SRU

German Advisory Council
on the Environment

Circular economy: Putting ideas into practice

ENVIRONMENTAL REPORT 2020
CHAPTER 3 (abridged version)

Circular economy: Putting ideas into practice

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Foreword

This translation is an abridged version of chapter 3 of the SRU environmental report "Towards an ambitious environmental policy in Germany and Europe", which was published in May 2020. Some sections/items from the German version are omitted, but the original numbering is retained. The full version of chapter 3 is 85 pages long.

When the original report was written, the "New Circular Economy Action Plan" of the EU Commission (European Commission 2020b) had not yet been published. References to this are now included in the final section of this abridged English translation.

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Circular economy: Putting ideas into practice

A circular economy has come to be regarded as the solution to the problems of resource scarcity while at the same time acting as a motor for jobs and welfare in Europe and Germany. However, the use of primary raw materials is still increasing – with harmful environmental impacts. Only a small proportion of the demand for materials is currently met by circularity, since waste management is lagging behind the requirements of a circular economy. People and markets need product policies which will combine a good standard of living with lower demand for raw materials. The goal of reducing material flows must therefore be anchored politically and greater attention must be paid to sufficiency. Products must be designed to be compatible with a circular economy and high-grade recycling must finally become a reality. In order to put ideas into practice, new regulatory and economic instruments must be implemented which have an environmental orientation.

3.1 Introduction

126. The use of natural resources is an important basis for life in civilisations today and in the future. At the same time, the rising global use of primary raw materials is partly responsible for the destruction of natural habitats and for reaching, and in part exceeding, planetary boundaries (SRU 2019).

In the view of the German Advisory Council on the Environment (SRU), it has not yet been possible in Germany to proceed from a system of recycling-based waste management to a circular economy which promotes aspects of reduced consumption and waste prevention as well as high-grade recycling. As a consequence, the use of primary materials in Germany is nearly twice the global average. In 2013, secondary materials derived from waste accounted for only some 16% of total demand, while hardly any targets had been set which would promote waste prevention and preparation for re-use. The increasing variety of products and materials presents the waste management sector with new challenges and requires adaptations. However, changes have so far mostly been incremental and within existing structures. This applies for the organisation of waste collection, the existing waste treatment and recycling/recovery plant infrastructure, and the financing of waste management, as well as the general strategic approach to dealing with products and waste. New EU requirements are mostly only transposed one-to-one into German law. However, a fundamental transformation cannot be achieved by hesitant policies within the existing inflexible system.

127. In 2018, the Circular Economy Package of the EU introduced a strategy and new, binding requirements which were intended to link the waste sector to other policy areas along the life cycle of products and goods, forming a circular economy. In future, products and goods should not be viewed solely in terms of waste management but should be considered from the perspective of product and material flows.

In this chapter, the current status of the circular economy in Germany is evaluated in the light of the ambitions of the EU Circular Economy Package. We discuss how a circular economy can be implemented which also leads to reduced material flows. This requires that both established and new instruments should in future be targeted more precisely and integrated to a greater extent within product policies.

3.2 Circular economy: Basic principles and the current situation in Germany

3.2.1 Materials use and environmental impacts

128. The annual global material extraction of biomass, fossil fuels, metals and non-metallic minerals (measured as Domestic Extraction (DE)) increased from 7 billion tonnes (Gt) in 1900 to approximately 68 Gt in 2009 (KRAUSMANN et al. 2009, updated 2011). The Organisation for Economic Co-operation and Development (OECD) reports that the global use of extracted materials was 89 Gt in 2017 and predicts an increase to 167 Gt in 2060 (OECD 2019). The data of UNEP (2019a) show that the rate of increase of global material extraction is increasing (Fig. 3-1). Whereas the global material demand grew annually on average by 2.3% from 1970 to 2000, this rate of growth increased to 3.2% over the period from 2000 to 2017.

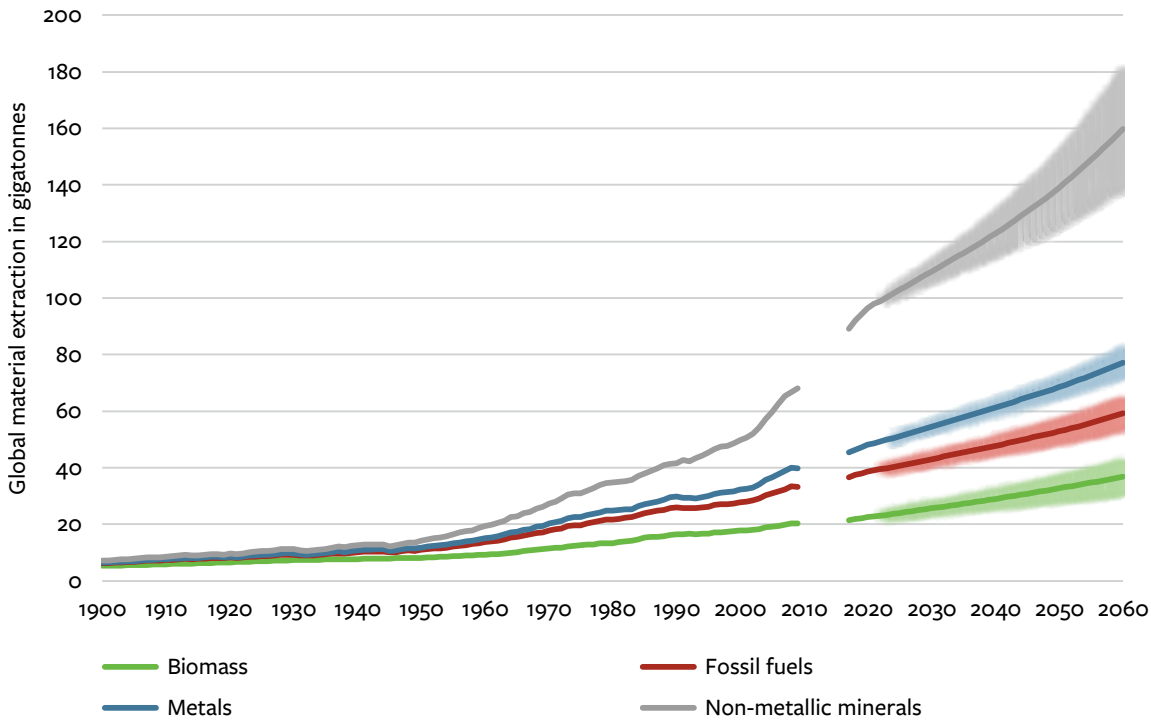
Living standards and the patterns of consumption which generate the demand for resources vary considerably between nations. The use of materials in industrialised countries is many times higher than in developing countries and emerging economies.

In Germany, the use of materials has been very high for decades. The raw material consumption in 2017 was 22.8 t per capita (calculated from UNEP 2018 and population data, Statistisches Bundesamt 2020), nearly twice the global annual average of 12.2 t per capita (UNEP 2019a, p. 42). The average annual raw material consumption (RMC) of African countries in 2017 was 3.1 t per capita (RMC, calculated from UNEP 2018 and population data, UNDESA – Population Division 2019).

129. Extracting, processing, using and disposing of raw materials and the products made from them has numerous and in some cases grave environmental impacts and societal consequences (CHAHOUD et al. 1999; ERICSSON and SÖDERHOLM 2010; MUDD and WARD 2008; UNEP 2019a; OECD 2019; UNEP and IPSRM 2010; UBA 2018c; Circle Economy 2019). The flows of the various material streams therefore have a decisive influence on the state of global systems (for more details see SRU 2019, items 125 et seq. and 272).

Figure 3-1

Extraction of primary biogenic, fossil, metallic and mineral materials from 1900 to 2060 in gigatonnes per annum



SRU 2020; Data source: Data 1900 to 2009 see KRAUSMANN et al. 2009, updated 2011; Data 2017 to 2060 see OECD 2019; stacked; from 2017 model predictions with variation

It is estimated that from 10% to 30% of global greenhouse gas emissions are attributable to the processing of primary raw materials, not including emissions during the use phase of the products made from them (Deloitte 2016; UNEP and IPSRM 2010). In view of the rising demand for raw materials, it is expected (especially in the case of metals) that the environmental impacts of extraction will have roughly doubled by 2060 in comparison with 2015 levels (OECD 2019).

There are additional environmental impacts during the use phase of the products made from or with the extracted raw materials due to energy consumption or dissipative inputs into the environment, for example as a result of tyre abrasion. Sooner or later, when further use or recovery is no longer thought to be possible, the products have to be disposed of. Such measures also involve environmental impacts and possibly also irreversible material losses.

The distribution of the environmental effects varies widely. While a large proportion of the value creation and consumption occurs as a rule in the industrialised countries, the environmental impacts are concentrated mainly in emerging and developing economies (UNEP 2019a). Given the high levels of use of materials in the industrialised countries and the associated environmental impacts, it is clear that this is neither acceptable nor globally scalable.

3.2.2 What is a circular economy?

From recycling-based waste management to a circular economy

130. In 2012, the German Circular Economy Act (KrWG) defined a "circular economy" in terms of the "prevention and recovery of waste" (§ 3 sec. 19 KrWG). On the

basis of specified and quantified requirements for recycling and other recovery (item 133), this has led to a system of waste management that is oriented towards recycling. While the Directive 2008/98/EC on waste does not provide a definition for the circular economy, the first recital of the preamble to the EU Directive amending the Waste Framework Directive explains that it is to be achieved "by focusing on the whole life cycle of products in a way that preserves resources and closes the loop" (2018/851/EU). The Circular Economy Action Plan calls for "a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised" (European Commission 2015c).

The EU strategy explicitly includes the production and consumption phases in the circular economy (JARON 2017; UBA 2018c). This goes beyond the previous use of the equivalent term in German-speaking countries (Kreislaufwirtschaft), which we refer to here as "recycling-based waste management". The term circular economy is used in the wider sense of the EU Circular Economy Package.

Why a circular economy?

131. There are widely differing opinions about what exactly a circular economy is and what problems it will solve (SCHROEDER et al. 2017; LAZAREVIC and VALVE 2017; KIRCHHERR et al. 2017; PARCHOMENKO et al. 2019; GEISSDOERFER et al. 2017). The EU Circular Economy Action Plan states that the circular economy will make a decisive contribution towards climate neutrality and economic growth which is decoupled from resource use, while ensuring a competitive economy. The economic motivation is emphasised in the introduction to the Action Plan and in public communications (WILTS 2016). The goals of the circular economy according to the EU Directive amending the Waste Framework Directive (2018/851/EU) are to protect the environment and human health and to ensure the careful use of natural resources. A further motivation is the recovery of materials for which supplies may be threatened (in particular critical raw materials – CRM, see European Commission 2017b; 2014; 2011b).

An evaluation by KIRCHHERR et al. (2017) of 114 definitions of "circular economy" in the literature found that the most frequently cited main goal is economic welfare, followed by environmental quality. In the majority of cases there is no emphasis on the need for a systemic change. Rather, the circular economy is taken to involve a combination of reduction, re-use, and recycling activities. There is also hardly any discussion of the effects on social equality or on future generations (ibid.). At the same time, the circular economy is regarded as being important for achieving sustainable development goals (SDGs), in particular Goal 12 of ensuring sustainable consumption and production patterns (see European Commission 2015c; SCHROEDER et al. 2017).

Since secondary materials can generally be produced with lower inputs of energy and additional agents than primary raw materials, overall emissions of greenhouse gases and other emissions are reduced by recycling (GRIMES et al. 2008; BGS 2019; MICHAUD et al. 2010). For example, aluminium recycling uses only 3 to 10% of the energy required for primary production; in the case of steel the corresponding figure is 25 to 40% (UNEP 2013 cited in BGS 2019). Expanding recycling can therefore make an important contribution to decarbonising the production of metals (BGS 2019).

Over and above recycling, the prevention of waste has considerable potential for reducing negative environmental impacts. Extending product lifetimes and reusing products reduces the demand for new products and thus also the consumption of primary and secondary materials (Deloitte 2016). With fairly conservative measures, such as a moderate level of re-use or the introduction of a sharing economy, it is possible to achieve large reductions in some areas. For example, increasing the rate of re-use of electrical and electronic equipment (EEE) to 30% from a baseline of 2% would halve the emission of production-related greenhouse gases. Increasing the average recycled content of materials in EEE to almost 100%, even without efforts to promote the re-use of EEE would decrease production-related greenhouse gas emissions by more than 40% (ibid.).

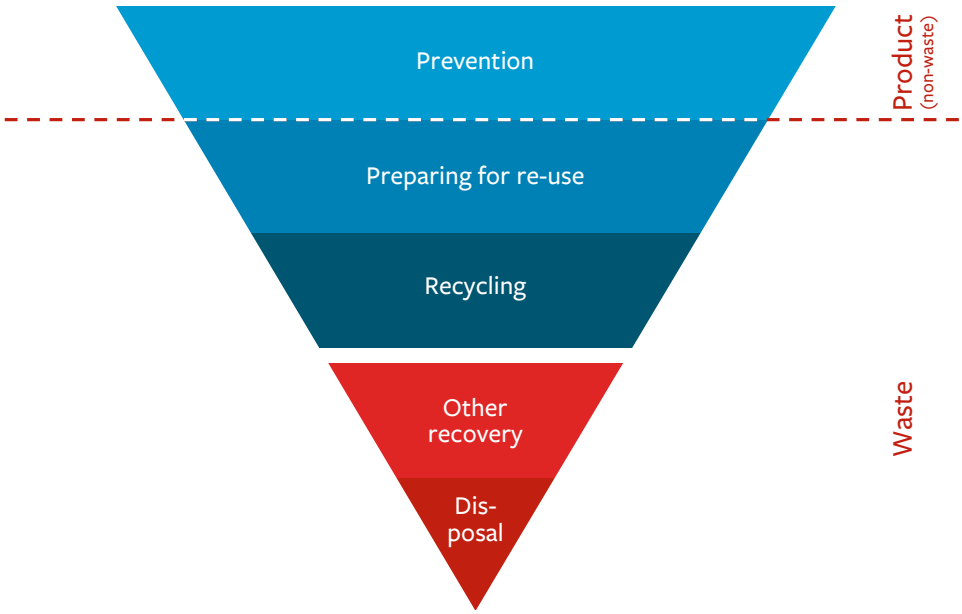
3.2.3 Established approaches and instruments for waste management and circular economy

Waste hierarchy

133. In the Waste Framework Directive 2008, the three-level waste hierarchy was extended to a five-level waste hierarchy, representing ranked priorities (Fig. 3-2).

Figure 3-2

Waste hierarchy according to the Waste Framework Directive



SRU 2020; Data source: Waste Framework Directive

For the implementation of the waste hierarchy, the various waste management regulations specify a series of requirements for the separate collection and return of waste or end-of-life products and rates of recycling and recovery. There are also requirements regarding the nature of waste for disposal, and also for the operation of waste disposal plants. In contrast, no quantitative targets have yet been set regarding prevention and preparation for re-use, with the exception of prevention of food waste.

High quality and high-grade recovery

134. At various places in the legislation at European and national levels reference is made to high-grade or high-quality recovery or recycling:

- Already in 1996, the German Act for Promoting Closed Cycle Waste Management called for "high-grade recycling" (§ 5 sec. 2).
- In 2012, the Circular Economy Act included a provision for a statutory ordinance to determine the requirements for this high quality of recovery (§ 8 sec. 2.2). Further "it may [...] be determined [...] that the recovery of the waste shall take place [...] by several consecutive material and finally energy recovery operations (cascade use)". Importantly, high quality recovery is required at each level of the hierarchy (BMUB 2017).
- Transposing the EU Waste Framework Directive, the German Circular Economy Act calls for proper, safe, and high-quality recycling. Paper, metal, plastic, and glass wastes are to be collected separately.
- In the amended Waste Framework Directive, the term "high-grade" is used with reference to recycling and secondary raw materials (Pre-amble, recitals 41 and 56, 2018/851/EU).

Neither the Waste Framework Directive nor the German Circular Economy Act specify what is meant by "high-grade". It remains unclear how high-grade collection, recycling and recovery should be achieved or what precisely constitutes a high-grade secondary material.

Reference is also made in the literature and in discussions to downcycling and cascade use. In its Guidance on Cascading Use of Biomass, the European Commission refers to cascade use as "a resource-efficient and 'circular' use of any biomass." (European Commission 2019b) Other terms

used include upcycling and zero waste. There are no generally agreed definitions for these terms either. However, the term upcycling seems to be used frequently for promotional purposes, without any distinction being made to existing measures for continued use, re-use, or recycling. Zero Waste is understood as a differentiated and extended waste hierarchy, in which the two lowest levels (other recovery and disposal) will become unacceptable (SIMON 2019).

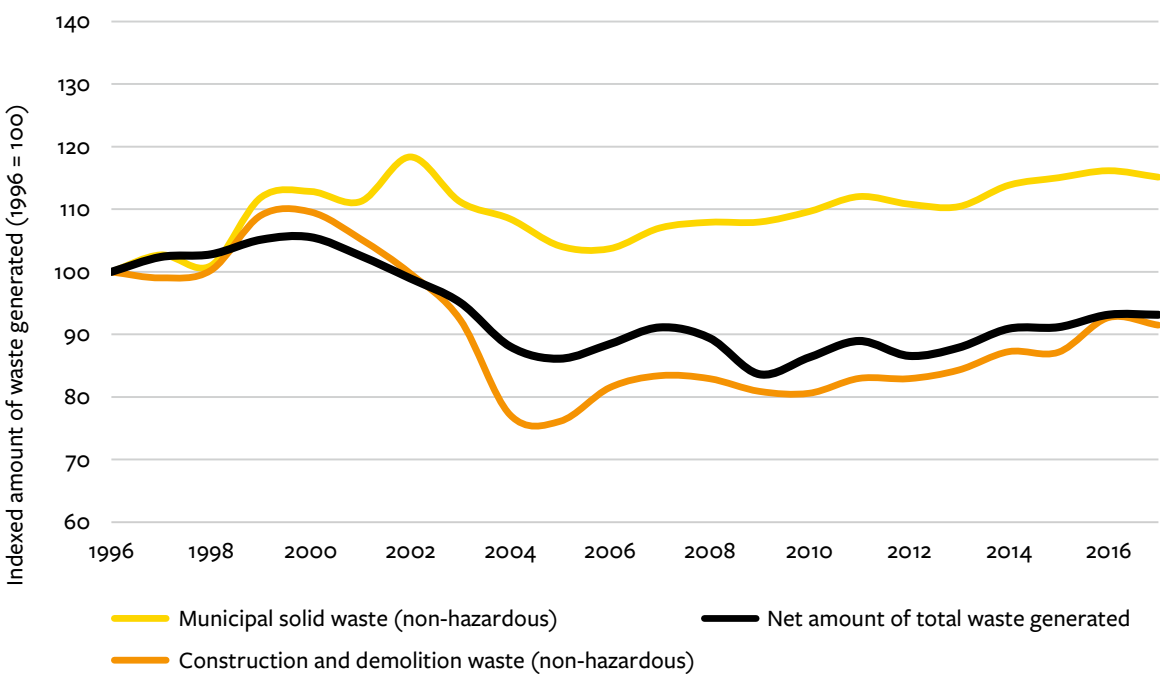
Financing waste management and circular economy measures

135. Over a number of decades, a structure of waste management has developed in Germany within the framework of legislation and economic influences which has involved high levels of investment by public institutions as well as the business sector. The resulting infrastructure includes waste incineration and sorting plants, as well as vehicle fleets and waste collection systems. The latter also include, for example, the installation of reverse-vending machines in the retail sector, and a widespread network of collection points for waste batteries.

With the introduction of the principle of extended producer responsibility (EPR), some of the responsibility for the waste management of selected types of municipal waste streams was transferred to the producer, namely waste electrical and electronic equipment (WEEE), packaging waste, waste batteries, end-of-life vehicles (ELV), and waste oil. Various costs are incurred by the producers, depending on the logistics involved in the collection, the type of treatment, the value of the secondary materials, and any necessary recovery and disposal measures. As a rule, the producers will be concerned to keep these costs as low as possible. In some cases, for example vehicles, the producers in Germany do not bear are not any costs, and the dismantling and shredder facilities will have to act in accordance with the economic situation (EUWID 2019a; 2019b). In other cases, such as the disposal of refrigerators, the costs of the treatment including the safe removal of refrigerants, oils and harmful gases are borne by the producers. In some cases, revenues are generated that exceed the costs, so that the producer can profit from recycling, for example with computers or IT equipment (EUWID 2019d; 2019c; 2017).

Figure 3-3

Net amount of waste generated in Germany from 1996 to 2017 in total and for selected types of waste (1996 = 100)



SRU 2020; Data source: Statistisches Bundesamt 2019a

3.2.4 Waste in Germany in figures

Waste quantities and recovery

136. Between 1996 and 2000, the net total amount of waste generated annually in Germany increased from ~385 Mt to ~407 Mt (Statistisches Bundesamt 2019a). By 2005 the figure had fallen to approximately 332 Mt. From 2006 to 2017 it increased again, with fluctuations, to 359 Mt. More than half of this is construction and demolition waste, followed by municipal solid waste, and waste from production and commerce (ibid.). Despite the target of waste prevention, the amount of municipal solid waste has shown a continuous upward trend (Fig. 3-3).

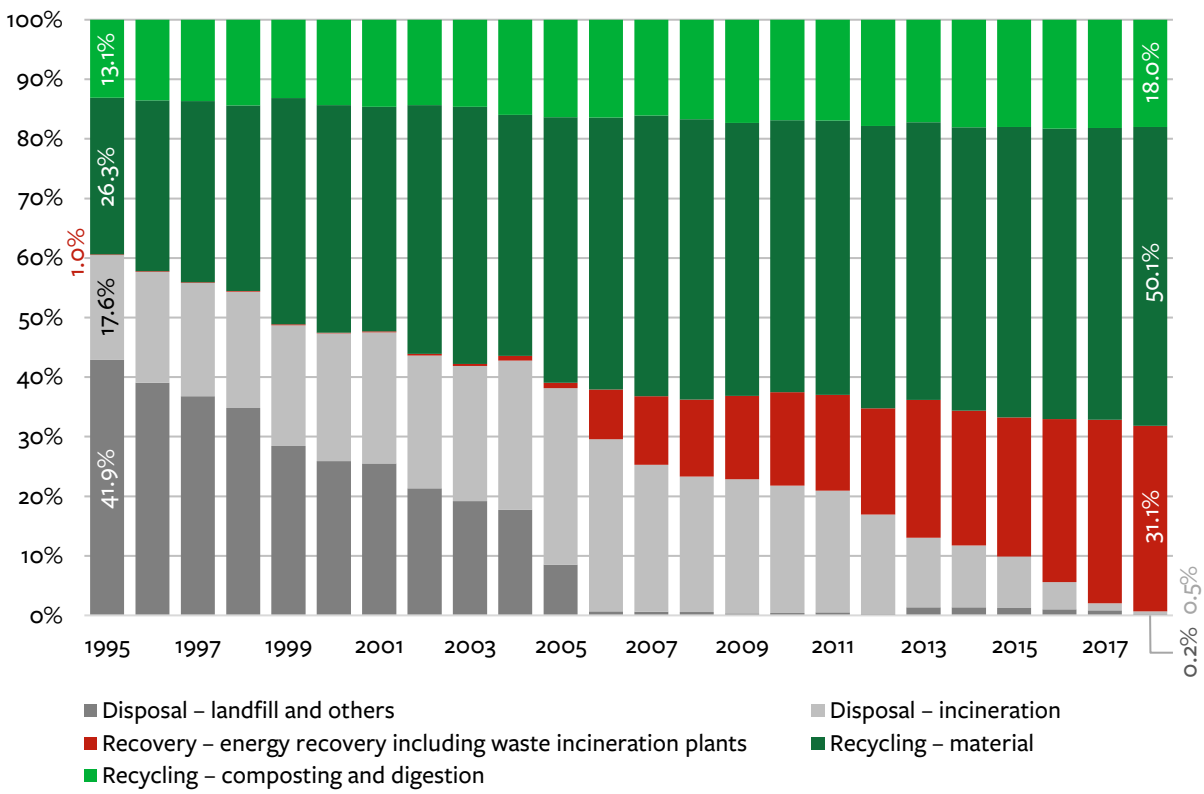
138. The proportion of municipal solid waste going directly to landfill decreased from ~61% in 1995 to 38% in 2005 (Fig. 3-5). New landfill regulations were introduced in 2005, and from 2006 onwards the landfill rate for municipal solid waste was below 1% (UBA 2019a). However, the statistics do not cover waste going to landfill after treatment. The proportion of recycled waste increased from circa 39% in 1995 to 61% in 2005. Between 2005 and 2018 there was then only a moderate increase in recycling to 68%. Whereas the energetic recovery of municipal waste only played a minor role from 1995 to 2005 (below 1%), it increased after 2005 to approximately 31% (Eurostat 2020).

Of the net amount of total waste generated annually, the proportion going to landfill decreased from 29% in 2000 (UBA 2019a) to 21% in 2017 (Statistisches Bundesamt 2019a).

Due to changes in the calculation methods (Art. 11a sec. 1 lit. c and sec. 2 Waste Framework Directive) recycling

Figure 3-5

Primary treatment of municipal solid waste in Germany (1995–2018)



SRU 2020; Data source: Eurostat 2020

rates will in future have lower values (NELIGAN 2016; OBERMEIER and LEHMANN 2019). For example, instead of a recycling rate for municipal solid waste of 67% in Germany in 2016, the new method would give a recycling rate of 49% (OBERMEIER and LEHMANN 2019).

Replacing primary raw materials with secondary materials

139. In addition to the amount of waste that is recycled or recovered, it is also important to know the extent to which this leads to the substitution of primary raw material. For this information, two newly developed indicators can be used – DIERec (Direct and Indirect Effects of Recovery) and DERec (Direct Effects of Recovery). UBA calculations show that some 16% of the material requirements in Germany are met by secondary materials and 84% by primary raw materials (calculated from STEGER et al. 2019).

Interim conclusion: Circular economy not yet achieved in Germany

140. Germany has managed to move from landfill-based waste management to recycling-based waste management. However, it has not yet established a circular economy (WILTS 2017). There has so far not been a clear reduction in the use of primary raw materials in industry and household consumption. The amounts of waste generated also remain high. The high recycling rates calculated in the past do not reflect the actual amounts that are recycled. It is also questionable whether the recycling and other recovery is of a high quality. The consequence is that only about 16% of the material requirements of the German economy are met by secondary materials.

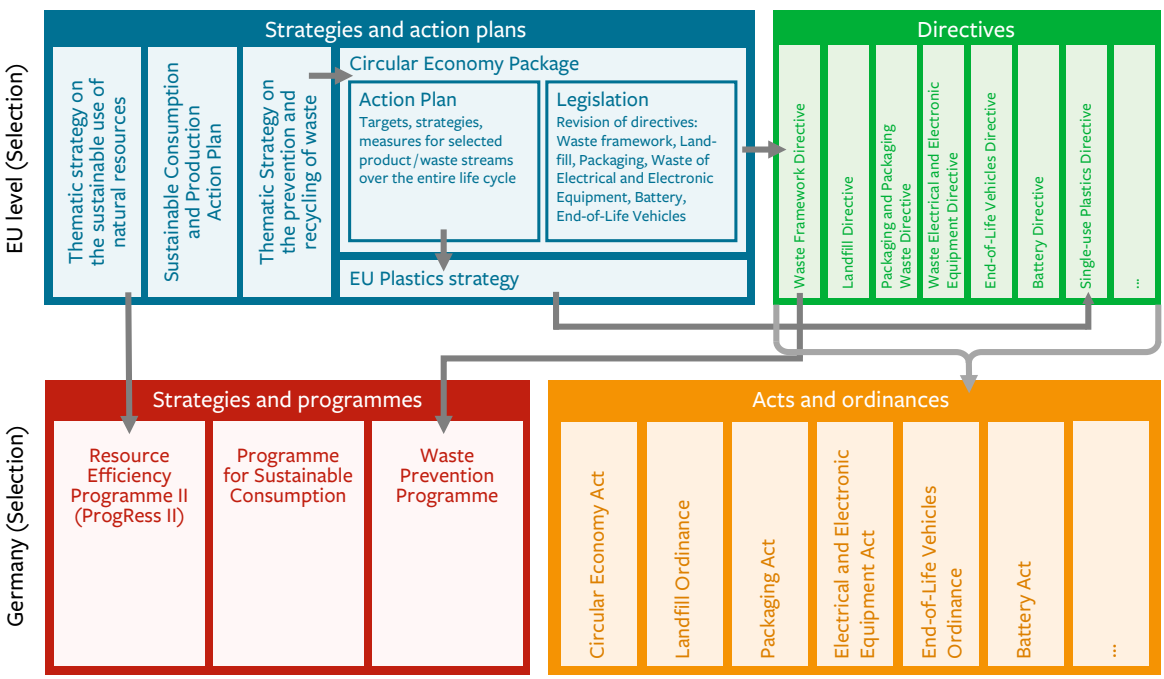
3.3 Current developments towards a circular economy

Interaction of European and German strategies and regulations

141. The circular economy in Germany is influenced to a considerable extent by decisions that are made at the European level, but these have to be implemented and filled with life at the national level. In addition to binding regulations there are also non-binding strategies, programmes, and plans (Fig. 3-6).

Figure 3-6

Interaction of strategies and regulations on the circular economy at European Union and German levels



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Further developments at the EU level

142. The European Commission proposed a Circular Economy Package in 2015. It consisted of the Circular Economy Action Plan (European Commission 2015c) and amendments to the Waste Framework Directive, the Packaging and Packaging Waste Directive 94/62/EC, and the Landfill Directive 1999/31/EC, as well as the End of Life Vehicles Directive 2000/53/EG, Battery Directive 2006/66/EG, and WEEE Directive 2012/19/EU. The Action Plan specifies 54 measures in the life cycle phases of various products. For example, the design and production sectors and consumption phase should be linked with the waste phase. The measures cover a broad range of instruments (e.g. legislation, economic measures, financial subsidies for projects).

146. The President of the European Commission attaches considerable importance to the circular economy and promised a new Circular Economy Action Plan (von der LEYEN 2019). In the European Green Deal, the European Commission has presented an ambitious new vision which also includes the development of a circular economy (European Commission 2019c). A focus of a second Circular Economy Action Plan will be on a strategy for sustainable products which supports circular design and is intended to define new market conditions for the use of products. Sectors for which measures are to be developed as a priority include textiles, construction, electronics, and plastics. (The New Circular Economy Action Plan was published after completion of the full report).

Further developments in Germany

147. In Germany, the goal of a circular economy is promoted by three programmes:

- The Waste Prevention Programme from 2013 (BMU 2013)
- The German Resource Efficiency Programme II (ProgRess II) from 2016 (BMUB 2016b)
- The National Programme for Sustainable Consumption from 2016 (Bundesregierung 2019)

Actions and measures outlined in the Waste Prevention Programme are voluntary in character and in most do not include quantified prevention targets. Indeed, the German government makes plain that these would not be appropriate, because the state has only limited scope to enact measures for waste prevention and cannot interfere in the individual decisions of the economic actors. A further argument is that prevention might not lead to the reduction of environmental impacts due to substitution effects and the rebound effect (item 153). To this extent, waste prevention is "not a categoric mandatory objective". Rather the goal is the decoupling of economic growth and waste generation (BMU 2013, p. 19).

The German Resource Efficiency Programme, like the Circular Economy Action Plan, considers the entire life cycle of products – from the primary raw materials, through design, production, and consumption, to waste disposal. However, hardly any additional quantitative targets are introduced. As in the Waste Prevention Programme, the proposed measures are generally non-binding.

The National Programme for Sustainable Consumption aims, in accordance with SDG 12 "Sustainable production and consumption", to ensure that patterns of consumption do not jeopardise the ability of current and future generations to satisfy their needs within the limits of the carrying capacity of the Earth. The Programme includes proposals for measures in fields such as education, consumer information, eco-design, and public procurement. It does not include any binding targets or commitments.

148. The draft bill for transposing the Waste Framework Directive of the European Union into German law (5 August 2019 (KrWG-E)) also draws on some provisions of the Single-use Plastics Directive. The declared goal is a further environmental development of the Circular Economy Act, which was based to a large extent on a one-to-one transposition of the EU stipulations (BMU 2019b). Other regulations which could lead to positive effects for waste prevention and high-grade recycling are the obligations regarding public sector procurements (§ 45 KrWG-E) as well as an obligation to exercise custodial care as an extension of product responsibility (§ 23 sec. 1 sentence 2, sec. 2 no. 11, § 24 no. 10 KrWG-E). The obligation of custodial care is intended to reduce the destruction of goods that can still be used. These regulations correspond to the requirement of Art. 4 sec. 3 of the amended Waste Framework Directive that EU Member States should "make use of economic instruments and other measures to provide incentives for the application of the waste hierarchy" (2018/851/EU). Otherwise, the measures included in Annex IVa are only named in the Circular Economy Act, without any specific requirements being implemented.

3.4 Extended waste hierarchy and deficit analysis

3.4.1 Arguments for an extended waste hierarchy

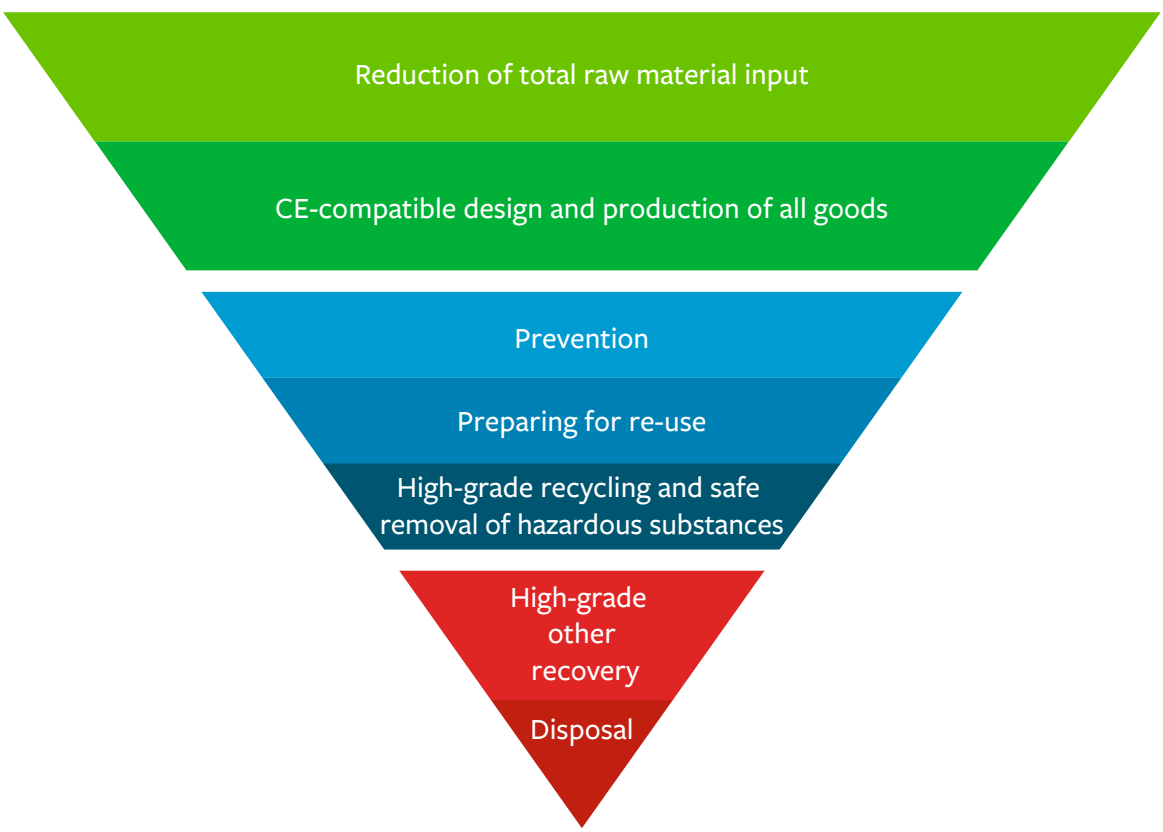
151. The SRU regards the circular economy as a way of managing societal material flows with a view to achieving environmental sustainability (SRU 2019, items 126 et seq., 272 et seq., and 362). The previous national and European waste policies based on the waste hierarchy have not succeeded in reducing the absolute use of primary raw materials or significantly improving the continuous circular use of substances and materials (BEHRENS et al. 2007; VAN EWIJK and STEGEMANN 2016). It is therefore necessary to realign the strategic and operational approach to the circular economy to include aspects of consumption and to place more emphasis on the top two levels of the waste hierarchy. With the inclusion of material extraction and production in the circular economy, the European Commission has, in the opinion of the German Advisory Council on the Environment, chosen the right approach. In this way, waste legislation is linked up with other fields such as product design and policies relating to chemicals.

152. In view of the need to upgrade the management of societal material flows (see SRU 2019, items 125 et seq., 274 et seq., and 362), "Product levels" should be added to the five-level waste hierarchy (item 133, Fig. 3-2). The SRU therefore recommends a new, extended target system for future measures and instruments:

- Reduce the input of materials for products, infrastructures, and services

Figure 3-7

Extending the waste hierarchy to a circular economy hierarchy



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- Design products that are CE-compatible
- Define binding targets for waste prevention and preparation for re-use
- Measure recycling not only in terms of quantity, but also quality, and ensure the removal of hazardous substances, components, and mixtures from the material cycle

In Figure 3-7 these targets are presented in an inverted hierarchy pyramid.

"Reducing the material inputs" requires both efficiency and sufficiency measures. It must also be ensured that negative environmental impacts are reduced. In order to achieve this, alternatives must be provided to existing consumption patterns. The absence of a cultural transformation in dealing with resources and products is a key impediment to the implementation of a circular economy (KIRCHHERR et al. 2018). As far as possible, coherence should also be ensured with the goals in other areas of environmental policy. And to ensure that measures are effective, environmental priorities must also be set.

"CE-compatible design and production" means that products will have a long service life and will be free of hazardous substances, material-efficient, reparable, and recyclable. The term "CE-compatible" is therefore more comprehensive than "recyclable". CE-compatible product design has a direct influence on the prevention and recycling of waste.

"Prevention of waste" corresponds the top level of the waste hierarchy, and here it is directly followed by "preparation for re-use".

"Recycling" is now specified as "high-grade", and "safe removal of hazardous substances" is included, in order to ensure that products will be free from hazardous substances in future.

Finally, "other recovery" and "disposal" correspond to the lowest levels of the waste hierarchy. As with recycling, "other recovery" is specified as "high-grade". These two lowest levels should in future be used as little as possible. Their main function should be the elimination of hazardous substances.

Taking the step from the recycling-based waste management to a circular economy requires the right instruments to be applied in the right combination (WILTS 2017). Problem analysis, the development of measures, and the selection of instruments are complex issues, given the various products and actors involved, the fact that well-being is linked to the ownership of material goods, and the fact that both the production sector and the waste management sector operate in a global setting.

3.4.2 The circular economy is not sufficiently integrated in environmental policies

Consumption and the circular economy

153. Efficiency and recycling measures are not sufficient to achieve the required reduction of the environmental impacts associated with the use of primary raw materials (UBA 2015; BRINGEZU 2015; IVANOVA et al. 2016; OECD 2019). Strategies are needed which lead to an absolute reduction in their use. Sufficiency involves changing consumption principles and associated use considerations (FISCHER and GRIESSHAMMER 2013, p. 9 et seq.). Changing patterns of consumption for reasons of sufficiency does not necessarily mean going without. Rather it involves considering alternatives (QUACK et al. 2017, p. 16).

154. The various political programmes (Fig. 3-6) do not include a clear commitment to the goal of reducing overall societal material flows. However, the definition of waste prevention in the Waste Framework Directive also covers consumer behaviour. The aim should be to purchase products that are low in waste and hazardous substances, and to use reusable packaging. The Circular Economy Action Plan (European Commission 2015c) also clearly views consumption as part of the circular economy. However, instead of binding regulations it proposes providing consumers with information that will allow them to choose the less environmentally harmful product. By means of eco-design, the environmental life cycle balance of products is to be improved gradually.

155. In order to achieve effects at scale, in addition to a strategy of consuming "differently" there should also be a strategy of consuming "less". Reducing material use should not focus solely on primary raw materials. Even though recycling to provide secondary materials involves lower environmental impacts than the production of primary materials (item 131), it is not sufficient to establish recycling loops without also considering the associated environmental impacts.

Interactions with other areas of environmental policy

156. In the view of the SRU, it is necessary to link the goals and measures of the circular economy with those of other environmental policies. This involves close links between the programmes and strategies that directly address the individual life cycle phases of products. At the European level these are the Circular Economy Action Plan (European Commission 2015c), the Action Plan for Sustainable Consumption, Production, and Industry (European Commission 2008a) and the Strategy on the sustainable use of natural resources (European Commission 2005a). The programmes at the national level (Waste Prevention Programme, Programme for Resource Efficiency II, and Programme for Sustainable Consumption, item 147) also overlap with one another, and in part also address the same actors, but they set different priorities. In order to improve transparency and acceptance, these programmes should be merged together.

The EU Circular Economy Action Plan already sees the need for strengthening synergies between chemicals, products and waste legislation (European Commission 2018c; 2019f). Many suggestions have been made to allow higher levels of hazardous substances in secondary materials than for primary materials, so as to promote recycling. However, the SRU feels that this would lead to the permanent retention of hazardous substances in the material cycle, and from there into products.

There are many other strategies – both in the field of environmental protection and relating to economic development. These include the Climate Action Plan, the High-Tech Strategy, or the National Bioeconomy Strategy. As a rule, there is no consideration of the influence they have on material flows and whether management of the material flows could help to achieve the goals of these strategies.

True environmental costs

157. Introducing "true" prices for products and goods would have a significant influence on production and consumption. The necessary internalisation of external costs has long been discussed as a way to equalise market imbalances which cause environmental damage (SRU 2019, item 182 et seq.). If the prices for products reflected the costs of the environmental impacts they cause and the cost of maintaining social standards, they would be higher than present levels in many cases. The higher price would reduce the use of primary materials and make it more economically viable to recycle waste to generate secondary materials. Another effect could be that because of the higher costs the products would be made more durable or would be used for longer.

The costs of high-grade waste management are often also not included in the product price (collection system, type of treatment, etc.). Recovery systems with high environmental standards often involve considerable investments and higher running costs, so that they are unable to compete economically with simpler recovery methods. Producing high-grade recyclate is also more expensive than less demanding recycling. Using established economic instruments of recycling-based waste management such as disposal fees or EPR systems it is only possible to reach the goals of the circular economy in part, if at all. Therefore, the use of economic instruments requires a thorough re-examination (see YRJÖ-KOSKINEN et al. 2018 for Finland).

Prioritising circular economy measures

158. Apart from compliance with minimum standards, for example for removal of hazardous substances and recycling rates, waste management activities are guided by economic factors rather than the best environmental solution (item 135). In the view of the SRU, it is necessary to decide from an environmental perspective which material flows should be addressed as a priority, and which entry points over the life cycle are most beneficial for environment. This has not received sufficient attention in either the EU Circular Economy Package or the German programmes for sustainable consumption, waste prevention, and resource efficiency (item 147). The effectiveness of various measures should not be compared solely within a waste hierarchy level; for example, the effectiveness of prevention measures should also be compared with that of recycling measures. When priorities are being set, it is also important not to consider the current framework conditions solely on the basis of older data, since this can lead to decisions being made which are not forward-looking (LAZAREVIC et al. 2012). For example, it is important to factor in the effects of a different electricity mix resulting from the decarbonising of the energy supply (item 182).

Product policies for CE-compatibility are only in a rudimentary form

159. Developing methods and implementing regulations for durability, repairability or recyclability under the Eco-design Directive is a first important step towards being able to set up requirements for specific products. Requirements for product design in the WEEE Directive are very general and unsuited for practical application,

with specific limitations only for certain heavy metals, flame retardants and plasticisers (RoHS Directive). Analogous regulations also exist for vehicles, batteries, and packaging. Further limitations are provided in particular in the POP regulation (EU) 2019/1021 and the REACH regulation Nr. 1907/2006. However, since the product design affects the demand for input materials and all measures on the waste management side, there is an urgent need to make eco design rules more concrete and to extend them to cover more products.

3.4.3 Lack of targets for waste prevention

160. In 2011, the European Commission formulated as a milestone: "By 2020, waste is managed as a resource. Waste generated per capita is in absolute decline" (European Commission 2011a). The strategies for the prevention of waste are mostly covered by a national waste prevention programmes, although some countries, including Germany, chose not to include quantitative targets (EEA 2015). However, there are also exceptions (ibid.). For example, by 2020 France had the goal to reduce the amounts of municipal solid waste produced per capita by 10% relative to 2010 levels. Bulgaria aimed to be below its 2011 level by 2020. Other countries and regions that have set targets include Portugal, England, Italy, Estonia, Finland, Flanders, and Wales. In some countries, a goal was expressed relative to gross domestic product (GDP) rather than aiming for a reduction in absolute terms (e.g. Estonia).

3.4.4 Recycling should be more environmentally oriented

High-grade recycling

162. As a rule, there are only very general requirements for recycling in the form of quantitative recycling rates. Specific materials or quality aspects are not taken into consideration. The extent to which individual materials are recycled depends in practice on the mandatory recycling rate, the technical feasibility and viability, and revenues that can be generated. The outcome is that not all materials are recycled optimally from an environmental point of view (BUNGE 2015; defra 2011). There are limits on recycling due to the complexity of products and the laws of thermodynamics, so that there are always unavoidable losses (CIACCI et al. 2015; UNEP 2013; 2011). The design of products and the nature of treatment and recycling processes are crucial for the quantity and quality of the recycling.

163. Output-fractions from recycling are classed as "recycled" irrespective of their quality or the use to which the secondary material can be put (i.e. which primary raw material they replace), and also irrespective of whether they can later be recycled again. For example, plastic products are frequently recycled to mixed plastics (Consultic 2015, p. 23; Conversio 2018a, p. 68) but products made using this material will not subsequently be recycled but will go to energy recovery. In the case of alloyed metals, reference is made to so-called non-functional recycling (UNEP 2011; NAKAMURA et al. 2012; LØVIK et al. 2014; MODARESI et al. 2014). The accumulation of alloy elements or metal impurities that hinder high-grade recycling can lead in the long term to a scrap surplus, since in order to achieve the necessary product quality, the concentration of impurities in the secondary material has to be reduced by mixing with high purity material (NAKAMURA et al. 2012; LØVIK et al. 2014; REUTER et al. 2013). Indeed, for certain applications only primary raw material can be used. High recycling rates are achieved for construction and demolition waste, but the recycled material from buildings is often only used in civil engineering projects, which is not high-grade recycling (KNBau 2018; UBA 2019c).

Although reference was already made to high-grade recovery in German waste legislation in 1996 (item 134) and also more recently in the EU Circular Economy Action Plan, there are still no studies that address the issue of high-grade recycling and the long-term prospects for recycling a given material.

The role of the removal of hazardous substances

164. Without knowing which hazardous substances are contained in products and infrastructure elements in which quantities, or when these end up as waste, it is hardly possible to target these and remove them permanently from the material cycle (SRU 2005). Both the Circular Economy Action Plan and the German Resource Efficiency Programme II recognise the importance of reducing levels of hazardous substances in materials – not least in order to promote acceptance for secondary materials. In addition, the Circular Economy Action Plan notes the need to address the interface between legislation on chemicals, products, and waste. Some waste management regulations already contain requirements for separating out components that contain hazardous sub-

stances. However, the conflict between the removal of hazardous substances and the increase in the quantity of materials that are recycled is not addressed sufficiently, and no clear targets are set. In the view of the SRU, more attention should be paid to the removal of hazardous substances when developing circular economy strategies.

3.4.5 Financing circular economy measures

165. A study carried out on behalf of the Swiss Federal Office for the Environment evaluated the effects of various systems of fees and charges on the prevention, recycling and recovery of waste (Ecoplan 2015). A key conclusion is that waste fees are not effective in preventing waste, but they can help to direct waste to recycling and recovery. Fees related to a circular economy or waste prevention are most efficient and effective at the beginning of a material stream (input fees), i.e. directly at the extraction of the primary raw material or the import of materials or products.

166. In the Circular Economy Action Plan and the amended Waste Framework Directive, EU Member States are called on to make increased use of economic and other instruments to support the implementation of the waste hierarchy. The instruments and measures listed in Annex IVa of the amended Waste Framework Directive have a broad scope, but they remain unspecific. While this allows Member States to flexibly develop their own circular economy systems, it can result in these instruments not being used due to the lack of binding requirements. The draft proposal for the relevant German legislation simply adopts the individual items on the list, rather than adding specific provisions to these instruments and measures (item 148).

3.5 Challenges on the way to the circular economy: The example of plastics

169. Specific challenges are faced when recycling a given material to a high quality. This section considers the topics: Recovering plastics, Plastics and the climate, Prevention of plastic packaging, and Recycling of plastics in vehicles.

3.5.1 Recovery of plastics and its influence on climate change

171. The production and use of plastics increased globally from 2 Mt in 1950 to 381 Mt in 2015 (GEYER et al. 2017). In 2017, 4 to 6% of the crude oil consumed in Europe was used to make plastics (PlasticsEurope 2018a, p. 8). More than 99% of plastic waste is classed as recovered according to the definition of the Waste Framework Directive, more than half of it by energetic recovery. In 2017, mechanical recycling accounted for 46.2% of the total amount of plastic in Germany.

175. For the assessment of recycling management, it is decisive which quantities and qualities of recyclates are fed into the material cycle and which primary materials they replace. In Germany, out of 2.2 Mt input for recycling in 2017 some 1.9 Mt recyclate was produced (of which 0.8 Mt was from post-consumer waste). This includes both re-granulates of defined quality, and mixed plastics with no more than 10% impurities. The latter are used for products such as park benches, road sign bases, posts, and barriers (Consultic 2015, p. 23; Conversio 2018a, p. 68). In such applications, the plastics will not only be replacing primary plastics but also other materials, like wood and concrete or other mineral products. Limits on mechanical recycling are imposed by the product design, e.g. the use of composites with various functional layers that cannot be separated mechanically, or the use of a wide range of inks and additives (RAGAERT et al. 2017).

177. In 2017, more than 99% of plastics were produced using intermediate products derived from crude oil (see IfBB 2018, p. 42; PlasticsEurope 2018b, p. 18). Already the production of plastics has environmental impacts (CIEL 2019). Emissions from the production fluctuate between 1.6 and 4.0 t CO_{2eq} per tonne of plastic (PlasticsEurope 2019) with an average of 2.5 t CO_{2eq} per tonne (Material Economics Sverige AB 2018, p. 79). The emissions from the incineration of end-of-life plastics with or without energetic recovery depend on the chemical composition of the plastic and its carbon content (KOST 2001). Direct emissions from the oxidation of the carbon are between 1.4 and 3.1 t CO_2 per tonne of plastic (ibid.). According to Material Economics Sverige AB, the average emissions from the incineration across all types of polymer (ibid.) are 2.7 t CO_2 per tonne of plastic. In Germany, the plastics in products currently in use account for emissions of approximately 30 Mt CO_{2eq} per annum from production and 9 Mt CO_2 from the in-

cineration of the accumulated plastic waste (in comparison, in 2017 Germany released a total of 904.7 Mt greenhouse gases, see "Climate Balance 2017: Emissions decline slightly", joint press release of UBA and BMU, 26 March 2018). The global climate impact of the use of plastics is highlighted by calculations of CIEL (2019). The authors estimate that the cumulative global greenhouse gas emissions from the production and the incineration of plastics through until 2050 will amount to 56 Gt CO_2 if no fundamental changes are made to the way we use plastics. This would represent some 10 to 13% of the maximum global carbon budget remaining if the 1.5° climate target is to be met (with a 50–67% probability of reaching the target). These figures make clear that effective climate action will require some careful thinking about how best to use and handle plastics.

3.5.3 Prevention of plastic packaging

179. Single use plastic packaging quickly ends up in a highly varied waste stream, in quantities which policy makers and societal actors are striving to reduce (BMU 2018; PwC 2018). In 2017, out of a total of 3.4 Mt plastic packaging in Germany some 47% went for recycling and 47% for energetic recovery, the rest being exported for recycling (SCHÜLER 2018, p. 133 et seq.). The total rate of recovery (recycling and energy recovery using the appropriate calculation method for these years) increased over recent decades from 11.7% in 1991 to 99.4% in 2017 (GVM 2018, p. 16). Over the same period, however, the amount of plastic packaging generated and disposed of in Germany every year increased from 20.5 kg per capita in 1991 to 38.5 kg per capita in 2017 (SCHÜLER 2018, p. 48), of which 12.2 kg and 25.4 kg respectively was attributable to private end users (ibid., p. 51).

180. The German Packaging Act obliges producers to adopt a packaging design which uses material sparingly, is recycling-oriented, and free of hazardous substances. Requirements also include increased reusability and the highest possible use of recyclates.

181. According to the German Packaging Act, prevention is to be achieved by an increase in the proportion of beverages filled into reusable containers. The current target for this is 70% – but in 2017 the rate of reusable containers was only 42% (BMU 2019a; LEIGHTY and HEINISCH 2018). Already in 2003, obligatory deposits were introduced for certain single-use beverage packaging. This has led to high rates of return of these single-use beverage packaging, better material purity of separately collected beverage packaging, and a decrease in litter, but did not result in the intended stabilisation of the proportion of reusable beverage containers.

182. In various studies (SCHONERT et al. 2002; GDB 2008; IFEU 2010; KAUERTZ et al. 2018) types of reusable beverage packaging were not found to offer a clear environmental benefit under current conditions, and in part were not as good as single-use options (KAUERTZ et al. 2018; IFEU 2011). Reasons include the long transport distances that are often involved with returnable glass bottles and their weight, the CO_2-emissions due to the use of natural gas in glass production, and on the other hand the appreciable electricity credits and CO_2-credits obtained from the energetic recovery of composite beverage cartons made with biogenic materials. Life-cycle assessments on the basis of current conditions are often cited as reasons why the reusable beverage container system will be used less and less in future for environmental reasons. However, a forward-looking environmental policy should be based on life-cycle assessments that take future conditions into account. These include in particular a greenhouse gas neutral, largely decarbonised economy. At present, allowance is made for CO_2-credits for energetically recovered materials which replace electricity and heat derived from fossil fuels. However, these credits will be reduced with the increased proportion of renewables in the energy mix, and in the long-term will no longer be applicable (Öko-Institut 2014). This will mean that incinerating the fibre content of beverage cartons for power generation no longer generates CO_2-credits (ibid.), while on the other hand glass production will involve lower CO_2-emissions due to the use of alternative fuels. Transport will become greenhouse gas neutral and returned bottles will be washed using energy from renewable sources. Such assumptions will affect the environmental assessment, which is currently still CO_2-dominated (KAUERTZ et al. 2018; UBA 2014). Changes in the system can also lead to a revised evaluation. For example, the increased use of standardised reusable pool bottles that can be filled by a range of companies will make it possible to introduce regional distribution and return structures, considerably reducing the transport distances involved ("Further decline in 2017 of reusables share in beverage packaging", UBA Press release, 18 September 2019).

183. Reusable systems for other types of packaging and other uses, for example transport packaging and outer

packaging (Fraunhofer IBP 2018; LANG and PELKA 2013) or To-Go beverage cups (KAUERTZ et al. 2019), can offer overall environmental benefits due to high turnovers, increased standardisation, and real pool solutions.

A further instrument within the framework of the German Packaging Act is licence fees, payable by distributers to one of the "dual systems" that are responsible for collection, treatment, and recycling of waste packages. However, these fees have not yet led to an absolute reduction in the amounts of packaging. Since January 2019, the licence fees have depended on the recyclability of the packaging. However, non-recyclable or poorly recyclable products can still find their way onto the market if the distributer is willing to pay the higher licence fee.

3.5.4 Recycling plastics from end-of-life vehicles

186. After the packaging and construction sectors, the automotive industry in Germany is in third place with regard to the use of plastics. Plastics account for 12 to 15% of a new vehicle weighing 1.5 tonnes (PlasticsEurope 2013), and this proportion could increase to 28% by 2030 (FAULSTICH et al 2018). A variety of high-grade plastics are used in vehicle construction (CHEManager 2014), and their recycling is particularly beneficial from an environmental perspective (WÄGER and HISCHIER 2015). However, there are constraints on recycling. Flame retardants have been included in various components which have meanwhile been banned in part by the POP Regulation. These must be safely taken out of the material loop prior to recycling (MEHLHART et al. 2019).

188. Between 2004 and 2017, the recycling rate for end-of-life vehicles by weight increased from 77.2% to 89.5% (UBA 2019b). For an average empty weight of 1047 kg, 160 kg or 15.2% of the vehicle is disassembled before shredding. The extent of disassembly depends on the economic viability. There is demand for parts such as engines, alternators or starter motors, and tyres (PARKER et al. 2015). However, there is little demand for plastic parts, which account for more than 140 kg of the vehicle weight (SANDER et al. 2017, p. 317) and high labour costs make their removal uneconomic; in 2017 only 2.1 kg was recycled per vehicle (UBA 2019b).

The body of the vehicle is then shredded, and a large proportion of the plastic ends up in the light shredder fraction, together with rubber, glass, some residual metal, and other materials. This fraction goes to energetic recovery (MEHLHART et al. 2019). There is hardly any high-grade recycling of plastics. The increasing importance of plastics in vehicle construction (WENZ and ZÖLLNER 2019) is not reflected in the recycling due to the economic unviability of dismantling.

191. The legally required rates of recycling and recovery can be achieved firstly because vehicles consist to more than 75% of readily recyclable metals, but also because backfilling of mineral fractions is classed as recycling (UBA 2018b, p. 7). This means that there is little incentive to remove glass and plastics from end-of-life vehicles for separate recycling (SANDER et al. 2017).

192. The existing waste management system for end-of-life vehicles is financed by the sale of the scrap metal and used parts (SCHMID and ZUR-LAGE 2014). There is also competition from exporters, who buy second-hand and end-of-life vehicles; they have to refinance their outlay by adopting cost efficient handling measures. Vehicle manufacturers in Germany are de facto not financially involved in the waste management. Therefore, the principle of producer responsibility contained in the End-of-Life Vehicles Directive has hardly any implications for this product stream.

As long as the legal requirements can be met by the existing system, the quality of recovery will not improve and the goals of the circular economy will not be achieved in full.

3.5.6 Interim conclusion: Established instruments are not (yet) effective

201. The established waste management and circular economy instruments for products containing plastics are not able to exert the necessary influence towards the hierarchy of the circular economy described in chapter 3.4. A readjustment should first aim to reduce the amounts of plastics used and secondly to improve the framework conditions for much better re-use and recycling. Both the quality and quantity of the recycled materials must be improved so that primary raw materials can increasingly be replaced by recyclates. Strategies, goals, and instruments should be chosen in a way that ensures the safe removal of hazardous substances from material cycles and reduces climate impacts.

3.6 Recommendations for the further development of the circular economy

203. Figure 3-14 gives an overview of the recommendations on the basis of the target system developed in section 3.4.1. The recommendations of the SRU are of a strategic nature and relate to the role of the circular economy in a precautionary environmental policy, and the prevention and high-grade recycling of waste. There are also three cross-cutting fields: Producer responsibility, Role of public institutions, and Monitoring. No recommendations are made for the two lowest waste hierarchy levels, shown in red in Figure 3-2. In future they should play a subordinate role and serve mainly only the elimination of hazardous substances. The strategic recommendations are discussed for selected examples, but the considerations are also applicable for other materials and products.

3.6.1 Circular economy policies as part of a precautionary environmental policy

Reducing material flows and promoting sufficiency

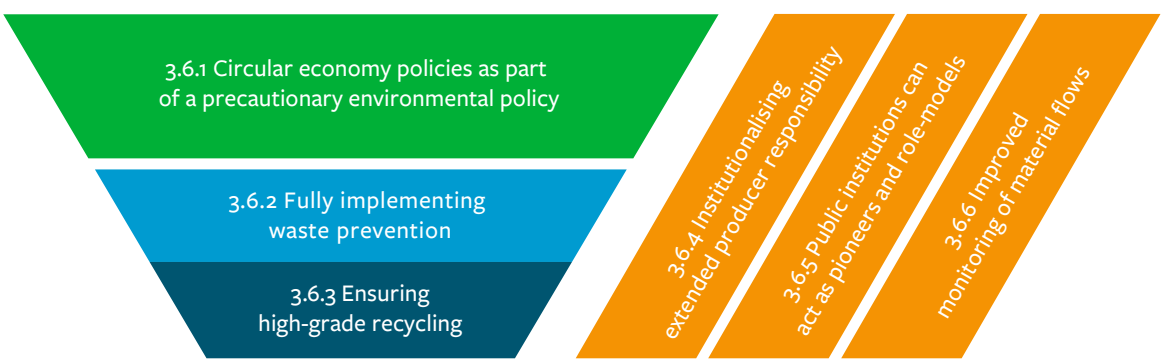
204. In view of the predictions for future demands for raw materials and the associated environmental impacts (item 128 et seq.), the SRU recommends that the reduction of material flows should be anchored as a goal of circular economy policies. This would involve using smaller amounts of material overall, in particular by reducing consumption and designing material-efficient and reparable products with long service lives (items 153 et seq. and 159). Both sufficiency measures and efficiency measures should be implemented. This approach should also be adopted at the European level.

205. A successful sufficiency strategy that reduces the use of raw materials and increases circularity should highlight the benefits for public welfare and the positive aspects of changed consumption patterns. A clearly defined goal should be pursued in a programme that can be introduced step by step. It is necessary to overcome cultural barriers if the circular economy is to be implemented successfully (KIRCHHERR et al. 2018).

206. For a policy to reduce overall societal material flows to generate environmental benefits, it is necessary to consider specific material streams and their links with associated environmental impacts. Developing such a policy requires an improved knowledge base. The SRU has previously recommended establishing a national material flow inventory (SRU 2017, item 270 et seq.; 2019, item 362). On the basis of such an inventory, priorities can be set for reductions of material flows. It should be possible to link the monitoring of individual material streams directly to the Raw Materials Information System (RMIS) of the EU.

Figure 3-14

Recommendations for the further development of the circular economy



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207. In order to improve the monitoring of material use in the Sustainability Strategy and in the Resource Efficiency Programme II, the German government should augment the total raw material productivity indicator as follows:

- Present raw material consumption (RMC) with a reduction target.
- Express raw material inputs and consumption (RMI and RMC) for material groups so that specific reduction targets can be established.
- In addition to material groups, the flows of individual material streams should also be considered, depending on their environmental relevance. This would make it possible to track their environmental profile, use pathways, recycling rates etc., and to develop specific measures.

It is also important to harmonise the methods used to calculate various indicators, for example the RMC. This would allow worldwide comparisons.

Provide coherent policies and weigh up conflicting targets

208. In climate policy discussions, new technologies are often considered which require different types and quantities of materials (VIDAL et al. 2013; HERTWICH et al. 2015; GIBON and HERTWICH 2014; UBA 2019d). When formulating climate action measures in accordance with the German Federal Climate Change Act, the Council of Experts on Climate Change (§ 11 Federal Climate Change Act) should always take into consideration the availability of primary raw materials, the environmental and social conditions for their extraction, as well as their CE-compatibility (in particular eco-design and recyclability).

Regarding the climate benefits of recycling, the influence of downcycling should be investigated.

Strengthening the circular economy using environmental true cost pricing

210. Business models which aim to prevent waste and promote high-grade recycling are often not able to compete economically with models involving primary raw materials extraction (KIRCHHERR et al. 2018). If the prices of primary raw materials showed their true environmental cost, this would change the economic framework for waste prevention and recycling. Economic instruments should be implemented in order to achieve this.

Since many of the primary raw materials used for production and consumption in Germany – in particular metals – originate from other countries, the internalisation of external costs can only be promoted by international cooperation. As a first step, support should be given for higher environmental and social standards in the primary raw material exporting countries. For primary materials such as construction materials that are mainly domestically extracted, a national regulation could be introduced to incentivise the use of secondary materials. The focus should be on those primary raw materials for which recycling is technically feasible and environmentally beneficial. The German Environment Agency (UBA) proposes a primary construction material tax for gravel, sand, and natural gypsum (UBA 2019g). Sufficiently high CO_2-pricing could also have positive effects for the circular economy. This should also include appropriate pricing for CO_2-emissions from waste incineration.

211. The Action Plan for the Circular Economy and the amended Waste Framework Directive emphasise that the EU Member States should use economic instruments and further measures to promote the targets of the circular economy (items 143 and 145). For example, in accordance with Annex IVa, no. 8 of the Waste Framework Directive, the Member States should consider phasing out subsidies which are not consistent with the waste hierarchy. The regular UBA report on "Environmentally Harmful Subsidies in Germany" has not to date included a section on subsidies that have negative effects on the circular economy (UBA 2016c). The scope of the report should be extended to cover this as a matter of urgency.

Further economic instruments included in Annex IVa of the Waste Framework Directive are "fiscal incentives for donation of products, in particular food" (no. 3) and "fiscal measures or other means to promote the uptake of products and materials that are prepared for reuse or are recycled" (no. 9) (see recommendations in sec. 3.6.2). The draft of the German Circular Economy Act envisages adopting the list in Annex IVa of the Waste Framework Directive directly in a new Annex 5 (KrWG-E). In the view of the SRU, rather than simply transposing the list, the German legislators should implement the appropriate instruments and measures together with corresponding requirements. The SRU also recommends that the German government should urge the European Commission to develop recommendations and minimum standards for the instruments of Annex IVa.

212. In addition to using economic instruments, information measures should also be introduced to make consumers more aware of the consequences of their patterns of consumption. In the view of the SRU, the German government should pursue the idea of a "second price tag" (BMUB 2016a, p. 56; UBA 2016a, p. 63), develop appropriate assessment methods, and establish binding requirements for such tags on environmentally-relevant products. For example, in view of the current media interest, clothing could be considered as a first product.

Developing product policies for CE-compatibility

213. Push instruments should be introduced to reduce waste, such as planned minimum service lives for products and critical components, and also proof of repairability. The German government should consider mandatory documentation of relevant technical information for repairs and the provision of diagnostic software and product-specific tools and spare parts. The German government should also work to extend the range of products covered by the Eco-design Directive.

214. For certain products containing hazardous substances that have been or will be placed on the market, the information obligations should be widened and linked to product approval. The German government should work at the European level for the further development of the SCIP Database (Substances of Concern In Products) of the European Chemicals Agency (ECHA) to produce a broader product register. The SCIP Database is currently being developed on the basis of Art. 9 sec. 2 Waste Framework Directive. Corresponding information could be made available by producers in a product passport (see SRU 2017, item 274).

In addition to banning substances or restricting their use (item 159), future European product and chemicals policy should also include positive lists. Materials which allow high quality recycling and recovery should be recommended for use in products. This would show producers ways to reduce the environmental impacts of their products. The German government could begin a discussion on this as part of the work of the European Commission on the interfaces between policies on waste, chemicals and products, within the EU Circular Economy Package.

215. In order to remove hazardous substances from the circular economy, the same limit values should apply for recycled materials as for primary raw materials – even if at first this means that smaller amounts of secondary materials will be available. Meeting recycling rates should have a lower priority than the final removal of hazardous substances from the material cycle.

216. In order to recycle more products to a high quality, a suitable instrument is the assessment of the recyclability. However, recycling should not be the first priority for eco-design. More important are criteria such as absence of hazardous substances, durability, and repairability, taking possible conflicts into consideration (den HOLLANDER et al. 2017). In the long-term, product assessment methods should consider criteria such as repairability and durability along with recyclability.

The SRU recommends that the German government should endeavour to ensure the development of instruments of life-cycle-oriented product development for product groups with high material inputs and a large environmental footprint, and that these should be implemented, evaluated and up-dated within the framework of the Eco-design Directive. Germany can make an important contribution by providing priority Federal funding for scientific research. This will make it possible to transition from waste-management oriented producer responsibility to a precautionary product policy with more specific requirements than those in the current regulations (item 135).

Using environmental assessment when making decisions about the circular economy

217. Environmental assessment instruments should be used when formulating policies in order to compare the environmental impacts of measures at various levels of the target hierarchy developed in section 3.4.1. This will provide an overall picture so that measures can be compared in terms of their environmental benefits. Environmental assessment instruments should be upgraded and further standardised. In future they should be based on framework conditions such as a decarbonised economy. Alternative scenarios should also be examined thoroughly in order to determine which solution is best for the environment under any given conditions, and how existing systems can be optimised (DETZEL et al. 2016). Waste-specific aspects such as the environmental impacts of littering and inputs of macro- and micro-plastics in soils and bodies of water should be included in assessment instruments. In order to prevent more harmful replacements being developed or used, available alternatives for substitution should always be examined together with a product, material or substance for which restrictions are being considered.

3.6.2 Fully implementing waste prevention

Quantitative prevention targets as dynamic control instruments

218. In order to make waste prevention instruments effective (especially soft instruments), mandatory targets should be set and progress monitored, with specified consequences if targets are not met. The SRU proposes defining input- and output-oriented indicators for the measurement and assessment of societal material flows. The effects of the waste prevention programme can then be monitored continually, and incentive measures can be adapted

219. Voluntary commitments of commercial actors on waste reduction, as currently formulated in Germany for packaging, show that it is also possible to set measurable targets at company level. The SRU welcomes these initiatives. However, an agreed process channelled through the German Environment Ministry (BMU) would help to harmonise the activities, their scope, and their level of ambition, so that they can be integrated in Germany's waste policies. This could ensure that the voluntary commitments are really compliant with the overriding goal of waste prevention and are not simply being used for marketing purposes.

Changing patterns of consumption

220. The German government, as well as the regional and local authorities, could act as role models in selected areas and could make infrastructure available which would support changes in consumer behaviour (sec. 3.6.5). For example, installing public drinking fountains or making free drinking water available in public institutions such as schools, offices, or at large events saves packaging and can stimulate changes in behaviour. The public sector can also act as a role model for procurements and increase the demand for new technologies or consumption structures. Examples include the acquisition of office bicycles or the creation of vehicle pool systems to replace personal official vehicles.

The German government should provide funding for model sufficiency initiatives and accompanying research (item 205) within the revised Waste Prevention Programme, so that the transformation of behavioural patterns is supported by relevant findings.

Extending the service life

222. In recent decades, many sectors have seen a decline in knowledge about measures to extend the service life of products, with poorer access to the relevant infrastructure. In order to achieve a longer service life, an important aspect is a design for a robust, functional product that can be repaired or refurbished. To this end, a structural framework is needed with specific incentives. Key instruments here are the Eco-design Directive, specific product-group implementation measures, and self-regulation initiatives of the producers. In order to support consumer decisions in favour of durable products, obligations to declare the expected service life could be introduced (UBA 2017; GILJUM et al. 2016).

An extension of guarantee and warranty periods to cover the planned technical life of products could provide a stimulus for new business models in which services and product-service systems are marketed rather than the material products, while the producing companies themselves carry out repairs and refurbishment. The Consumer Sales Directive (1999/44/EC) sets only minimum requirements for the legal warranty period, but there is considerable scope for extending these (ECC-Net 2019). Sweden has introduced an extended warranty period of three years for all types of products. In Norway and Iceland, products which have a declared minimum service life of at least two years, have a warranty for five years (ibid., p. 16 et seq.). However, eco-design alone is not sufficient to revive the repair culture. Financial incentives such as a reduction in the rate of value-added tax for repair services, as already introduced in nine EU Member States (AX 2017), would encourage the use of these services and make them more competitive.

223. For packaging (sec. 3.5.3), re-use systems offer much longer useful service lives. The continued failure to reach the target of 70% for reusable beverage containers (item 181) highlights the need for action here. The SRU recommends that the target for reusable beverage packaging should be maintained, but the framework conditions should be revised to achieve the environmental benefits and the contribution to waste prevention. In the view of the SRU this includes primarily:

- Voluntary self-commitment of the distributors and bottlers to use reusable pool bottles.
- Introduction of mandatory re-use rates for all market actors, with a requirement to report quantities of single-use and reusable packaging.

3.6.3 Ensuring high-grade recycling

225. Mass-related recovery and recycling rates are not adequate as a parameter for the effective implementation of high-grade recovery (item 162 et seq.). The achievable quality of recovery depends on a range of factors over the life cycle of a product. It is therefore more appropriate to use a range of control instruments at the various stages. Figure 3–15 gives an overview of instruments which in the view of the SRU can be combined to ensure high-grade recycling.

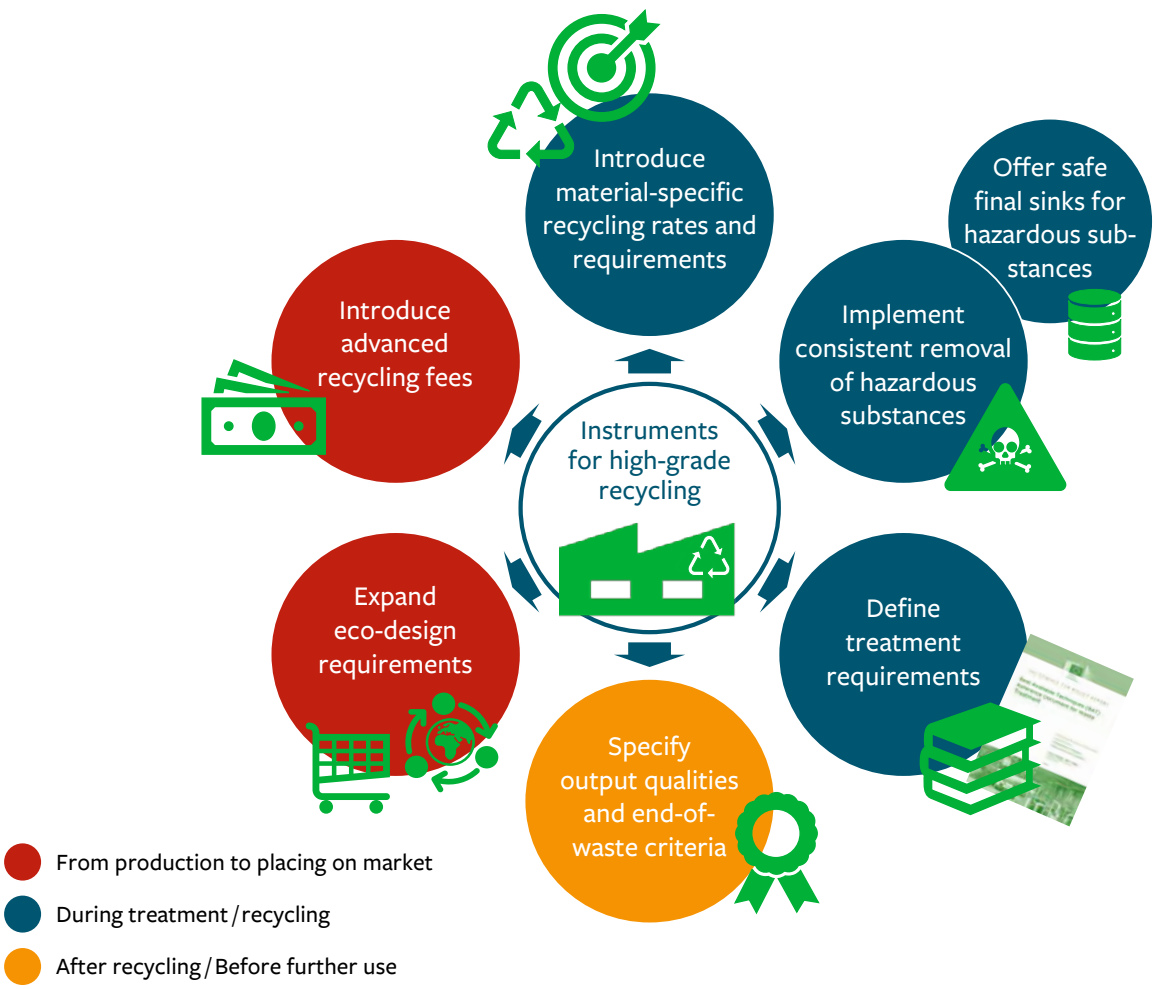
Further development of recycling rates

226. Recycling rates are an instrument of waste management that can incentivise the recycling of waste streams. However, merely increasing the weight-based recycling rates only provides limited incentives for high-grade recycling (FELLNER et al. 2018). The recycling term should be made more specific and different recycling qualities should be taken into consideration. In particular the scope of recycling in the End-of Life Vehicles Directive should be amended so that backfilling no longer contributes to meeting the recycling rates.

In the case of complex products such as waste electrical and electronic equipment (WEEE) or end-of-life vehi-

Figure 3-15

Instruments to ensure high-grade recycling



SRU 2020

cles (ELV), material-specific recycling rates for plastics or also for precious and special metals could help to increase the recycled quantities of these environmentally relevant substances and materials (item 162 et seq.). In the case of vehicles (sec. 3.5.4), but also for WEEE, this would mean defining a sub-target to the recycling rate defining to which share it has to be met by the recycling of plastics in general, or specific high-value technical plastics (UBA 2016b, p. 9), or alternatively the proportion of the plastics contained which should be recycled. For packaging, specific recycling rates could be introduced for plastics where environmentally appropriate. Monitoring could be simplified by defining the targets for separation and recovery of specific fractions in absolute terms of weight per unit, e.g. the mechanical recycling of 20 kg plastics for each end-of-life vehicle (UBA 2016b, p. 9).

Removal of hazardous substances

227. Already in 2005, the SRU called for a resource strategy which introduces environmental quality targets and took into account the physical limitations on sinks (SRU 2005). Awareness of the physical capacity of sinks is necessary, because the environmentally permissible anthropogenic material flows (item 164) are also limited by the shortage of sinks. The requirements for the final sinks should be clearly formulated and their capacity should be examined.

At the same time, national inventories should be drawn up for known hazardous substances, the use of which in production is already banned or restricted, e.g. POPs, mercury, CFCs (chlorofluorocarbons), or asbestos. The inventory should contain information about quantities that are still in use, and this could be used to formulate exit strategies. The aim should be to rapidly remove from circulation products containing hazardous substances that are still in use, so as to simplify future recycling and the generation of recyclates that are free of hazardous substances.

228. The necessary removal and subsequent elimination or disposal of hazardous substances requires knowledge of what is contained in the products in question. Since declarations are currently unavailable for many products in the waste streams, particularly if they have long service lives, it is necessary to closely monitor the substances in the waste streams. Batch tests can be carried out to determine what products contain and the proportion of products containing hazardous substances in the waste received for treatment. Methods have been described for the batch testing of waste electrical and electronic equipment (CEN 2014, Annex D). Comparable investigation methods should be developed for other waste streams such as waste batteries, end-of-life vehicles, and construction and demolition waste, as well as for waste textiles and furniture where appropriate.

Information gathered in treatment plants or collection systems on hazardous substances should be included in the reports regularly submitted to the relevant authorities. In order to ensure uniform implementation and to avoid competition for the least strict implementation, target values should be specified for removal and treatment.

Removing and eliminating hazardous substances can mean that large quantities of waste cannot be recycled. In the view of the SRU, meeting recycling rates is less important than removing hazardous substances from the material cycle so that these are not carried over into new products (item 164).

Defining best available techniques and treatment requirements

229. The implementation of treatment requirements in so-called Best Available Technique Reference Documents (BREF), developed on the basis of the Industrial Emissions Directive (2010/75/EU) is in the view of the SRU not well-suited for small-scale and specialised plant operators treating packaging, waste electrical and electronic equipment, or end-of-life vehicles. Alternatives could be

- Binding European or national technical specifications and standards for specific waste streams or
- Treatment requirements developed and implemented at the national level.

European standards, for example for waste electrical and electronic equipment (EN-50625 Series) harmonise in particular monitoring and reporting for recycling and the removal of hazardous substances and make different types of treatment comparable. The SRU welcomes this and recommends that the German government works to extend such standardisation activities at the European level. Specifically, the feasibility and benefits for the treatment of batteries and end-of-life vehicles should be examined.

230. In the view of the SRU, it is necessary to specify further how the target values are to be achieved. The UBA has formulated specific treatment requirements for waste

electrical and electronic equipment and components (RECHENBERG et al. 2019). The UBA recommendations are based on a comprehensive process involving the relevant actors. This ensures the practical applicability and acceptance. Requirements discussed in this process cover not only the removal of hazardous substances, but also recommended requirements to recycle valuable materials.

In the view of the SRU, European and national standards complement one another and should be developed further. They should both be adapted regularly to take into account changes in product designs and treatment and recycling techniques. Since the industrial sector is often over-represented in standardisation activities, the Federal government and the Länder should introduce their expertise in such processes to a greater extent. In order to strengthen the position of environmental associations, ways should be found to provide financial support for their participation.

Specify output qualities and define end-of-waste criteria

231. By defining output qualities for fractions from treatment and recycling processes it would be possible to control which uses these secondary materials would be suitable for. Requirements could include permissible levels of impurities that prevent high-grade recycling or the combination of specific materials contained (e.g. how pure a specific type of plastic should be, or which fraction of metal alloys should be separated). This is particularly appropriate for waste that contains plastics, biowaste, and construction and demolition waste, and can help to avoid the production of large amounts of secondary mixed plastics or backfilling of construction and demolition waste as way of meeting quota requirements. This increases the transparency about the quality of recycling products and thus improves their market acceptability. At the same time, by introducing requirements for the ending of the waste status for certain substances and objects, quality standards can be defined for recycling products (secondary materials).

Increasing recyclability and the use of recyclates

232. The transposition of the Eco-design Directive 2009/125/EG offers an opportunity in principle to regulate two key aspects for ensuring the high quality of recycling of specific product group:

- Minimum requirements for recyclability (Annex I Part 1. no. 1.3 lit. f)
- Use of materials issued from recycling activities (Annex I Part 1. no. 1.3 lit. b)

233. In the course of the further development of product policies, stricter requirements should be formulated for the recyclability of individual product groups. Because this is a new instrument, the SRU recommends accompanying investigations of the effectiveness and implementation of the ten eco-design implementing regulations adopted by the European Commission in October 2019 (e.g. for refrigerators, washing machines, displays, or light sources) and the standards developed on behalf of the European Commission under Mandate M/543 (European Commission 2015b).

The methods used to assess recyclability are crucial. They must be standardised and established in the context of specification of the recycling concept and the term "high-grade" (items 134 and 162 et seq.).

234. In order to visualise the recyclability of a product and to provide transparency for consumers, a recycling index could be developed similar to the EU energy efficiency labels (Fig. 3-16; van SCHAIK and REUTER 2016; REUTER et al. 2015). As with energy efficiency requirements, this would lead to poorly recyclable products being phased out step by step.

235. In order to promote the use of recyclates in products, where possible input quotas should be set for the use of recycled material from end-of-life products. This creates a pull-effect for the production of recyclates and thus also for investment in the relevant treatment and recycling infrastructure. Experience with voluntary environmental labels (e.g. "Blue Angel" shows that recycled plastics can be used in various products. When drawing up standards for recyclates (items 149 and 163), care should be taken that products which contain these recyclates can themselves also be recycled. This is necessary to ensure that the materials can continue to stay in the material cycle over long periods.

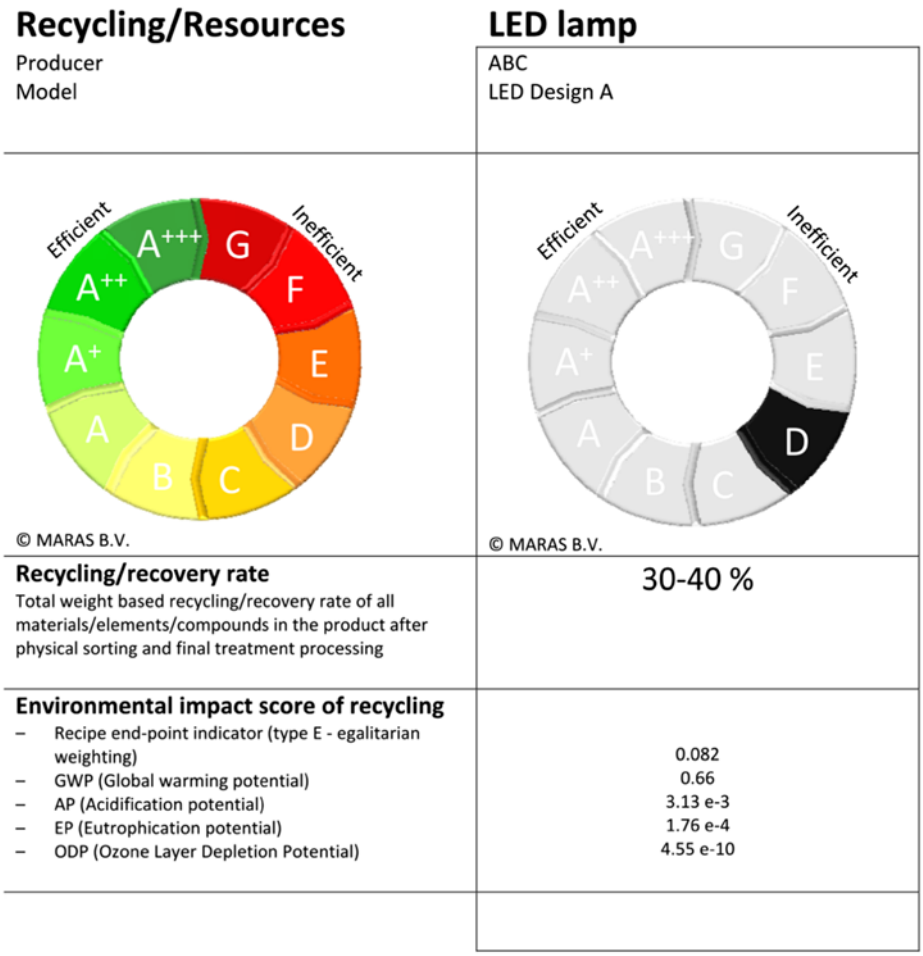
Finally, the European Commission should extend the Eco-design Directive to include other environmentally relevant product groups, e.g. vehicles, selected construction products, photovoltaic cells, or wind-power generators.

Introducing advanced recycling fees

236. The measures described here for high-grade recycling require reliable funding. Transparency should be ensured in the allocations for collection, identification and removal of hazardous substances, monitoring, reporting, etc. This will prevent recycling being carried out primarily with the goal of cost minimisation. A useful

Figure 3-16

Labelling the recyclability of products – for example LED lamps



Source: REUTER et al. 2015

instrument here could be advanced recycling fees payable by the producer of a device or other good, which have been introduced in Japan (Ministry of the Environment 2014, p. 27), the Netherlands (ARN 2019) and Switzerland (Ecoplan 2015). In Japan and the Netherlands this system also applies for vehicles, and in Switzerland to EEE. The level of the fee depends on the requirements for high-grade treatment and recycling. In Switzerland, the advanced recycling fee is also used to finance research on waste management (Swico 2019). In addition to the financial effects, advanced recycling fees also raise consumer awareness about the waste management costs for products.

3.6.4 Institutionalising extended producer responsibility

Extending producer responsibility

238. Extending producer responsibility by the introduction of minimum requirements in Art. 8a Waste Framework Directive is to be welcomed, because it has a knock-on effect for producer responsibility systems for packaging, vehicles, batteries, and electrical and electronic equipment in Germany (UBA 2018b). It will also open up opportunities to apply the instrument to other products. The German government should examine how producer responsibility could be introduced at the na-

tional level for environmentally relevant products, such as furniture, textiles and selected construction products. For example, in the past two decades France has introduced national regulations on producer responsibility for tyres, printing paper, textiles, and furniture (French Ministry of Environment 2014).

Standardising information obligations

239. The revision of producer responsibility in Art. 8a Waste Framework Directive makes it possible to introduce extended information obligations as a condition for market access. In order to make information about products available in a transparent and useful form, the SRU recommends introducing binding circular economy passports for specific product groups. These product passports should not only provide information about valuable and hazardous substances contained, but should also include information about repair methods and recycling in a permanent and readily accessible form (item 214; see SRU 2017, sec. 5.5.3; 2018, item 190). The idea of electronic product passports is also included in the European Green Deal of the European Commission. The information should be in a suitable form to contribute to a national inventory of societal material flows (see SRU 2017, sec. 5.5.2; 2019, item 362).

Financial contribution of producers to true environmental cost pricing of products

240. Art. 8a of the Waste Framework Directive also includes requirements for extended producer responsibility schemes regarding the financial contributions to cover waste management costs. However, lit. a of Art. 8a sec. 4 makes an exception for the extended producer responsibility schemes already established pursuant to the ELV Directive, the WEEE Directive, or the Battery Directive. In the view of the SRU, protecting the status quo in this way blocks the opportunity to develop these producer responsibility schemes further. The exceptions cover sectors for which in Germany either no financial contributions are made or for which the producer only bears a part of the costs. In the case of waste electrical and electronic equipment, collection is the responsibility of municipal authorities and major distributors and they bear the costs. Collection of WEEE by the producer is voluntary. The producer only has clear financial responsibility for the treatment and recycling. This so-called shared product responsibility does not correspond to the principle of cost responsibility. For there is de facto no financial participation by the producer (items 135 and 192). The SRU recommends that provisions for financial participation should be included when revising the Electrical and Electronic Equipment Act, the Batteries Act, the End-of-Life Vehicles Ordinance and the Packaging Act, so that the costs of a circular economy are actually borne by those responsible for the products and such costs are made transparent in the product prices.

Further development of European producer responsibility

241. In order to preserve the Single Market and to achieve true costs for the use of material products, the German government should increase its efforts on the EU level to further develop systems of producer responsibility. This include introducing new Europe-wide regulations for environmentally relevant product sectors, such as textiles, furniture, and certain construction materials, or infrastructure for renewable sources of energy.

In addition to the usual imports and exports, online trade leads to new products being imported from other EU member states, while used products are exported. The German government should make efforts to ensure that electronic market operators based in the EU are obliged to confirm the orderly registration of the producers of products offered using this marketplace. This would restrict the placing on the market of electrical appliances, batteries, and packaging to the Single Market for which the producer has made no contribution to the waste management costs (OECD 2018; BMU and BMJV 2019).

With regard to used devices, it is first necessary to gain an overview of the quantities sold across national borders which will be disposed of in a country in which they were not originally placed on market. There will therefore be no registration in the producer responsibility system of the importing country. In order to be able to monitor cross-border trade in used products, the official statistics should make a distinction between new and used goods. If the trade with certain countries shows a significant flow of used goods in one direction, then mechanisms should be developed to involve the original producer in the waste management costs.

3.6.5 Public institutions can act as pioneers and role-models

Public procurements based on environmental considerations

243. Public procurements in Germany account for 10 to 15% of the gross domestic product. Of an estimated expenditure of up to EUR 350 billion per annum, the total

expenditure of the Federal government, Länder and municipal authorities accounts for 35%, and the procurements of other institutions like public funds or utilities for 62% (ESSIG and SCHAUPP 2016; SOLBACH 2018).

245. Federal authorities in Germany are already obliged under § 45 of the Circular Economy Act to promote the circular economy, to conserve natural resources and to contribute to reducing the environmental impacts of waste disposal. The previous obligation to examine options has been developed further in the draft transposition of the amended Waste Framework Directive to include an obligation to favour CE-compatible options (KrWG-E).

Public institutions, in particular Federal government institutions, should make voluntary commitments and report regularly on their progress in order to document the feasibility of such measures and motivate other public institutions to follow their example. A model here is the Netherlands, which set an aim to raise the proportion of circular procurement to 10% of the total volume by 2020 (Government of the Netherlands 2016, p. 28).

Playing a leading role in waste prevention

247. Regulations and guidelines on public procurements are generally concerned with acquiring products that are more sustainable, but this does not necessarily lead to less waste being generated. In the view of the SRU, the public sector should also demonstrate that waste prevention is possible by changing consumption patterns. Similar to private commercial companies (item 185), public institutions could make voluntary commitments in which they define clear waste prevention goals. They could actively communicate their progress to the public and in this way enhance their credibility. It could also generate a multiplier effect among the personnel of the various institutions.

Since the German government emphasises in the Waste Prevention Programme and elsewhere that national prevention targets are not feasible and only "soft" measures can be adopted, it should itself act as a role model and systematically identify its own potential to prevent waste and adopt appropriate measures. These could include purchasing used equipment (e.g. office kitchen devices, computers), setting prevention targets for paper consumption (in addition to using recycling paper), introducing reusable systems for food and beverages in its canteens to replace single-use systems (in particular also for To-Go sales), and offering free tap water from glasses in the canteens of official institutions.

Such concrete measures should be included in the national programme on measures for sustainability (Staatssekretärsausschuss für nachhaltige Entwicklung 2017).

3.6.6 Improved monitoring of material flows

248. Without well-organised monitoring it will not be possible to achieve a circular economy (MORAGA et al. 2019). Both the targets and the monitoring must extend around the entire life cycle of materials. The circular economy at the macrolevel, for example, should ideally be measured on the basis of the material inputs, the recycling (circular flows) of substances and materials, and the output of waste, backed up with targets (MORIGUCHI 2007). Proposals have been made in preceding sections of this report, e.g. for the material inputs by extending the indicators for the overall material productivity of the German Sustainability Strategy (sec. 3.6.1). Further recommendations were the development of indicators for voluntary trade commitments to avoid packaging (sec. 3.6.2), and developing material-specific recycling rates (sec. 3.6.3). For nationwide monitoring purposes, a material flow inventory is proposed (items 214, 227 et seq., and 239). Concerning waste generation, the increasing numbers of products that are produced in other countries and their waste generation should also be included in a reliable set of circular economy indicators (BARTL 2015).

Since the circular economy is not an end in itself, it is necessary to measure how environmental impacts are affected. For example, waste prevention should not only be measured in terms of weight, but also for example in terms of reductions in amounts of CO_{2eq} (UNEP 2019b). Finally, it is also necessary to introduce indicators for the capacity of final sinks to take up pollutants (KRAL et al. 2014).

The topic of monitoring is addressed in the EU Circular Economy Package and a set of ten indicators has been drawn up (Eurostat 2019). For Germany, indicators for waste prevention have recently been developed (WILTS et al. 2019).

A detailed consideration of indicators for the circular economy is beyond the scope of this report, but in the view of the SRU there is an urgent need to upgrade the existing monitoring and the statistics it draws on in order to provide a sound basis for policy-making for a circular economy.

3.7 Conclusions and outlook

249. Waste policy goals have progressed gradually over recent decades from risk avoidance to a system of recycling-based waste management. However, a circular economy begins long before products become waste. We are still lacking a comprehensive and coherent framework in Europe and Germany. The changes initiated with the EU Circular Economy Package for dealing with materials and products goes a step beyond the previous recycling-based waste management provisions.

The question for Germany, with its strong economy, is whether it is willing and able to develop and implement innovative measures to reduce its high levels of use of primary raw materials and prevent waste, acting as a role model within the EU for the further development of a circular economy.

250. The SRU recommends strengthening the environmental orientation of measures which serve a circular economy. Achieving this goal calls for the fundamental adaptation of the instruments used to implement circular economy policies. In the long term, a circular economy can only be successful under market conditions if the prices of material streams are increased to reflect the true environmental costs. Directly transposing imprecise EU stipulations into German law will not provide the necessary incentives for the transformation of structures and investments in infrastructure.

Therefore, many of the SRU's recommendations address the clear and binding definition of targets, harmonised implementation, in particular with regard to the removal of hazardous substances, and the transparent financing of circular economy measures within the framework of producer responsibility. In particular the upper levels of the waste hierarchy should be addressed, with the additional programmatic target of reducing material flows and making products CE-compatible.

The EU's "New Circular Economy Action Plan" published in March 2020 develops the circular economy on the basis of the European Green Deal (European Commission 2019c). Various targets and measures are consistent with recommendations of the SRU. It is particularly welcome that the plans include developing comprehensive product policies by extending the Eco-design Directive. In addition, the coherency of policies should be increased. Targets for the reduction of quantities of waste should be developed, and the broader implementation of economic instruments should be promoted. Also, a European data space should be developed which would make applications such as product passports and inventories possible.

In the view of the SRU, insufficient consideration has been paid to the need to reduce societal material flows. There has not been sufficient discussion of what high-grade recycling means and how it can be achieved. Overall, the motivation for CE seems still predominantly economic rather than environmental.

However, the European Green Deal and the New Circular Economy Action Plan open up opportunities to put ideas for a circular economy into practice. By setting ambitious targets and implementing the appropriate measures, Germany can play a leading role in Europe, and provide impulses and knowledge at the EU-level.

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Cover picture: © Nikita Maykov/stock.adobe.com

Design: WERNERWERKE GbR, Berlin
Typesetting and printing: Typework Layoutsatz & Grafik GmbH, Augsburg

Printed on CO_2 neutral 100% recycled paper