



Circular Economy – as a transformative (innovating) Endeavour

A transdisciplinary Higher Education basic Curriculum

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1. INTRODUCTION

Most production and consumption processes fall into the category of the linear economy. Accordingly, natural resources are taken from the environment for production, which are returned to the environment in different state after production and consumption. The resulting environmental pollution is one of the starting points of the concept of sustainable development developed in the 1980s. As part of this concept one approach is to move the economy away from a linear economy towards a circular economy.²

While there is no single definition of the circular economy, it is generally assumed that the transition to a circular economy involves a reduced demand for natural resources and the materials derived from them³. For the European Commission, for example, the circular economy means maintaining the value of products, materials and resources in the economy for as long as possible and minimising waste. Different mechanisms to reduce demand are often highlighted. Creating material cycles involves substituting primary materials with secondary materials (i.e. materials that have already been used in production processes and come from the recycled waste from households and the industry) or new products with used, repaired or remanufactured ones.

The Erasmus+ project CirThink aims to embed the idea of the circular economy in Higher Education as a transdisciplinary basic competence field. Building on the findings of the project presented in CirThink (2021)⁴, the following curriculum on circular economy for higher education institutions was developed. The curriculum is aimed in particular at lecturers and is intended to help with the systematic integration of circular economy thinking into academic teaching. For this purpose, the target group and the goal orientation of the curriculum will be the first topic presented in the following. Then, the relevance of the curriculum is highlighted based on the findings of the project so far. Subsequently, the topic of circular economy is presented in a structured way. Based on this, the structure of the curriculum, didactic assumptions and the curriculum itself is illustrated. In order to simplify the practical use and thus the integration into teaching, exemplary topics of the individual areas are then outlined.

² Kirchgeorg, 1999, p.1f.

³ McCarthy et al., 2018

⁴ We would like to thank all members of the project for their valuable contributions and feedback. Special thanks to Sarah Evans and Chris Fortune for their analyses and reflections (cf. CirThink 2021).

2. TARGET GROUP AND OBJECTIVE OF THE CURRICULUM

The curriculum is aimed at colleges, universities and other HEIs and is to be understood in the sense of a cross-sectional curriculum. Cross-sectional curricula describe trans- or interdisciplinary competences that are to be acquired, for example, within the framework of studies. The concrete implementation of the contents as well as the integration into the subject context needs to be reflected within the single subjects.

The relevance of transversal curricula becomes particularly clear in view of the international discourse on education policy. In recent decades, more and more framework papers on cross-curricular competences have emerged. Examples of this are the wide-ranging EU paper entitled "Key Competences for Lifelong Learning"⁵ or the focused OECD paper entitled "Reference Framework of Competences for Democratic Culture"⁶. The OECD paper's goal is described as follows: "model of the competences that need to be acquired by learners if they are to participate effectively in a culture of democracy and live peacefully together with others in culturally diverse democratic societies".⁷ The curriculum below is to be understood analogously. The academic competences for general understanding of circular economy and its principles and for implementing circular economy into the pertinent areas of action of different disciplines.

3. RELEVANCE OF THE CURRICULUM

The curriculum builds on comprehensive findings of a stakeholder engagement analysis. The analysis was conducted as part of the first work package of the project and aimed, among other things, to identify the drivers, barriers and opportunities of the circular economy from a stakeholder perspective. For this purpose, interview studies were first conducted in the countries of the project partners (Turkey, Denmark, Germany, Italy, United Kingdom, Spain) with representatives of the circular economy from industry, universities and projects. The results were then compared and validated through workshops. During the online and face-to-face workshops in the project partner countries, the findings were discussed and drivers, barriers and opportunities were identified. The findings form the basis for this curriculum and are therefore briefly presented below.⁸

⁵ Council (edt.), 2018

⁶ Council of Europe (edt.), 2018

⁷ Council of Europe (edt.), 2018, 11

⁸ The detailed results can be read in CirThink, 2021

The relevance of circular economy principles for HEIs was emphasized several times during the interviews and workshops⁹. In particular, good communication to the relevant stakeholders is important, as a circular approach to business is necessary to protect future generations. In addition, there is a need for clarification of the concept of circular economy and appropriate awareness raising activities to improve the understanding of circular economy as a distinct approach to create societal value. Accordingly, the curriculum for universities aims to raise awareness of circular economy practices among the younger generation and build a general academic understanding of circular economy. The aim is, for example, to ensure that the circular economy is not perceived as a trend, nor as merely waste-related. In particular, the various facets of the circular economy are made clear and brought together in this curriculum. For example, circular economy does not only focus on recycling, as often assumed, it focuses on all areas of production.

Furthermore, it became clear that universities are at the forefront of bringing about positive change by integrating circular economy practices into their courses and in its structure. This is due in part to their international reach and status. Accordingly, universities were required to develop strategy and policy documents with long-term plans for integrating circular economy practices into learning, teaching and research. Only through this integration universities can motivate their students to reflect the topic and build knowledge bases. Accordingly, the curriculum should support lecturers in integrating circular economy-related topics into their teaching and thus learning.

Additionally, there was consensus that a curriculum for the circular economy is imperative for HEIs. The curricula or syllabi should provide an overview of the topic as well as raise awareness. The main focus should be on giving students experience in different roles so that they learn to ask the right questions in the right places. In addition, it should contribute to lifelong learning by creating awareness of circular economy. In the course of this, the following expectations for the curriculum were formulated in the workshops:

1. "That the students acquire knowledge of the concept of circular economy.
2. That the students become more aware of the school, stakeholders and own circular economy practice or lack thereof.
3. That the students are involved in influencing and changing actions and behaviour patterns in favour of an improved circular economy practice at the school and

⁹ These findings are consistent with the results of Bianchi et al. (2022). They found that there is a need for fundamental improvement in sustainable behaviour and developed therefore a European sustainable competence framework.

thereby influence the school's C.E. culture / hidden curriculum in an appropriate direction.”¹⁰

This goal orientation is the basis of the curriculum. By addressing the topic of the circular economy and integrating it into various professional contexts, students can build a comprehensive awareness of it. It also provides opportunities for perspective-taking through clear role definition and delineation. By building up a structured body of knowledge, students are equipped with the necessary foundations to reconsider and, if necessary, change their own behaviour and values.

4. STRUCTURING THE CONTENT OF THE CURRICULUM

The origins of the circular economy concept can be traced back to "The Ecology of Industry" developed by environmental scientists in the 1970s. Pearce & Turner (1990) used the term circular economy for the first time officially in an economic model. The authors criticised the traditional linear economic system on the basis that everything can be used again for something else and developed a new economic model called the circular economy.

In our curricular design we start with the term itself. Curricular design is based on functional differentiations. A user of a curriculum, i.e. an educational planner or trainer, is to be provided with a viable order or sequence of thematic issues. First, the term circular economy is broken down into its components: circularity and economy. Against the backdrop of curricular clarity, economics is to be prespecified with regard to circularity. For a curriculum that aims to increase the ability to act - in decision-making positions - it is appropriate to first differentiate according to the functional or social roles in which responsible economic decisions are made. The next step is to differentiate these decision-making situations with regard to relevant phases in a circular production-consumption process. The 'social' and the 'circular' dimension thus span the curricular matrix, which will be explained in more detail below. The matrix can thus be used to identify subject-specific topics and their sequential treatment.

Since not all users of a curriculum on the circular economy are economists, the differentiated decision-making situations or fields of action must be differentiated in a way that is as generally understandable as possible.

¹⁰ CirThink, 2021, 7

Economy Dimension

People do business with the fundamental goal of generating value. The term “value” is broadly defined and thus also includes, for example, monetary profit. The various economic relationships between people can be divided into different areas. As this curriculum aims at academics and thus potential decision-makers it differentiates economic areas according to the functional roles in which responsible economic decisions are made. With regard to the topic of circular economy, the following five areas provide a satisfactory coverage: "Within a company", "Between cooperating companies", "Between competing companies", "Framework conditions for companies" and "Private individuals". These are briefly described below.

Within a company

‘Within a company’ is about decisions taken in concern of the inner processes of a company and the development of a corporate culture. This area covers the entire organisational structure of a company. This includes, for example, the division of labour, responsibility and management style. Furthermore, the materials used as well as the production processes and the mindset for the planning tasks of a company also belong to this area.

Among cooperating companies

‘Among cooperating companies’ is about how companies interact, particularly within supply chains or the joint production of goods. In our understanding, this area focuses on cooperating and communicating companies, which try to achieve their individual goals. Actions of one company in concern of more sustainable processes depend on the alignment of the other companies in its network.

Between competing companies

‘Between competing companies’ is about the influence companies have on each other due to competition, i.e. without necessary communication. Behaving antagonistically limits the scope for action and decision-making of these companies. This is important to reflect because this also limits the effect of appealing to the good will.

Framework conditions for companies

‘Framework conditions for companies’ addresses a higher level of decision making. It refers to the regulatory level and has two parts:

a) The framework conditions under which private companies operate, cooperate or compete or do ‘co-opetion’. This includes, for example, political regulations concerning taxes for harmful

production processes or standards for products. How private consumers are dealt with is part of these processes.

b) The framework conditions under which private companies and public bodies interact, i.e. particularly tendering procedures.

Private consumer

Within circular economy the 'private consumer' has to be seen similar to companies. Individuals try to achieve their goals on the market with the help of businesses. In a circular economy they are also just one station of the material flow, and regulations channel the ways they act. Nevertheless, they need to be reflected especially because of their specific preferences and their specific cognitive limitations, particularly in concern of systemic thinking. In this context, an understanding of circular economy and circular economy practices, and thus the ability to think systemically, is fundamental to developing a sustainable mindset.

Circularity

Next to economics, circularity is the second dimension of the circular economy. Many production processes and economic procedures are structured in a linear manner. Resources are taken from the environment and then used to make products. After use, the products are thrown away - packaging even before. In order to move away from this linear economy and become circular, cycles must be created and optimised. This circularity is intended to maintain the value of products and keep materials and resources in the economy for as long as possible and at the same time avoid waste.

Konietzko and Bocken (2020) describe four ways of doing this:

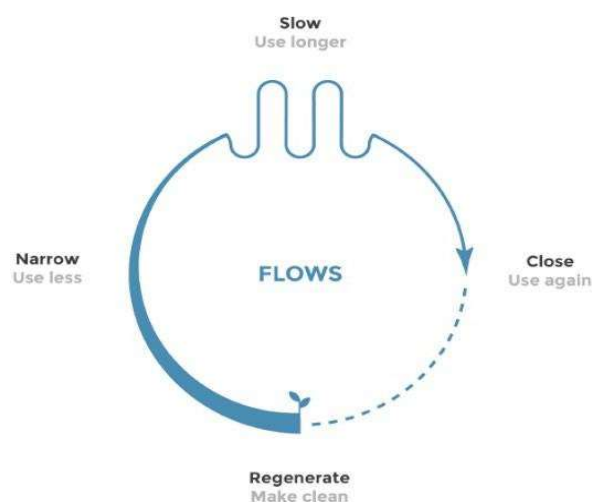


Figure 1: A circular economy: narrow, slow, close and regenerate material and energy flows.¹¹

¹¹ Konietzko et al., 2020, 3

These four mechanisms are briefly described below.

Close, Narrow and Slow Circles

Close, narrow and slow circles are the three main mechanisms often mentioned for maintaining the value of products, material and resources. Therefore, they are briefly described below:

Closing loops primarily refers to closing material loops. Thus, the materials and resources of the goods should be reused after use. To do this, the original parts, materials and resources must be returned to the material pool. This can be done, for example, by returning the product to the manufacturer. A complete return can involve several hundred steps for a complex product. To successfully close a loop, the entire supply chain must be considered and it must be ensured that the links within the loop are not lost or broken.¹² Only by recycling resources can a downward cycle be avoided.

In addition, material cycles should be narrowed. This includes the more efficient use of natural products, materials and resources. For example, the development and diffusion of new production technologies, the increased use of existing facilities or the shift in consumer behaviour away from material-intensive goods and services can narrow the material cycle.

Further, material cycles should be brought to a slower pace. To this end, for example, products must be developed that remain in the economy longer due to their more durable product design. In addition, the repair of materials, for example, means that no new product is purchased for the time being, thus slowing down the material cycle.^{13 14}

Regenerate / Restore

On top of closing, narrowing and slowing down material cycles, regeneration and restoration of damaged ecosystems can also play an important role. Possible measures for this are, for example, the use of non-toxic resources, the use and expansion of renewable energies, and the restoration and protection of natural ecosystems.

As regulative ideas, these four principles (closing, narrowing, slowing down, regenerating) form the conceptual background for the differentiation of the second dimension of the curricular matrix. The second dimension is also about a situational contextual determination of decisions, insofar as it is about the question at which different points in economic decision and action contexts possibilities of closing, narrowing, slowing down, regenerating exist. For the

¹² Meadows & Wright, 2008

¹³ Bocken et al., 2016; EMF, 2015; Geissdoerfer et al., 2017; McDonough & Braungart, 2002

¹⁴ Konietzko et al., 2020, 3

differentiation of this dimension, the following phases of the provision of goods, which are to be transformed or newly seen with regard to the circular economy. The phases are: Product development and risk management, resource extraction (and potential return) and product use.

Product development and risk management

This area covers the entire field of product development as well as risk management from the perspective of circularity. Thus, the emergence of a product is addressed from idea generation and a market analysis to feasibility assessments and the creation of prototypes to production and market launch. Attention is paid to the circular economy and thus circularity at every stage of product development. For example, the raw materials selected should be circular-friendly and the design easy to deconstruct. The accompanying increase in complexity and dynamics in the production processes illustrates the importance of appropriate risk management. For example, this should be preventively and efficiently adapted to the complex systems and processes. Only through such adaptation opportunities for the improvement of circularity can be created, for example through digitalisation and networking.

Resource extraction (and potential return)

In the linear model, resource extraction is at the beginning of the actual production process. In the circular model, the aim is to make them disappear, so to speak, i.e. to extract fewer and fewer resources and to reduce the need for raw materials by reusing, repairing or recycling resources. Production processes must follow this premise accordingly and be thought of as being 'long' enough to include resource extraction back into them. From the perspective of curriculum design, this conceptual shift is crucial.¹⁵

Production, for example, includes resource recovery from waste products. Although resources, materials and products should remain in the economic cycle for as long as possible, there are nevertheless waste products at various points that cannot be returned to the cycle. New material cycles must be established for these waste products.

Product use

This area includes product use in the sense of a circular economy. The different needs of the users are often the starting point for the design of long-lasting product uses. For example, short-term fashions can be counteracted by increasing the added value of the product. In addition, various sharing formats, for example, offer a material-saving alternative to private ownership. All these measures aim to increase the efficiency of product use.

¹⁵ Bundesministerium für Bildung und Forschung, 2018, 19.

5. THE STRUCTURE OF THE CURRICULUM

The subcategories of the dimension economy and the dimension circularity described above constitute a curricular matrix. This systematically links the economic fields of action with the salient phases of product-provision within a circular economy. The resulting matrix looks as follows:

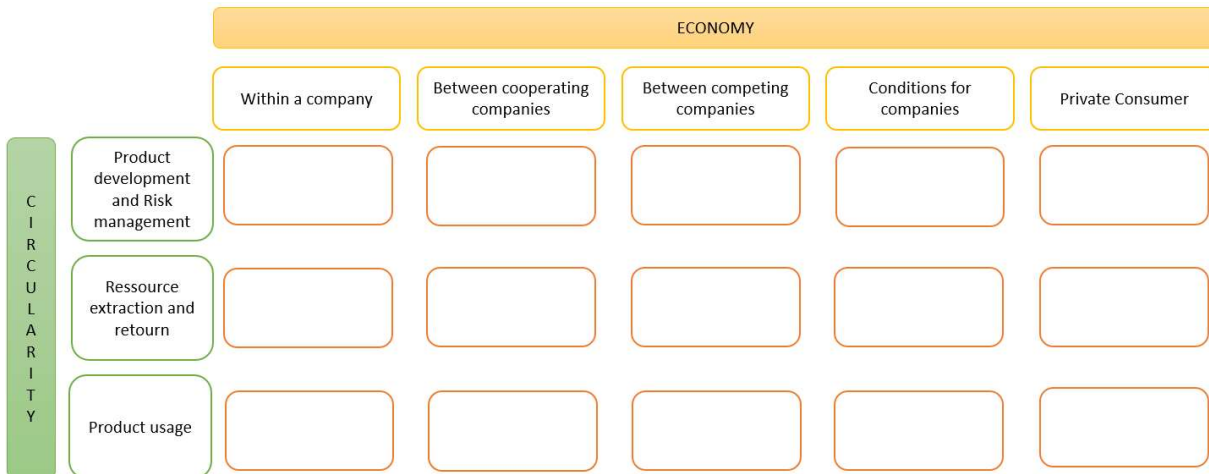


Figure 2: Pictorial representation of the systematics of the curriculum

The aim of the systematics is to anchor the content-related competences on the different system levels of the economy as well as to represent the complexity. By crossing the two dimensions, content-related competences can be systematically represented for the individual areas. These competences fill the orange fields of the matrix.

For within the orange fields, short content-related information on the topic was provided and additional learning obstacles and topics were elaborated.

6. DIDACTIC ASSUMPTIONS

A transdisciplinary curriculum must abstract from the different backgrounds of the disciplines that are to use it. Nevertheless, there are central reference disciplines besides economics, i.e. central for the conceptual differentiation with regard to the organization of a circular economy. These are among others chemistry and engineering, which are fundamental for the understanding of 'material' and its possible processing. In addition to the individual competences, learning hurdles and exemplary topics of the individual areas are presented. The learning hurdles and topics given are for illustrative purposes and do not claim to be complete.

Typical reasons for learning hurdles are the concepts, which are too complex or counterintuitive. They can imply just too many factors and relations of too different types to be understood in a coherent way by an untrained person (e.g. stock and flow ...). Also, the relevant expert concept can be in contradiction to lay intuition (e.g. the 'market' as a place of trade or as an abstract feedback structure). This relates to systems-thinking in general (i.e. the difference between system where the whole determines the function of parts and a mechanism that is determined by the structure of the parts – the latter being the more intuitive way of thinking). Or the dimension of the issue is just beyond our intuitive capacity (e.g. exponential growth).

The learning obstacles mentioned in the three parts are not analytically restricted to these parts; the distribution is due to saliency.

Circular Economy
as a transformative (innovating) approach

		Economy (economic value generated - where/by whom? Value in a broad sense but including monetary profit!)				
		Within a company	Between cooperating companies (particularly supply chains)	Between competing companies	Conditions for companies	Private consumer
C i r c u l a r d e s i g n i n g c l o s e + n a r r o w + s l o w / / r e s t o r e	Product development Risk management	CE oriented development guidelines	CE optimized co-innovation	CE optimized standardisation	regulatory incentives e.g. taxing, adaptation or IPR	
	Learning obstacles	identification / prioritisation of resources and risks		understanding co-opetition and social dilemmas	governance - social dilemma management	consumer integrated product development (prosumer)
	Topics	specific topics in relation to given disciplines e.g. provision of broad mobility instead of selling cars, using common standards, using common online portals with CE transparency functions,...				
	Resource extraction and return	minimisation of use of newly extracted resources use of secondary materials waste avoidance	organisation of material loops	standardisation for efficient services	regulatory incentives e.g. exemptions from competition laws or research support / knowledge transfer	CE incentivizing
	Learning obstacles	transaction costs, externalities, scarcity - competitive advantages				
	Topics	specifics topics in relation to given disciplines e.g. different material loops, waste management, ...				
	Product usage	CE oriented business models eg. providing service instead of selling good	from linear to circular supply chains (b2b - g2b)	common recycling systems	regulatory incentives e.g. high waste costs etc.	CE oriented consumer awareness and behavior
	Learning obstacles	systemic thinkink (feedback pos/neg, stock/flow, efficient business cases, ...)				
	Topics	specifics topic in relation to given disciplines e.g. tender rules, ...				

Figure 3: The curriculum

7. EXEMPLARY TOPICS IN THE DIFFERENT ARRAYS OF THE CURRICULAR MATRIX

In the following, exemplary topics from different disciplines are presented to provide ideas for the adaptation of the curriculum.

In addition, certain learning obstacles related to the different parts are addressed.

7.1 PRODUCT DEVELOPMENT / RISK MANAGEMENT

Within a company

Within a company with a view to product development and risk management the development of circular economy-related standards is particularly important. This starts, for example, with the analysis of processes in product development as well as the elaboration of requirements for new products. For example, if one wants products to be more durable, attention must be paid to appropriate technology and material selection during production.

There are also some changes with regard to risk management with a view to integrating circular economy practices in a company. Companies need to include criteria in the middle- and long-term production planning and research that include e.g. environmental risks. Less types of waste and smaller amounts of waste is an effective way of risk prevention, which it is fully in line with circular economy. This applies to issues like not mixing materials in packaging to excluding non-recyclable materials.

Particularly for larger companies appropriate in-house software can help handling the complexity that arises. This means, for example, that it must be able to coordinate material flows and report corresponding requirements to the right places.

Between cooperation companies

The design of durable products that can also be produced in a resource-saving manner requires innovations in product development also in an organisational perspective. Adequate cooperation in the supply chain with other companies is essential to fostering these technological innovations. Also, precursor materials need to be analysed in concern of their potentials for circularity.

As a result, companies need to discuss with each other regarding new circular production paths, for example, or even conduct research on them together. At least in the long run this will likely increase their market position.

Between competing companies

Improving circularity between competing companies requires communication between them, if it is not based on development on the regulatory level. Companies can foster the development of sustainable circularity enhancing standards (elimination of CFC). Additional recycling services can, e.g., be developed easier if the types of by-products and waste are uniform (lithium batteries).

General Regulatory Framework

Where – particularly competing – companies are not able to find sustainable solutions themselves, the state(s) need to act; e.g. forbidding the production or usage of certain materials and products or taxing more circular processes less than others (fossil energy tax).

Between public bodies and private companies

By changing tendering procedures, for example, public bodies can provide incentives to implement circular economy approaches. For example, in most cases, tenders focus on the price of products. Sustainable production methods are given little weight in the decision; e.g. the elimination of certain harmful processes throughout the supply chain. If circular production methods were to be given more weight in the decision, incentives could be created for companies to adapt their internal behaviour as well as that directed at cooperating and competing companies.

Private consumer

At least on small scales consumers can be integrated in product development processes. The way products will be used in the 'real world' can be important for decisions in companies and on the regulatory level. For example, the development of a durable product design always requires the inclusion of how and where the product is finally used. With these two components in mind, durable materials can be selected and durable product designs can be developed.

In addition, integrating private consumers into the product formation process can lead to a perception of the complexity of circular economy practices. For example, individuals are guided to ask themselves circular economy-related questions. This can contribute to the development of sustainable attitudes.

Learning obstacles

Complexity is everywhere. Improving one issue can create unwanted harm at another point, so that real improvements are hard to make (e.g. it is not always clear that the use of plastic is

worse than the use of paper, due to higher energy and water consumption for paper production; rebound effect)

Complexity increases with the future range of decisions. Internationally there are two major concepts for production related risk management: the precautionary principle, that is favoured by the EU, and that takes regard of potential risks, whereas the North American approach focuses on proven risks. Such ambivalence can hamper taking decisions when necessary.

Social Dilemmas are often hard to understand because it is not easy to view and generalize a situation and to consider the behaviour of one (or more than one) person in dependence on the behaviour of another person or persons. Decisions taken within companies are taken in a situation of competition between companies. Being the first to move to more circularity can create a comparative disadvantage. As this applies to all, none will do it. For costumers it is difficult so see an effect of them as individuals acting more environmentally friendly, while others are not doing it.

7.2 RESOURCE EXTRACTION (AND POTENTIAL RETURN)

Within a company

Within a company, for example, care should be taken to use secondary materials in as many places as possible. For example, office furniture can be purchased second-hand or recycled paper can be used. In addition, as few primary materials as possible and as many secondary materials as possible should be used in production. For example, the yogurt cup can be made from recycled paper instead of plastic.

Among cooperating companies

In some areas, it is not always possible to close the circles within a company. For example, if waste is generated during production, it may not be possible to reuse it within the company. However, other companies can process this waste. Furthermore, it may not be possible to reuse all materials to the same extent after use. In this case, too, the cycles can be closed through cooperation with other companies. For example, if plastic is no longer useful for use as a yogurt cup or piece of furniture, the construction industry can still make sign holders out of it.

In addition, companies can support each other by, for example, one company organizing the flow of materials and the return of resources so that the other companies can produce.

Between competing companies

Even if price competition is high, companies can increase their efforts in extracting less resources. It is possible to advertise this and the plan to further improve as a positive feature of one's products.

In addition, using their own secondary products can lead to a competitive advantage. If companies use their own waste products, they no longer have to rely on suppliers. Thus, for example, supply bottlenecks or an increase in material prices have less impact on production and production costs.

General Regulatory Framework

Public bodies can assist in the development of online platforms for the recycling of resources by expanding the relevant regulations. In particular, this involves data protection rules. The recycling of resources requires a constant exchange of data. Appropriate rules are needed for this.

Between public bodies and private companies

Public Private Partnerships can change their objectives. For example, they can change their supply chain or reduce energy consumption.

Private consumer

The direct influence of consumers on resource extraction is low; concerning their much bigger role and responsibility in concern of product usage see below.

Learning obstacles

From an economic point of view there are different complex concepts that need to be understood to develop a coherent view.

Negative externalities are an essential concept for the advancement of circular economy. First, it helps analysing production processes, as it asks where steps or (contractual) relations are that externalise costs (particularly: dealing with waste). Second, it helps internalizing these costs; e.g. CO2 certificate trading systems are a measure to internalize the environmental costs of dumping CO2 in the atmosphere into the production process, thus fostering the search for less energy intensive processes.

Transaction cost are often forgotten when estimating at cost structures for different products, because they are not directly related to production, i.e. its 'materiality', but can be quite

decisive. It can be e.g. much less time consuming, i.e. cheaper, to stick to a business partner who does not apply high sustainability standards than to find a new one, who might.

Intuition can be misleading, e.g. that a gas like CO₂ cannot be seen and touched. Nevertheless, burning 1kg of coal produces around 3,6kg of CO₂.

7.3 PRODUCT USAGE

Within a company

Product use within a company can, for example, be adapted through new use models in the sense of the circular economy. For example, companies can offer products and services for rent instead of selling them. Some companies already make intensive use of this model by offering their goods for rent instead of selling them. This means that fewer products have to be produced and the cycles are narrowed.

In addition, companies can try to integrate circular economy practices within their own premises. In this way, they would be setting an example for their employees and customers to follow. For example, in terms of product use, they can use recycled paper, provide new employees with the functional products of the predecessor instead of new products etc.

Furthermore, companies can offer workshops for their employees to highlight the relevance of circular economy practices and build a corporate culture. Developing an appropriate mindset can lead to more sustainable employee behaviour during work as well as in personal life.

Among cooperating companies

It is already a standard business model that companies buy access to certain goods instead of owning it – this can be a harvester or a computer centre.

Between competing companies

Even if price competition is high, companies can benefit from partial cooperation (cf. 'coopetition'); e.g. by investing in a common waste management.

General Regulatory Framework

By charging high garbage fees, for example, the government can create incentives to avoid waste. In this way, people are encouraged to avoid waste by separating it properly. Some countries have already introduced a system based on this target orientation. Thus, individuals pay significantly less fees if they separate waste according to its components. In addition, high garbage fees lead individuals not to throw away products directly, but to have them repaired. This prolongs product use enormously.

Between public bodies and private companies

Public Private Partnerships can change their objectives. They can agree to include further stakeholders, that improve the circularity of their processes, e.g. a special recycling company.

Private consumer

Private consumers in particular need to move away from the idea of a throwaway society and try to adapt a circular usage behaviour. This includes the avoidance of waste, the use of various sharing offers, the careful handling of products and sometimes the abandonment of various products.

However, even if consumers like to buy sustainable products, they also look at the price. Consumers are also faced with the decision of whether they really want to spend more on an environmentally friendly product than on a less sustainable one. Mere appeals to buy sustainable, fair or organic products have only a limited effect. Most people know what the more sustainable alternative would be. Many think that their decision in favour of the sustainable product ultimately changes nothing in the overall situation. Therefore, it doesn't matter if they take the cheaper one and can use the money saved for something else. If an excessive packaging presents the product in a shiny way one might take it rather than the one with less fancy wrapping.

Consumers are not (direct) competition with each other. For them, the many different ways of using the available funds are in conflict. After all, you can only spend money once. Since sustainable products are typically more expensive than conventional ones, a social dilemma arises here as well, and the transformation of the economy, i.e. the part controlled by consumption decisions, to a more circular and sustainable system does not take place as quickly as is actually desired. Accordingly, there is an attitude-behaviour gap with regard to sustainable consumption. Nevertheless, the phenomenon of social desirability influences both attitude and behaviour. Its effect depends on the observability or control of the attitude expression or behaviour. Apart from the data privacy issue included in allowing others to observe one's behaviour, there are potentials from car insurances asking less for defensive driving or challenges in social groups like 'veganuary'.

Like among cooperating companies, another aspect is the neglect of possession in favour of access. Companies providing this service of access to certain goods will also have an incentive to use this good as good as possible, instead of, e.g., lots of machines lying around in every household to be used once or twice a year.

Learning obstacles

Systems thinking is a salient topic in the field of conceptual change or threshold concepts. Taking the perspective from the whole and particularly whether it builds on negative feedback processes that uphold a dynamic equilibrium (e.g. ecological predator-prey relation) or whether it is in crisis due to positive feedback loops (e.g. heating up the climate will set free more CO₂ and Methane and reduce the amount of sun reflecting polar ice shields).¹⁶

¹⁶ Systemic thinking is a key learning hurdle not only with regard to the circular economy, but moreover with regard to the entire topic of sustainability. Thus, Bianchi et al. (2022, 20) present systemic thinking as a central competence for embracing complexity in sustainability.

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