (Boulding, 1966). Due to these constraints on available resources, the Earth also has a certain carrying capacity, which we today are overexploiting. Two indicators are the ecological

footprint (from the demand side) and the biocapacity (from the supply side), developed by the Global Footprint Network (figure 2) (Global Footprint Network, 2013). Ecological footprint is a measure of how much biologically productive land and water is needed to produce all the resources consumed and absorb all the waste generated. Biocapacity is a measure for the capacity of an ecosystem to produce the biological materials used by humans and to absorb the waste generated by humans. As illustrated in figure 2, the ecological footprint has since 1970 exceeded the biocapacity of the Earth, and consequently there has been an ecological deficit. In 2013, the ecological deficit was so large that we needed 1.68 Earths to produce all the resources we consumed and absorb all the waste we generated.

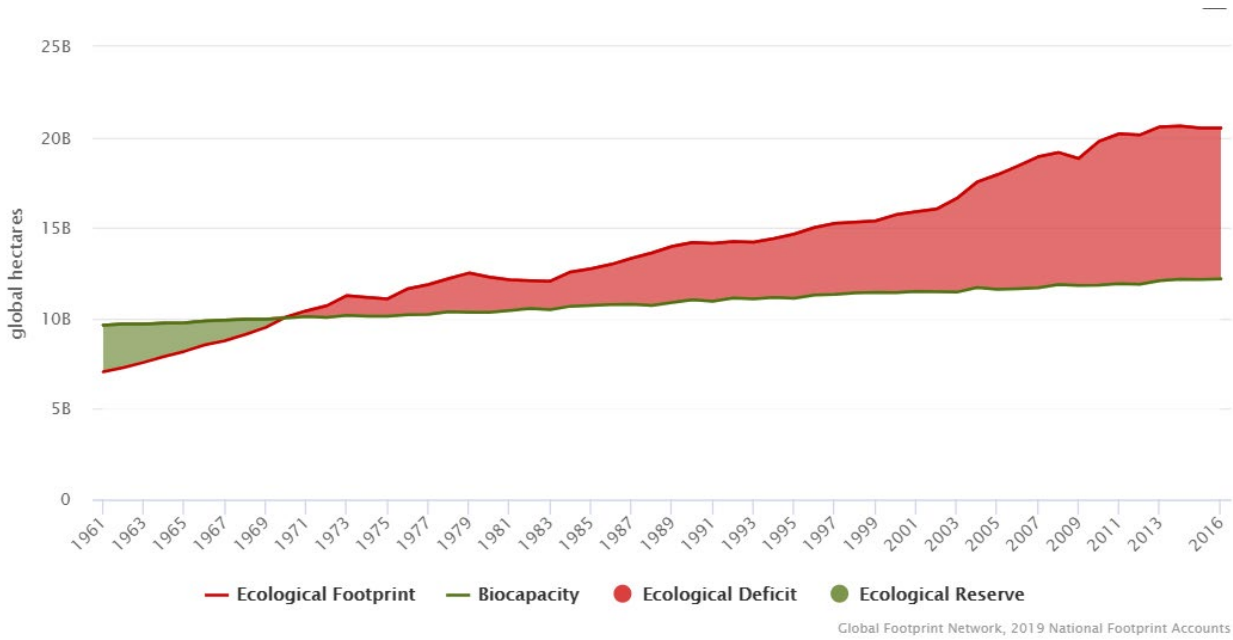


Figure 2: Ecological footprint vs biocapacity measured in global hectares (Global Footprint Network, 2019).

At the same time, rapid increases in extraction and exploitation of natural resources are having a wide range of negative environmental impacts in Europe and beyond (EEA, 2016). Air, water and soil pollution, acidification of ecosystems, biodiversity loss, climate change and waste generation put immediate, medium- and long-term economic and social well-being at risk. While resource use in Europe has become more efficient in recent years, resulting in absolute reductions in emissions of greenhouse gases and pollutants, the continent's burden on global ecosystems remains considerable, particularly if pressures in the countries of origin of imported products and materials are taken fully into account (EEA, 2016).

This overconsumption has had strong implications for the well-being of the biosphere, and thereby also the outset for our living conditions. Rockström et al. (2009) have defined nine of what they call planetary boundaries defining the safe operating space for humanity in terms of the planet's biophysical subsystems or processes, see figure 3.

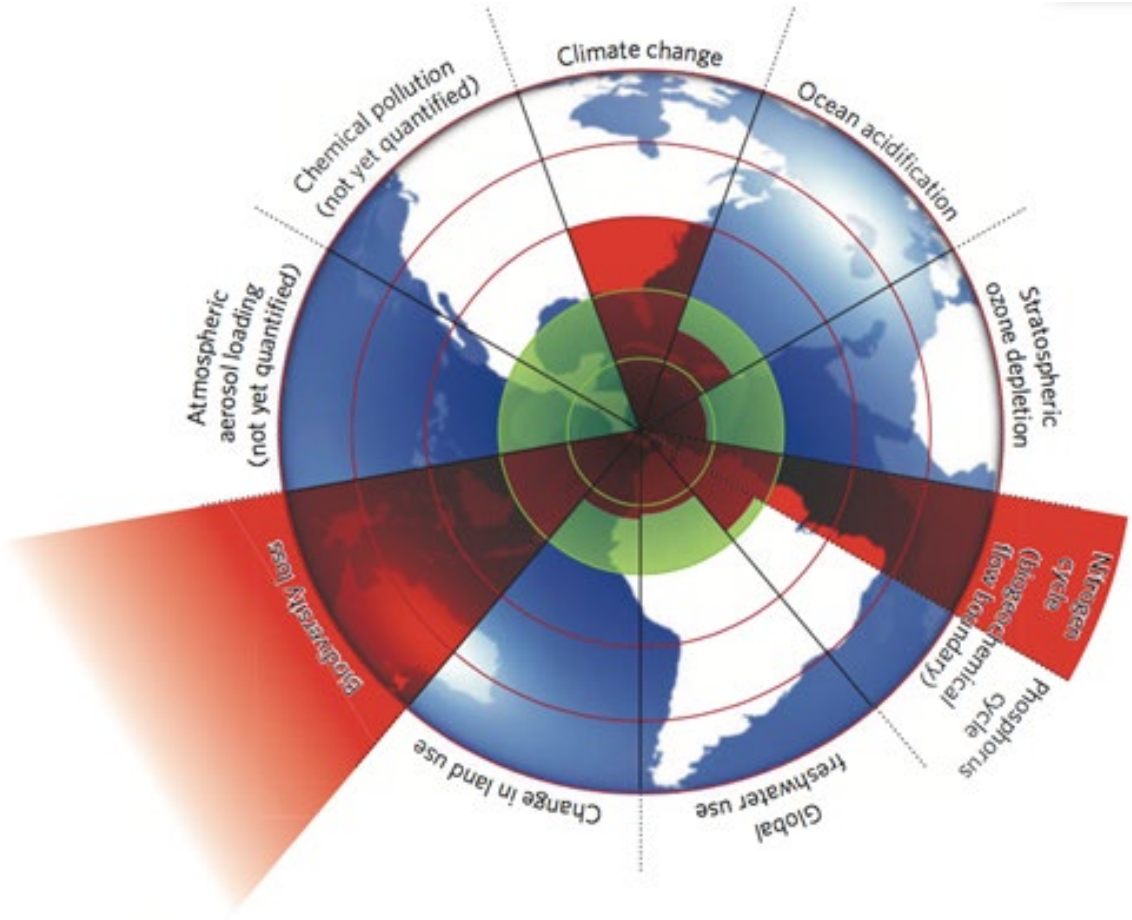


Figure 3: Planetary boundaries the green colour represents the proposed safe operating space, the red colour represents the estimated current position for each of the nine planetary system (Rockström et al., 2009: 472).

As figure 3 shows, three of the nine planetary systems have exceeded the safe operating space including climate change, the nitrogen cycle and biodiversity. Furthermore, humanity is approaching the planetary boundary for global freshwater use, changes in land use, ocean acidification and the global phosphorous cycle (Rockström et al., 2009). Hence, humanity is exceeding the Earth's carrying capacity and it can have severe consequences for our living conditions. This overexploitation of the biological system is partly a result of the increasing resource consumption linked with the linear economy or the take-make-waste paradigm.

Thinking circular can help to address many of these challenges. In essence, a circular economy represents a fundamental alternative to the linear take-make-consume-dispose economic model that currently predominates. This linear model is based on the assumption that natural resources are available, abundant, easy to source and cheap to dispose of, but it is not sustainable, as the world is moving towards, and is in some cases exceeding, planetary boundaries (EEA, 2016). Therefore, we need a fundamental transition into a more sustainable consumption and production system. In a circular model, on the other side, waste and pollution are designed out, products and materials are

kept in use and values sustained for as long as possible – and natural systems are regenerated (Ellen MacArthur Foundation, 2012).

The process of change necessarily involves (Rocha, 2010):

- Companies (placing more sustainable products on the market, promoting sustainability design and new business models such as product-service systems, which dissociate profit from natural resource consumption, and promote responsible marketing, for example);
- Policy makers (through legislation, financial incentives, environmental and social labelling schemes, awareness-raising campaigns geared to different socio-economic segments, and by adopting sustainability criteria in public procurement and thereby power of the government, as a client, to influence the market);
- Organized civil society (more and more non-governmental organizations dedicated to sustainable consumption, with an important role in informing citizens);
- Citizens, as individual consumers, who are facing the first major challenge that is to be aware of the implications of their choices and how they meet their welfare needs.

Assignment 1

Argue for 3 main reasons for a transition from the linear business as usual approach

2. Defining circular economy, underlying principles and related strategies

2.1 Understanding the concept towards a KATCH_e definition of CE

The idea of a circular economy is not new but goes back to the 60s and 70s (Boulding, 1966; Nicholas Georgescu-Roegen, 1975). However, it was not until the beginning of the 90s that the term circular economy emerged, when introduced by Pearce and Turner in 1990. In 2012, the concept re-emerged as the Ellen MacArthur Foundation published their first of many publications on circular economy (Ellen MacArthur Foundation, 2012). Since then, the concept has spread to the political arena with amongst other the European Commission's Action Plan to a Circular Economy (European Commission, 2015), and a revision of a number of directives such as the waste framework directive and the directive on packaging waste (see section 7 on EU CE Policy and Regulation). Moreover, since the re-emerge in 2012, a large number of publications, research papers, etc. suggesting definitions, models and strategies to circular economy has been developed. As a result, there is no shared and common understanding and definition of circular economy (Kirchherr, Reike, & Hekkert, 2017). These authors analysed nothing else than 114 definitions, which indicates that the meaning of circular economy is far from consensual.

Just like there is no single agreed upon definition of circular economy there are also various notions on what are the fundamental principles behind circular economy. Furthermore, there is no clear distinction between a CE strategy and a CE principle. In the KATCH_e context, we understand a principle as a basic idea or rule, whereas a strategy sets out more specific indications of which actions to take.

In the KATCH_e project, the consortium developed its own definition of circular economy that will be presented below and is meant to suite the projects' objectives, operational approach and sectors. It has its roots in several existing definitions: the one provided by the Ellen MacArthur Foundation (EMF) serves as a starting point since it is often enhanced as the most prominent definition of circular economy. The EMF definition defines circular economy as:

> *"an industrial system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impairs reuse, and aims for the elimination of waste through the superior design of materials, products, systems and within this, business models." (Ellen MacArthur Foundation, 2012: 7).*

The EMF definition can be criticized for not specifying the need for reducing consumption levels and not including the social aspects of sustainability.

To overcome the weak point related to the need of reducing consumption rates, we include the definition of CE developed by Geissdoerfer et al. (2017):

> *"a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling." (Geissdoerfer et al., 2017: 759).*

This definition applies three strategies to move towards a circular economy: slowing, closing and narrowing, see figure 4:

- Slowing resource loops is to extend or intensify the utilization period of a product resulting in a slowdown of resource consumption. This can be done through designing products with a long lifespan, repair and remanufacturing.
- Closing resource loops is to close the loop between post-use and production through recycling.
- Narrowing resource loops is to use fewer resources per product, thus also considering reduction of the resources used (Bocken et al, 2016).

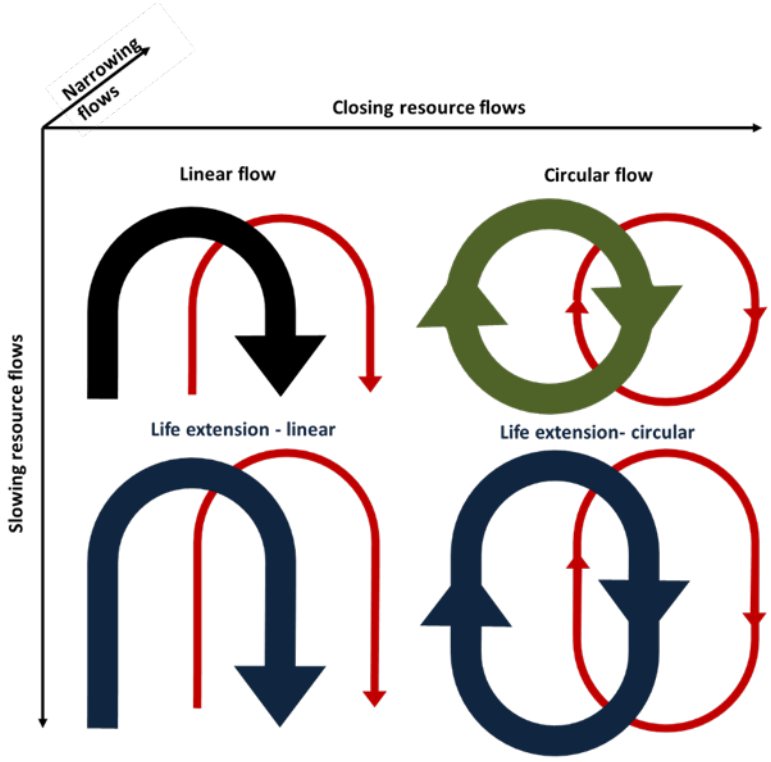


Figure 4 – Categorization of linear and circular approaches for reducing resource use. (Bocken et al, 2016).

Throughout the KATCH_e modules there are several examples on how to work with the slowing, closing and narrowing strategies.

The Geissdoerfer et al. (2017) definition, however, like the one from EMF (2012), does not specifically include a reference to the social aspects of sustainability. Therefore, we include a third definition in KATCH_e's understanding of circular economy.

Murray, Skene and Hayes (2015) include human well-being in their definition, which opens for taking into account important moral and ethical issues like diversity and social equity. Their definitions goes:

> *"The Circular Economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being" (Murray, Skene, & Haynes, 2017: 377).*

The strength of this definition lies exclusively on the gap it intends to fill in - the focus on human well-being.

With all these considerations in mind, and in order to frame the development of the KATCH_e training materials and tools, the following definition and basic strategies applies:

Circular economy is a system that is restorative and regenerative by intention and design, which supports ecosystem functioning and human well-being with the aim of accomplishing sustainable development. It replaces the end-of-life concept with closing, slowing and narrowing the resource flows in production, distribution and consumption processes, extracting economical value and usefulness of materials, equipment and goods for the longest possible time, in cycles energized by renewable sources. It is enabled by design, innovation, new business and organizational models and responsible production and consumption. Figure 5 illustrates how other existing definitions are used to develop the KATCH_e definition.

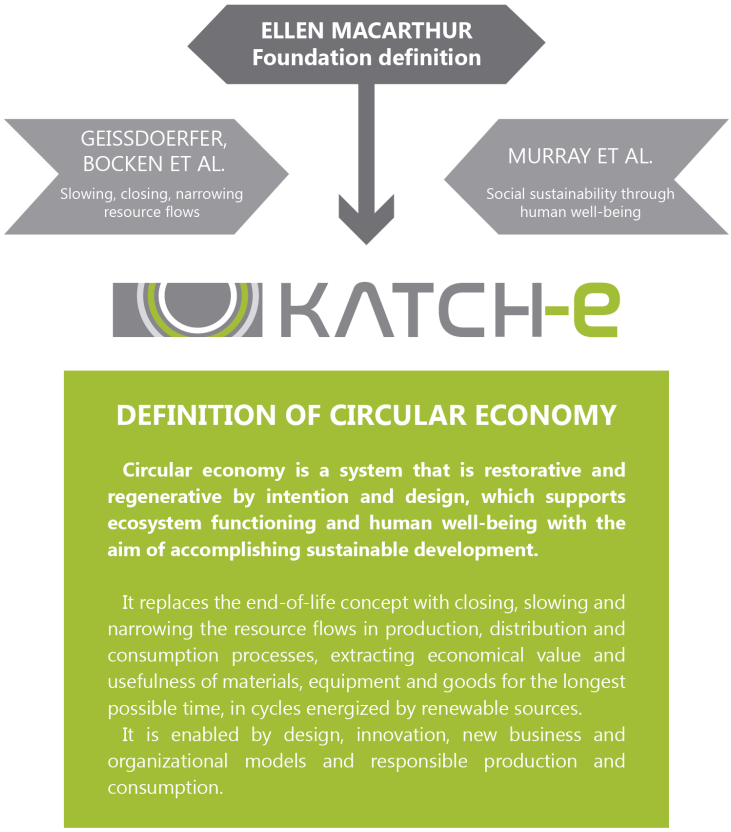


Figure 5: Development of the KATCH_e definition of circular economy

Since the KATCH_e definition of CE takes a point of departure in the work of Ellen MacArthur Foundation (EMF) who focus on designing out waste and keep all materials and values in technical or biological loops. Their model, known as the CE butterfly diagram, see figure 6, deserves more explanation. The understanding of circular economy applied by the EMF is influenced by the cradle-to-cradle concept developed by Braungart and McDonough (2002).

On the left hand side of the model, there are loops related to biological nutrients, which are "consumption products". This means that they are used up during the act of consumption, such as food, soap, etc. Once they serve their purpose, they enter the biosphere through the soil, water or air, and there they should be safe nutrients to the biosphere and renewable resources for new products.

On the right hand side, the diagram shows the metabolism of technical nutrients or "service products". These are not consumed while fulfilling their purpose and examples are cars, textiles, furniture, etc. These are the types of products that concern the KATCH_e project as it focus on construction and furniture.

It is true that a piece of wooden furniture could in principle fit the left hand side circular strategies, especially if no chemicals (such as preservatives, varnishes, etc.) have been applied to it. But if the idea is not only to close loops but also to keep products in the economy for the longest feasible time, the right hand side strategies are the ones that are going to be explored in the project (figure 6). In principle, the closer to the inner circles/loops the better, since this will preserve as much value as possible, and demand less resources and energy in processing products and materials into new uses.

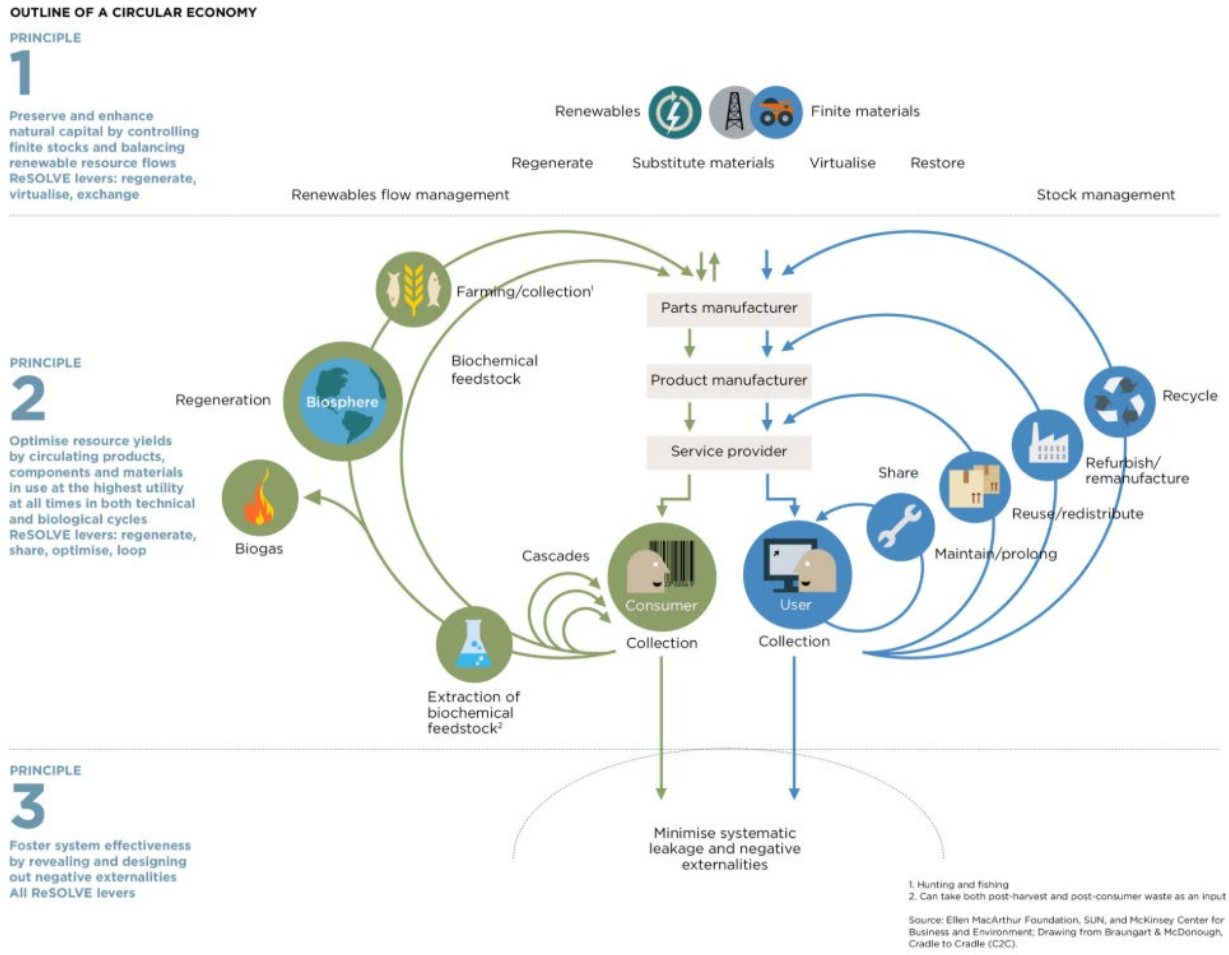


Figure 6: The "Butterfly" model of circular economy from the Ellen MacArthur Foundation. Section 2.2 further explains the 3 principles. (Source: https://www.ellenmacarthurfoundation.org/circular-economy/infographic)

Assignment 2

Discuss different CE definitions and which understanding of CE they represent

2.2 Principles and strategies

A definition of circular economy is helpful in creating an understanding on a conceptual level, but it does not in itself provide guidance on, how to work with CE in practice. Therefore, we also need some basic principles and related strategies. The Ellen MacArthur Foundation developed the following three principles as a basis for their work:

Principle 1: *Preserve and enhance natural capital by controlling finite stock and balancing renewable resource flows*. The principle concerns the optimal use of our natural resources for example through dematerialisation, using, when possible, virtual utilities instead of physical products. However, when

the use of resources are unavoidable then a wisely use of resource should be ensured by selecting technologies and processes that rely on renewable or better-performing resources (Ellen MacArthur Foundation, 2015a).

Principle 2: *Optimise resource yields by circulating products components and materials in use at the highest utility at all times in both technical and biological cycles*. This principle concerns the design of products, components and materials. Here, the design should ensure that products, components and materials can be circulated and continuously contribute to the economy through actions such as remanufacturing, refurbishing and recycling. A circular system should use inner loops (see figure 6 – the butterfly), when possible to preserve energy and value – and to extend product life and enhance reuse (Ellen MacArthur Foundation, 2015a).

Principle 3: *Foster system effectiveness by revealing and designing out negative externalities*. The third principle is about reducing the damage to human utility such as food, shelter, mobility, health and education. Furthermore, it concerns the management of externalities such as land use, water, air and noise pollution, climate change and the release of toxic substances (Ellen MacArthur Foundation, 2015a).

The principles are further developed into the ReSOLVE strategic framework providing more specific actions on how to reach a circular economy (see Table 1).

Table 1: The ReSOLVE framework (Ellen MacArthur Foundation, 2015a)

Regenerate	Change to renewable energy and materials
Share	Keep product loop speed slow and maximize the use of products by sharing.
Optimize	Increase performance and efficiency of product in a life cycle perspective.
Loop	Keep materials and components in closed loops and priorities inner loops.
Virtualize	Supply utility virtually.
Exchange	Exchange old materials with advanced non-renewable materials, use new technologies, select new products and services.

Chapter 4 on Design and Innovation for Circular Economy will look more at principles and strategies, but first, we look into how circular economy and sustainability are related.

3. Circular economy and sustainability

Circular economy is often closely linked to sustainability. The links between circular economy and sustainability are, however, subject to debate, and at least two different views on the links exist. Some believe that circular economy surpasses sustainable development because sustainable development is rooted in linear thinking strategies, while others see circular economy as a tool to reach sustainability and thereby circular economy becomes a tool to operationalize sustainable development principles (Merli et al., 2017), especially from the environmental perspective. KATCH_e is in line with the latter approach.

Coming back to the definition above and the narrowing, slowing and closing loops: some authors argue that narrowing loops is related to resource efficiency and this is aligned with a linear economy (Bocken et al., 2016). For many reasons including rebound effects, efficiency ("doing things right") has proven short in the goal of achieving a sustainable development. The EMF evokes the concept of "eco-effectiveness" ("doing the right things"), where "products and their associated material flows such that they form a supportive relationship with ecological systems and future economic growth. The goal is not to minimise the cradle-to-grave flow of materials, but to generate cyclical, cradle-to-cradle 'metabolisms' that enable materials to maintain their status as resources and accumulate intelligence over time (…)". (Source: https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram/efficiency-vs-effectiveness).

The KATCH_e consortium agrees that a smart combination of three types of loops is necessary, as illustrated in chapter 2: in theory, the cycles of materials need to be not only longer and circular, but also thinner. The three loops, however, do not consider another important approach to sustainability, namely "sufficiency". Sufficiency requires serious changes in mentality and behaviour, since the right to consume (more and more) is questioned. From a business perspective, sufficiency clearly brings challenges, since – in a simple understanding – it's about consumers buying less, which is not attractive in a traditional linear business model. Therefore, new business models are needed. Chapter 5 and the *KATCH_e **Business models** module* look more into this challenge.

It is not always obvious that a circular solution is also sustainable. For example, recycling of products containing hazardous chemicals or materials may create new or unknown environmental effects when they enter a product life cycle, that it was not intended for. Another example is the establishment of a take-back system, where one will need a car to hand in products for recycling. It will augment environmental impacts from the transport, and may also have a potentially negative social impact for people not having a car. Another case concerns a research conducted in relation to LED products: it is not straightforward that longer life-times have lower environmental impacts; improved efficiency, improved material design and decarbonisation of electricity supply need to be considered to come up to a conclusion (Richter et al., 2013).

A main difference between CE and sustainability is related to the social aspects. Sustainability on a conceptual level focus on all three pillars of sustainability (the social, the environmental and the

economic), while circular economy as it is used today tends to focus more on the environmental aspects combined with an economic evaluation. The social dimension is not systematically included in the practical solutions so far (Merli et al., 2017). However, to be sustainable, systems for production and consumption will have to take aspects like for example the uneven distribution of wealth and resources, access to welfare, and human rights into account. That said, many initiatives declared sustainable are also not giving the social aspects the same attention as the environmental and economic ones.

In a circular economy, there will be easier access to reuse of products, which may benefit people with lower incomes and give them a possibility for consumption, they would not have had. On the other hand, this may lead to a raise in the consumption level in total. So, in a transition towards more circular and sustainable societies, the question of who has the "right" to consume when resources are restricted becomes important. This is a question with no simple answers, but it will require new and innovative design strategies and business models, including solutions that can fulfil people's needs with much less materials.

Assignment 3

Give examples and related argumentation on, where circular solutions may not be sustainable

Companies have traditionally paid most attention to the environmental, social and economic impacts related to their production sites and manufacturing processes, and not so much to their products, by applying strategies such as pollution prevention and cleaner production. However, the increasingly globalised and complex product chains need another perspective including the whole value chain. Here, the concept of life cycle thinking becomes relevant as a way to understand the environmental, social and economic impacts of a product or service in the entire life cycle of the product or product-service from cradle to grave. Or, preferably, from cradle to cradle, where products, components and materials are reused, recycled or recovered into new products. The main objective of life cycle thinking is to reduce the resource use, reduce the emissions to the environmental and improve the socio-economic performance throughout the products entire life cycle (Remmen, Astrup, & Frydendal, 2007). It requires a close cooperation within the value chain, for example in developing new solutions with suppliers, facilitating the customers' handling of the products with the aim of minimizing the environmental impacts during use and when discarding the product.

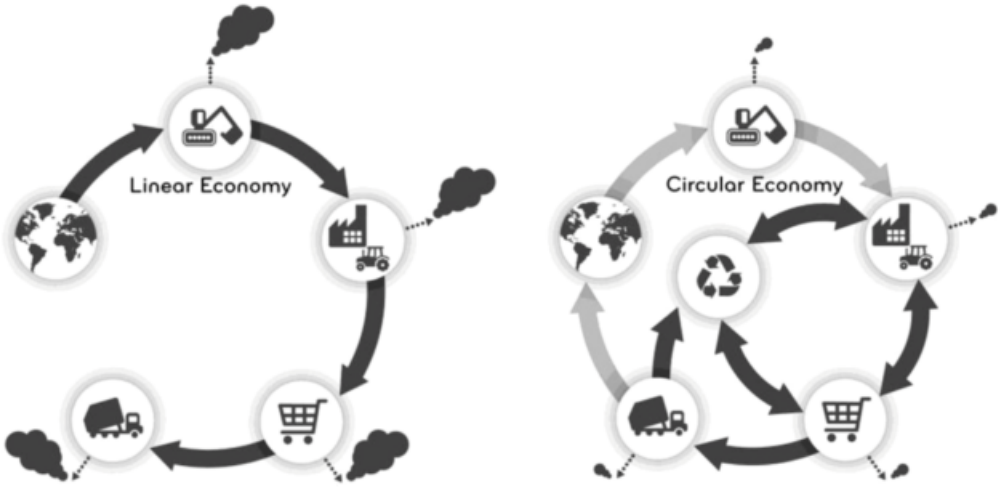


Figure 7: Life cycle thinking in a linear and a circular economy (Sauvé et al. 2016)

In a linear economy, some recycling may take place, but as illustrated to the left in figure 7, the cycles are not necessarily closed. As they will be in a circular economy, illustrated to the right in figure 7. Recycling and closing of material loops can take many forms, as illustrated by the EMF butterfly model in figure 6, involving all phases of the life cycle – not just the ones included in this figure.

The life cycle thinking and how to assess the environmental and social impacts through Life Cycle Assessments is further unfolded in the *KATCH_e **Life Cycle Perspective** module*.

Assignment 4

Give examples on how life cycle thinking in a circular economy may differ from life cycle thinking in a linear economy

4. Design and innovation for a circular economy

To reach a circular economy, materials and products should be designed for closed loops. However, the majority of products today are not designed for circulation, but are designed to fit into a linear economy with fast replacement rates (Andrews, 2015). Therefore, to create a circular economy we need to consider circularity already in the product design (Andrews, 2015; Bocken et al., 2016; Moreno et al., 2016). Design for circular economy is a relatively new design approach, it takes, however, the outset in more established design approaches such as ecodesign, design for the environment and design for sustainability. Thereby, design for circular economy can be considered as an additional focus when designing for sustainability.

However, what does design for a circular economy imply? In connection with the KATCH_e a definition of design for circular economy has been developed and it reads:

Design for Circular Economy is the design and development of products, services and product-service systems that replaces the conventional end-of-life concept by closing, slowing and narrowing the resource flows in production, distribution and consumption processes. It is enabled by innovation and novel business and organizational models and aims to accomplish sustainable development through supporting of ecosystem functioning and human well-being, and through responsible production and consumption.

To understand the actual implementation of design for circular economy, an outset can be taken in the practical implementation of circular economy and its links to the three overall circular economy strategies closing, slowing and narrowing resource flows. The practical implementation of circular economy are often linked to the "3Rs" reduce, reuse and recycle (Dajian, 2004; Ghisellini et al., 2016; Goyal et al., 2016; Lieder and Rashid, 2016; Su et al., 2013). Van Buren et al. (2016) and Potting et al. (2017) expanded the "3Rs" framework to the "9Rs" framework adding refuse, repair, refurbish, remanufacture, repurpose and recover energy. Hence, when designing for a circular economy we need to consider if we actually need a physical product or if we can replace or refuse it. We also need to consider if we can rethink the design the product and product system, so we can use the product more intensively through sharing products. Then, we need to design products which are as efficient as possible by reducing energy and resource consumption throughout the products entire life cycle. Finally, we need to design products that can be reused, repaired, refurbished, remanufactured, repurposed, recycled and recovered.

Design for circular economy is further unfolded in the *KATCH_e **Design and development** module*, including eight main strategies as illustrated in table 2. Furthermore, in the *KATCH_e **Radical innovation and collaborative design processes** module*, the focus is precisely on the role of radical innovation to attain sustainability and circularity and different types of innovation are discussed. Related to both modules, KATCH_e tools are provided to support the practical work of designing innovative, circular solutions.

Table 2: KATCH_e Design strategies for developing circular solutions

Slowing loops	– Design of long-life products (1) – Design for product-life extension (1) – Design of product-oriented services) (2) – Design of use- or result-oriented services (2)
Narrowing loops	– Design for materials sustainability (1) – Design for energy sustainability (1)
Closing loops	– Design for recycling (1) – Design for remanufacturing (1)

Note: (1) product design; (2) service design

4.1 How to define a circular product?

During the design process, you will also have to consider, whether or when a product or a solution is circular. For example, is a product more circular because it has a longer serviceable life, even if at end of use it is being landfilled? The answer is not simple, but it can be "yes", if the longer lifetime will save a large amount of resources. In any case, an assessment will be needed, and the *KATCH_e* ***Life cycle perspective*** *module* presents methods for evaluation.

From a material resource perspective, the Ellen MacArthur Foundation has defined a circular versus a linear product: A 100% linear product is a product that is manufactured only using virgin feedstock and ends up in landfill. A 100% circular product, on the other hand, contains no virgin feedstock and is completely collected for recycling or reuse at the end of its use phase (Ellen MacArthur Foundation, 2016).

The 100% circular product is theoretical, because the collection, recycling and reuse will never be a 100% efficient process, there are losses. Thus the emphasis on slowing and narrowing resource loops, in addition to closing resource loops is needed.

The *KATCH_e* ***Processes and materials*** *module* and the related KATCH_e tools explain and give examples on benefits and challenges related to different types of materials and production processes.

Assignment 5

Design goes beyond the product. Discuss, eventually for a given product, what "designing" should include to create a sustainable, circular solution

5. Circular economy requires new business models

Circular economy represents a new way of understanding value in the economic system. In the linear economy, the success of the economy is measured by the amount of throughput going through the system, an example being gross national product. In the circular economy, on the other hand, the primary concern is to maintain the stock and the values of the resources (Boulding, 1966). Thereby, the circular economy represents a new way for companies or producers to create value compared to the more traditional linear business model of production where profits is generated from selling products (Bocken et al., 2016). In the circular economy, the companies need to generate profits from the flow of materials and products over time (Bocken et al., 2016).

This calls for the development of new business models such as product service systems, leasing, collaborative consumption, sharing platforms and business models based on maintenance and repair (Bocken et al., 2016). Stahel also introduced in the 1990s the functional service economy with the purpose of selling performance instead for a selling a product (Stahel, 2013). Circular economy is also linked to the sharing economy, where the consumer buys access to a product instead of owning it (Hobson and Lynch, 2016). Many of these circular business models assign the consumer with a new role, which is further developed in the *KATCH_e **Business models** module*.

A circular business model should create value while at the same time close, slow or narrow the resource flows. In a "closing" model, materials are recycled into the production process of the same type or other types of products. In such a solution, however, values may be lost. When using crushed materials from demolished buildings, for example, only about 15% of the economic value is recaptured, compared to the value if the building element was reused as a building element (Sommer, 2018).

As for a product, a business model is never 100% linear or 100% circular. This is illustrated in figure 8.

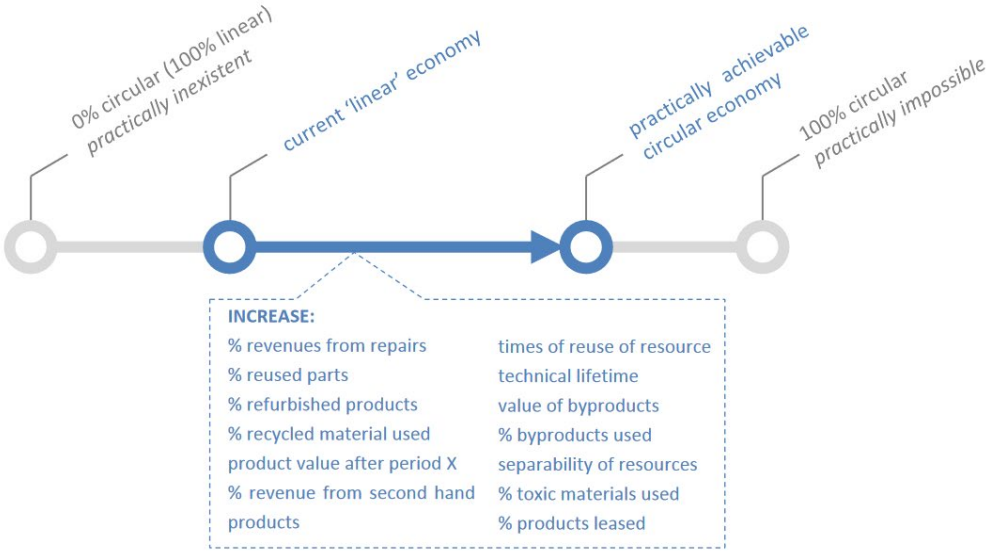


Figure 8: From 100% linear to 100% circular business models (Mentink 2014)

A circular business model requires a shift in the value proposition from quantity to quality. As linear business models are generally sales oriented, there is an inherent incentive to build products with a short lifespan to maximise revenues. By extracting resources from the earth, refining them further within the manufacturing process, assembling them into products and distributing and selling them to consumers, value is added every step of the way. At the point of sale the value is at its highest. Due to the incentives described, the value is quickly lost after a short use phase. Products end up in landfills or are incinerated. Circular business models, on the other hand, create value based on a product's longevity and the closing of resource cycles. The *KATCH_e **Business models** module* takes the discussion further and illustrates how to develop new circular business models, and the related challenges.

In this context, the success of implementing a circular economy strategy and a circular business model strongly relies on the capacity of an organization to clearly understand how the value of a product or a service is and can be created within and across value chains and networks, as well as on its capacity to establish the right interactions and relationships among relevant stakeholders in order to create this value.

This way, businesses and organizations need to focus on optimizing and creating value along the entire system in a holistic way, through cooperation with different stakeholders (within an organization, between organizations and/or with consumers) (Kraaijenhagen et al., 2016; Bicket et al., 2014). A change of mind-set is needed, shifting from a traditional supply chain thinking to a value chain approach (Cassell et al., 2016; WEF, 2016). The value chain must be understood as part of wider networks and systems, that allows different flows of resources, knowledge and skills and in short, a new way of thinking and doing things, leading to the launching of more sustainable solutions to the market, based on a circular value chain approach. As an example, the Danish Architect company Lendager Group, who specialized in developing circular solutions in the construction sector, has established a new business unit for recycling of concrete to facilitate the use of this material in new buildings.

The *KATCH_e **Value chains** module* focuses on how value chains and value networks should be understood and managed to benefit a circular economy. Moreover, communication plays a crucial role in documenting and stimulating new circular and sustainable solutions, which is explored in the *KATCH_e **Communication** module*.

Assignment 6

Discuss for a given product how you would expect a circular solution will affect the traditional business model and the value chain.

6. Main challenges and drivers in shifting to a circular economy

As illustrated in the previous chapters, the transition towards a circular economy is complex, both on an organizational, a market and a societal level. There are dilemmas, for example a circular product where the environmental impacts may be higher compared to a traditional product – but where the circular one is prepared for reuse, recycling and cascading of materials. Methods to measure and assess value and risks related to circular products, business models, etc. are only in the beginning. As stated by Arup and bam (2016, p.15): "Current financial models use past performance to predict future results".

On the way towards circularity, an organization will come to face many different types of barriers and challenges – but also drivers; internally, in relation to the market and on an overall systems level, since policies, regulation, infrastructures, economic structures, traditions, mind-set, knowledge and skills, etc. are set up for the linear economy. Figure 9 illustrates the main types of challenges – and the need for thinking across traditional disciplines and professions and for building new relations within the organization, with the suppliers and customers, and with stakeholders. Clearly, such a transition will need a high level of radical innovation, but also willingness to break old routines and to face economic, practical and cultural risks.

To overcome regulation and market barriers, the Danish company Gamle Mursten (Old Bricks) had to develop a new technical description for the European CE-label (safety and quality), to be able to market recycled, old bricks in EU. The recycled bricks are now approved for use in masonry, where the requirement to the rock strength does not exceed 20 MPa.

Figure 9. Different types of challenges in changing to a circular economy (Based on Ramanathan et al., 2014; Valkokari et al., 2014; EMF, 2015b; Arup and bam, 2016; European Environmental Bureau, 2017; Ritzén and Sandström, 2017; Celades et al., 2017)

In the categories illustrated in the figure, there are also drivers, accelerators and enablers of circular economy. For example:

- Technology drivers such as Internet of Things; Asset tracking; mobile computing; 3D printing of spare parts, construction elements; integration of new technologies, etc.
- Regulatory drivers like taxes to limit consumption of certain resources; or reduced VAT for refurbishment of buildings instead of building new
- Custom and habit drivers such as stewardship; changing consumption patterns; open sourcing; sharing or leasing (access to) products as alternatives to owning, etc.
- Market drivers such as competition, ethical and fair trade approaches, companies acting as motivators for other organizations, stakeholder pressures
- Organizations' internal dynamics, including awareness raising among employees

Assignment 7

Argue for what you see as the 3 main enablers and 3 main challenges for circular economy in the construction and the furniture sectors. How to address the challenges?

7. EU policy and legislation for circular economy

Policy and legislation set the framework for the requirements that products, packaging and services must meet in order to enter the EU market. Ideally, policies establish visions and overall strategies for societal developments across or within nations, bridge different stakeholder perspectives and create a platform for businesses' license-to-operate. Policies and legislation can thus stimulate new agendas like the transition to sustainability and circular economy. However, existing legislation established with other purposes may also become a serious barrier to new developments and therefore hamper innovation. This chapter gives an overview of the development of the CE agenda on EU level and related policies and regulation from a non-sector specific perspective.

7.1 The EU initiatives supporting CE

Over the last decade, the European Commission has developed several initiatives aiming at improving resource efficiency and, more recently, supporting the transition to a circular economy. The initiatives are shown in figure 10.

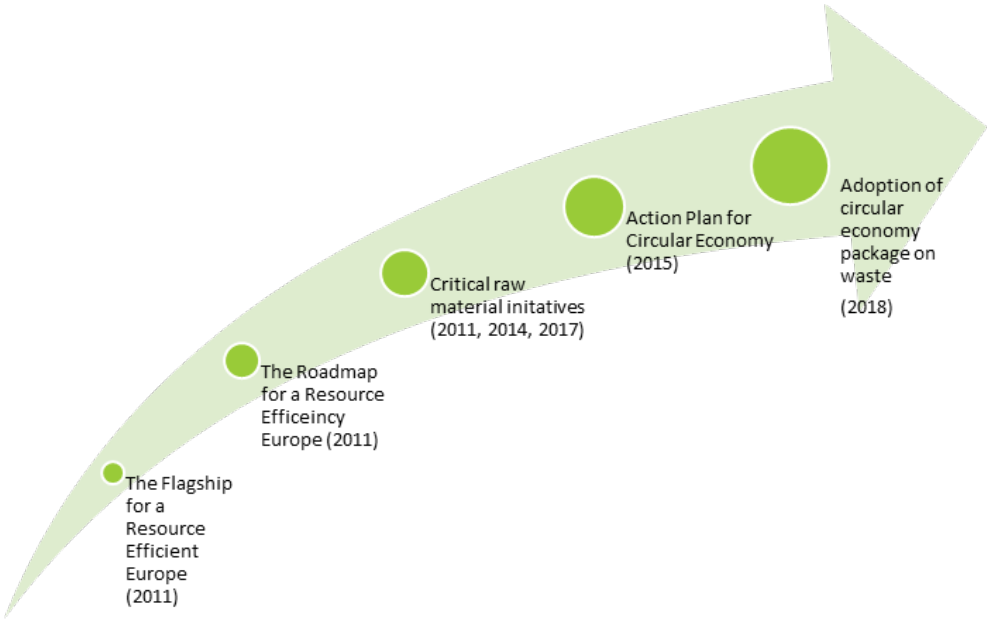


Figure 10. EU initiatives for improving resource efficiency

The Flagship on resource efficiency sets out a policy framework that can support the change in Europe towards a resource efficient and low carbon economy (European Commission, 2011a), whereas the Roadmap to resource efficiency specify objectives and targets. Another important initiative is the publication of critical raw materials lists in 2011, 2014 and 2017. Critical raw materials are "raw materials with a high supply-risk and a high economic importance to which reliable and unhindered access is a concern for European industry and value chains" (European Commission, 2014).

In 2015, the European Commission took a step further in publishing "Closing the loop - An EU action plan for the Circular Economy". The action plan defines circular economy as an economy,

> *"where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised''. The transition to a more circular economy would make "an essential contribution to the EU's efforts to develop a sustainable, low-carbon, resource-efficient and competitive economy'' (European Commission, 2015: 2)*

In connection with the 2018 circular economy waste legislation package, the meaning of circular was further elaborated on in relation to product and material flows:

> *"In a circular economy, products and the materials they contain are valued highly, unlike in the traditional, linear economic model, based on a 'take-make-consume-throw away' pattern. In practice, a circular economy implies reducing waste to a minimum as well as re-using, repairing, refurbishing and recycling existing materials and products. Moving towards a more circular economy could deliver benefits, among which reduced pressures on the environment, enhanced security of supply of raw materials, increased competitiveness, innovation, and growth and jobs. However, it would also face challenges, among which finance, key economic enablers, skills, consumer behaviour and business models, and multi-level governance" (European Parliament Thinktank, 2018)*

The action plan from 2015 established a coherent vision for developing a circular economy in EU including four key areas or strategies to close the loops in the circular economy: production, consumption, waste management and from waste to resources. The related initiatives and strategies were strongly linked to legislation and the set-up of the existing European regulatory framework. As an on-going process, the focus in the initiatives is to remove regulatory barriers and create requirements and incentives to support a circular economy. Many of the earlier policy instruments were revised to further support a transition to a circular economy. The consumption phase is mostly regulated through voluntary initiatives like Ecolabels and Green Public Procurement. Chapter 8 on Production and consumption explains the initiatives, and chapter 9.2.3 on circular economy in the European regulatory framework for the furniture sector details the type of criteria set in the European Ecolabel Scheme and in Green Public Procurement.

Four years later, the 54 actions specified in the plan were delivered or being implemented. Among the key initiatives are:

- an EU strategy for plastics adopting a material-specific lifecycle approach to integrate circular design, use, reuse and recycling activities into plastics value chains, and stating inter alia, that by 2030 all plastic packaging placed on the European market is recyclable or reusable;
- a revised waste legislative framework implemented in 2018 and including e.g. the EU waste hierarchy; targets for reduction of waste and for recycling rates, clarified legal status of recycled materials, and minimum requirements to improve the governance of extended producer responsibility schemes;
- implementation of the Ecodesign Working Plan 2016-2019 to promote the circular design of products, together with energy efficiency objectives. Ecodesign and Energy Labelling measures for

several products now include rules on material efficiency requirements such as availability of spare parts, ease of repair, and facilitating end-of-life treatment.

Read more on the implementation of the circular economy action plan, including the related regulation: http://ec.europa.eu/environment/circular-economy/index_en.htm.

Following the EU waste hierarchy, prevention, re-use and recycling present the most favorable options in terms of maintaining the highest possible value of products or components as illustrated in figure 11.

Figure 11. The EU waste hierarchy (European Commission, 2008)

But one needs to be aware that the waste hierarchy is not fully in accordance to the circular economy concept, in the sense that it assumes that products will inevitably become waste in a certain period of time. As discussed in this module, circular economy challenges this idea.

As an example, the cascading use of renewable resources like wood, be it construction elements or wooden furniture, should be encouraged where appropriate with several reuse and recycling cycles.

One of the initiatives in the action plan, a monitoring framework including ten indicators was established in 2018 to measure the progress towards circular economy in a way that encompasses its various dimensions at all stages of the lifecycle of resources, products and services. The indicators are grouped into four aspects: 1) Production and consumption, 2) Waste management, 3) Secondary raw materials, and 4) Competitiveness and innovation (see figure 12).

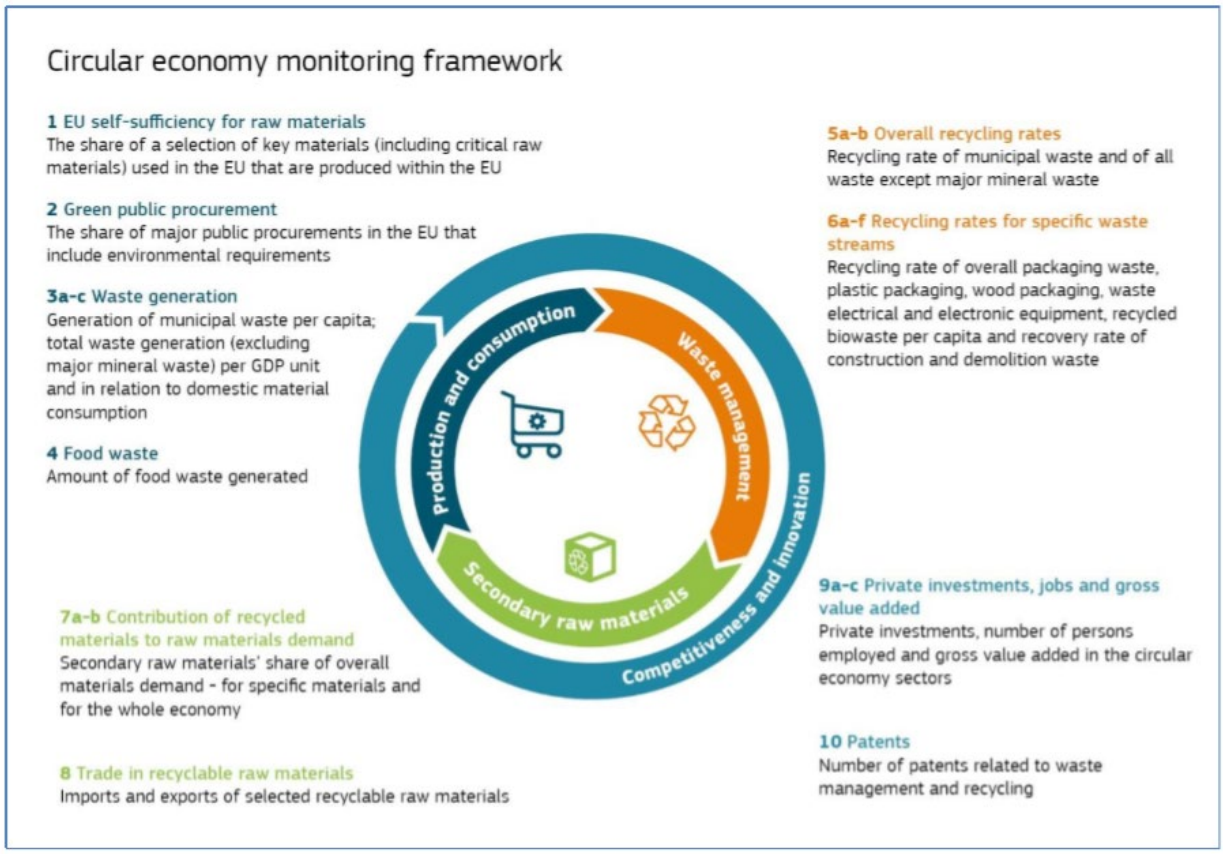


Figure 12. EU Commission's circular economy monitoring framework (EU Commission 2018)

The CE action plan also highlighted five priority areas: plastics, food waste, critical raw materials, construction and demolition, and biomass and bio-based products (European Commission, 2015). As for construction and demolition, the EU Commission developed actions to ensure recovery of valuable resources and adequate waste management, and to facilitate assessment of the environmental performance of buildings, the so-called "Level(s)" initiative (European Commission, 2019a). Read more in chapter 9.1.3.

8. Sustainable production and consumption

Production and consumption represent two sides of the same coin. Clients and consumers shape the market and send messages to decision-makers in governments, industries, companies, designers and other stakeholders through their consumption and purchasing choices and by supporting or dismissing certain practices. Companies also create needs and demands by offering (new) products on the market. Thus, the way we consume will determine supply and the way production is organized will influence demand, in a complex relation. This happens in the consumer market (where clients are individuals or families), in the business market (in which clients are companies and other professional organizations not ruled by public procurement rules) and in the government market (formed by public organizations, subject to public procurement rules).

The transition to a circular economy is a complex process and managing the transition will require a better understanding of broad societal trends and the drivers of production and consumption patterns. Responsible action is required from both production and consumption sides; it is not enough that producers provide more sustainable products and services, it is crucial that consumers and clients accept them (Inaba, 2004) or even are the driving force for them. Therefore, many initiatives to set up a sustainable consumption and production agenda have been developed, including the establishment of a goal related to "responsible consumption and production" within the Sustainable Development Goals (see figure 13) that came into effect in January 2016 and guide the United Nations Development Programme's policy and funding until 2030.

Goal 12: Ensure sustainable consumption and production patterns

Targets (selected):

- By 2030, achieve the sustainable management and efficient use of natural resources
- By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
- By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
- Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
- Promote public procurement practices that are sustainable, in accordance with national policies and priorities
- By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

Figure 13 – Overview of Sustainable Development Goals and selected targets of SDG 12 – Responsible consumption and production, adopted in the United Nations General Assembly Resolution "Transforming our word: the 2030 Agenda for Sustainable Development". (Own elaboration, based on: https://commons.wikimedia.org/wiki/File:Sustainable_Development_Goals.jpg https://www.un.org/sustainabledevelopment/sustainable-development-goals/

On a political level, the European Action Plan for the Circular Economy (EU, 2015) has identified a number of aspects that are being addressed and concern consumption. These include:

1) The use of **labels** as part of an effort to make green claims more trustworthy and influencing greener consumer choices. The trend is that existing labels at EU level include a new criterion on durability (*KATCH_e **Communication** module*).

2) Promoting **reuse and repair**: beside action at different levels to promote reuse and repair, for example design measures to make products easy to repair, or political measures such as taxation benefits in repair shops, it is crucial that clients and consumers are willing to accept reuse and repair, instead of opting for buying new as a first choice. The Bower cooperative

(http://bower.org.au) refers to a "reuse and repair" culture and points out that values of mass consumption include convenience, standardisation, disposability, being in vogue and aspirational status (see section 2). According to them, these same values can be met through investing in repair culture – for instance, items that are upcycled are often unique and therefore unobtainable by others, providing status.

3) Promoting **innovative forms of consumption**, such as **collaborative consumption**. The consumption patterns and the way people consume to satisfy their needs is changing in parallel with the changes in business models. Collaborative consumption is a new way to consume related to the reinvention of traditional market behaviours based on different approaches like renting, lending, swapping, sharing, bartering, gifting, etc., through technology and only possible with the evolution of internet (www.fastcompany.com). While peer-to-peer interactions have long been practised on a local scale, the new concepts have developed into a different dimension through the use of online sharing marketplaces and platforms, through which the demand for certain assets, products or services is matched with their supply, usually through consumer-to-consumer (C2C) channels (EEA, 2017). This consumption model has a higher potential within Circular Economy. According to a global online survey (2014) 54% of European respondents were willing to share or rent out their possessions, while 44 % were happy to rent goods and services from others (Nielsen, 2014). From a business perspective, this model allows to drastically lower the costs of certain services for clients and increase revenues by minimizing expenses and investments, which may bring important sustainability benefits:

– From an environmental point of view, decrease in the use of natural resources, energy and emissions throughout production and consumption cycles based on longer or more intensive use of existing products.

– Social benefits, measured through enhanced social interaction and cohesion, as well as job creation.

– Economic benefits related to consumer access to a broader selection of products and services without incurring the liabilities and risks associated with ownership.

On the other hand, the collaborative consumption approach can trigger negative sustainability impacts by promoting the longer use of inefficient appliances, an increase in transport and an increase in the consumption. The rapid growth of some internet-based consumer-to-consumer business models and platforms has sparked discussion about fair competition, safety, risk allocation, workers' rights, etc.

Another innovative form of consumption highlighted by the EU Action Plan on Circular Economy is **consuming services rather than products**. Examples: a printing contract using a pay-per-copy model, in which the supplier provides all equipment, repairs, replacements and training rather than simply selling copy supplies; a contract according to which what is sold is light instead of light bulbs. The focus is on the needs of the user (copies, lighting) and not on the product (copy machines, light bulbs).

Circular public procurement, which can be defined as the process by which public authorities purchase works, goods or services that seek to contribute to closed energy and material loops within supply chains, whilst minimising, and in the best case avoiding, negative environmental impacts and

waste creation across their whole life-cycle (European Commission, 2017). Public procurement can have a tremendous impact on the market and can create demand and lead by example, since the amount of this public money represents approximately 19% of the EU GDP or more than 2.3 trillion euros (www.interregeurope.eu).

Slowing, closing and narrowing resource loops are important principles in designing circular solutions, but what do they mean in terms of consumption? Table 3 gives some examples:

Table 3. Slowing, closing and narrowing loops from a consumption perspective (Bocken et al, 2016)

Slowing consumption is to extend or intensify the utilization period of a product resulting in a slowdown of resource consumption	- Choosing long life products in detriment of short lived products - Extending product life through maintenance, reuse and repair during the use phase - Choosing sharing, leasing or renting services instead of buying products - Buying a result instead of buying products	CORT company provides a furniture rental service for home and office, and other services. After its rental life is complete, almost all furniture (97%) is discounted and resold to the public, making the reuse rate between 2 and 6 times longer than direct sale models and producing 49% fewer greenhouse gasses. www.cort.com
Closing resource loops through consumption is to focus on recycling	- Choosing products made of recycled material - When products have to be discarded, sort them for recycling	EcoKalçada is an innovative sidewalk product, resulting from 100% recycled rubber from used tires with the combination of virgin or recycled coloured rubbers. The product has a high resistance, durability and capacity of absorption of impact. www.eco-solutions.pt
Narrowing resource flows through consumption is to use fewer resources per product, thus also considering reduction of the resources used	- Choosing products that are lighter or smaller - Choosing products that minimize or eliminate the need of water, materials and energy during use - Choosing products in which packaging has been eliminated or minimized	Swiss Eco Line consists of sustainable energy and water efficient bathroom and wellness products that reduces the water consumption by 90 percent. 100% energy saving due to cold water. No costs for warm water preparation No unpleasant feeling of coldness on the skin due to a special spray technology https://www.swissecoline.com

Changing consumer values in a more sustainable direction raises many questions. If it is acceptable that sustainable production and consumption should be able to satisfy the needs of all (as proposed by the definition of sustainable development in the Brundtland's Report (Brundtland et al., 1987), the

question concerns the overconsumption related to wants or desires. Jackson et al. (2004:15) note "(…) it is particularly vital to be able to identify which bits of consumption contribute to human needs satisfaction, and which simply operate as pseudo-satisfiers and destroyers" (Sto et al., 2008).

As for attitudes (more specific than values, more constant in human behaviour), the main conclusion of studies related to sustainable consumer behaviour is that there is a weak correspondence between reported attitudes and actual behaviour (Sto et al., 2008).

In order to promote the knowledge of consumers about the environmental and ethical profiles of products, several methods have been used, including campaigns, green marketing and claims. The most successful ones seem to be eco-labelling schemes (Rubik and Frankl, cited in Sto et al, 2008). It is therefore very important to disclose reliable informative instruments. Nevertheless, eco-labelled alternatives are often more expensive than the non-labelled products and the question is whether or not consumers are willing to pay more. Studies on this matter are inconclusive, but if the difference in price is not significant (some 5%), consumers are willing to award greener alternatives (Sto at al., 2008).

Consumers' choices are not always rational, in the sense that they often are based on evaluations beyond the value for money evaluation. Symbolic aspects such as the story that is associated with a product or a service are very important and consumers often use this to boycott products that are associated with bad social and environmental practices (Sto et al, 2008). On the contrary, sustainability values (equity, human rights, care for nature) should become a common part of the 'intangible' symbolic value related to consumer goods and firm brands. This implies articulation of such values in society, via government, consumer organisations, or action (Tukker, 2006). Sto et al. (2008) highlight that habits and routines are also a non-rational aspect of consumption and it is decisive to create routines that stimulate sustainability, although it is not easy to perform this, given the obligations and time constraints one faces, even if we are well informed and motivated. Therefore, it is very important to explore windows of opportunity (see next point). Windows of opportunity, in this context, occur when people make fundamental changes in their life, such as changing home, having children, getting married or divorced, etc. These are times that are susceptible of changes in other aspects than the core of the situation, so routines are broken anyway.

Assignment 8

Think of your daily life at home, at school or in the office. Which other examples of consumption choices that are aligned with slowing, closing and narrowing loops can you come up with?

9. Circular economy in the construction and furniture sectors

9.1 Construction sector

The built environment comprises the man-made elements of our surroundings such as buildings as well as infrastructure including transportation, telecommunications, energy, water and waste systems. Design, planning, and construction contribute to the quality of the built environment, which has a significant impact on human health, well-being and productivity. The construction sector generates about 9% of GDP in EU and provides 18 million direct jobs and is therefore a significant part of our society (European Commission, 2016).

Even if the products delivered by the sector, namely buildings and infrastructure, seem stable and have long lifetimes, the sector is constantly influenced by social trends as illustrated in table 4.

Table 4: Main trends for the construction sector

Trend	Description	Source
High performing buildings	This can relate to sustainability, environmental impact, effect on the occupants (including a healthy environment), life cycle asset value or resiliency.	https://esub.com/important-construction-trends/ accessed the 18th May 2018
Greater emphasis sustainable consumption	A recent U.S. Green Building Council study found that green construction was outpacing overall construction growth. Increasing concern about environmental sustainability is reflected in the choice of more environmentally friendly materials. Large buildings made from timber are now possible. Also, intelligent lighting systems and improved planning on power generation will reduce environmental damage.	https://blog.capterra.com/2018-construction-industry-trends-heres-what-to-expect/ accessed the 18th May 2018 https://www.verdict.co.uk/five-trends-changing-construction-industry/ accessed the 18th May 2018
Collaborative contract approach	Especially the growing public-private partnership (P3) model — which involves funding and construction	https://esub.com/important-construction-trends/ accessed the 18th May 2018

	collaboration between private and public entities — have picked up steam in the industry. It is important people understand how complicated this is and manage relationships. Usually P3 relate to big and complex projects and such multi stakeholder processes allow for more creativity.	
Focus on local markets and core business	This is due to better local market conditions and supply chain pressure and the trend of digital construction. In a post-economic crisis era, as markets rebound and demand for buildings increases, the adaptation of new technologies in the construction industry is finally booming.	European_construction_monitor 2016_2017
Technology is moving in	Prefabrication has come a long way in recent years and is no longer limited to cheap, poorly constructed uninteresting designs. Top architects are getting involved in the prefabrication and modular construction business. Lower cost, quicker build and portability are pros, whereas cons are: difficulty to customize, high costs of transport (need of proximity to the factory) and potential incompatibility with zoning rules	https://blog.capterra.com/2018-construction-industry-trends-heres-what-to-expect/ https://blog.capterra.com/the-pros-cons-and-cost-of-modular-homes/ accessed the 18th May 2018
Influence of end consumer is increasing	End consumers – in the construction sector these are the building owners and users – increasingly demand products that exactly fulfil their individual needs. To this end, all markets are developing new dynamic processes in order to better adapt to these consumer preferences.	https://www.vaillant.info/architects-planners/magazines/new-opportunities-for-architects-and-the-construction-industry/ accessed the 18th May 2018

Changes in lifestyles and family structures	More people living in cities, diversification of the family structure with an increase of single person or single-parent households and ageing population are some of the trends that mark the need of buildings that respond to new and changing needs of higher adaptability of houses.	EC, 2013. Future lifestyles in Europe and in the United States in 2020. Oláh, L.S. 2015. Changing families in the European Union: trends and policy implications. Analytical paper, prepared for the United Nations Expert Group Meeting, "Family policy development: achievements and challenges", New York, May 14-15, 2015.

Construction products affect the performance of buildings with respect to safety, health, environmental performance and energy efficiency. Sustainable use of resources relates to recyclability, durability and the use of environmentally compatible materials.

Environmental impacts from the sector arise at different stages of a building's life-cycle including the manufacturing of construction products, building construction, use phase, refurbishment, reform and the management of building waste (COM(2014) 445 final).

The construction and use of buildings in the EU count for about half of all our extracted materials and energy consumption, and about a third of our water consumption (COM(2104) 445 final). Moreover, construction and demolition waste accounts for approximately 25-30% of all waste arising in the EU. In Europe, 2,7 billion tons of waste was generated in 2010, and only 40% was reused, recycled, composted or digested, but even during recycling values may be lost. As an example, in the case of Denmark, the construction sector reuse or recycle 84% of the waste, however it is done in a way where most of the material value is lost during demolition (Sommer, 2018).

Reducing the amount of waste we produce however, is far more than simply ordering the right quantity of materials. Current construction practices have waste built into the design. This is especially apparent where standard material sizes are used, for example sheet materials and traditional masonry (Arup and bam, 2016).

A building is an entity of many components with a variety of materials, consumption of resources like energy and water, and therefore with different challenges and options when designing for sustainable and circular buildings with long lifetimes. For example, the basic building shell has a lifespan of 50-100 years, a façade lasts 25-50 years, installations in 15-25 years, and finally fixtures and fittings have a typical lifespan of 5-15 years. Furthermore, users and owners may change over time, introducing new needs and ideas for the use of the building (GXN and Responsible Assets, 2018).

9.1.1 CE and the construction sector

Ellen MacArthur Foundation (EMF) published the report "Delivering the circular economy – a toolkit for policy makers" based on Denmark as a case study. The report aimed at identifying circular economy opportunities, barriers and policy interventions to overcome these barriers. Key barriers proved to be unintended consequences of existing regulations, social factors such as lack of experience, and market failures such as imperfect information and unaccounted, negative externalities.

The report looked into five sectors, where Construction and real estate showed the largest, economic potential, which is probably recognizable in most European countries. Figure 14 gives an overview of these potentials, and of the key barriers and identified policy options.

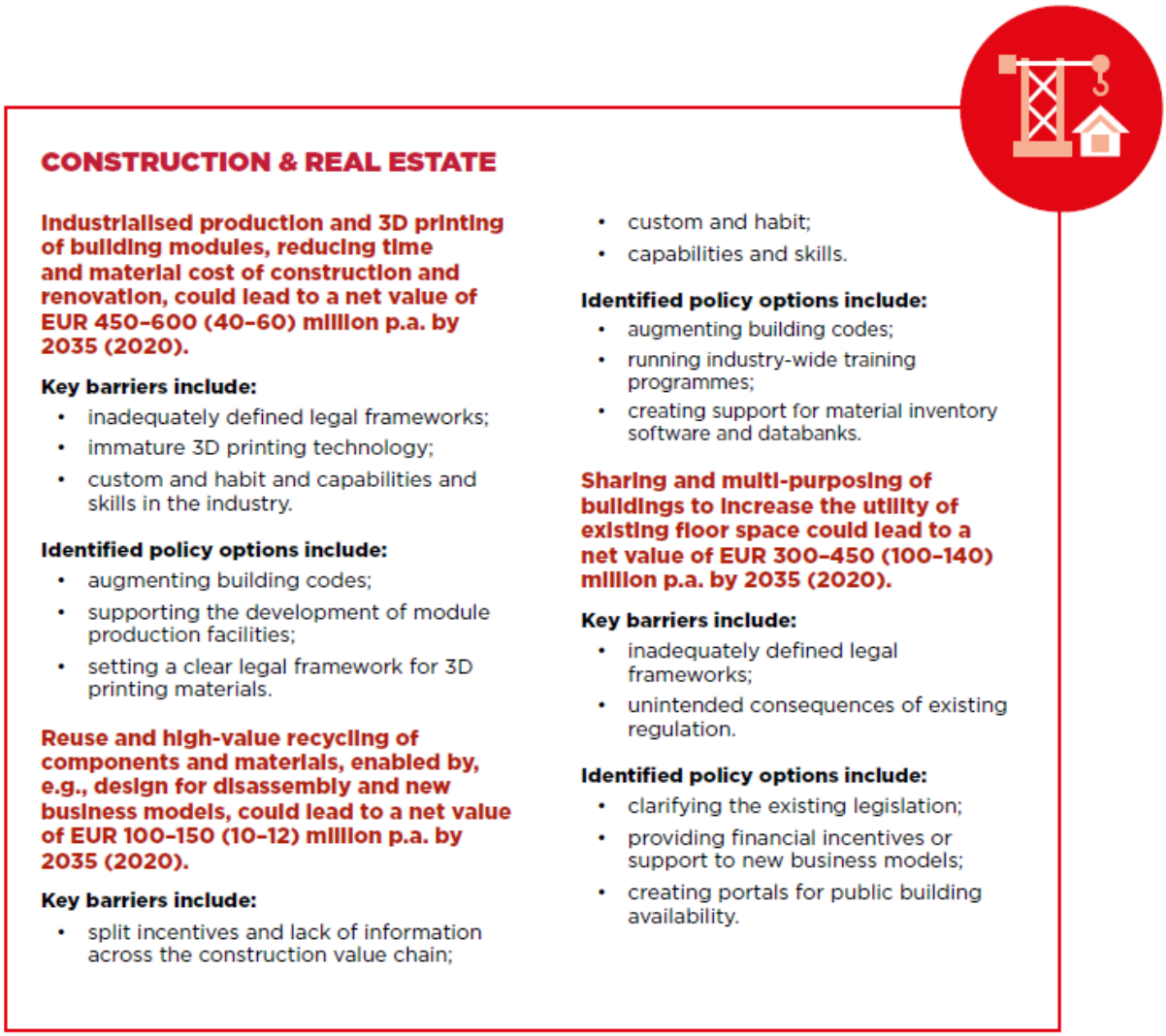


Figure 14: CE opportunities in the Danish Construction and real estate sector (EMF, 2015b)

The application of circular economy to the construction industry requires a systems-thinking approach, one which gives an understanding of the whole building lifecycle and the construction

value chain, or in other words, understanding the wider context in which development takes place. The complexity of the external environment still works to the advantage of the current linear model. Looking at the construction industry in particular, inherent contradictions pose challenges to the adoption of circular business models (CBMs). To overcome these contradictions, the value chain needs to take the following points into consideration:

- Long term thinking - Design for deconstruction - Innovation	- Flexibility vs durability - Utilize new models of production and consumption - Collaboration (Arup and bam, 2016)

Minimizing negative externalities is a core aim of the circular economy. In the built environment these include climate change, water, soil, noise and air pollution. They also include less tangible impacts on human and animal welfare, health, employment and social equality. These externalities can apply to both the operation of assets and the sourcing, manufacture, transportation, installation of materials and components, and disassembly. Preventing or minimizing these impacts is critical to enhancing natural capital and maximizing the use and value of resources (Arup and bam, 2016).

Enabling factors for CE in the construction sector:

- Eco-design (deconstruction, reassembly, future flexibility, etc.).
- Information (Cost/condition, resource productivity, life cycle data, ownership, warranty, traceability).
- Collaboration (share incentives, transparency, innovation→new products, long term business models vs short term).

(Arup and bam, 2016)

CE value is added by increasing the ability of assets to respond flexibly to market conditions, increasing asset use, diversifying income streams and maximizing the residual value of a building's materials (Arup and bam, 2016).

Design should be incorporated at an earlier stage with other disciplines to ensure that the product is designed for longevity, changing user needs, flexibility, reuse and deconstruction. Designers should discuss the future strategy of the building with local authorities and the asset owners to ensure that re-figuration is possible by using a modular approach allowing for easy disassembly and assembly of components (Arup and bam, 2016). Another example is to design a ventilation system that allows for energy recovery.

The adoption of circular construction will require collaboration between the entire value chain (architects, engineers, builders, customers, etc.) in order to reduce the use of resources and increase the reuse after deconstruction by having this in consideration since the design phase.

The idea of short-term solutions for construction does not apply. For example, 75-90% of the existing buildings will still be in use by 2050. Other data indicate that 80% of these buildings were built before 1990 and half of them before 1960. This points to an average lifetime between 60 to 90 years.

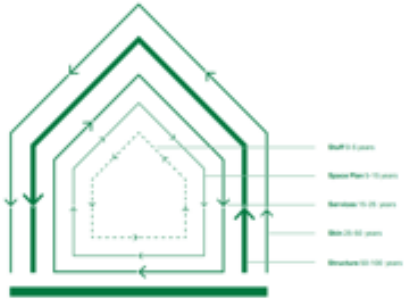
Buildings are constructed of standard manufactured products, but when these are assembled they create a unique, complex, long-lived and ever-transforming entity.

Therefore, one of the main challenges is to conciliate high durability of buildings and building products (which is desirable from a circular economy perspective) with adaptability/versatility required by the market trends and evolution in lifestyles.

9.1.2 Examples of CE in the construction sector

Philips and Turntoo – pay per lux project			
Description	Architect Thomas Rau worked with Philips to purchase light as a service. The end result was a bespoke 'pay-per-lux' intelligent lighting system to fit the requirements of the space, at a manageable price. Philips retain control over the items they produce, enabling better maintenance, reconditioning and recovery. A collaborative project between Philips and Turntoo is a showcase for the pioneering 'Pay-per-lux' model.		
Organization and country	Philips and Turntoo, Amsterdam, the Nederlands		
Sources	Company Website, Philips: https://www.lighting.philips.com/cases Company Website, Turntoo: https://www.turntoo.com/en		
Images			
Image source or credits	https://www.lighting.philips.com/main/cases/cases/industry-and-logistics/bruynzeel		
Sector	Construction	Related module(s)	Introduction
Circularity approach(es)	Slowing, Narrowing loops		
Design Strategy	Design of products as services Design for materials sustainability Design for energy sustainability		
Business Strategy	Use-oriented services		

Circle House – Denmarks first circular housing project

Description	The Circle House project consists of 60 general housing units, which are expected to be completed in 2020. In addition to serving as housing, Circle House is a scalable demonstration project that can give the building industry new knowledge about circular construction. Circle House consists of a range of building systems that can be assembled, disassembled and reassembled into other buildings while keeping their economic and aesthetic values intact.
Organization and country	Circle House, Denmark
Sources	Website: https://gxn.3xn.com/wp-content/uploads/sites/4/2019/02/CircleHouse_ENG_2018.pdf
Images	 
Images' source or credits	https://gxn.3xn.com/wp-content/uploads/sites/4/2019/02/CircleHouse_ENG_2018.pdf https://gxn.3xn.com/wp-content/uploads/sites/4/2019/02/CircleHouse_ENG_2018.pdf
Sector	Construction
Related module(s)	Introduction
Circularity approach(es)	Slowing, Closing, Narrowing loops

Tata Steel – Designing steel products for reuse

Description	Buildings and structures can be designed to allow component parts to be easily separated and recycled. Standardisation of components will also facilitate this process and increase recyclability. Designing for reuse has the potential to significantly reduce carbon emissions and mitigate fluctuating materials prices. For Tata Steel, calculations showed lower environmental impacts and resource use for both recycling and reuse of steel at the end of life of two buildings. This revealed potential savings of 6–27% for a warehouse, 9–43% for an office and 2–10% for a whole building.
Organization and country	Tata Steel, Indian origin, now worldwide
Sources	Company Website: https://www.tatasteel.com/products-solutions/europe/ Arup and bam, 2016: Circular business models for the built environment
Image	
Image source or credits	Arup and bam, 2016: Circular business models for the built environment
Sector	Construction
Related module(s)	Introduction
Circularity approach(es)	Narrowing, Closing

Assignment 9

Select a number of trends mentioned in Table 4 and that are relevant to the neighbourhood/town/city where you live. Based on a group debate, identify circular design specifications for a construction element (e.g. a wall) at your choice.

9.1.3 CE in the European Regulatory framework for the construction sector

The construction sector is covered by a vast European regulatory framework, thus not all is relevant in relation to a circular economy. However, the EU Construction and Demolition Waste Protocol and Guidelines are key. The protocol was established in 2018, and is expected to develop over time. Read more: https://ec.europa.eu/growth/content/eu-construction-and-demolition-waste-protocol-0_en.

Moreover, the Construction Products Regulation (CPR) lays down harmonized rules for the marketing of construction products in the EU. Read more: http://ec.europa.eu/growth/sectors/construction/product-regulation_en.

Buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the EU, making them the single largest energy consumer in Europe. The EU has set a target for all new buildings to be nearly zero-energy by 2020. Read more: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-performance-of-buildings.

The newest initiative, Level(s), is a voluntary reporting framework to improve the total sustainability of buildings. The framework includes indicators within a number of areas: 1) Greenhouse gas emissions throughout the building's life cycle, 2) Resource efficient and circular material life cycles, 3) Efficient use of water resources, 4) Healthy and comfortable spaces, 5) Adaptation and resilience to climate change, and 6) Life cycle cost and value. Read more: http://ec.europa.eu/environment/eussd/buildings.htm.

Figure 15 illustrates some main elements of the European regulatory framework for buildings covering circular aspects. The figure does not claim to be complete or fully updated.

Figure 15. Developed from Herczeg et al (2014) and EU: https://ec.europa.eu/environment/eusdd

9.1.4 Barriers in the construction sector

As a part of developing the first Danish circular housing, "The Circle House" an analysis was made on the legal barriers to building circular. The overall conclusion stated, that the existing regulation does not exclude circular construction. On the other hand, the legislation does not promote circularity either, which in practice creates some barriers. First of all, tenders are not based on life cycle costing, but on initial investment. Secondly, it is difficult to declare the quality (performance, content and durability) of recycled construction materials. Moreover, there are too few legal requirements on resource optimization (GXN and Responsible Assets, 2018).

However, the barriers are not only related to regulation. One of the partners in the Circle House project, the contractor MT Højgaard, highlights the need to change both the mind-set and structures of a highly conservative sector: "In the construction sector, we like to highlight our high level of recycling, more than 80%. But we destroy most of the value because we crush the materials in the demolition process. We need to change the mind-set and the practices. (….) The sector is extremely focused on risk handling, and therefore very conservative. In the future, we will see (and need) new types of services: consulting, assessments, insurances, warranties, take-back warranties, etc. Some services may be delivered by existing contractors, others may come from new companies specializing in that type of service" (Sommer, 2018).

9.2 Furniture sector

Around a quarter of the world's furniture is manufactured within EU, representing a € 84 billion market, employing approximately 1 million European workers and consisting of primarily Small and Medium sized Enterprises, SMEs. The domestic sector accounts for around 82% of the furniture consumption, and B2B accounts for around 18%. Public sector spend on office furniture represents 15% of the market (EEB, 2017).

In terms of materials, the most common material used for furniture is wood (56% of the pieces of furniture) metal is the second most commonly used material (12% of items produced), followed by plastics (6% of items produced) (European Commission, 2013).

Furniture products can cause very different environmental impacts depending on the type of furniture considered (office, kitchen, etc.), the materials and processes used in the manufacturing, the energy source (fossil fuels, or renewable) and origin of the wood (local, from sustainable forest, etc.).

Table 5 illustrates the main trends in the sector.

Table 5: Main trends for the furniture sector

Trend	Description	Source
Changing in the work conditions and increase of home-based work leads to a **higher demand for home office furniture.**	The need for home offices increased during the financial crisis in 2008-2009 and the European debt crisis in 2011-2012, and the changes in home-based work habits is increasing the demand for new, office furniture.	https://blog.marketresearch.com/5-top-trends-in-the-furniture-industry accessed the 21st May 2018
Multi-functionality and versatile furniture is gaining popularity	Multi-functional furniture is gaining in popularity in the home furniture market in Europe.	https://www.prnewswire.com/news-releases/european-home-furnishings-market-report-2016-2020---multi-functional-furniture-is-gaining-in-popularity---research-and-markets-300295269.html accessed the 21st May 2018
Transition to e-commerce - Changes	Online retailing has been around for some time but it will continue to grow,	www.cmtc.com/ accessed the 21st May 2018

Trend	Description	Source
in market to online retail stores	especially for millennials. With instant access to **catalogues and price lists**, customers have a clearer idea of what they want and they can use online **software to design and experience** the use of products.	
Increase in demand for **luxury and quality** furniture	Linked to the evolution and growth of the economy, more consumers are willing to buy luxury items for their living and work environments. The global luxury furniture market is expected to grow. Europe has the largest market for luxury furniture.	https://blog.marketresearch.com/5-top-trends-in-the-furniture-industry accessed the 21st May 2018
Sustainability concern is increasing	A trend which is positively impacting the market is the rising demand for eco-friendly furnishings. Growing environmental consciousness and concern for a healthy and green environment have led to the increased demand for eco-friendly furniture and other furnishings. Awareness of the effect of deforestation on climate change and the effects of toxic finishes in the air inside homes has led to many furniture manufacturers going green.	www.prnewswire.com accessed the 21st May 2018

Trend	Description	Source
Increase in **renting of homes**	The constant rising prices of home, and the delay of millennials to start their own families are some of the reasons owning a home is not a priority currently. A growing trend is leading toward consumers to choose **smaller furniture** to fit their rental homes or apartments where space may be limited.	www.cmtc.com/ accessed the 21st May 2018
Single-person households are increasing	Single-person households are expected to increase over the next years, and smaller households are opting to live in apartments or smaller homes. This demands for **more modular, space-saving and multifunctional furniture**, and furniture for **storage**.	https://www.cmtc.com/blog/furniture-manufacturing-challenges-trends-2016 accessed the 21st May 2018
Changing lifestyles	With lower disposable income and higher levels of debt, millennials tend to delay the decision to start a household. The generational demographic of consumers demands for furniture manufacturers to **diversify their products to meet the specific needs of each group**. While this may mean additional investment on new development,	www.cmtc.com/ accessed the 21st May 2018

Trend	Description	Source
	design and innovation, it also leads to new possibilities for additional revenue sources and a motivation to embrace more sustainable processes and resources.	
Increase in **tourism** leads to an evolution of the furniture for the hospitality sector	European manufacturers and contractors serving the **hospitality market** can count on a **demand** driven by a constant increase of international tourist arrivals.	https://www.iffs.com.sg/csil-special-report-contract-furniture-furnishing-market-europe/ accessed the 21st May 2018
Home **improving/renovation market** is increasing	The growth of the home improvement and renovation market is likely to play a major role in market growth. The home improvement market is highly diversified, providing many opportunities for manufacturers to explore the market with new products and services.	www.prnewswire.com accessed the 21st May 2018

Assignment 10

Select a number of trends mentioned in Table 5 and that are relevant to a space of your choice (classroom, canteen, garden, museum gallery, house). Based on a group debate, identify circular design specifications for a piece of furniture at your choice.

9.2.1 CE and the furniture sector

The challenge faced by the furniture sector is to find a sustainable balance between implementing circular solutions and satisfying consumers' needs. (EFIC n.d.).

In Europe, despite the increasing demand for sustainable products, each year, around 10 million tonnes of furniture are discarded by businesses and consumers, the majority of which is destined for either landfill or incineration.

Figure 16 shows the distribution of furniture waste per EU28 country in absolute numbers (EEB, 2017), where larger countries in population have a higher contribution, but also reflecting national habits of furniture substitution.

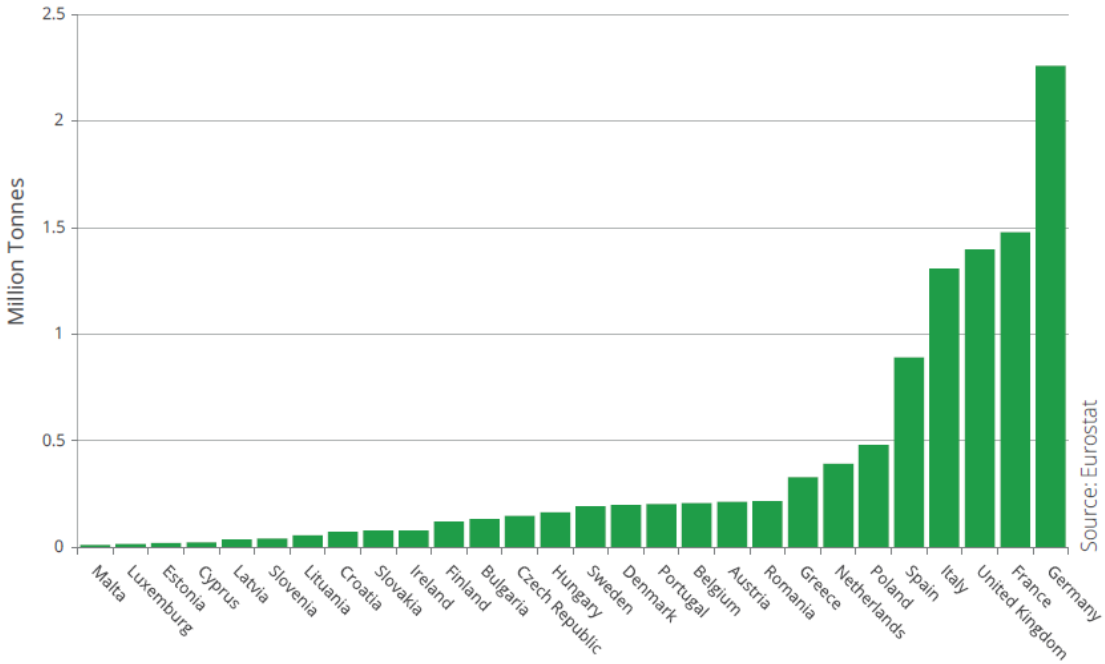


Figure 16. Annual production of furniture waste by EU member state. (EEB, 2017)

The EU Waste Framework Directive requires 50% of household waste to be recycled by 2020, and the European Environmental Bureau (2017) estimates that household furniture represents between 2% and 5% of Municipal Solid Waste in the EU28. So, even if the waste volume in the furniture sector is lower than in the construction sector, there is still a large potential for circularity, also in terms of business. The size of the European remanufacturing sector is estimated to have € 300 million turnover and employing 3.400 workers – which is less than 0.1% of the total furniture industry. (Source: EEB, 2017: Circular economy opportunities in the furniture sector)

Circular economy interventions have the potential to help counter these trends, with repair, refurbishment and remanufacture allowing value recovery, economic growth and job creation within the European furniture industry, while saving on resources and the environment. Yet, realizing these

economic, environmental and social benefits will require the adoption of appropriate demand and supply chain levers, to support a significant step change across the industry. Figure 17 gives an overview of the CE potentials. (EEB, 2017).

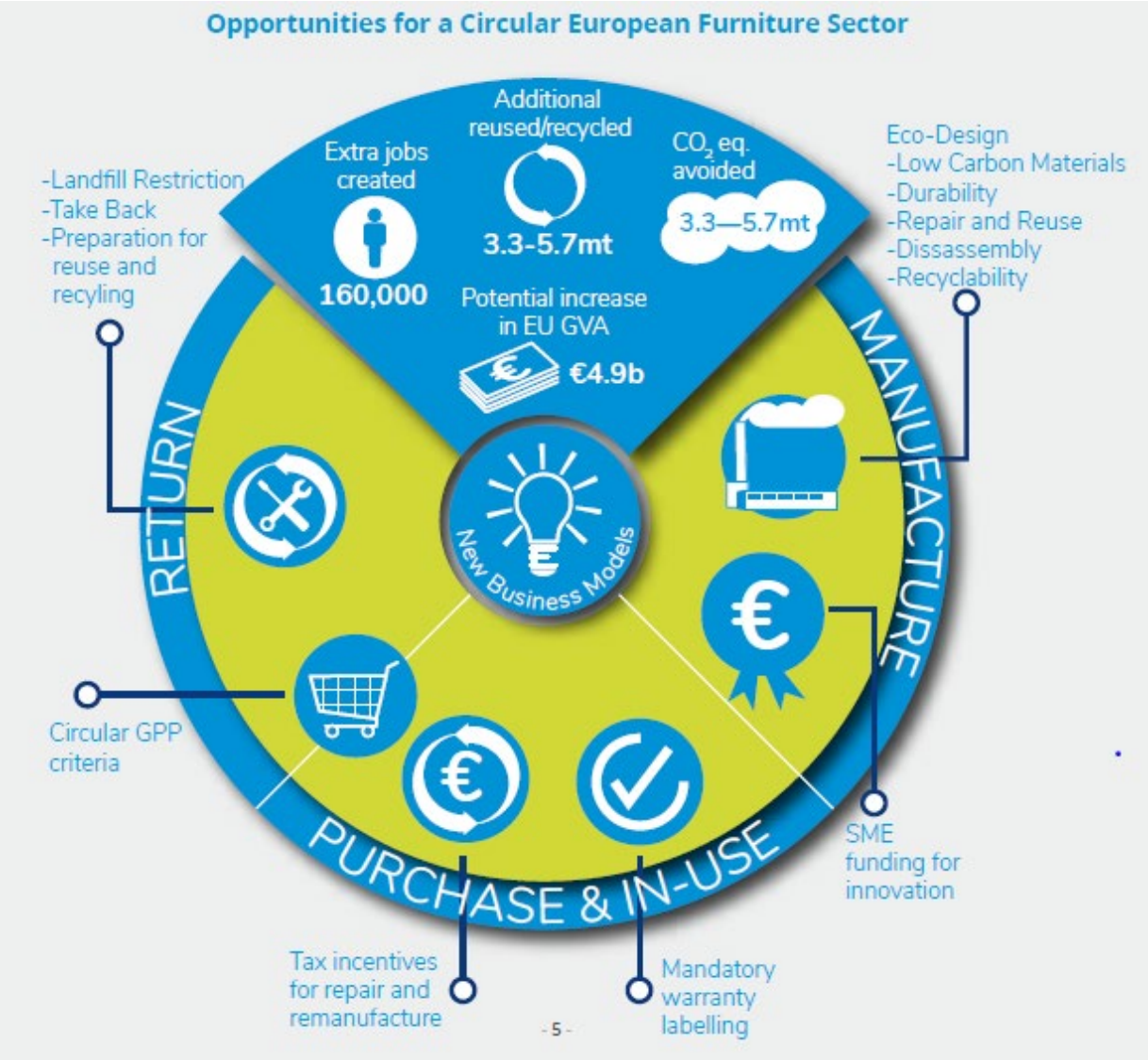


Figure 17. Opportunities for circular economy in the furniture sector. (EEB, 2017, p.5)

The furniture industry can contribute to the Circular Economy Strategy in several ways. In the production phase, one can apply eco-design focusing on the following 5 criteria: 1) Increase the life cycle, 2) Better reparability, 3) Recyclability, 4) Efficient use of material, 5) Avoid environmental unfriendly materials.

Other important aspects are related to consumer information, promotion of circular tendering, extended producer responsibility schemes, and a smart chemical policy. (EFIC, n.d).

There are various initiatives, which aim to move in the direction of a circular economy. Still, environmental policies in the furniture sector are mainly concerned with energy efficiency in

production and during usage, recycling and human health. The more innovative CE approaches that promote a holistic economic system with efficient resource cycles (furniture leasing, product service systems, etc.) are in the early stages.

Reuse of furniture is common, but it tends to be on a small scale and with local, social goals in mind rather than larger scale environmental and economic ones. Reuse mostly takes place through commercial second-hand shops, social enterprise companies or charities.

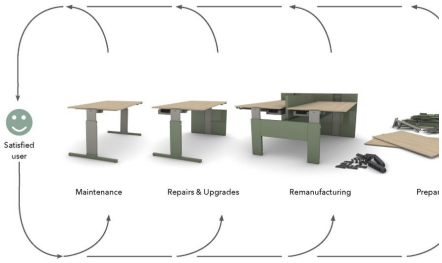
The environmental benefits associated with the reuse are not necessarily higher than the recycling benefits, even where the latter can be properly calculated. Much depends on whether the reused article results in the avoided purchase of a new manufactured article. Where this is the case, the environmental benefits of reusing that article are likely to be more substantial than those of recycling. This is because the impacts associated with producing the constituent materials contained in furniture are typically higher than the impacts associated with recycling the constituent components. However, where reused articles are purchased by lower income households who would otherwise not have purchased anything, the benefit associated with avoided production does not occur. Transport impacts may also be higher for the reuse scenario, and there may also be additional energy associated with the preparation for reuse, although the latter typically results in only a relatively small impact.

9.2.2 Examples of CE in the furniture sector

Højer Møbler – Circularity in school furniture

Description	Højer Møbler, producer of furniture and related services for schools, won the first public procurement scheme in Denmark where circularity principles were included. At the schools, new, reused and refurbished furniture are combined into activating learning spaces allowing for new pedagogic learning where school kids can learn in different ways. Saving resources, also economic, allow the schools to re-equip their classrooms faster since they don't have to invest in brand new furniture all over.		
Organization and country	Højer Møbler, Vodskov, Denmark		
Sources	Company Website: https://www.hojermobler.dk		
Images	 		
Images' source	Højer Møbler	Højer Møbler	
Sector	Furniture	Related module(s)	Introduction
Circularity approach(es)	Slowing, Closing loops		

Eco-design, leasing and take-back business models

Description	Whilst principally focused around design and manufacturing, Gispen's business model has shifted towards delivering facility management services to its customer base. The approach to design and supply circular furniture products follows guiding principles, including sustainable material selection, disassembly potential, maintenance and upgradability, and recyclability. Post installation, Gispen also offers reverse logistics for furniture, and furniture updating and reconfiguring services, as office furniture requirements for office spaces evolve. Gispen provides a variety of financing models to its customers, including pay-per-use. The amount customers pay is reflected in the number of workstations required, functional and aesthetic need, and the period of use / intensity of usage
Organization and country	Gispen, The Netherlands
Sources	Company Website: *https://www.gispen.com/en/circular-economy* *EEB, 2017: Circular economy opportunities in the furniture sector*
Images	
Image source	https://www.gispen.com/en/circular-economy/cimo-circular-modular-workstation-highlighted
Sector	Furniture
Related module(s)	Introduction
Circularity approaches	Slowing and closing loops

Range of modular furniture

Description	IKEA launched a modular furniture range as a part of its continued commitment to product-life extension. This will enable customers to customize and build up/add to or extend the function of individual products. This encompasses standardized design to enable customers to upgrade or convert furniture items into alternative uses – including for example conversion of a sofa to a bed, replacement of arm rests, addition of side tables, or transforming a storage to a wardrobe. *(Source: https://www.ikea.com/gb/en/ikeacontentcatalog/this-is-ikea/people-planet/energy-resources/waste/)*
Organization and country	IKEA, Sweden
Sources	Company Website: http://www.daasbaksteen.com/en/Facade-systems/ClickBrick/page.aspx/67 http://www.zi-online.info/en/artikel/zi_2011-03_ClickBrick_for_a_wall_without_joints_1090523.html
Images	
Image source	https://www.ikea.com/gb/en/this-is-ikea/people-planet/energy-resources/waste/
Sector	Furniture
Related module(s)	Introduction
Circularity approach	Slowing loops

Assignment 11

Discuss what you see as the potential outcomes of a CE approach in the construction or the furniture sectors on a social and on a company level.

Eco-Mobilier – reduced furniture waste

Description	In France, end-of-life furniture is managed in line with the Extended Producer Responsibility regulation. The main objectives of the French EPR include: - Decreasing waste furniture sent to landfill; - Achieving a 45% recycling/reuse target; and - Driving eco-design principles within the furniture manufacturing sector. In 2015, the domestic EPR scheme achieved a 55% recycling and 86% recovery rate, and in 2016 Eco Modulation Criteria for new furniture placed on the market introduced a reduced levy on furniture fulfilling specific eco-design criteria.		
Organization and country	Eco-Mobilier, France		
Sources	Website: https://www.eco-mobilier.fr/ (Information in French only) Source in English: European Environmental Bureau, 2017: Circular economy opportunities in the furniture sector		
Images	 		
Images' source or credits	https://www.facebook.com/Eco-mobilier-292944897807583/		
Sector	Furniture	**Related module(s)**	Introduction
Circularity approach(es)	Slowing and closing loops		

9.2.3 CE in the European Regulatory framework for the furniture sector

The furniture sector is covered by EU regulation on e.g. safety, consumer rights, waste and chemicals for packaging and products as illustrated in figure 18.

Figure 18. EU regulation in the furniture sector (https://eur-lex.europa.eu/legal-content; https://eur-lex.europa.eu/legal-content)

Moreover, two voluntary initiatives linked to the consumption of furniture are important - the European Ecolabel Scheme and Green Public Procurement.

The European Ecolabel Scheme

The EU Ecolabel was established in 1992 as a voluntary tool to encourage businesses to develop products with a reduced environmental impact throughout their whole life cycle, and to help consumers find the best environmentally performing products in their category. The EU Ecolabel is multi-criteria, based on scientific evidence and life-cycle based approach, third party certified and revised regularly to follow technological evolution (European Commission, 2019b).

For the product group "furniture", the Ecolabel criteria concern:

- Criteria for use of certified raw materials,
- Avoidance of hazardous substances in products and production processes;
- Prohibition of use of certain substances (e.g. biocidals, flame retardants, Vinyl Chloride Monomers etc.);
- Fitness for use;
- Reparability;
- Design for disassembly;

- Emissions of VOC and formaldehyde;
- Information to consumers

Read more: http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html

The European Green Public Procurement

Green Public Procurement (GPP) is a voluntary instrument with the aim of using the market forces of the public sector to stimulate sustainable and circular products and services. The GPP criteria for furniture are divided into three areas: A) Refurbishment service for existing used furniture, B) The procurement of new furniture items, and C) The procurement of furniture end-of-life services, which include collection and reuse of existing furniture stock. (European Commission, 2019b).

The proposed GPP criteria follow some general principles illustrated in table 6.

Table 6. Proposed EU GPP criteria for furniture (European Commission, 2018b)

Key environmental impacts during furniture lifecycle		Proposed EU-GPP approach
Loss of biodiversity and soil erosion as a result of unsustainable forest management and illegal logging	→	Procure timber from legal sources
Depletion of resources due to the use of non-renewable resources such as oil/natural gas for plastics. CO2 and other emissions as a result of energy consumption in the production of several materials.		Use materials made partly or totally from renewable materials such as wood
Risk to workers, consumers or to the wider environment of the release of toxic substances. Contribution to poor indoor air quality due to Volatile Organic Compounds (VOC) emissions from indoor furniture products.		Set maximum limits for total VOC emissions from furniture items and specific formaldehyde emission limits for wood-based panels and upholstery materials
Wasted materials due to premature End of Life of substandard quality furniture.		Procure durable and fit-for-use furniture complying with relevant EN standards
Wasted materials due to difficulties with repairing, acquiring spare parts or separating parts for recycling.		Procure easy-to-disassemble, repairable and recyclable furniture that is covered by a warranty

Case: Public tender on learning environments for schools in Aalborg

In 2017, Aalborg was one of the first municipalities in Denmark to introduce circular economy into their public tenders through a tender on school furniture. Besides a focus on circular economy,

municipality also wanted to stimulate inspiring learning environments suitable for differentiated learning instead of traditional school furniture.

The final criteria in the tender included seven environmental criteria, which were minimum requirements, and four award criteria. The award criteria covered the following aspects and had the following weighting: circularity (40%), quality of the offered interior design (20%), quality of advice (20%) and economy (20 %). Hence, circularity was the award criteria with the highest weighting and economy only weighted 20%. More specifically, the circularity award criteria covered aspects such as life-time, service and maintenance, reuse, refurbishment and material recycling. The specific aspects are further described in table 7.

Table 7: The criteria included in the circular procurement for sustainable learning environments in Aalborg (http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue79_Case_Study_155_Aalborg.pdf)

The minimum environmental criteria	A minimum five-year guarantee on the lifetime of new furniture A minimum two-year guarantee on the lifetime of the refurbished part of the furniture A minimum five-year guarantee on spare parts A service which informs schools once a year (during the warranty period) of the relevant maintenance service available and advised for each product Packaging made from recycled materials Labelling of plastic parts above 50 grams for recycling Minimum 70% of wood used should come from sustainable sources
The circular award criteria covering circulatory	**Service and maintenance (25%)** – Spare part guarantee which exceed the minimum requirement of five years – Products can be disassembled into different parts for replacement and refurbishment **Reuse (20%)** – Reuse of existing furniture – Handling of furniture for reuse, that is, minimisation of environmental impacts in the process, such as transport impacts **Refurbishment (15%)** – Refurbishment of existing furniture, that is, replacing a table top, or recoating and repainting, etc. – Refurbishment is carried out by employees on special terms, that is, employees who are disabled or receive social assistance **Material recycling (10%)** – New furniture is made of recycled materials and/or materials recycled with the refurbishment of any existing furniture at the schools – Any leftover furniture parts are recycled

9.2.4 Barriers in the furniture sector

The European Environmental Bureau (EEB, 2017) analysed the barriers to a circular furniture sector and pointed at the following:

– Lower quality materials and poor design

- the move away from solid wood and metal furniture to cheaper materials, which restricts the potential for a successful second life. Weak product design and specification drivers – in relation to recycled content, reuse of components, product durability, and design for disassembly/reassembly, repair, reuse, remanufacture and recycling, the drivers for improvement are weak or absent.

– REACH Regulation (on Registration, Evaluation, Authorisation and Restriction of Chemicals)

- legacy hazardous substances pose challenges and additional costs for recyclers, together with a lack of information on chemicals contained in products and on ways how to deal with them appropriately.

– Poor consumer information and availability of spares

- consumers are rarely given guidance on how to maintain and repair furniture, in order to prolong and extend the product lifespan. A lack of availability of spare parts encourages the purchase of new furniture over circular consumer patterns.

– Limited collection and reverse logistics infrastructure

– currently there are weak drivers and underinvestment in the collection and logistics for furniture takeback. Producer responsibility mechanisms are not widely used in the furniture sector.

– High cost of repair and refurbishment

- in many parts of the EU, transport and labour costs are high, making any significant repair and refurbishment costly, particularly where re-upholstery is required. In general, economies of scale and economic incentives are needed to make repair and refurbishment viable.

– Weak demand for second-hand furniture

- the price differential between new furniture against the cost of second-life furniture, is not significant enough to drive more sustainable purchasing behaviour. This is coupled with poor awareness of the availability and benefits of sustainable furniture options, for both domestic and commercial purposes.

– Poor demand for recycled materials

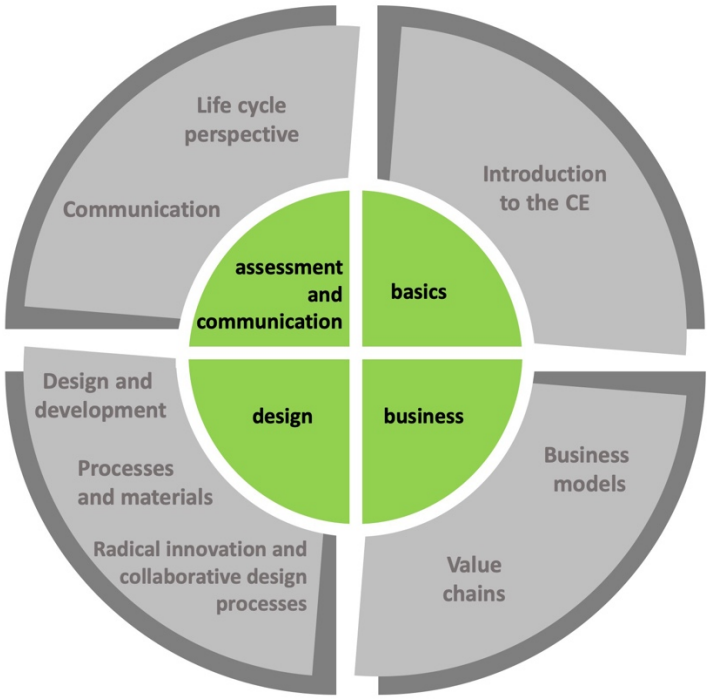
- end markets for recycled materials, post deconstruction, are underdeveloped, and in some cases, already saturated, with these associated market failures restricting further investment in recovery.

– Weak over-arching policy drivers

– typically furniture is not managed in accordance with the waste hierarchy, with reuse failing to be prioritised over recycling, incineration and landfill. Underinvestment in reuse, repair and remanufacturing infrastructure limits the potential for furniture being managed in accordance with the principles of the waste hierarchy or the circular economy.

10. Tools for introducing circular economy

Seven tools are developed in the KATCH_e project: as illustrated below:



The tools are presented in the modules, they are related to. For introducing how to think about circularity in a business context, you could play the KATCH UP Board game.

10.1 KATCH UP Board game

The objective of this game is to stimulate the users to generate value ideas from a business challenge, applying circular design and circular business strategies. The game acts as a guide to get an idea about an innovative product-service or to solve a real business problem and generate opportunities.

No previous knowledge of circular economy (CE) is required, however, having knowledge about CE design and business strategies is preferred, as the application of the tool will be more agile, efficient and effective, leading to better defined ideas.

Creation of a product-service idea applying circular design and circular business strategies to solve problems from case studies or your own company issues.

This tool can be applied under different situations: Company, academia and worshops. When this game is played in companies, real cases can be applied, i.e., to a specific product-service category and to solve specific company challenges. When this game is played in classrooms or workshops, the game offers hypothetical contexts to work on them.

PREPARATION: Form groups of 3-4 people and prepare the board and its elements

PLAYING: The game has 6 basic steps:

Step 1 – Problem context:

Presentation of the product-service category, business challenge and target group;

Step 2 – Way to the solution:

Presentation of CE strategies that can be used to deal with the problem context;

Step 3 – Idea creation:

Development of the innovative idea that will solve the initial problem;

Step 4 – Business model:

Definition of the most appropriate business model;

Step 5 – Market launch:

Definition of how your product-service will be launched to the market;

Step 6 – Presentation and scoring:

CE ideas got as a result of the game should be pitched by the groups and scored using a Likert scale (1-5).

10.2 Other tools

Tool	Description	Source
Circular Economy Toolkit	The CET is a free resource for businesses to find opportunities in the Circular Economy. With the vast number of possibilities for creating value out of the Circular Economy and cradle-to-cradle thinking, it can be challenging to assess all the options. The Circular Economy Toolkit has consolidated all the opportunities and provided information on how your company could start finding benefits. The Assessment tool offers a questionaire to evaluate circular strategies Besides the assement features, the tools provides useful information in each strategy.	http://circulareconomytoolkit.org/Assessmenttool.html
In the Loop	The "In the Loop" game simulates complex, global resource supply chains and triggers players to find solutions. Players take on the role of a manufacturing company and try to be the first to seven 'Progress Points' by collecting resources and building products. Along the way, they face difficult strategic decisions while navigating through constricted resource mines and unpredictable world events.	https://intheloopgame.com/
Circulab	The Circulab homepage offers a number of tools, games, etc. for developing circular business strategies, inspiring creativity and stimulating teamwork for developing circular solutions.	https://circulab.eu/tools/#creatif
Biomimicards	A game to explore biomimicry by travelling through continents including 25 examples, the players discover the superpowers of nature and thus the value of biomimicry.	https://biomimicards.com/

11. The Ten KATCH_e Essentials of circular economy

Through the introduction to the circular economy, you have probably realized that the subject is vast, complex and challenging. Going to work with designing circular solutions, a number of key points may guide the process. We call these points "The Ten Essentials of Circular Economy":

CIRCULAR ECONOMY

KATCH-e

10 ESSENTIALS

1. Think circularity already in the **design phase**;
2. Think in **functionality** instead of products;
3. Analyse where **value** is created and destroyed;
4. Circular solutions should also be **sustainable**;
5. Keep a **life cycle perspective;**
6. Involve **stakeholders** in developing new solutions;
7. Lead the **transition** to a circular economy;
8. Understand new **consumer** practices;
9. Make the circular solutions **attractive**;
10. Consider the local, **social value**.

1. Think in functionality instead of products

2. Analyse where value is created and destroyed, to understand how it can be captured

3. Think circularity already in the design phase of products and business models

4. Assess the consequences and relevance of your solutions from a life cycle perspective to avoid moving problems, or creating new ones

5. Involve the stakeholders along the value chain in developing new solutions

6. Understand which new, or changed, consumer practices are needed to make your circular solution work

7. Make the circular solutions attractive for the users and be a part of the solution, not the problem

8. Any circular solution should also be sustainable

9. Adopt a stewardship role and lead the transition to a circular economy by example

10. Consider the local, social value. For example, job creation, inclusion, development of new services

The modules in the KATCH_e training materials can support you in working with the essentials.

Assignment 12

Brainstorm on questions you find relevant to consider for each of the 10 Essentials

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