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The Circular Economy – Concept and Facts

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The Circular Economy – Concept and Facts

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Introductory Remarks: *This first part of the textbook on the circular economy introduces the concept and explains the economic background and its close relationship to a sustainable development and the waste hierarchy. Relevant environmental regulations are briefly introduced, important paragraphs addressed, whereas examples show that current attempts to implement certain features of a circular economy by means of this legislation still pose a serious challenge.*

The second part of the textbook focusses then on the implementation of a circular economy by means of appropriate tools and policies. In this context, the concept of an "Integrated Environmental Policy" is developed, practical examples are provided – after a thorough analysis of deficiencies of the current regulations.

Not all sections of the first part of the textbook are necessary in order to work with the second part. Thus, a basic understanding of the concept of a circular economy including the dimensions of the waste hierarchy should be sufficient to continue with the material contained in the next part. However, for those, interested in more details of the economic background, a more careful reading of the following chapters is recommended.

1. What is a Circular Economy?

A recent count of definitions of a circular economy resulted in 114 different approaches to this concept, which gained and is gaining momentum both in theory and practice, both among scholars and practitioners. Kirchherr et al. (2017) claim that a circular economy may mean many different things to different people, in particular to critics of the concept. They find that many definitions refer to the 3Rs: reduce, reuse, recycle, sometimes neglecting "reduce", sometimes entirely focusing on "recycling", often without emphasizing the necessity of a systemic shift. With regards to the implementation of a circular economy, they point to missing business models and the unclear role of various stakeholder groups as enablers of the circular economy (cf. Kirchherr et al. 2017, p. 228ff).

Similarly, Prieto-Sandoval et al. (2018) mention the growing importance of the concept of the circular economy for attaining a sustainable development with its supposed and expected positive impacts on economic prosperity, on environmental quality and social equity. Many definitions reveal linkages to sustainability. Among the dominant determinants of a circular economy, which they find in their literature review, they mention the waste hierarchy, both as a conceptual basis for a circular economy and a guiding principle for implementing a circular economy. Other publications in their review use sustainable design strategies, eco-design, as official principles of a circular economy.

Fig. 1 indicates the relationship between the waste hierarchy, a circular economy and sustainability: waste hierarchy is part of a circular economy, but aspects beyond a strict observance of the waste hierarchy might play a role in a circular economy. A sustainable development goes beyond the concept of a circular economy, which is more focused on environmental and economic issues, whereas sustainability takes also into account pure social issues. But, for sure, the waste hierarchy is an integral part of the concept of a circular economy.

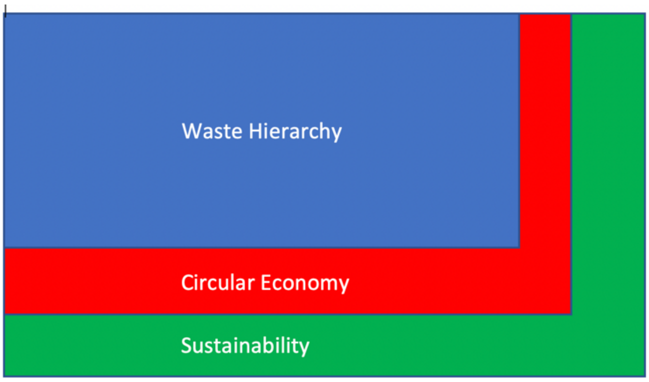

Fig.1: The relationship between the waste hierarchy, a circular economy and sustainability. Source: Own drawing.

Needless to say, different concepts of a circular economy may require different approaches for the implementation. Business model are mentioned, which are based on increasing recycling activities, claimed as part of a circular economy. However, explicit and detailed business models to help to implement a circular economy, are scarce so far. Extended Producer Responsibility (EPR) and Design for Environment (DfE) are sometimes mentioned, although it is not straightforward to understand it as a viable business model. Also, links between a circular economy and sustainable development need yet to be discussed more intensely in the literature.

Meanwhile, many developments in waste management can be observed, which may at least hinder the implementation of a circular economy. This refers in particular to the tendency to “misuse” the waste hierarchy for many other (business) purposes. In Germany, for example, chain stores (discount stores) enter successfully the waste management and recycling business. Consequently, they are establishing their business case on two sides: by selling their products they help to generate packaging waste, and then they help to recycle it. At the first glance, this looks like a perfect implementation of the producer-pays principle, part of many environmental laws (cf. also Georgia 2014), and it sounds too good to be true in view of the waste hierarchy. For all these and some more reasons, finding a somewhat precise concept of a circular economy and focusing on its implementation, thereby observing incentive compatibility with all environmental regulations, seems to be of utmost priority.

After these basic remarks, it is therefore the goal of this introductory textbook, to focus on an appropriate concept of a circular economy. A closer look at definitions related to a sustainable development with indications of the possible gains expected to accompany the implementation of a circular economy will open the next chapter. Thereafter the guidelines of the Ellen MacArthur Foundation with its focus on the need of suitable business models, relevant environmental legislation of Germany and the European Union will be reviewed, complemented by further remarks on potential gains. This first chapter concludes with a workable concept of a circular economy, which will then be used in the remaining parts of this textbook.

The next chapter is devoted to relevant aspects of the waste hierarchy, its origin in environmental economics. This will then lead to further remarks on environmental commodities, externalities and public goods characteristics. Some emphasis has to be given to the allocation of environmental commodities, which cannot automatically be trusted to the market mechanism due to the mentioned externalities. The role of environmental policies has to be highlighted in this context.

The existing or planned environmental legislation related to issues of a circular economy is briefly considered in the then following chapter. The legal regulations, existing or planned, are mainly taken from Germany, the EU, and Georgia and cover the areas of a circular economy in general, waste, packaging waste, in particular drinks packaging, and waste electric and electronic equipment (WEEE), end-of-life vehicles (ELV), mitigation of climate change with some international aspects.

These environmental regulations will then be used to review certain facts on the path towards a circular economy. These facts will refer to experiences to reduce or limit one-way drinks packaging, and to similar efforts regarding plastic waste in general, then to the rebound effect, to the question what to do with WEEE, and to the role of environmental standards, which affect large parts of environmental policy, including air pollution and mitigation of climate change.

2. Definition of a Circular Economy

2.1 Various Approaches

Kirchherr et al. (2017) propose the following definition of a circular economy, without, however, completely ruling out other concepts (cf. p. 224f): "A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/ distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."

This definition, beyond pointing to the aim of accomplishing a sustainable development, draws the attention in particular to a multi-level vision of a circular economy: ideally, at the micro level companies are focused on eco-innovation because of a positive impact on its prestige and associated reduction of costs, the meso level refers to companies, which will benefit from the cleaner natural environment, whereas the macro level is more focused on the development of eco-cities or eco-provinces. All these activities should be initiated and guided through the development of environmental policies and institutional influence. Fig. 2 indicates this cycle of extraction and transformation of resources, the distribution of the commodities, and the use and recovery of goods and materials, which closes the loop in view of the circular economy. For further literature in this context see also Geisdoerfer et al. (2017) and the literature cited in this and the other publications. Already at this point, it is interesting to note that consumers do not play an explicit, nor a very active role in this concept.

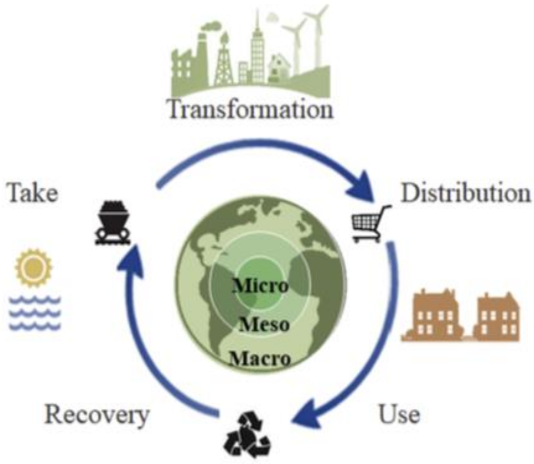

Fig. 2: Circular Economy Cycle. Source: Prieto-Sandoval et al. (2018), Fig. 5.

Korhonen et al. (2018) propose a slightly different concept, referring in particular to the three dimensions of a successful of sustainable development: the economic, environmental and social dimension (cf. p. 39). Regarding the benefits of a circular economy focusing then on a sustainable development, Korhonen et al. (2018) provides the details in Fig. 3:

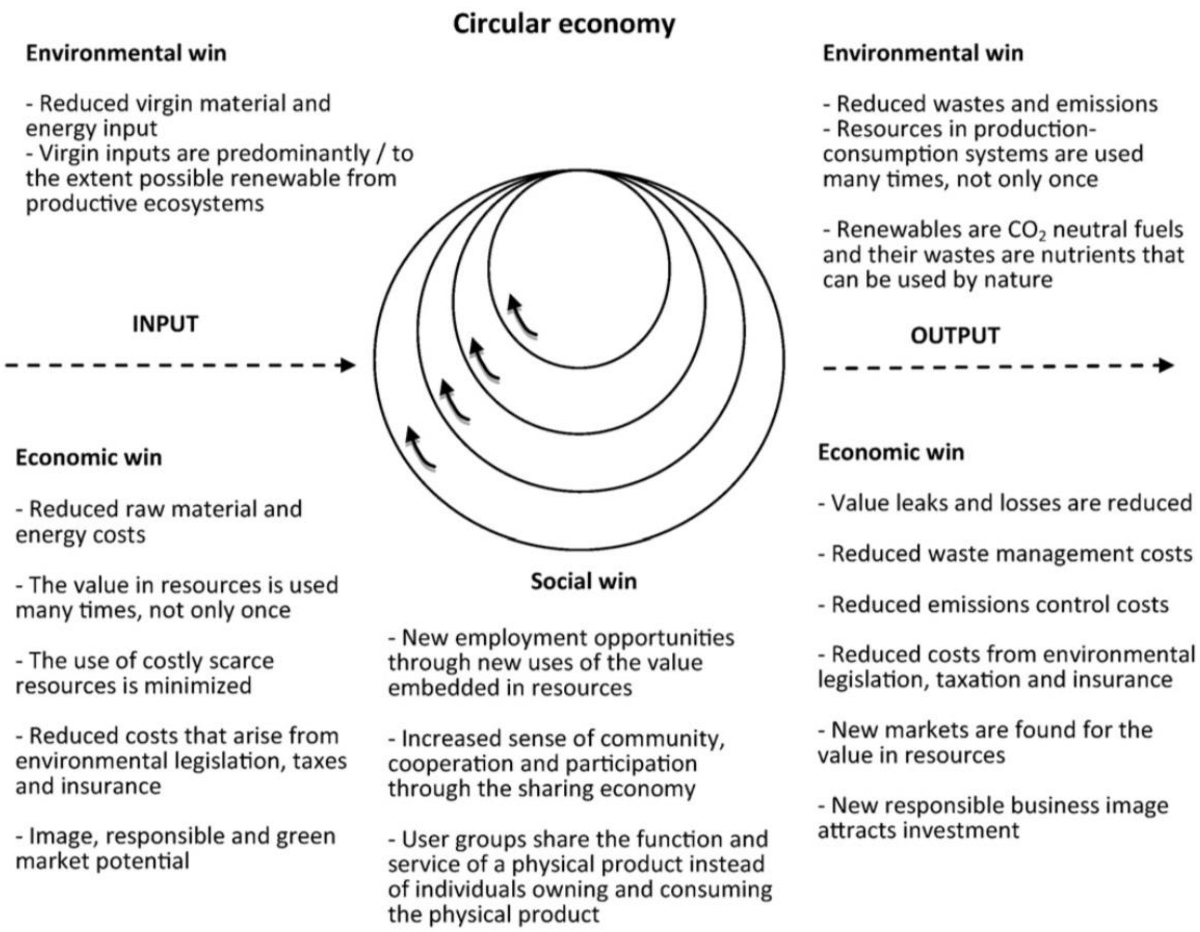

Fig. 3: The win-win-win potential of a circular economy. Source: Korhonen et al. (2018), Fig. 3.

The important question arising with this concept is, how to implement a circular economy? How to design the appropriate environmental policies and the institutional support? How to reap all the proclaimed benefits of a circular economy? Some policy impulse seems to be necessary.

2.2 The Ellen MacArthur Foundation

This renowned foundation also considers a sustainable development an important dimension of a circular economy: "Circular economy is 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 impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models" (Ellen MacArthur Foundation 2013, p. 7).

According to the Foundation, a circular economy aims to prevent waste, as a "products are designed and optimized for a cycle of disassembly and reuse". Circularity introduces a strict differentiation between consumable and durable components of a product, with consumables largely made of biological ingredients, and durables made of technical ingredients, like metals and plastics, designed for reuse. In addition, the energy required should be renewable (cf. Fig. 4).

The systemic shift required for the implementation of a circular economy replaces, again according to the Foundation, the concept of a consumer with that of a user, implying a new contract between businesses and their customers based on product performance. Durable products are leased or shared, and there are incentives in place to ensure the return and thereafter the reuse of the products or its components (Ellen MacArthur Foundation 2013, p. 7).

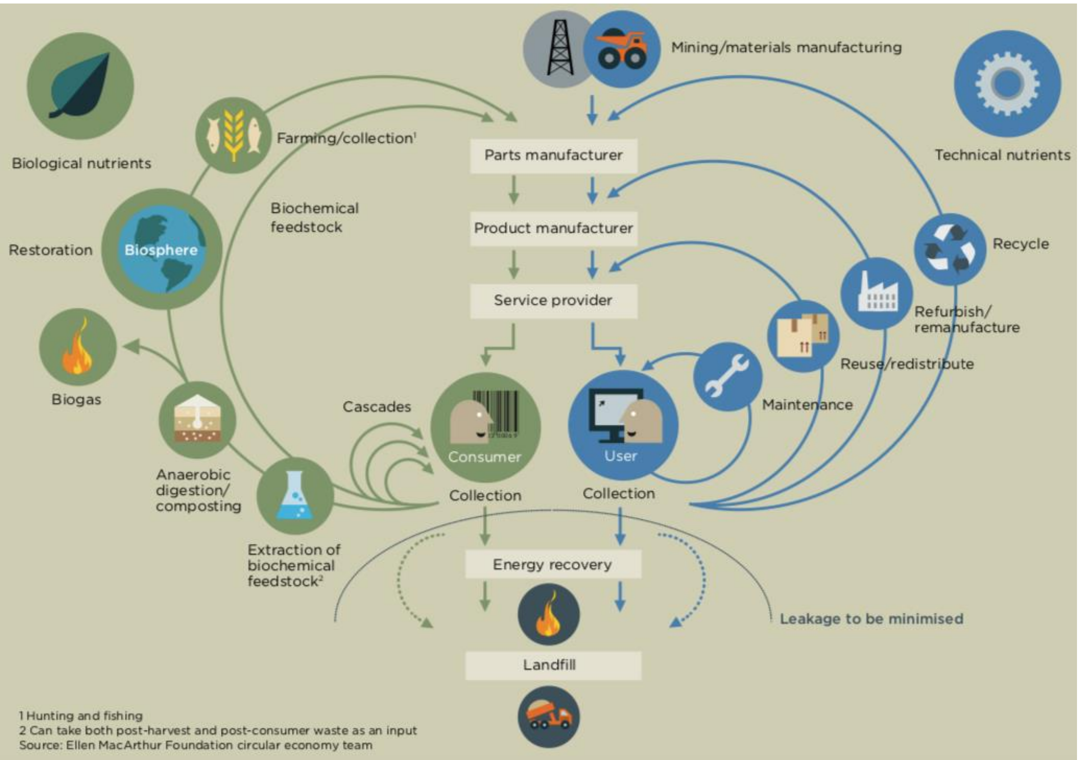

Fig. 4: The circular economy – an industrial system that is restorative by design. Source: Ellen MacArthur Foundation (2012), p. 24.

The circular economy is, thus, meant to replace the existing model of a linear economy, which can be illustrated as in the following Figure 5:

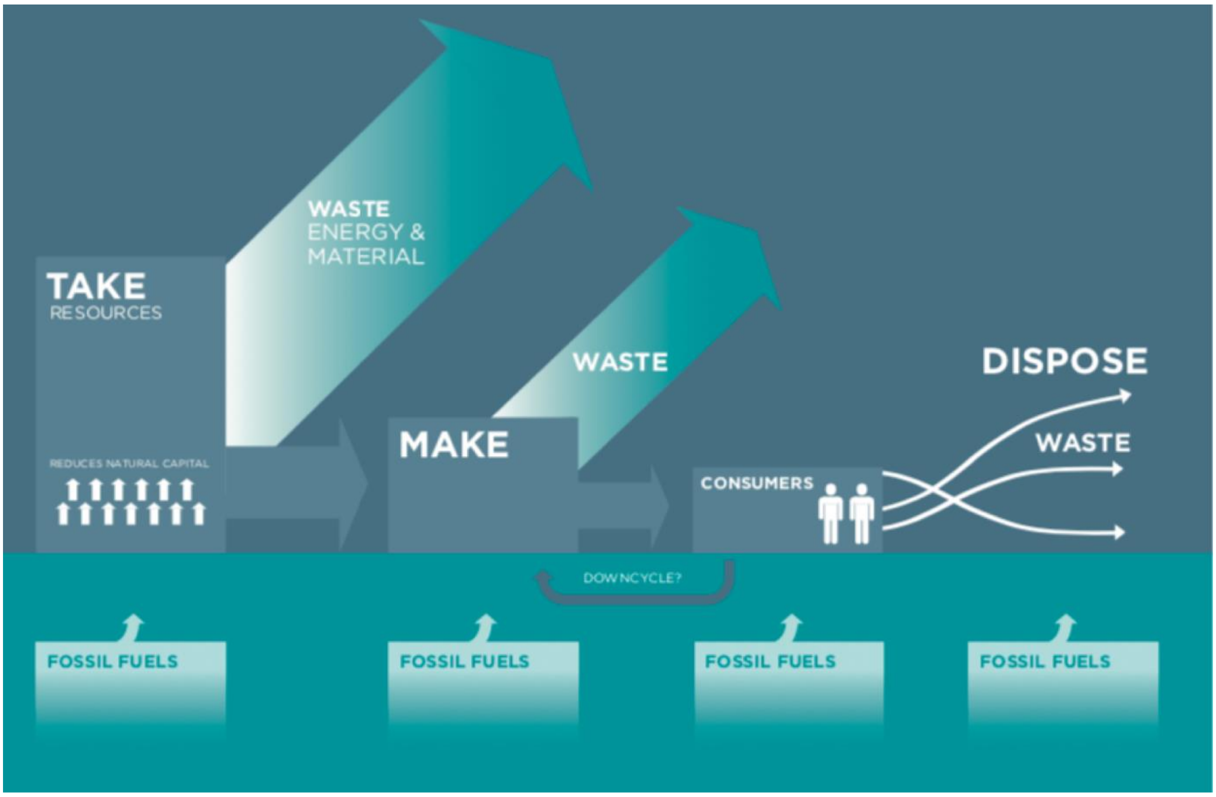

Fig. 5: A characterization of a linear economy. Source: Ellen MacArthur Foundation (2017), p. 13.

Whereas the traditional linear economy is characterized as a "throughput economy", a take, make and dispose economy based on the use of fossil fuels. This linear economy has been very successful for many decades in terms of economic growth as measured by GDP per capita. This is in contrast to subsistence or rural economies that till today prevail in some parts of the world. The success of the linear economy is, of course, a consequence of the framework conditions determining economic systems in earlier times: "there was plenty to take and plenty of room to dispose". This situation seems to change in view of climate change and other environmental issues increasingly affecting current economies on a global scale (cf. Ellen MacArthur Foundation (2017), p. 13).

According to the Foundation, economies will benefit, in particular, from substantial material savings and the long-term resilience of the economy. Companies can gain from reduced costs and new business opportunities, for example, in reverse cycle services (collection, sorting, funding and financing new business models). Consumers will profit from reduced total ownership costs (cf. Ellen MacArthur Foundation (2013), p. 9ff).

The question is again, how to implement such a circular economy associated with a system change? The Foundation refers to business models such as EPR and DfE. These business models will be investigated in the second part of this textbook.

2.3 The European Union

In its action plan for a circular economy, the European Union (EU) points out that in a circular economy "the value of products, materials and resources is maintained in the economy as long as possible, and the generation of waste is minimized". This is considered to be "an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource efficient and competitive economy" (EU 2015a, p. 2).

And about addressing possible gains: "The circular economy will boost the EU's competitiveness by protecting businesses against scarcity of resources and volatile prices, helping to create new business opportunities and innovative ways of producing and consuming. … At the same time, it will save energy and help avoid the irreversible damages caused by using up resources at a rate that exceeds the earth's capacity to renew them in terms of climate and biodiversity, air, soil and water pollution. … Action on the circular economy therefore ties in closely with key EU priorities, including jobs and growth, the investment agenda, climate and energy, the social agenda and industrial innovation, and with efforts on sustainable development" (EU 2015a, p. 2).

The EU considers business and consumers as key in driving this process. Besides local, regional and national authorities, the EU also assumes a fundamental role in supporting this transition. The aim thereby is to provide the right regulatory framework for the development of a circular economy. Appropriate measures should promote economic incentives and improve EPR schemes and commitments on DfE. Moreover, targeted actions in areas such as plastics, food waste, construction, critical raw materials, industrial and mining waste, consumption, public procurement, fertilizers and water reuse are or will get funding under the EU's Horizon 2020 research programme.

The circular economy will start at the very beginning of a product's life: both the design and production processes have important impacts on resource use and waste generation throughout a product's life. By means of, among others, an improved labelling system for the energy performance of household appliances, the EU wants to direct consumer demand to the most efficient products. A product's lifetime can be extended through reuse and repair, thereby reducing waste, supported through other initiatives to reduce waste. The waste hierarchy plays a central role in waste management and aims at encouraging the options that deliver the best environmental outcome (cf. EU 2015a, p. 4ff).

So far, the concept of a circular economy of the EU and the proposals for its implementation, which are based mostly on framework conditions provided through an appropriate legislation. The existing legislative framework, which is still incomplete and not functioning completely satisfactorily, will be reviewed in Chapter 4.

As Georgia signed an association agreement with the EU, it is natural to adopt the view of the EU regarding the concept of a circular economy and its implementation. We thus arrive at the following summary of Chapter 2:

Summary: *The majority of definitions of the concept of a circular economy refer in one way or the other to the waste hierarchy and to the goal of a sustainable development. Expected gains from a circular economy arise from a sustainable development. In general, however, the implementation of a circular economy is not yet precisely outlined, despite of existing pieces of relevant legislation.*

The focus in this textbook will be on the actions of the EU, which also emphasizes the waste hierarchy and sustainability. Moreover, DfE and EPR are mentioned as appropriate tools for the implementation of a circular economy.

3. The Waste Hierarchy

The waste hierarchy refers to the following priority order regarding waste management: prevention; preparing for reuse; recycling; other recovery, e.g. energy recovery; and disposal. It is meanwhile a part of most legislations on waste management, although interpretations vary. Sometimes, as we shall discuss later, practitioners seem to consider the recycling of waste as being equivalent with preventing waste, or the goal of preventing waste is simply neglected (see also Kirchherr et al. 2017, p. 229). Moreover, we shall have to address situations, where the strict application of the waste hierarchy is at least questionable regarding the overall goal of a sustainable development. This points to the incomplete congruence of the waste hierarchy with the concept of a circular economy.

In order to understand the origin of the waste hierarchy and its current importance and influence on the concept of a circular economy, we have to make a brief excursion into the basics of environmental economics (cf. Wiesmeth 2011, Ch. 4).

3.1 Environmental Commodities

The concept of a "good", or, equivalently, a "commodity", comprising both a physical commodity or a service, is basic for any economic system and can be extended to include "environmental goods" or "environmental commodities". Like any other good, environmental commodities influence the well-being of mankind in general, or of consumers and producers, in particular. However, as is the case with scarce regular commodities, only "perceived scarcity" renders environmental commodities relevant for a rigorous economic analysis.

The concrete experience of "scarcity" of an environmental commodity depends on a variety of conditions of which actual physical scarcity is only one. For example, research activities in natural sciences contribute to the continuous discovery of more and more "scarce" environmental commodities. In this context, the ecological relevance of the earth's ozone layer and its limited capacity to store chlorofluorocarbons (CFCs) only became known with the advancement of science and the development of sophisticated instruments to measure and document the relevant chemical processes. A similar context applies to the emission of nitrous oxides, which is currently under rigorous discussion in Germany. The fact that these issues are perhaps of less importance in Georgia right now, points to different levels of a perceived scarcity regarding these environmental commodities (or, rather, environmental "bads") in the two countries.

Most important for the perceived scarcity of environmental commodities is, however, the state of "environmental awareness" in a particular population. A high level of environmental concern raises the importance of environmental issues in a society, which is a prerequisite for an effective environmental policy. The difficult thing is that environmental awareness itself seems to depend on the level of economic well-being (cf., for example, Grossman & Krueger 1995), and, even more importantly, need not prevent pollution.

A lower level of perceived scarcity regarding certain environmental commodities can affect the implementation of environmental policies, also the implementation of a circular economy or certain parts thereof. This might, in particular, affect cross-border or even international environmental issues, such as climate change. But why do we need environmental policies anyway, in particular in a market economy?

3.2 Allocation of Environmental Commodities

At this point a closer inspection of the economic "allocation problems" is necessary, with a clear reference to environmental commodities. The allocation problems postulate answers to the following fundamental economic issues:

- Which commodities shall be produced? Which quantities are required?
- How shall these commodities be produced?
- Who shall have access to these commodities? Under which conditions will access be granted?

For a specific example in the environmental context think about the "services" provided by the earth's ozone layer. It is well understood today that the ozone layer protects life on earth from the effects of ultraviolet rays from the sun, and should therefore have no "holes", no significant reductions in concentrations. A way to restore this layer is the ban on CFCs, and once restored, nobody can be excluded from the services of the ozone layer.

In general, a solution to the allocation problems requires a "mechanism" or "system", which – ideally – leads to an "optimal allocation", at least under some reasonable conditions. The "market mechanism" constitutes such a mechanism or system, based on a "decentralization of economic decisions" by means of a "price system". This concept of decentralizing economic decision (including decisions on environmental commodities) will play an important role for the implementation of a circular economy.

Clearly, in order for the market mechanism to function properly, regular markets are required for each commodity. Moreover, none of the economic agents should have an effect on the price system; otherwise distorted prices would provide false signals to consumers and producers.

Applying these considerations to the allocation of environmental commodities, one has to deal with some problems. First of all, for quite a few environmental commodities regular markets will, for more or less obvious reasons, not exist. This is true for the above-mentioned services of the ozone layer, for example: anyone buying these services is also buying them for many others without receiving their financial contributions. Moreover, the consumption or the production of most environmental commodities involves "environmental" or "external effects", which are not reflected in the market system. The emission of nitrous oxides or particles through transport activities provides an example for this case: typically, nobody pays or has to pay for these emitions while driving a car, and it is difficult to imagine a regular market for these emissions for reasons similar to those mentioned above in the context of the ozone layer.

As a consequence, the market mechanism cannot be expected to function optimally, when environmental commodities exerting external effects are present. There is a gap between private and social costs of using or producing these environmental commodities: from a private point of view the earth's ozone layer can be used as a place to store CFCs without any costs; however, it is well-known today that the social costs of such behavior can be quite high. Most environmental tools and instruments therefore aim to reduce or close this gap.

To be more precise, the services of the earth's ozone layer provide an example of a "public commodity": exclusion of somebody from the consumption of the commodity is not feasible, and total supply is not affected by the number of consumers. Similarly, the available supply of "clean air" is (almost) not affected by the decision of an additional individual consumer to use a private car for commuting instead of public transport: this decision has only negligible effects on traffic congestion and the state of the environment. Again, these features are characteristic for public commodities with ensuing complications for the market mechanism, pointing to the necessity of applying other tools for the allocation of environmental goods, for example, environmental policies. This view is emphasized through the existence of two mechanisms, which are of utmost relevance for the design of environmental policies (cf. also Wiesmeth 2011, Section 5.3).

3.3 The Tragedy of the Commons

Consider the above example issue of the modal split, the distribution of commuters to the various means of transportation, such as public transport or private cars. Despite a higher level of pollution (also in the form of greenhouse gases), and despite daily traffic congestion, especially during rush hours, many commuters continue to use their own car to get to and from work, also in spite of a presumably high level of environmental awareness in most cases. An explanation is provided by the "Tragedy of the Commons": the additional (or marginal) pollution of a commuter in a private car is negligible, as is the marginal effect on the overall traffic situation in the city. So, why switch to the less comfortable public transport? If the other commuters take the public buses or trains, then the streets will be less crowded. . . The consequence is clear: nobody has much of an incentive to change his or her behavior. Of course, there are reasons to use public transport for commuting: cost saving, no need to search for a parking space, . . . But these reasons are "competing" with the other ones mentioned above.

3.4 The Prisoners' Dilemma

Consider the issue of mitigating climate change, referring to a global environmental good. In the Kyoto Protocol of 1997 and the Paris Climate Change Conference of 2015 participating countries have agreed to take appropriate measures to reduce greenhouse gas emissions, to fight climate change. However, as each country will profit from the corresponding efforts of all other countries, it might consider reducing its own efforts. This could provide an advantage regarding competitiveness through saving costs resulting from climate change activities. However, if various countries are thinking and acting like this, the agreement is doomed to fail.

These two mechanisms again point to the gap between individual rationality and social rationality, which has to be closed through carefully designed environmental policies. Various practical examples (cf. Ch. 5) will show that this is not always an easy thing to do. Environmental awareness certainly helps, but, as experience demonstrates, cannot completely solve these issues.

3.5 Economic Efficiency

As a consequence, environmental commodities should be and have to be integrated into the economic allocation problems to allow a thoughtful analysis of environmental issues within the context of the economy. This does not imply a subordination of the environment to the economy. But it means that economic and environmental issues are intertwined and should not be separated. This conclusion is clearly in favor of the concept of a circular economy.

In this sense this section continues the discussion of the last section with further remarks on "feasible allocations". Most important, however, is the extension of the normative criterion of "Pareto efficiency" to allocations covering environmental commodities. This raises the question, whether an economic efficiency criterion can also serve in an environmental context?

A "feasible allocation" is an attainable solution to the allocation problems. For a particular period of time it provides a more or less satisfactory answer to the continuing challenges of an economic system to allocate first the available resources to the various production processes of the economy and thereafter the commodities produced to the consumers. The concept of an "economic system", such as a market economy or a centrally planned economy, then describes the never-ending attempt to choose, again for a period of time, a feasible allocation with certain "optimality" properties. The result is an optimal or efficient allocation which affects the well-being of the economic agents.

The concept of efficiency has to be based on a normative criterion, which is, in the case of market economies, the already mentioned "Pareto Criterion". A feasible allocation is Pareto-efficient or Pareto-optimal, if there is no other feasible allocation which improves the well-being, the "utility", of at least one individual (consumer or household), without diminishing the utility of any other. Interestingly, in a market economy with a market for each good and perfect competition the market mechanism yields an efficient "equilibrium" allocation (A. Smith's metaphor of the "invisible hand").

A simple consequence of these efficiency consideration, which will not further be considered in this textbook, is the observation that an allocation, to which there exists an alternative providing the same amounts of the private commodities at a lower environmental pollution, cannot be optimal or efficient. Cases, where a lower environmental pollution is associated with smaller amounts of certain private goods (cars with a diesel engine, for example) or with different private cars (e-vehicles, for example) can, of course, similarly demonstrate the inefficiency of an existing allocation, although it is quite difficult, in general, to define the optimal levels (cf. also Section 5.11).

This is then basically the (optimistic) idea behind a circular economy: that it is possible to shift the economic system towards a different one, allowing a sustainable development with all its favorable features. In principle, if there were an appropriate mechanism, comparable to the market mechanism, we could entrust this task to this mechanism. Our approach, designing suitable environmental policies, is a surrogate for this missing mechanism, and the implementation of this surrogate requires a lot of information, as we shall see. In this context, we can now address the relevance of the waste hierarchy more carefully.

3.6 The Waste Hierarchy

Due to the lack of a mechanism, which efficiently allocates the environmental commodities, we can only provide partial answers to structural properties of such an efficient solution. One of these properties is the priority order of waste hierarchy: waste as an economic bad should first of all be prevented, because the initial allocation cannot be efficient, if it is possible to reduce waste and produce the same quantity of the private commodities. Thereafter the other options come: reuse saves resources and costs, and recycling saves resources, costs and reduces the pollution of the environment. To what extent we should reduce waste, reuse or recycle waste, is, however, not always straightforward to say, because we have only rather incomplete information on an efficient allocation with environmental commodities. To be more precise, it could happen that "reducing the environmental impact of a product at the production stage may lead to a greater environmental impact further down the line" (EU 2012a).

In EU (2012a) various questions that can arise in this context in a local or regional setting are posed:

- Is it better to recycle waste or to recover energy from it? What are the trade-offs for particular waste streams?
- Is it better to replace appliances with new, more energy efficient models or keep using the old ones and avoid generating waste?
- Are the greenhouse gas emissions created when collecting waste justified by the expected benefits?

Answers to these and related questions also depend on the local or regional context. Thus, universal answers can, in general, not be provided, making the design of environmental policies more challenging, but also more interesting.

Summary: *Due to external effects associated with environmental commodities, we have to find a surrogate for allocating environmental commodities. Similarly, we have to think about approaching an efficient allocation. The waste hierarchy, by defining some more or less generally valid structural properties of an efficient allocation, provides a direction, in which to develop a circular economy. However, there might be situations, where a departure from a strict observance of the waste hierarchy is justified. This depends to a great deal on the local situation.*

4. Existing Environmental Legislation with a View on the Circular Economy

In this chapter various environmental laws, directives and ordinances from different countries will be briefly analyzed in view of their regulations aiming at a circular economy.

4.1 The Waste Directive (EU)

This Directive (EU 2008) is based on the waste hierarchy (cf. Art. 4), and refers to EPR to strengthen prevention, reuse, recycling and other recovery of waste (cf. Art. 8). The costs of these activities in waste management shall be borne by the original waste producer, or the current or previous waste holders – in accordance with the polluter-pays principle (cf. Art. 14).

The member states of the EU shall ensure that their authorities establish waste management plans analyzing the current waste management situation, and the measures to be taken for preparing for reuse, recycling, recovery and disposal of waste (cf. Art. 28). In addition, the directive postulates a waste prevention program with clearly identified waste prevention measures (cf. Art. 29). Of course, the Commission of the EU has to be informed regularly of the implementation of this directive (cf. Art. 37).

Annex IV of the directive presents a list of examples of waste prevention measures. This list includes measures that can affect framework conditions related to the generation of waste, the design and production and distribution phase, but also the consumption and use phase.

As this basic Directive has to be adopted by the member states, all regulations regarding waste in the EU refers also to this Directive, and therefore to the waste hierarchy, in particular.

4.2 The Packaging Directive (EU)

This Directive (EU 2018), amending the original version of 1994, points to the necessity of improving waste management in the EU. It stresses again that waste prevention is the most efficient way to improve resource efficiency and to reduce the environmental impact of waste. It encourages the reuse of packaging with, for example, deposit-return schemes and setting targets. There shall also be incentives for the application of the waste hierarchy in general. Moreover, the Directive increases recycling targets in order to recover economically valuable waste materials.

The EU also points to certain issues, such as developing the necessary waste management infrastructure, or the reporting of the member states on the implementation of various regulations, which require more attention.

4.3 The Directive on WEEE (EU)

This Directive (EU 2012b), amending the original version of 1996, supplements the waste management legislation in an important field. The market for in particular electronic equipment increases, innovation cycles get shorter and the replacement of equipment accelerates, making electric and electronic equipment a fast-growing source of waste. The subject of this Directive is therefore to lay down measures "to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste from WEEE …" (cf. Art. 1).

Important measures refer to the product design, facilitating reuse, dismantling and recovery of WEEE (cf. Art. 4), the separate collection with collection rates (cf. Art. 7) to minimize the disposal of WEEE in household waste (cf. Art. 5), and proper treatment for recovery of WEEE using best available techniques (cf. Art. 8), recovery targets (cf. Art. 11). Shipments of WEEE to countries outside the EU are allowed, if they are in compliance with other regulations concerning the transboundary movement of waste (cf. Art. 10). The financing of these activities has to come from the producers (cf. Art. 12). Again, there are requirements for the registration of the producers, for information and reporting on the quantities of equipment placed on the markets and the collected, reused, recycled and recovered WEEE (cf. Art. 16).

4.4 End-of Life Vehicles Ordinance (Germany)

The German end-of-life vehicle legislation (Germany 2011) is based on the corresponding EU-Directive (EU 2011). The main regulations refer to the take-back requirement of old cars through the manufacturers at no cost to the owner. Moreover, the manufacturers have to take care of the certain recycling targets. Again, there is a reference to a DfE in order to reduce waste with old cars.

4.5 The Packaging Act (Germany)

With this new legislation (Germany 2019a), which entered into force on January 1, 2019, Germany wants to strengthen certain regulations of the previous Packaging Ordinance. It refers explicitly to the requirements of the German "Closed Substance Cycle" legislation and emphasizes in Art. 1 once more the waste hierarchy. Special attention is devoted to reusable drinks packaging with a postulated share of at least 70% of drinks in reusable containers.

The Act requires that manufacturers register with a newly established National Authority, before putting packaging on the market. Moreover, they have to contract with a packaging scheme ("dual system"), report the packaging volumes and declare completeness at the beginning of the next year. Packaging schemes have to take into account ecological criteria when determining licensing fees. These criteria will be defined by the National Authority under supervision of the Federal Environmental Agency (cf. Germany 2019b).

Various regulations of the previous Packaging Ordinance continue to hold. This extends, for example, to the separate collection, to the take-back requirement and the recovery of the of packaging waste. Drinks packaging gain special attention. There is, in particular, a mandatory deposit on one-way drinks packaging, in addition to various efforts to reduce or even avoid plastics waste.

4.6 Climate & Energy (EU)

The 2020 climate & energy package of the EU is a set of binding legal regulations to ensure the EU meets its climate and energy targets for the year 2020 (EU 2015b). The key targets include a 20% cut in greenhouse gas emissions from 1990 levels, 20% of EU energy from renewables, and a 20% improvement in energy efficiency.

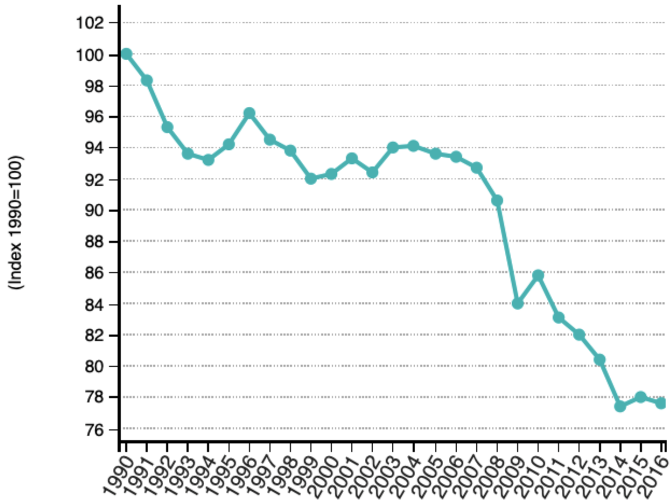

Fig. 6: Greenhouse gas emissions trend, EU-28, 1990-2016. Source: Eurostat

To meet these targets the EU is employing its emission trading system (ETS) for cutting greenhouse gas emissions. There are, in addition, national targets covering sectors not in the ETS, accounting for 55% of total EU emissions, such as housing, agriculture, waste and transport (excluding aviation) – the targets differ according to national wealth. There are also binding national targets for raising the share of renewable energies in their energy consumption by 2020 – again varying across countries, to reflect their relevant differences regarding the economy, the geography and others (cf. Fig. 6).

Among the benefits, the EU counts an increasing energy security, as well as advancing green growth and rendering the EU more competitive.

4.7 Law on Environmental Protection (Georgia)

This basic environmental legislation of Georgia (Georgia 1996) refers also to a "stable development", which in principle means a sustainable development (Art. 4 (k), (l)). Moreover, this law mentions the polluter-pays principle (Art. 5 (e)), waste prevention and recycling (Art. 5 (g), (i)).

4.8 Waste Management Code (Georgia)

This Code (Georgia 2014) establishes "a legal framework to implement measures that will facilitate waste prevention and its increased reuse as well as environmentally safe treatment of waste" (cf. Art. 1), thus clearly pointing to the waste hierarchy, which is detailed again in Art. 4. In Art. 9, EPR is mentioned to address issue such as product design and others. It should also be mentioned that Georgia is cutting back on plastics waste by forbidding plastics bags. The "National Waste Management Strategy" [NWMS] (Code: Article 11) for the period 2016-2030, and the "National Waste Management Action Plan of Georgia" [NWAP] (Code: Article 12) for the period 2016-2020 are prepared in accordance with the Association Agreement and the Code.

Summary: *This (incomplete) survey of the environmental legislation with a focus on the European situation shows that many legal measures have been taken to curb environmental pollution, to reduce waste, in particular packaging waste, one-way drinks packaging, ELV and WEEE. Although these measures have entered into force often decades ago, at least within the EU, the actual results are not seldom behind the expected ones, or miss the aims of the legislation.*

When part of this legislation was enacted, the concept of a circular economy was not as much in use as it is today. Nevertheless, these environmental regulations have to be and are further developed to better serve the requirements of this new systemic approach. Moreover, new legislation, such as preventing plastics waste, comes into the picture.

Once again, we have to remind ourselves that these measures have to fulfill the tasks of an allocation mechanism for environmental commodities. Unfortunately, it is difficult to compensate for the decentralizing features of the market mechanism, which helps to bring into the allocation system the knowledge, which all the individuals have. Moreover, as a consequence of that, we have to use only the partial information on efficient allocations that is available in the form of the waste hierarchy, for example.

5. Some Aspects Regarding the Implementation of a Circular Economy

As indicated above, we have to consider part of the existing environmental legislation, in particular most regulations regarding different kinds of waste, as means to prepare the way towards the circular economy, towards a sustainable development. Implementing a circular economy seems to be, however, a challenging enterprise, despite all the undoubtable positive effects of the environmental legislation. This chapter presents and briefly discusses some of the attempts based on the current legislation. The focus is on Germany, other member states of the EU do not show more promising results.

To make this point clear: this chapter is not about criticizing the efforts to implement a circular economy. It is rather an attempt to reveal the difficulties associated with such an endeavor and perhaps to provide ideas for more goal-oriented regulations.

5.1 Packaging Waste (Germany)

According to the German Environment Agency (UBA), a total of 18.16 million tons of packaging waste was generated in Germany in 2016, an increase of 0.05% over 2015 (cf. also Fig. 7). The amount is equivalent to 220.5 kg per capita, compared to the 167.3 kg per capita consumption in the EU in 2015. 70 % of the total packaging waste was recycled, with most of the remainder used for the production of energy ("thermal recovery". With these numbers, Germany generates far too much packaging – taking the lead in Europe (cf. UBA 2017a).

The recycling quota varies depending on the packaging: it is relatively high for glass (85.5%), paper/cardboard (88.7%), aluminum (87.9%) and steel (92.1%). Plastics (49.7%) and wood (26%) still hold a lot of potential. Plastic packaging in particular – because of the diversity of the materials concerned – is difficult to sort and recycle. Nevertheless, the recycling of plastics packaging in 2016 was 0.9 percent higher than in the previous year – higher for the first time than the rate for energy production (cf. UBA 2017a).

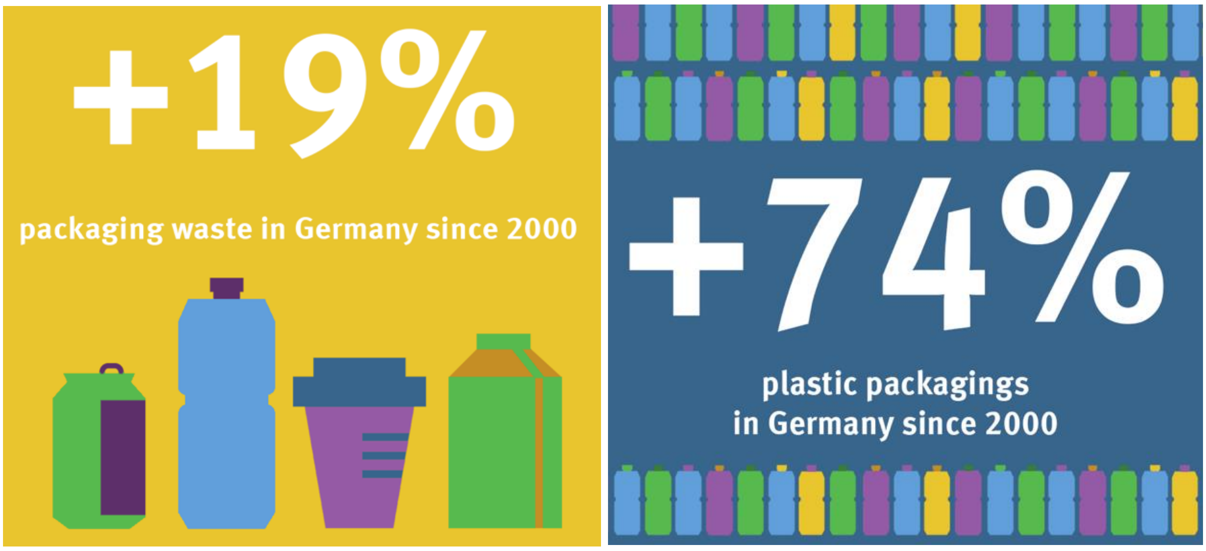

Fig. 7: Development of packaging waste and plasticc packaging in Germany since 2000. Source: UBA.

It is also interesting to note that export of packaging waste amounted to 10.9%, all of which was reportedly destined for recycling. Also, 10.6% of plastic waste was exported, with no imports of same (cf. UBA 2017a).

One of the conclusions of the UBA regarding prevention of packaging waste is that "waste prevention still remains just that – a principle for which no actual law has yet to be enacted" (cf. UBA 2017a). It is, of course, questionable, whether an additional law would help to this regard. Maybe, looking at the incentives provided by the current legislation to motivate prevention of waste turns out to be more promising.

5.2 Waste (Georgia)

Meanwhile in Georgia, manufacturers who place a product on the market will be soon soon (end of 2019) obliged to take care of packaging waste, to reduce negative environmental impact that may follow its production, use, waste recovery or disposal. 900,000 tons of municipal waste is generated in Georgia annually, corresponding to approximately 240 kg per capita (cf. Georgia 2018a). One has to observe, however, that this number extends to municipal waste in total and not just to packaging waste.

5.3 One-way Drinks Packaging (Germany)

As already mentioned, the German Packaging Act aims to increase to at least 70% the share of beverages filled into reusable drinks containers.

Similar goals have been in existence since the early 1990s. In 1992 the first version of the German Packaging Ordinance was enacted (cf. Germany (2009) for a comparable version), which was amended several times before the Packaging Act entered into force in 2019. The instruments applied to achieve these goals have changed over time in order to catch up with the actual development of refillables quota.

Considering the various versions of the Packaging Ordinance, there is and was an obligation to charge a deposit on drinks packaging which is not reusable (cf. Germany 2009, § 8). However, till 2003, there was an exemption from the obligation to charge deposits, as long as, roughly speaking, the combined proportion of drinks packaged in reusable packaging stayed above 72%, the actual share in 1991, when the first Packaging Ordinance was enacted (cf. Germany 2009, § 9 (2)). Fig. 8 details the actual development of the refillables share in Germany over recent years.

Quota of reusable and ecologically advantageous one-way packaging			
Year	2014	2015	2016
Water	40.8%	39.7%	38.7%
Beer	83.6%	82.9%	82.1%
Soft drinks	29.7%	30.6%	28.8%
Mixed alcoholic drinks	6.4%	6.4%	6.4%
All beverages	**46.1%**	**45.5%**	**44.2%**
reusable	45.1%	44.3%	42.8%
ecologically advantageous one-way packaging (1)	1.1%	1.2%	1.4%

Fig. 8: Development of the refillables share in Germany. Source: Gesellschaft für Verpackungsmarktforschung mbH.

As already mentioned, in 1992 this share was 72%, and therefore all attempts to keep this share on this historically high level obviously failed. Moreover, without beer, which Germans traditionally prefer to buy in refillable glass bottles, the situation would be much worse (cf. Fig. 8 and also GVM 2018).

What happened in this case is that the environmental regulations in the early versions of the Packaging Ordinances provided misleading incentives. In particular, the requirement of a "combined proportion" of 72% of drinks packaged in refillable containers proved to be disastrous. Each small manufacturer could hope that all the others were complying with the regulations, a typical feature of the Prisoners' Dilemma (cf. Wiesmeth 2011, Section 9.2.2). Thereafter, again according to the regulations, Germany had to introduce the mandatory deposit system for one-way drinks containers, which it did not want in the first place. Now, after developing and installing sophisticated take-back machinery, Germany is locked into this framework condition.

Currently more and more large drinks producers and drinks distributors, using their specially designed drinks containers, switch to one-way packaging. This, is for example, the case with Coca-Cola, with a packaging mix of plastic PET bottles (59%), aluminum and steel (12%), refillable glass (8%), refillable PET (6%), non-refillable glass (1%) and other packaging (14%) in 2017. Coca-Cola reports that 59% of all packaging introduced into the market could be recovered, and most of the packaging is 100% recyclable (cf. Coca-Cola 2018).

Coca-Cola's vision of a circular economy refers to a "design for reuse" of the packaging material, not the bottles themselves. Thus, waste reduction is tantamount to collecting and recycling in the company's worldview (cf. https://www.coca-colacompany.com/stories/a-vision-of-a-circular-economy-our-packaging-aspirations-for-the-u-s).

In Germany, Lidl, a chain of discount stores, is also offering drinks in its own one-way bottles. The arguments are more or less the same: high collection rates dues to the deposit system in Germany ensure that most empty bottles can be recycled, thus reducing littering (Lidl 2017). These action point to a somewhat different interpretation of the requirements of the waste hierarchy: collection and recycling of one-way plastic bottles is tantamount to waste prevention.

5.4 Drinks Packaging (Georgia)

According to a market study by the Waste Management Technologies in Regions Program on the waste management sector in Georgia (WMTR 2016, p. 33ff), in 2015 annual plastic waste was estimated to 26-33 thousand tonnes, paper waste to 45-50 thousand tonnes, and glass waste to 90-100 thousand tonnes. A large proportion of these waste commodities go to landfills, and consequently packaging waste constitutes a growing and already substantial share of municipal solid waste, which is likely to increase in the near future: between 2012 and 2015, the production of plastic containers and PET bottles in Georgia grew by an average of 12% annually (WMTR 2016, p. 39ff).

Most of the drink containers are single-use bottles. There is yet no infrastructure to take back refillable bottles, no incentive system for consumers to return empty bottles, and no separation of waste at the source. In cities, bottles are usually deposited in waste containers and landfilled. Outside of major cities bottles may end up in the environment or find use in households.

Packaging Type	Size of container					Total of Selection	Total
	0,2	**0,25**	**0,33**	**0,5**	**1**		
Elopak				15.531		15.531	15.531
Barrel						0	6
Can		6.435.258	5.000.581	371.906		11.807.745	13.253.052
PET	45.103	366.484	469.423	16.664.699	18.641.208	36.186.917	44.541.986
Tetrapak	4.538.135	1.802.171	4.600	2.113.863	2.981.779	11.440.548	14.016.506
Paper packaging	541.652	36.982			217.117	795.751	1.700.823
Glass bottles	17.973	159.941	1.036.720	4.828.197	67.603	6.110.434	6.209.243
Total	**5.142.863**	**8.800.836**	**6.511.324**	**23.994.197**	**21.907.708**	**66.356.926**	**79.737.147**

Table 1: Numbers of containers for locally produced and imported non-alcoholic drinks in Georgia in 2016 – according to excise stamps issued (Source: IRS Tbilisi).

Table 1 shows in particular that about 83% of containers for non-alcoholic drinks were the standard-sizes containers listed above. Moreover, the quantity of PET bottles is by far leading the list with a share of almost 56%.

These 80 million bottles for non-alcoholic beverages constitute, in comparison to other countries, a rather small number of drinks containers. In Germany, for example, 14.70 billion liters of mineral water were consumed in 2015 (UBA 2017b, p. 13), corresponding to some 600 million liters for a country the size of Georgia. However, Georgia is still developing, also with respect to the consumption of beverages in bottles. Therefore, it might be better to start controlling this process already at this early stage, before it will get more and more difficult (cf. also Wiesmeth et al. 2018).

5.5 Rebound Effects (Germany)

Sustainable resource use necessitates efficient use of energy, raw materials and water, leading to increased efficiency often allowing lower prices and operating costs for products such as refrigerators, washing machines etc. This in turn influences purchasing behavior and product use.

If you buy, for example, a new energy-efficient refrigerator with low operating costs you might come upon the idea to continue to use the old one. Thus, you end up with two refrigerators, which together consume more energy – although you wanted to act in an environmentally conscious way in the beginning.

The scope of any rebound effect depends, of course, on the specific situation. There seems to be a certain saturation for lightning, for which the rebound effect is estimated to be as high as 20%. Thus, energy savings associated with new lightning technology may be up to 25% lower than technically feasible savings (cf. UBA 2014). Therefore, the question of optimizing the efficiency of energy consumption needs a careful consideration. It is part of the German government's "Energiewende" program, which is a challenging project towards a circular economy.

Anyway, if the policies fail to take into account rebound effects, then the targets of the policies may not be reached.

5.6 Renewable Energies and Greenhouse Gases

In Germany the share of renewable energies in electricity consumption increased from 6.3% to 36% between 2000 and 2017, the share in final energy consumption increased from 6.2% in 2004 to 15.9% in 2017 (UBA 2018). Nevertheless, Germany (and quite a few other EU member states) will miss their 2020 targets for greenhouse gas emissions (cf. Fig. 9).

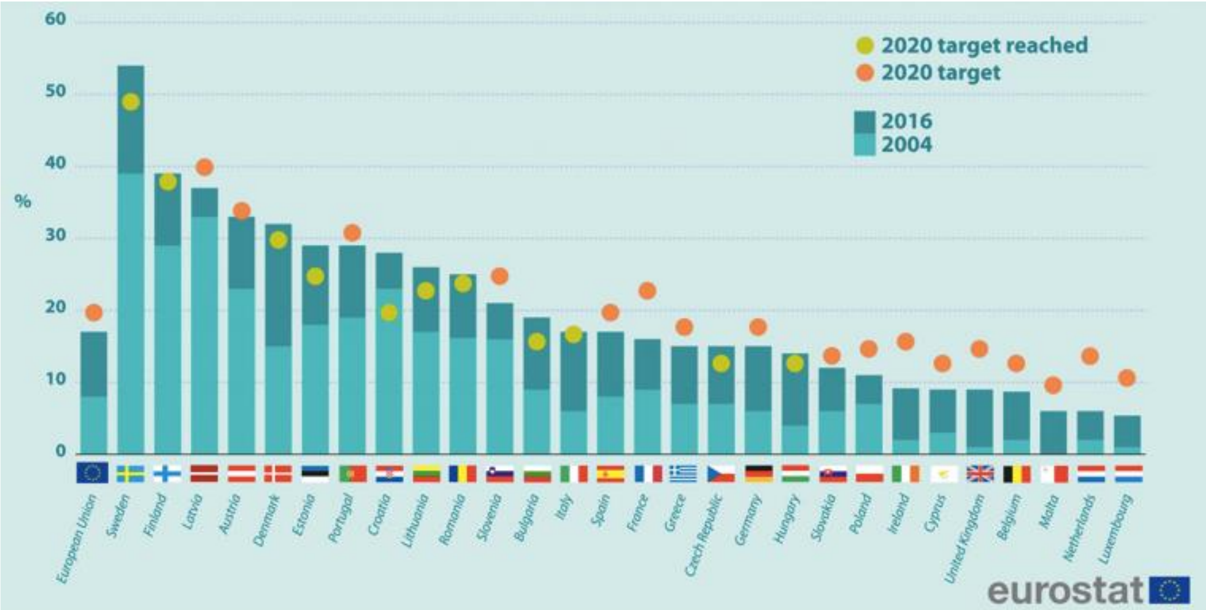

Fig. 9: Share of energy from renewable sources in the EU member states (in % of gross final energy consumption).

Also on a global level, energy-related CO_2 emissions continue to rise (cf. Fig 10). All attempts of the UNFCC and other global endeavors did not succeed in completely curbing greenhouse gas emissions. According to the International Energy Agency (IEA), these emissions rose by 1.4% in 2017, an increase of 460 million tonnes and reached a historic high of 36.5 Gt. This is clearly in contrast with the sharp reduction needed to meet the goals of the Paris Agreement on climate change (cf. IEA 2018, p. 3).

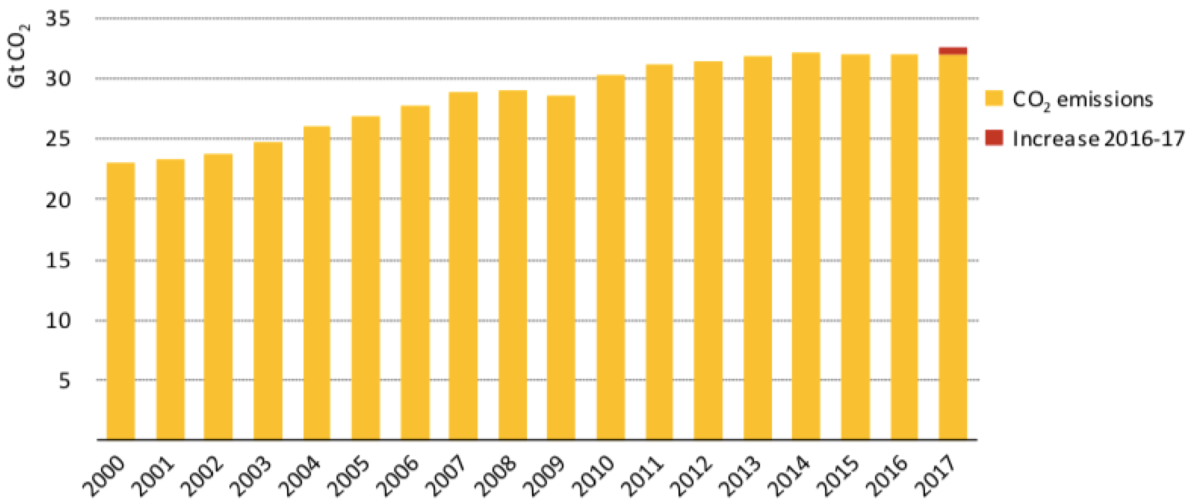

Fig. 10: Global energy-related CO2 emissions 2000-2017. Source: International Energy Agency (IEA 2018, p. 3).

Again according to the IEA, Asian countries, China and India, in particular, accounted for two-thirds of the global increase in emissions. However, one has to respect that China's emissions grew by just 1.7%, despite of an economic growth of 7%. And India's per-capita emissions were with 1.7tCO_2 still far below the global per capita average of 4.3tCO_2. For this reason, it is problematic that emissions in the EU grew by 1.5%, instead of declining and compensating for the expected further increase in some developing Asian countries.

From an economic point of view, this result is again a consequence of the Prisoners' Dilemma, aggravated through differences in awareness of climate change. Without a powerful supernational organization a change in this behavior might be difficult to achieve, at least not to the extent it would be needed to avoid a too rapid increase of the average global temperature. Thus, an effective global climate change policy will probably remain a challenging task for the years to come.

For this reason, quite a few countries start to prepare themselves for some likely effects of global warming, such as floods, or draughts, excessive cold or excessive heat. Adaptation to climate change seems to take over the role of mitigation of climate change.

5.7 Greenhouse Gas Emissions (Georgia)

Art. 51 of the Law of Environmental Protection (Georgia 1996) points to the issue of greenhouse gases and the protection of the climate against global changes. According to the Law, corresponding measures have to be taken by the jurisdiction.

5.8 Waste Electric and Electronic Equipment (Germany)

From 2019, there is a required collection rate of 65% of WEEE, given the quantity (in terms of weight) sold on average in the last three years. In 2015, Germany reached 42.5%, still below the rate of 45% required for 2016 (see also Fig. 11 with a survey on EU member states).

Wether it is meaningful to use absolute or relative collection rates, remains to be discussed. There is, however, another issue, which deserves a closer look: it is the often semi-legal or even illegal export of WEEE to developing countries. In 2008 some 155.000 tons of WEEE, declared as reusable, were exported from Germany, also to countries such as Nigeria, Ghana, India or South-Africa. In these countries, the old equipment was often "recycled" under conditions hazardous to health and environment (Sander & Schilling 2010).

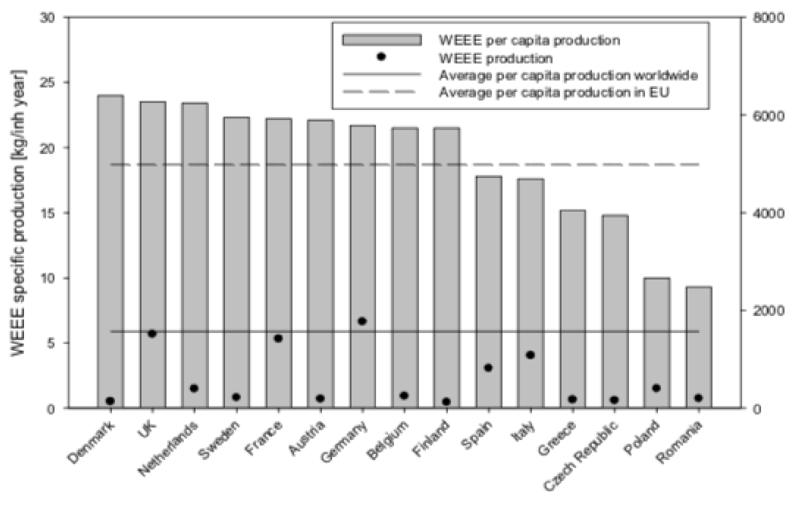

Fig. 11: WEEE generated in EU countries in 2014. Source: Cesaro et al. (2018), Fig.1.

Again, a closer look at the existing legislations can help to at least reduce these activities, which are certainly not tolerable from the point of view of a sustainable development in a circular economy.

It also remains to some extent unclear, whether manufacturers of electronic equipment are really interested in a DfE, which increases costs with perhaps uncertain return from demand. In this context, it has to be noted that it is the manufacturers, who have the necessary knowledge regarding a DfE, not the public authorities. In the sense of a Prisoners' Dilemma situation, they might want to wait with a DfE update till other manufacturers made the first move.

The consequence is that environmental policies aiming for a circular economy have to motivate manufactures to make use of their knowledge about a DfE.

5.9 Waste Electric and Electronic Equipment (Georgia)

Georgia is planning to use an ERP approach for various waste streams, WEEE among them. The goal, according to the Waste Management Code (Georgia 2014) is to affect product design, collect waste equipment separately, increase reuse, recycling and recovery of waste (see also Georgia 2018b).

5.10 End-of-Life Vehicle (Germany)

Each year some 400,000 end-of-life vehicles have to be recycled. In Germany. 97% of all metalls can be recovered. However, the more genral situation is as shown in Fig. 12.

The problematic issues are as follows: of the 2,88 million cars deregistered in Germany in 2016 only some 410,000 are carefully recycled in Germany. 1,42 million used cars are exported to other member states of the EU, and 260,000 used cars are exported to non-EU countries (also to Georgia). Surprisingly, the fate of 560,000 cars is unclear (Fig. 12). Thus, the statistics of Germany with a recycling rate of 97% has to be taken with a grain of salt.

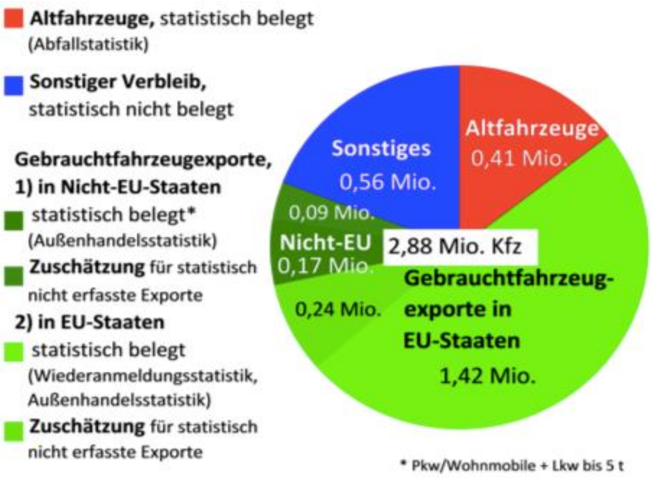

Fig. 12: Statistics of cars in Germany deregistered in 2016. Source: Germany (2018).

Of relevance is the fact that exports to non-EU countries can mean that appropriate maintenance of these cars is not guaranteed with immediate consequences for air pollution and other environmental concerns. A similar consideration applies to recycling of these cars. The question is, how to modify this practice without preventing car drivers from buying used German cars? This is for sure also a matter of a circular economy, as it affects sustainability, at least in other countries. Germany exported some 14,000 used cars to Georgia in 2016 (cf. Germany 2018, p. 34). Chapter 6 in the second part of this textbook will reconsider this issue, which is of some environmental relevance for Tbilisi, if not for Georgia.

The aspect of a DfE, raised for the case of electrical and electronic equipment, also refers to the car manufacturers. The less old vehicles they have to recycle in Germany (or the EU), the lower the pressure for a costly DfE, which reduces the total expenditures for recycling (cf. also Gerrard & Kandlikar 2007).

5.11 Environmental Standards

The last area to be discussed in this context refers to environmental standards. These standards play a role in practically any environmental regulation. They show up as required collection or recycling rates, as shares of renewable energies or as shares of refillable drinks containers, as maximum values for certain air or water pollutants, and as global emission values for greenhouse gas emissions, which are still compatible with a 2-degree global warming.

By necessity, many of these values are scientifically determined estimates regarding the impact of the emissions on human health or on the environment in general. Others, such as the share of refillable drinks containers or collection and recycling rates are estimates regarding a feasible path towards an efficient allocation in the context of a circular economy. They describe more a desirable result than a standard of absolute relevance.

Standards, which are perceived as too high, can have, as some recent developments show, disastrous effects. In Germany, Volkswagen’s problems regarding the emissions of nitrous oxides of the diesel engines, and the current issues regarding concentrations of nitrous oxides in hot spots of major cities, which are above the relevant standards, are proof of this. In order to avoid similar situations in the future, the environmental relevance of these standards has to be clarified. Standards, which are considered to be more or less arbitrary, risk to lose their meaning, sooner or later.

For the implementation of a circular economy, it is therefore important to determine and regulate appropriate levels of environmental standards, and also the procedure to raise them in the future. Is it reasonable to enforce higher standards by raising them more or less automatically through the policy makers?

Summary: *These results show that experiences with these to some degree first attempts regarding the implementation of certain features of a circular economy are mixed. Quite a few of the environmental regulations, which integrate the EPR approach, the polluter-pays principle, obligations for a DfE, mandatory deposit systems etc., motivate producers and/or consumers to actions, which are not consistent with the sustainability aspects of a circular economy.*

Thus, we observe, among others, rebound effects, obviously delayed DfE, not properly returned WEEE, not adequately recycled WEEE and old vehicles, increasing local and global greenhouse gas emissions, increasing packaging waste, consistent violations or consistent misinterpretations of the waste hierarchy, in particular in the context of drinks packaging, and environmental standards, which are not taken seriously.

Going once more back to economic theory, this summary is not too surprising: after all, these policies are meant to complement the market mechanism for the efficient allocation of environmental commodities. Whereas the market mechanism, as a tool to decentralize economic decisions, makes use of the available knowledge of the consumers and producers, a policy maker has to think about all possible reactions of the consumers and producers, when designing an environmental policy. This is a challenge, which is anything else than easy to master.

The second part of the textbook on the implementation of a circular economy will, nevertheless, attempt to discuss some features of environmental policies, which may help to overcome one or the other of the obstacles we are currently facing with environmental policies – meant to prepare the path towards a circular economy.

6. Final Remarks

A circular economy can be described as an attempt to optimally solve the basic economic allocation problems in the context of environmental commodities. Obstacles on this way are the information deficits (regarding feasible standards, for example), or information asymmetries (on possibilities of a DfE, for example). Therefore, only quite general perceptions exist regarding the properties of an optimal allocation. The waste hierarchy, however, likely extends to all kinds of waste and emissions – with some possible exemptions.

Current attempts to achieve the requirements of the waste hierarchy by means of the various environmental policies are mixed, so far. Thus, it remains to the second part of this textbook to analyze these policies with regard to their incentive compatibility properties and to design modifications for the path towards a circular economy.

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