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Henning Wilts

GERMANY ON THE ROAD TO A CIRCULAR ECONOMY?

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Henning Wilts

GERMANY ON THE ROAD TO A CIRCULAR ECONOMY?

FOREWORD

The resource problem is one of the great challenges of the twenty-first century. Resources are becoming increasingly scarce and expensive, above all on account of an increasing global population, rapid growth in developing countries and emerging economies, and the failure of the industrialised countries to detach growth from resource consumption. This applies not only to raw materials, but also to the entire environment, the natural resources and thus also the earth's capacity to absorb the waste products of human society. The United Nations Environment Programme (UNEP) already speaks of global overshoot: Our way of life exceeds both the earth's resources and its capacity to absorb waste products several times over. The solution consists in a dramatic increase in resource productivity, whose aim must be to detach economic growth from resource consumption.

Improving resource productivity is a matter of urgency, on grounds of ecological rationality and also – in view of steadily rising prices – on economic grounds. As a highly industrialised country, Germany is especially dependent on imports of energy and costly materials. Through its increasing role in production costs, resource productivity has thus become an important competitiveness factor for German businesses. Improving resource efficiency therefore represents an important contribution to maintaining employment in industry.

The circular economy plays a leading role in this connection. It involves more than the thorough and complete collection and recycling of all materials. The circular economy must begin with intelligent design, in order to enable the product to be recycled as fully as possible at the end of its life cycle, and the raw materials it contains to be recovered. As such, the circular economy bears enormous economic potential. It makes industry more independent of expensive and often volatile imports, and contributes to improving competitiveness by reducing production costs. The new, intelligent business models, products and services that emerge will not only secure existing jobs, but also create new highly-qualified professions. And cost savings in the economy as a whole will benefit all consumers.

In a series of expert discussions staged by Friedrich-Ebert-Stiftung (FES), experts representing the fields of politics, academia, administration, business and the trade unions discussed a series of central questions concerning the circular economy. The present study, prepared by Henning Wilts of the Wuppertal Institut für Klima, Umwelt, Energie, was commissioned by the Sustainable Structural Policy Working Group at FES. It lays out recommendations for advancing the circular economy on the basis of those intense discussions.

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1

INTRODUCTION

In the past the creation of waste in connection with production and consumption was accepted as a necessary evil. Today, that apparent common sense is increasingly being challenged: circular economy, zero waste, closed-cycle, resource efficiency, waste avoidance, reuse, recycling – all these terms can be attributed to the ideal of achieving a world largely without waste, and instead with a responsible attitude to resources, materials, products and the environment. However, it will require a comprehensive holistic concept to actually ensure that approaches like avoidance, reuse and recycling are taken into account in every stage of the product life cycle and at the level of materials and energy – with environmental product design applied from the very outset to permit recycling at the end of the product life cycle. That is the circular economy. The transformation to the circular economy is associated with high expectations in terms of both ecological and economic benefits. Studies increasingly emphasise these benefits on four levels: resource utilisation, the environment, the economy, and social benefits including the creation of new jobs.

On the waste management side, Germany has long been one of the absolute frontrunners, with impressive recycling rates for almost all relevant waste streams holding steady over many years. The situation is less rosy if we expand the perspective to consider the actual circulation of waste products: In 2010 just 14 percent of the raw materials used in Germany were in fact gained from waste (IdW 2010). Specifically in relation to activities in the "inner cycles" – reuse, repair and extending service life – we find that circular economy in Germany still possesses enormous development potential, especially with respect to product design.

Concepts for individual producer responsibility, statutory requirements for product design, and waste targets orientated more strongly on circular economy and resource efficiency offer possible starting points for such a regulatory framework. But in general we find that Germany has yet to make full use of the opportunities offered by the circular economy. This study therefore begins by outlining the various facets of the concept (chapter 2). Following a review of Germany's progress towards such a circular economy (chapter 3), a number of concrete implementation options are presented (chapter 4). The final chapter presents some important conclusions on the necessary next steps.

2

THE CIRCULAR ECONOMY CONCEPT

The central starting point for the current discussion of the circular economy concept is the critical question, whether the production of waste really represents a necessary evil of our mode of production. Is a world without waste possible? Alternative approaches, such as the circular economy, zero waste, closed-cycle, resource efficiency, waste avoidance, reuse, and recycling pursue the idea of responsible treatment of resources, materials, products and the environment. Although they have gained increasing traction in recent years, a "world without waste" can only be achieved with a holistic concept. That means taking account of approaches such as avoidance, reuse and recycling of both materials and energy at every stage of the product life cycle to ensure environmental product design from the outset – with recycling at the end (see Figure 1).

2.1 LINEAR VS. CIRCULAR ECONOMY

Unlike a circular economy, our current modes of production and consumption are overwhelmingly based on the linear principle. Resources are extracted, processed, used, and ultimately for the most part discarded as waste. At the end of such a cycle, waste is typically disposed of by incineration (thermal utilisation) or landfill (although the latter has been banned for untreated waste in Germany since 2005). In both cases materials are withdrawn from circulation or destroyed (even if thermal utilisation does at least produce energy). But such a linear economic model can only function if endless resources are available to satisfy endless demand. Global demand is growing steadily, while the availability of both non-renewable and renewable raw materials is finite. A strictly linear economy will inevitably encounter its limits.

However, alternatives do already exist that disrupt the classical linear economy to reduce resource consumption and/or increase resource efficiency. These are also known as the "three Rs": *reduce* (demand and/or consumption of resources, materials and products), *reuse* and *recycle* (returning materials to another life cycle). All these approaches support the circular economy concept, which in its entirety can be regarded as a fundamental alternative to the linear economic model (EEA 2015: 9).

Here waste is always regarded as substances of value. The objective of the circular economy is to preserve the value of utilised resources and materials as long as possible, to use them as frequently as possible, and to produce as little waste as possible (ideally none at all). The concept covers all aspects of economic activity, from resource extraction through production, storage and consumption, ending with disposal or ideally recycling. The *reduce*, *reuse* and *recycle* approach goes a long way towards this concept, although waste avoidance is prioritised (European Commission 2014: 13). The idea is to close cycles to turn waste back into a resource (in this connection we also speak of "second-sourcing"). But if this idea is to be put into practice as effectively as possible, another earlier step is needed: to take account of later recycling already at the design stage.

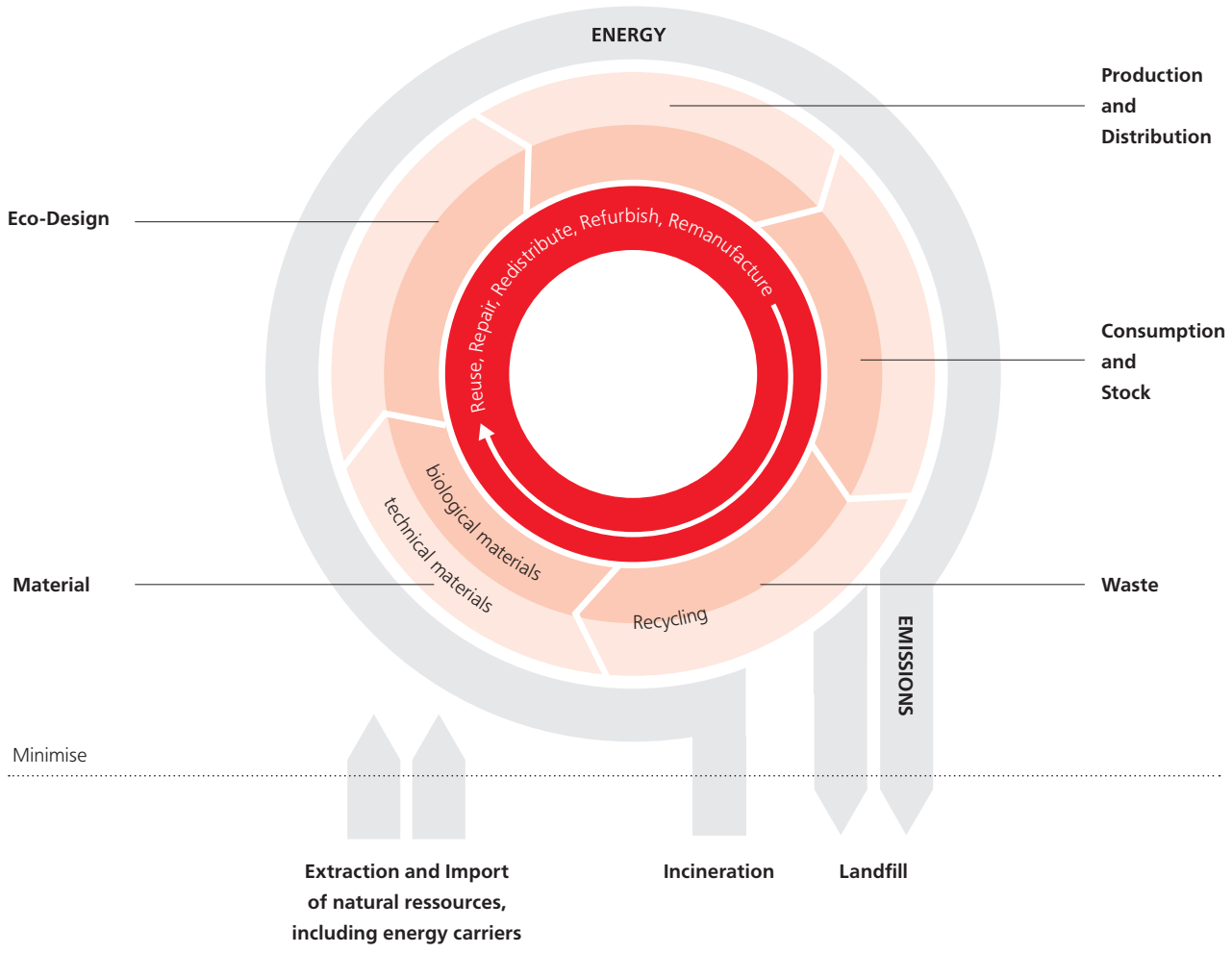
2.2 DIFFERENTIATING THE CONCEPT

The fundamental idea of the circular economy has given rise to various currents and variants featuring smaller or larger differences in concept, approach and scope. These include the circular economy of the Ellen Mac Arthur Foundation, the blue economy concept, cradle-to-cradle, and zero waste. The differences lie principally in the roles of bio-based cycles and renewable energy.

Blue Economy
The blue economy, propagated in particular by Gunter Pauli, describes business models based on the cascades found in ecosystems, where the waste product of one metabolic process forms the input for the next. When applied to industry that means returning by-products and waste to the process and circulating them as long as possible. Extending the life cycle of resources and materials can reduce waste (Lebensministerium Österreich 2012: 24).

Cradle-to-Cradle
The cradle-to-cradle (C2C) concept developed by Michael

Figure 1
The circular economy concept



Source: EEA 2015.

Braungart and William McDonough goes even further than the basic circular economy concept or the blue economy. It divides materials and resources into two cycles, the biological and the technical. In both, all materials should be completely "healthy" – in other words without harmful environmental effects – and able to circulate permanently. All materials should be fully preserved or completely degradable, so as to produce no waste at all. And during recycling the properties of the substances should ideally be improved (and definitely not reduced). Another important aspect is that the C2C concept involves a complete switch from fossil fuels to solar energy (McDonough/Braungart 2002).

Zero Waste

Zero waste can be regarded as a target to be achieved using various circular economy approaches. The zero waste movement is now global, and brings together very different aspects extending from simply reducing residual landfill waste through to comprehensive waste-avoiding product design (see for example Connett 2013).

2.3 BENEFITS OF CIRCULAR ECONOMY

The transformation to the circular economy is associated with high expectations concerning ecological and economic benefits: "Moving to more circular economic models promises a much brighter future for the European economy. … By helping to decouple economic growth from resource use and its impacts, it offers the prospect of sustainable growth that will last" (European Commission 2014). Studies increasingly emphasise these benefits on four levels: resource utilisation, the environment, the economy, and social benefits including the creation of new jobs.

Resource availability benefits: improving resource security and reducing import dependency

The circular economy has the potential to improve efficiency of primary raw material use both in Europe and at the global level. If materials are preserved in high-quality products or waste is returned to industry as high-quality secondary raw materials, the circular economy can reduce European indus-

try's demand for primary raw materials. Lower demand for primary raw materials will in turn help to reduce dependency on imports, making value chains in many sectors of industry less vulnerable to price fluctuations in the international commodity markets and insecurity of supply caused by scarcity and/or geopolitical factors. Current estimates suggest that 6 to 12 percent of total material consumption (including fossil fuels) could already be saved or avoided through recycling, waste avoidance and eco-design strategies; the maximum potential on the basis of existing technologies is estimated at up to 17 percent (European Commission 2011).

Ecological benefits: fewer environmental impacts
The absolute decoupling of economic growth and quality of life from consumption of resources and energy (and the associated environmental impacts) is the principal objective of the EU's resource efficiency policy. Circular economy strategies contribute concretely to that goal in various ways, including by prioritising waste avoidance and reuse under the waste hierarchy. According to an impact assessment in connection with the EU's waste targets (European Commission 2014), the complete closure of landfill sites in combination with elevated recycling targets could generate an additional annual reduction in greenhouse gas emissions of approx. 440 million tonnes between 2014 and 2030. And in a circular economy waste avoidance, eco-design, reuse and similar measures can also contribute to climate protection: they are already responsible for avoidance of 2 to 4 percent of Europe's total annual greenhouse gas emissions (AMEC et al. 2013).

Economic benefits: opportunities for economic growth and innovation
Turning away from linear modes of production and consumption based on "take, make, use and dispose" can also offer considerable opportunities to improve competitiveness in various sectors of European industry. The circular economy offers important cost savings for various industries. According to estimates by the Ellen MacArthur Foundation, improving circulation in the manufacturing of complex consumer durables with medium lifespans could produce savings in material costs of up to $630 billion in the EU alone (WEF 2014). Beyond this, the circular economy can also offer a platform for innovative approaches, technologies and business models that create economic added value from limited natural resources. This can support European industry in becoming more resilient to external shocks and improving its global competitiveness.

Social benefits: sustainable consumer behaviour and employment possibilities
From a social perspective, too, Europe can profit from the transition to a circular economy. Social innovations associated with waste avoidance, reuse, recycling, eco-design, a sharing economy and other developments offer opportunities to establish more sustainable patterns of consumer behaviour and thus to contribute to human health and consumer safety. In particular, the circular economy can generate new employment opportunities in Europe. According to the European Commission's impact assessment for waste targets, simplified legislation, improved monitoring and dissemination of best practices alone could create more than 180,000 new jobs by 2030 (European Commission 2014).

2.4 LIMITS OF THE CONCEPT

However, it is conspicuous that certain questions have to date received little or no systematic consideration in the circular economy debate. Not only are the hopes to completely close materials cycles still a remote utopia in practice; even in theory they contradict the fundamental laws of thermodynamics, as certain quantitative or qualitative losses are practically unavoidable. In any event, energy is also required to recycle waste. While this is normally less than needed for extracting and processing primary raw materials, it remains impossible to circulate unlimited quantities of material without coming into conflict with climate targets (UNEP 2013). Fundamentally the transformation to the circular economy will not obviate the necessity to substantially reduce the consumption of natural resources in the interests of sustainable development.

Another associated aspect here is the fundamental availability of raw materials. Until recently the resource debate has been dominated by the so-called critical raw materials that are absolutely indispensable for particular processes or products. (especially for green technologies such as solar and fuel cells; Erdmann et al. 2011). No suitable substitutes exist for these substances, and at the same time supplies are endangered because demand exceeds supply, the static range may be disturbingly small, or the known reserves are concentrated in a small number of countries that could exploit their monopoly position to their own advantage. The most widely discussed example is the rare earths, without which no modern smartphone can be manufactured. China possesses 90 percent of the known reserves, and has in the past restricted exports. In view of rapidly growing demand, even a completely closed cycle would not suffice to supply industry. As these points illustrate, the circular economy still presents conceptual challenges where work remains to be done (Bringezu et al. 2009).

2.5 THE INSTITUTIONAL SYSTEM AND ACTORS OF THE CIRCULAR ECONOMY

The circular economy has very quickly turned into an extremely dynamic policy area, characterised in particular by its pronounced cross-cutting character with novel constellations of actors.

Waste management
In Germany classical waste management has been heavily shaped by the duty of public waste management authorities to ensure safe disposal of all residual waste. On the waste side, this approach was supplemented by the principle of expanded producer responsibility, anchored in the German Closed Substance Cycle and Waste Management Act of 1994, under which producers are responsible for coordinating the handling and utilisation of the waste they produce.

This has led them to develop and instigate various regional and national systems.

The European Waste Framework Directive obliges Germany to prepare a waste avoidance programme setting out concrete measures and targets for avoiding waste and the associated environmental impacts. At the level of the federal states waste management plans coordinate treatment capacity with need. Local authorities ensure reliability of disposal in concrete waste management concepts (Wilts 2016).

As yet, there is still no comparable institutional framework for the circular economy. Germany's Recycling Act (Kreislaufwirtschaftgesetz) still focuses strongly on the waste side of the equation; significant momentum is currently generated by the Resource Efficiency Programme II, which aims to double Germany's resource efficiency by 2020 (compared to 1994) including by closing materials cycles (BMUB 2016).

At the level of the European Union the action plan "Closing the Loop" lays out a considerably more comprehensive framework, designed in diverse respects to improve international competitiveness, boost investment, create jobs, and ultimately lead to sustainable growth (European Commission 2015: 1). The action plan comprises various legislative proposals and measures in the areas of production (product design and production processes), consumption and waste management, as well as concrete targets for creating an ambitious long-term roadmap for waste management and recycling in Europe. The objectives include:

- a recycling rate of 65 percent for household waste by 2030;
- a recycling rate of 75 percent for packaging by 2030;
- obligatory reduction of landfill disposal to a maximum of 10 percent of all waste by 2030;
- a ban on landfill disposal of separately collected waste (e.g. paper, glass packaging);
- economic incentives to make landfill unattractive.

The Commission believes that these targets will lead all EU member states to successively adopt proven methods and make the required investments (European Commission 2015: 3). At the same time, responsibility for individual issues and concrete implementation remains largely unclarified, as do the necessary measures at the level of the member states. The increasing focus on reclaiming and producing secondary raw materials as one of the central elements of the circular economy also leads to increasing Europeanisation of the policy area. Manufacturing industry as the consumer of recycled waste requires input of uniform quality in quantities that far exceed that which is available locally.

Industry

The circular economy concept is characterised – as described above – by linkage of the post-use phase with questions of recyclable design and the legal framework for resource-efficient and waste-avoiding production methods. These questions are currently still discussed in a largely sectoral framework ("green chemicals", "sustainable metalworking") or as a marginal topic in the otherwise strongly energy-orientated EU Ecodesign Directive. Especially in Germany, the closely related issue of resource efficiency – as one of the environmental policy priorities of recent years – had created a strong focus on optimisation of internal company processes, leaving an outstanding institutional gap in relation to a circular economy transcending product life cycles.

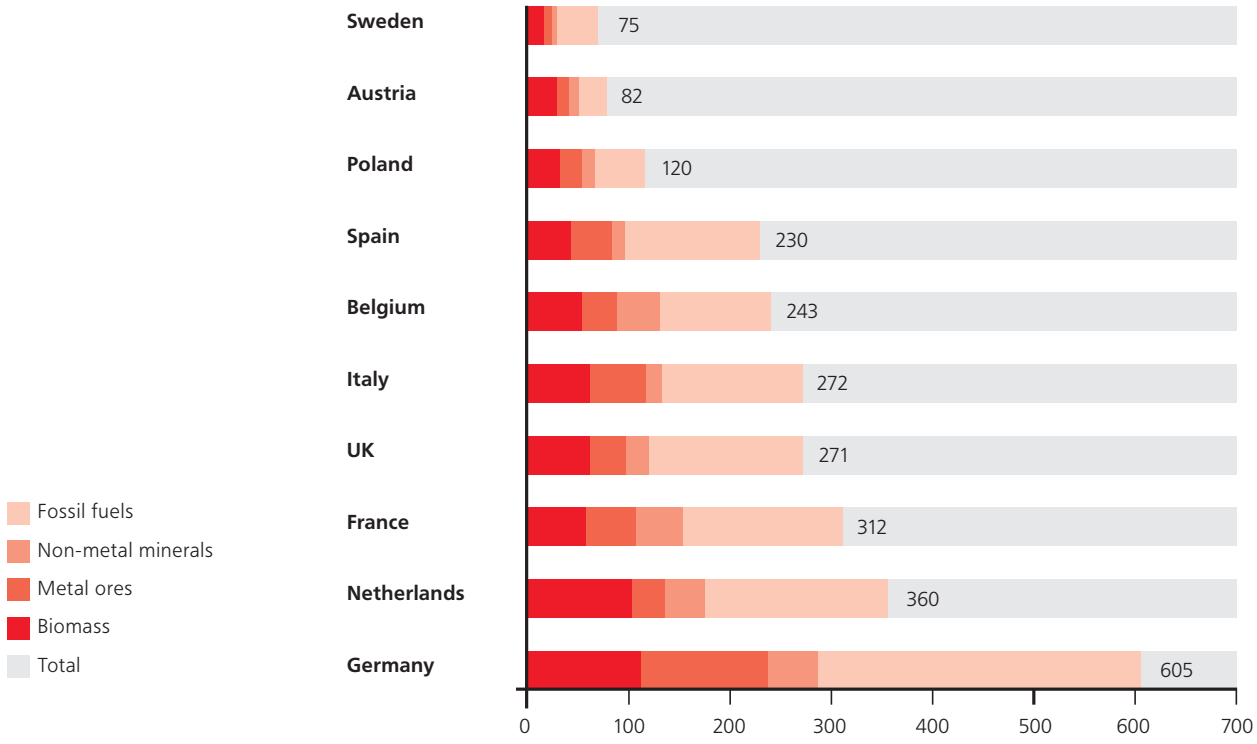
A successful circular economy will require not only new structures, but in particular the inclusion of additional actors. Compared to classical waste management, industry plays a considerably more important role here. From its perspective the trend towards circular economy offers significant potential for improving Germany's long-term competitiveness, because the use of secondary raw materials as input for industrial production processes can frequently make a crucial contribution to security of supply (in addition to the associated cost savings). As a resource-poor country, Germany is increasingly dependent on raw material imports, some of which are classified as "critical" for example by the European Commission. Important production processes depend on these raw materials (for example flat-screen televisions and monitors still cannot be made without indium); at the same time the supply is risk-prone, with existing reserves concentrated in individual countries or companies. Recirculation of such raw materials could make Germany more independent, also from the massive price fluctuations often associated with these commodities (Erdmann et al. 2011). As Figure 2 shows, Germany as an especially import-dependent country would profit especially from such a development.

Consumers

Although the concrete effects of the circular economy are still hard to assess, the role of the consumer will be fundamentally different to today. It can, however, be assumed that consumers will also benefit from the outlined benefits for industry. According to a study by McKinsey (2016) on the potential of the circular economy in Germany, the costs of mobility, housing and food could fall by 25 percent by 2030 (see Figure 3).

At the same time, however, high expectations are also placed on consumers. The various new circular economy business models will only be able to succeed if consumers change their habits and for example recognise the benefits of using rather than owning. The necessity to change patterns of consumption through education, market-based incentives or campaigns is frequently noted, but how this process will roll out is still associated with many imponderables. It will also be necessary to ensure that the high safety standards applying to products and pollutants continue to be observed in future, even if that means that particular waste streams cannot be circulated and must instead be disposed of.

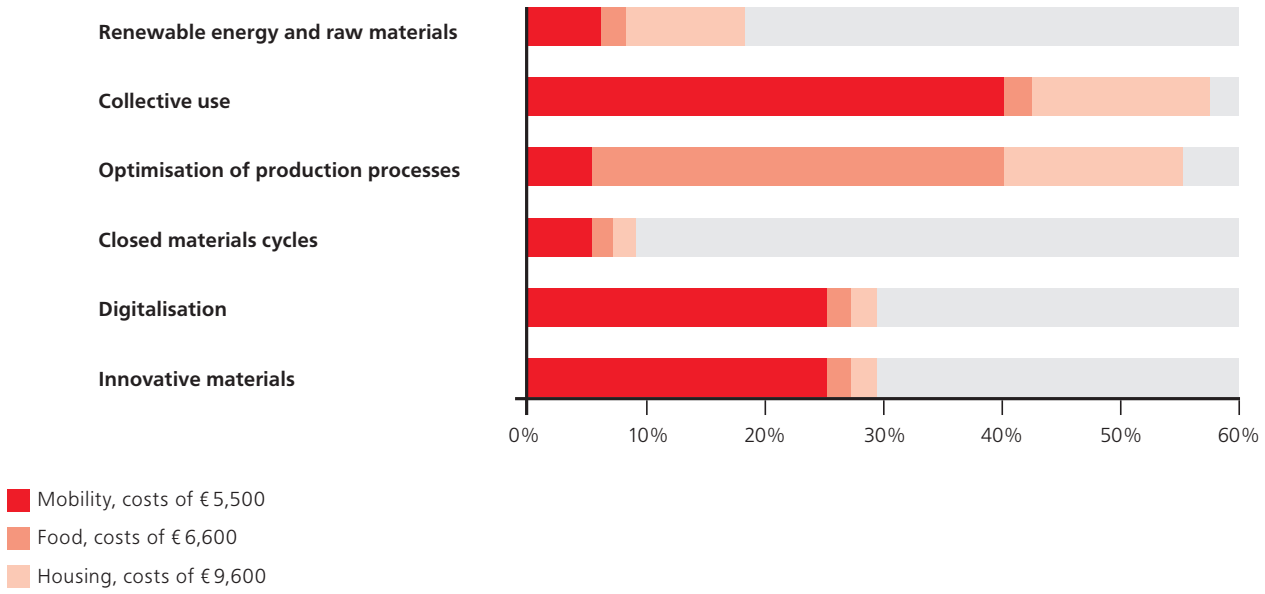
Figure 2
Total imports to Europe (million tonnes), 2014



Source: data from McKinsey 2016.

Figure 3
Potential cost savings in the circular economy

Annual spending in three areas representing 60 percent of household spending (EU average 2012) and optimisation potential for 2050



Source: data from McKinsey 2016.

3

GERMAN PROGRESS TOWARDS A CIRCULAR ECONOMY

3.1 THE WASTE MANAGEMENT PERSPECTIVE

With respect to the waste management side of the circular economy, Germany has long been one of the absolute leaders. Largely technical regulations – for example on landfill, incinerator emissions and producer responsibility for packaging waste – have created a technical level of waste management infrastructure that remains the envy of the world. This is associated with impressive recycling rates for almost all relevant waste streams, holding steady over many years. For example, 86.9 percent of household waste is recycled, while the European average in 2012 was just 37 percent (EEA 2015). Germany's overall recycling rate in 2013 was 79 percent (UBA 2015).

Environmental problems associated with the existence and treatment of waste have been substantially reduced in Germany, and "security of disposal" has been broadly established as the objective of the waste management. Waste is in principle comprehensively collected and could be returned to the materials cycles. In fact, many actors now regard waste as a problem that has been "technically solved".

In addition to the ecological benefits, recycling also pays economically in Germany. Waste management is a major sector of the economy, employing almost 200,000 people in about 3,000 companies, with an annual turnover of about €40 billion (UBA 2014). Ambitious waste management strategies and strong environmental awareness have in particular brought forth technological innovations for separation and recycling. Globally there is strong demand for German high-tech solutions and German know-how. German companies possess a global market share of 64 percent for automatic material separation technologies, such as optical and sensor-based identification processes for rapid recognition and separation of different plastics. Annual growth in automatic material separation equipment is expected to run at 15 percent through until 2020. The waste market overall will in all likelihood grow by at least 3 percent annually (BMU 2014).

3.2 THE CIRCULAR ECONOMY PERSPECTIVE

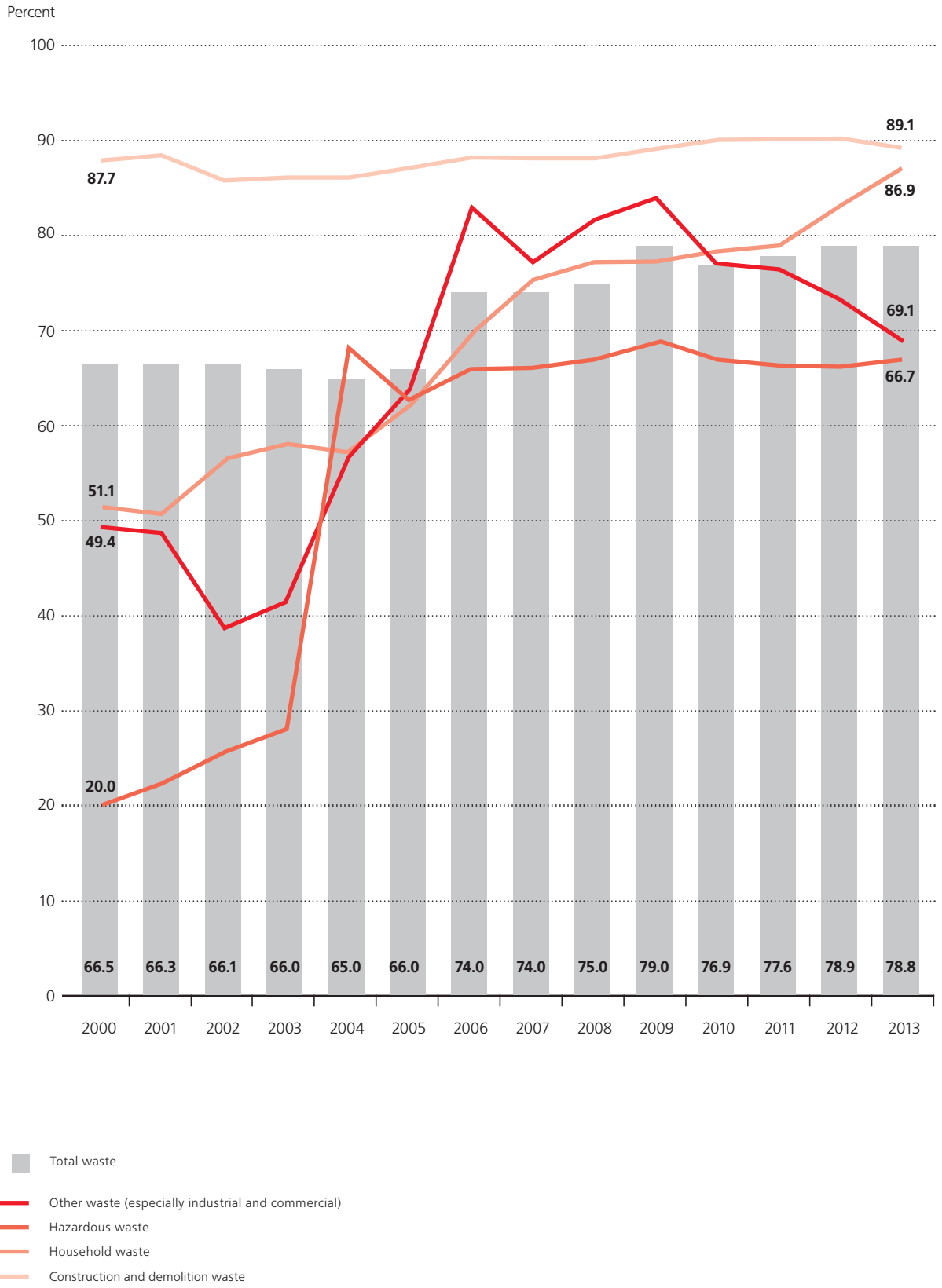
A very different picture appears, however, if we expand the perspective and examine the real circulation of waste. The Deutsche Gesellschaft für Abfallwirtschaft, for example, investigated what proportion of waste is actually "returned to production as secondary raw materials", and arrived at the sobering figure of just 38 percent for 2013 (DGAW 2016). In other words, two-thirds of waste is not used as a resource. This fits with the finding that in 2010 only 14 percent of the raw materials used in Germany were gained from waste (IdW 2010).

Recycling rates are therefore of only limited value as indicators of circular economy. Under current legislation a product such as a mobile phone can be classed as 100 percent recycled without reclaiming even a single milligram of the critical raw materials it contains, such as gold, palladium and indium. The reclamation rates for these substances – which are present only in minute quantities but represent a large proportion of the product's total resource use on account of the complexity of their mining and processing – still remain disappointingly small. In fact in some cases the lack of requisite technologies means that they still cannot be reclaimed at all (UNEP 2013). Even for substances such as aluminium, steel and copper, where the recycling technologies are long-established, secondary raw materials still only account for 40 to 50 percent of respective production in Germany (Statista 2016).

3.3 THE "INNER CYCLES"

The circular economy concept of maintaining the value of products and raw materials as long as possible implies a particular focus on activities such as preparation for reuse, repair and in general extension of the service life of products. Here we find that considerable development potential still exists in Germany. Durable, repairable and recyclable product design is one of the core elements of the circular economy. But the real developments in this area still remain extremely confused and opaque, as reflected for example in the discussion

Figure 4
Recycling rates by waste type



Source: Umweltbundesamt 2015.

about "planned obsolescence". Critics argue that products are designed intentionally to fail sooner than necessary (in particular shortly after expiry of the guarantee), forcing consumers to purchase unnecessary replacements.

A recent study commissioned by the German Environment Agency found that consumers today are keeping newly purchased products less long than they used to. In comparison to 2004, the time until the first user purchased a replacement for domestic appliances such as washing machines, dryers, fridges and stoves in Germany fell from 14.1 years (2004) to 13.0 years (2012/2013) (UBA 2016). Although no clear trend is observable for other product groups such as notebooks, the "phasing out of waste" through product design is definitely not yet reality.

While the German data on repair and preparation for reuse is also patchy, it is clear that the classical system of "produce–use–dispose" remains absolutely dominant. In the case of electronic devices, for example, the rate of reuse after disposal is just 1 percent in Germany. Comparison with other countries and regions such as Austria and Flanders reveals that considerable potential remains untapped, even with the current state of technology and the current design of products on the market. Reuse networks like Revital and Kringloop apply uniform quality standards and marketing concepts and enjoy political support respectively reduced VAT rates for repaired products – and achieve reuse rates that are in the case of certain products ten times better than Germany's (Wilts et al. 2014). While the annual volume of repair services in Germany is already about € 2.8 billion (see Figure 4), that is still considerably less than 1 percent of the market for new products.

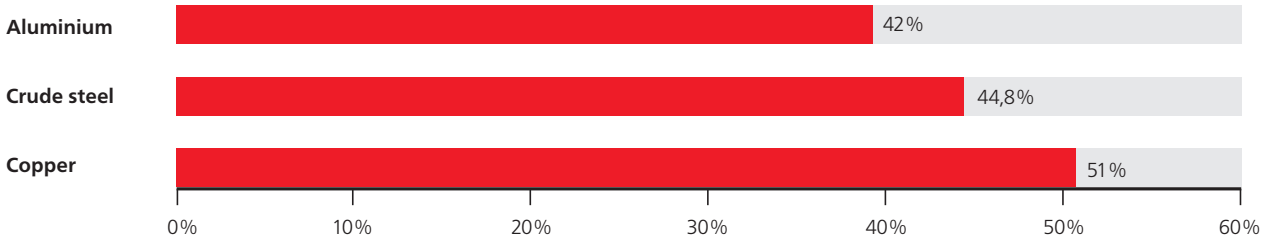
3.4 OBSTACLES ON THE ROAD TO THE CIRCULAR ECONOMY

The fact that the German waste sector appears to generate technological lock-ins appears noteworthy in this connection. Industry and consumers often have little incentive to pursue waste avoidance, as long as the waste regime offers attractive alternatives. For many years German waste management was characterised by overcapacity in the incineration market. Incinerators such as those in Cologne, Frankfurt and Stuttgart, with annual capacity up to 400,000 tonnes, have incurred enormous construction costs (hundreds of millions of euros). These monuments to classical waste treatment have been planned and designed for a service life of decades. Most of the first-generation incinerators were built in the 1970s and are still in operation. Large investments and correspondingly long repayment periods represent a key obstacle to waste avoidance. Both private and public investors have an interest in using existing infrastructures for as long as possible in order to maximise return on investment. Even if almost all incinerators in Germany are currently operating at full capacity – partly on imports from other EU-member states – low prices for waste incineration have led to a wave of insolvencies in medium-sized recycling businesses in recent years, because for many waste fractions it was cheaper to incinerate than to reclaim the materials.

This situation hampered innovations for closing cycles and avoiding waste to create a circular economy. In fact, the problem has been carried over into the new Recycling Act (Kreislaufwirtschaftgesetz): for waste streams with a calorific value exceeding 11,000 kJ/kg incineration has been declared equivalent to recycling. Various authors have expressed great doubts as to whether this arrangement is compatible with the European waste hierarchy (Frenz 2013: 45) or whether it in fact withdraws material flows from utilisation.

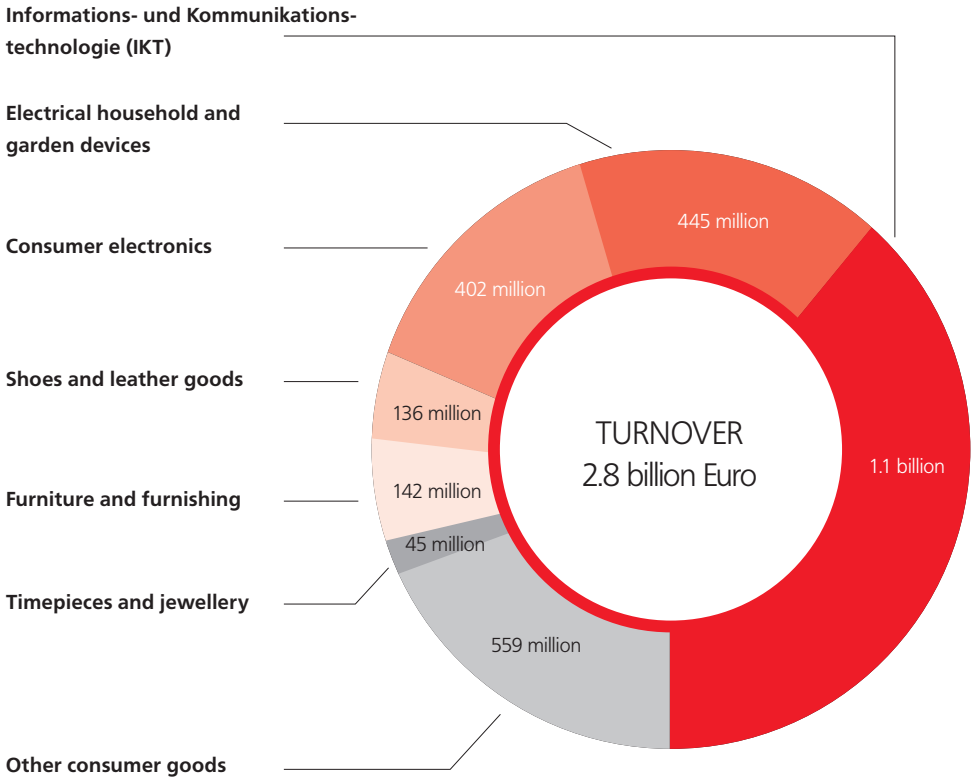
Analyses of innovations in Germany's leading environmental markets clearly reveal the effects of this technological path-dependency. Data on patents shows the waste sector falling behind in comparison to other markets such as air pollution and climate protection (see Figure 5): "In the areas of waste, recycling and sewage stagnation is observed in patent applications. If Germany is to meet the growing challenges of improving resource efficiency and security, the dynamism in recycling may not be sufficient" (translated from Gehrke et al. 2014: 51).

Figure 5
Proportion of secondary raw materials used in production of copper, aluminium and crude steel in Germany, 2014



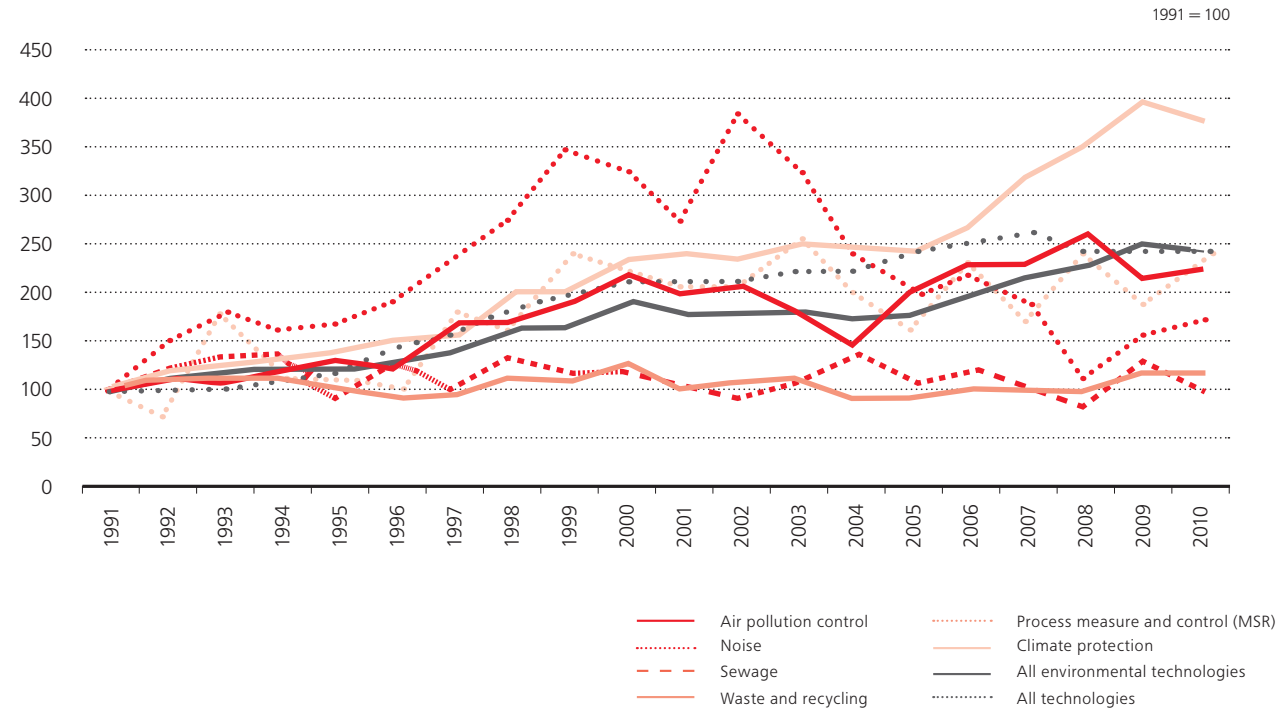
Source: Statista 2016.

Figure 6
The market for repair services in Germany



Source: Poppe 2014.

Figure 7
Patent applications in Germany, 1991–2010



Source: Gehrke et al. 2014.

4

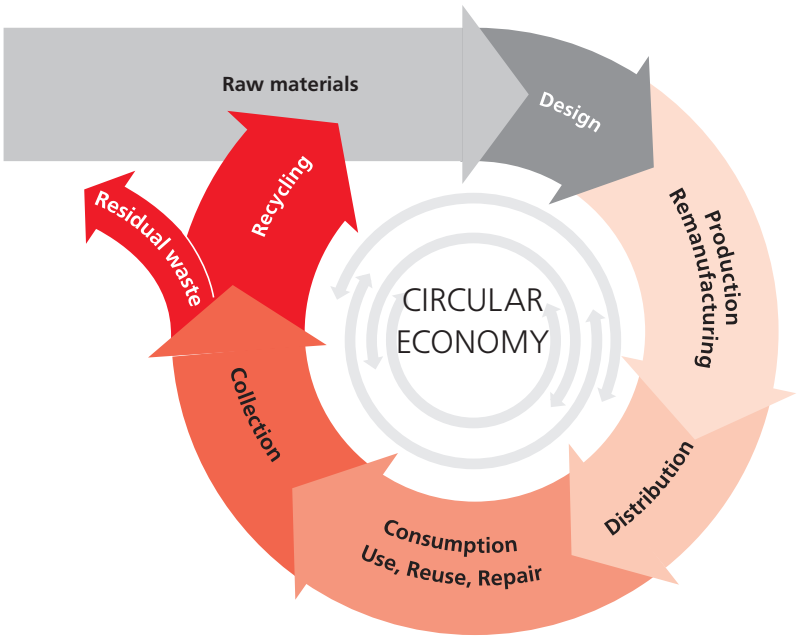
NECESSARY FRAMEWORK AND INSTRUMENTS

Even if, as outlined above, Germany still has a long way to go to achieving closed materials cycles (to the extent that makes sense) and implementing the circular economy, a number of discernible approaches and instruments could contribute to that goal. In the following a number of these are described, with their possible fields of application, strengths and weaknesses. The discussion follows the product life cycle (see Figure 8).

4.1 PRODUCT DESIGN

Improved and waste-avoiding product design will have to be one of the central levers for implementing the circular economy. Better design can help to make products longer-lived or easier to repair, refurbish or upgrade. It can assist recycling businesses when they dismantle products to reclaim valuable materials and components. Altogether, valuable resources can be saved in this way. Yet the current market signals

Figure 8
The elements of the circular economy



Source: European Commission 2014.

appear inadequate for realising this possibility, especially because the interests of producers, consumers and recyclers are not aligned. It is therefore essential to launch initiatives for improving product design, while preserving the internal market, upholding competition and enabling innovation. Because products are generally not manufactured for individual national markets, this is an issue in particular for the European Commission.

In order to promote better product design, the Commission will emphasise aspects of circular economy in future regulations under the Ecodesign Directive, whose objective is to improve the efficiency and ecological performance of energy-related products. To date ecodesign regulations have largely targeted energy efficiency; in future, questions such as repairability, durability, upgradeability, recyclability, and the identification of particular materials and substances will be systematically reviewed. The Commission will analyse these issues on a product-by-product basis in cooperation with relevant stakeholders, with new work plans and evaluations addressing the specific issues and challenges of various products (such as innovation cycles). As a first step the Commission has developed – in the scope of the Ecodesign Directive – obligatory product design and labelling standards, which will soon be presented to the member states. For example, the dismantling, reuse and recycling of electronic displays is to be made easier and safer (European Commission 2015).

In order to allow technical service life to be measured and compared in practice, progress is needed in the development of measuring norms and standards for components and devices. The framework for product repairability should also be improved, so that defective devices are more frequently repaired rather than replaced. This would include making spare parts and transparent repair information available to independent repair businesses (not tied to the manufacturer). The authors of a study on the influence of product life on environmental impact (Prakash et al. 2016) also recommend expanding manufacturers' duty to supply information.

On the one hand, they should clearly declare wearing parts and safety-related breaking points. On the other, they should inform consumers about the ecological advantages of long-lived products, servicing intervals and costs of potentially necessary repairs. The distribution of such information to consumers can also be organised at the national level, which would imply the involvement of national government. To concretise such measures, a DIN committee has already been established to examine and develop corresponding normed procedures.

4.2 SUPPORT FOR NEW BUSINESS MODELS

Innovative business models based on closed cycles and resource efficiency are one of the most powerful drivers of the circular economy. Where successfully established, such business models will have a direct and lasting impact on the economic system and at the same time advance the adaptation of the necessary framework. Here very different approaches exist (see EEA 2015). The various service-orientated concepts of "using instead of owning", for example, seek to create economic incentives for long-lived product design with optimised return systems, and also to intensify customer relations. From the customer perspective they often produce significantly greater transparency concerning the overall life cycle costs of products and thus enable more rational purchase decisions (Tukker and Tischner 2006). Two examples of such approaches have already become classics: Xerox, as a supplier of copying services rather than photocopiers (where the service model already contributes almost 50 percent of company profits; Xerox 2015) and the jet engine division of Rolls-Royce, whose power-by-the-hour contracts already include servicing and repairs. Other approaches focus more strongly on collective use through sharing or leasing. Here the business models generally involve the provision of online platforms for customer-to-customer exchange, whether private or commercial (B2B or C2C).

New financing models also play a crucial role. Whereas contracting is long-established in the field of energy efficiency, for example, similar models for circular economy concepts are frequently still in the early stages of development. The associated uncertainties and teething problems frequently make it difficult for innovative start-ups to gain the necessary access to capital markets. One fundamental problem affecting the aforementioned service-orientated concepts such as Xerox (and also Mud Jeans, for example) is that ownership remains with the manufacturer even in the use phase, and cash-flow is considerably delayed in comparison to linear business models. Such concepts could be supported by the new green bond market, although it is itself still in an early stage of development (EEA 2014).

Such circular economy business models could profit especially from ecological tax reforms, where the burden of taxation is shifted from work (earnings) onto resource consumption and environmental impact. This would particularly boost the position of reuse and remanufacturing – as labour-intensive sectors of the circular economy – vis-à-vis linear concepts for single-use products (EEA 2014). A deeper understanding of such possible financial incentives and market-based instruments, along with their effects on the circular economy, will be one of the necessary preconditions for the successful implementation of new business models.

One of the most successful examples in this field is the British National Industrial Symbiosis Programme (NISP), representing a network of more than 15,000 industrial enterprises to identify profitable transactions between businesses to optimise the use of resources including energy, water, waste and supplies. NISP has already enabled 47 million tonnes of industrial waste to be diverted away from landfill. It has also generated £1 billion in turnover and secured 10,000 jobs (ISL 2015). As its example underlines, the promotion of new business models must be clearly tailored to national and regional contexts and circumstances. In Germany, developing programmes and funding formats tailored to regional innovation potential will be principally a matter for the federal states.

One general characteristic of the most innovative business models is their fundamentally transformative character. This is in the first place positive, because a system transformation will depend on such impetus. But new business models can also have negative effects, for example if they undermine the payment of taxes or safety rules and social standards. These negative effects generally stem from existing political

conditions that fail to take account of social, technical and economic change. Innovation policy should deal with that problem by finding solutions that eliminate all negative social consequences associated with innovative business models, without reducing the positive ecological and economic successes.

4.3 INDIVIDUAL PRODUCER RESPONSIBILITY

Manufacturers' responsibility for their products after the use phase ("extended producer responsibility") is a central element of the circular economy, but one that has to date been only inadequately implemented. Achieving real effects would require individual responsibility on the part of each manufacturer. But in practice this responsibility is delegated to external organisations and thus loses its circular-economy-promoting incentives.

In the (collective) model the producers of a product group are held jointly responsible without heed to their individual brands. The benefit of individual producer responsibility lies in the strong tie it creates between the producer and the management of waste products. This relationship would do more to encourage improvements in product design than one based on shared responsibility. As long as the financial burdens are shared equally between brands, without regard for the differences in the ecological characteristics of the products, producers that work harder to reduce the ecological impacts of their products are in effect subsidising those who make less effort (see van Rossem 2008).

Appropriate incentives can be developed by differentiating the charges applied to end-of-life management of marketed products. Here individual producer responsibility is required, in order to create a feedback loop between the design of brand-specific products and their end-of-life management. Individual producer responsibility does not necessarily mean that each producer has to develop a separate infrastructure for collecting and processing their own products; but only that ways must be found to make manufacturers bear the real costs associated with their products.

Concepts for extended producer responsibility have to date been implemented almost exclusively at the national level, with differences in approach between EU member states frequently causing high administrative costs for businesses. With respect to concepts for individual producer responsibility it would be useful if the European Union established a framework for the European single market, as for example outlined in a study for the European Commission (Monier et al. 2014).

4.4 AMBITIOUS WASTE MANAGEMENT TARGETS FOR ALL LEVELS OF THE WASTE HIERARCHY

There is also a need for action on setting ambitious waste management targets, especially with respect to avoidance and reuse as fundamental priorities in the waste hierarchy. The action plan presented by the European Commission contains specific quantified targets for the recycling of individual waste streams. Some of these have been criticised as too cautious, and differences in recording methods between member states mean that the achieved recycling rates are not always comparable. Nonetheless, the targets give a clear orientation and as such also guide innovation processes.

In clear contrast to the situation with recycling, there are significantly fewer measures for waste avoidance and preparation for reuse (as the top levels of the waste hierarchy). Although the EU's waste policy generally gives low priority to waste avoidance, the Waste Framework Directive requires all member states to develop national waste avoidance programmes. The requirements for these programmes as listed in the Directive are not very concrete and leave a great deal of scope for interpretation by the member states. Member states may define specific quantitative targets under Article 29 (3) of the Waste Framework Directive (but are not required to). In fact only twenty of the twentyseven programmes published by 2015 contained quantitative targets for waste avoidance.

Certain targets relate to total waste, others to specific sectors or waste types (EEA 2015). Spain, Scotland and Wales have set quantitative targets for the total amount of waste; Italy has reduction targets tied to GDP. So most of the programmes are seeking absolute decoupling, which is regarded as a challenge because the volume of waste is historically linked to economic growth. Latvia has not set a reduction target, but instead defined an upper limit of 400 kilograms of household waste per head by 2020. The Netherlands has set a maximum limit for total waste production of 68 megatonnes in 2015 and 73 megatonnes in 2021 (the figure for 2006 was 60 megatonnes). The Brussels region, the Netherlands and Sweden have set targets for food waste. Wales has set targets for waste reduction in certain sectors of the economy. The Swedish programme includes a general target intended to contribute to reducing dangerous substances in materials and products (EEA 2015).

As these examples demonstrate, quantified waste avoidance targets at the national level are certainly possible. But the German government has refrained from defining concrete targets in its waste avoidance programme, on the grounds of lack of adequate data.

4.5 PREVENT ILLEGAL WASTE EXPORTS

If an effective circular economy is to be implemented, it will be imperative to stop the illegal removal of waste from Germany. In the case of used motor vehicles, for example, Germany possesses the necessary technologies and treatment facilities to fulfil even the European Commission's increased recycling target of 95 percent. At the same time, however, only about one in seven of the 3 to 3.5 million vehicles deregistered every year is actually recycled in Germany (UBA 2015). Considerable numbers are exported, sometimes illegally, to countries that have much lower environmental standards for operating and dismantling road vehicles. In the area of used electrical devices, reformed German legislation now stipulates that exporters must demonstrate that their exports are not waste – yet still illegal exports remain a problem.

That said, a blanket ban on waste exports is neither economically nor ecologically sensible. Just as Germany profits from trade in raw materials and products, so the circular economy can benefit from a global division of labour. However, the European Commission and the German government need to define clear criteria for the circumstances under which exports should be banned because they occur solely to cut costs by subverting environmental standards. At the same time, personnel levels in state administrations are frequently insufficient to actually verify the observance of existing regulations on a sufficiently broad scale.

4.6 FOCUSSED RESEARCH ON IMPLEMENTATION

Ultimately, the circular economy will also need to achieve a clear impact on research policy. Alarming findings on declining innovation activity in the area of waste management underline the need for new priorities in research and development. In place of technically dominated end-of-pipe solutions, more strongly interdisciplinary research approaches that also integrate sociological and economic aspects will be required to produce systemic innovations. The central questions will include how – in an existing regime still dominated by waste management – circular economy innovations can be supported vis-à-vis established technologies. Here so-called transdisciplinary technologies will also have an important role to play, bringing promising innovations to the market in cooperation with central stakeholders from the field of practice. Through the German Research for Sustainability programme (Forschung für Nachhaltigkeit; BMBF 2015), for example, and in particular its ongoing projects in the area of social-ecological research, the first steps have already been taken. That represents a foundation on which the significance of circular economy research can be further reinforced.

Further research priorities dealing with concrete operationalisation will emerge in association with the circular economy concept. For example: How can we measure how "circular" the German economy has already become? How can we determine whether policies actually contribute to waste avoidance, and where does that also make economic sense? Initial evaluation approaches such as the recycling index have already been developed for the ostensibly simple question of how "recycling-friendly" a product is, and could in turn form the basis for corresponding political initiatives for effective improvements in recyclability (Reuter et al. 2015: 671 ff.). The integration of such new concepts and indicators into the existing legal framework – and possible associated effects – could contribute to implementation of the new resource efficiency programme, for example in the environmental research plan of the German Federal Environment Ministry and the German Environment Agency.

4.7 ACTION AT DIFFERENT LEVELS

As the approaches and instruments outlined here demonstrate, the central challenge of the circular economy will consist in sensibly coordinating diverse activities at different levels. In the following, the core priorities for action at the levels of the local authorities, the federal states, national government and the European Union are outlined.

The **local authorities** will continue to possess a key function in implementing the circular economy. As providers of local public services they have historically assumed a responsibility extending beyond simply ensuring that waste is disposed of. In their function as the principal point of contact between government and citizen, they possess opportunities to support innovative patterns of consumption and fields of business, to sensitise consumers to the issue of waste avoidance, and by way of their procurement criteria also to create market incentives for better product design.

At the level of the **federal states** it will be necessary to verify whether existing instruments such as the waste management plan can be adapted to the requirements of the circular economy. With respect to closing materials cycles, more attention should be devoted to the raw materials contained in waste streams. Industrial symbiosis concepts (using industrial waste as input for other production processes) can also probably be best supported at state level, by improving the supply of information on the location of waste products. At the same time the federal states will continue to play an important role in monitoring implementation. For only if the illegal disposal of waste is excluded will the circular economy alternatives add up.

At the level of **national government** diverse initiatives have already been set in motion to treat waste more consistently as a resource and to feed it in a suitable form back into production processes (for example with the reform of the Electrical and Electronic Equipment Act and the Recyclable Materials Act). Above and beyond the waste management aspects, one of the central challenges will certainly be to enhance the role of product design, waste avoidance and resource efficiency. The recently revised German national resource efficiency programme (ProgRess II) represents an ambitious programme with the potential to identify considerable synergies with waste management objectives that would benefit the circular economy.

With its circular economy action plan, the **European Commission** has also set itself a large number of tasks that will need to be addressed with concrete measures in the coming years. Here too, coordination with entities including with the Energy Union and efforts to expand the Ecodesign Directive will be central challenges on the road to a real European circular economy serving a model function and contributing to sustainable development and competitiveness. Especially in the area of product design, Europe will have to bring its full market power into play in order to persuade global manufacturers to adapt their production processes.

5

CONCLUSIONS

Comparison of the potential benefits of the circular economy with the steps thus far undertaken to implement it underlines that Germany has yet to make full use of the opportunities on offer (as the Ellen MacArthur study concludes for Germany): "Comparatively few German companies or regions use the circular economy principle as a differentiating feature; resource management continues to focus on observance of limits and management of energy efficiency" (translated from McKinsey 2016: 10). On the basis of this study and the FES's series of discussions, four main conclusions can be drawn:

(1) The circular economy is more than improved waste management

One of the central conclusions, also backed by the findings of the FES discussions, is that the circular economy debate in Germany still concentrates too strongly on the topic of waste management. There continues to be an excessive focus on measures that only take effect at the end of a product's life cycle, such as optimised separation of recyclable materials from residual waste or reclamation of metals from incinerator ash. In fact, technical optimisation measures can also expand the economic and ecological potential – although in comparison to the possibilities of a real circular economy these appear rather marginal. One explanation for the focus on technical and purely waste-related solutions may also be found in Germany's leading global position in waste management infrastructure: Since the major waste scandals of the 1980s (including dioxin emissions from incinerators) German waste management has invested massively in high-quality filter techniques, landfill barrier systems etc., driven in part by an ambitious waste management policy that was among the global pioneers for example in the area of packaging. From the perspective of many citizens – and also political decision-makers – this made waste into a problem that had been technically "solved". One central challenge will consist in communicating that circular economy means much more than better waste separation and technically optimised waste management.

(2) The circular economy must bring new actors on board

Technical innovations will also play a central role in the circular economy. This is especially necessary in relation to the design of products, which need to be long-lived, repairable, and 100 percent cyclable. Yet the technical aspects of the circular economy are probably in fact the easier part of the challenge of switching an entire economic system from linear to circular. Especially in comparison to waste management, a whole new realm of cooperation and coordination will be required in order to make this model viable right along the entire value chain. Resource producers, product designers, merchants, consumers and not least waste management actors will have to work together on optimised solutions, rather than continuing to concentrate solely on "their" elements of the chain (optimised resource extraction, process optimisation, improved recycling rates etc.). For example, repairable products can only be sensibly developed if users also possess the necessary skills. This simple example suffices to underline why the European Commission for example speaks of the necessity for fundamental systemic innovations in connection with the circular economy. On top of this comes the challenge of connecting actors at very different levels: from globally operating corporations through European and national legislation down to the neighbourhood, where for example shared use can be arranged for power drills (which otherwise go unused 99 percent of the time).

(3) The circular economy will not emerge on its own

With respect to the different interests and expectations of the various actors, it thus becomes clear that the circular economy also requires a clear regulatory framework. The discussion about possible economic savings and market potential sometimes threatens to obscure the fact that many actors also profit very well from the existing linear system. The waste business in Germany turns over €50 billion annually. Many of those involved understandably wonder about the future of their business model if there is no longer to be any waste.

At the same time, primary resources – for which prices have in many cases halved in recent years – continue to offer an alternative to the circular economy. A combination of technical innovations (such as fracking) and geopolitical developments (opening access to new resource deposits for

example in Iran) has driven the oil price in particular to lows that represent a real obstacle to moves towards the circular economy. At the same time it is clear that these prices do not represent the "ecological truth", but that the environmental costs of resource extraction are frequently externalised and unloaded on the populations of mining regions (see for example the mining-related environmental disasters in Brazil and Hungary) or in the case of climate change, on the global population. Even in economic theory, such price distortions lead to lead to deadweight losses; reducing environmentally harmful subsidies and pricing in the environmental costs of raw materials (for example through a resource tax or differential VAT rates) will represent a necessary element of an effective circular economy policy in Germany. The transformation to the circular economy will certainly not come about automatically, and even the frequently-invoked new business models will only be able to fulfil their role as drivers of the circular economy if they are given the appropriate framework.

(4) The circular economy requires a new mix of instruments

Shaping the framework that could support a circular economy will require new policy instruments that extend far beyond existing waste legislation. As outlined above, such instruments should operate in particular where the cycles intersect: product design to enable recycling; business models that minimise waste, etc.

The big challenge will be to integrate these instruments in a new policy mix:

1. in which the individual elements are complementary and ideally mutually reinforcing. On account of the often unclear objectives for the future of the circular economy, relevant policy in Germany still often appears inconsistent and too many existing arrangements are still designed for a classical linear system – for example for the disposal of construction and demolition waste that could be used as a resource elsewhere.
2. that brings together in a sensible framework responsibilities that are distributed over a wide range of political levels and ministries. This also includes the question of the responsibility of local authorities and private-sector waste operators, which needs to be considered more strongly from the perspective of a long-term circular economy and less in terms of short-term market share.

Only a policy mix of that type can in the long term create the necessary stable and credible framework within which businesses will invest in innovative circular-capable production processes and consumers will be able to enjoy the advantages of such a sustainable economic model.

List of Figures

References

AMEC et al. 2013: The Opportunities to Business of Improving Resource Efficiency, Northwich, http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/report_opportunities.pdf (22.4.2016).

Bundesministerium für Bildung und Forschung (BMBF) 2015: Forschung für Nachhaltige Entwicklung – FONA, Rahmenprogramm des Bundesministeriums für Bildung und Forschung, Berlin, https://www.bmbf.de/pub/Rahmenprogramm_FONA.pdf (22.4.2016).

BMBF 2015: Sozial-ökologische Forschung: Förderkonzept für eine gesellschaftsbezogene Nachhaltigkeitsforschung 2015–2020, Bonn, https://www.bmbf.de/pub/Sozial_oekologische_Forschung.pdf (22.4.2016).

Bundesministerium für Umwelt, Reaktorsicherheit, Naturschutz und Bau (BMUB) 2014: Green Tech Made in Germany, Berlin.

BMUB 2016: Deutsches Ressourceneffizienzprogramm II: Programm zur nachhaltigen Nutzung und zum Schutz der natürlichen Ressourcen, Berlin.

Bringezu, Stefan; Bleischwitz, Raimund 2009: Sustainable Resource Management, Wuppertal.

Connett, Paul 2013: The Zero Waste Solution, White River Junction.

Deutsche Gesellschaft für Abfallwirtschaft e. V. 2016: DGAW-Pressemitteilung Quotenzauber: Neue Berechnungsgrundlagen als Herausforderung für die deutsche Kreislaufwirtschaft, Berlin, http://www.dgaw.de/files/uploaded/pressmessages/dgaw-pressemitteilung-quotenzauber-20160129_1454320087.pdf (22.4.2016).

Erdmann, Lorenz; Behrendt, Siegfried; et al. 2013: Kritische Rohstoffe für Deutschland, Berlin.

European Commission 2011: A Resource-efficient Europe – Flagship Initiative under the Europe 2020 Strategy, Communication from the Commission 2011/21, Brussels.

European Commission 2014: Towards a circular economy: A zero waste programme for Europe, Brussels, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52014DC0398&from=EN, COM/2014/0398 final (03.05.2016).

European Commission 2015: Closing the Loop: An EU Action Plan for the Circular Economy, http://ec.europa.eu/environment/circular-economy/index_en.htm, Brussels.

European Environment Agency (EEA) 2014: Resource-Efficient Green Economy and EU Policies, EEA Report No 2/2014, Copenhagen.

EEA 2015: Circular Economy in Europe: Developing the Knowledge Base, EEA Report No 2/2016, Copenhagen.

Frenz, Walter 2013: Energetische Verwertung nach dem neuen Kreislaufwirtschaftsgesetz, in: Thomé-Kozmiensky, Karl (Eds.): Strategie – Planung – Umweltrecht, Neurupping, p. 37–48.

Gehrke, Birgit; Schasse, Ulrich; et al. 2014: Wirtschaftsfaktor Umweltschutz. Produktion – Außenhandel – Forschung – Patente: Die Leistungen der Umweltschutzwirtschaft in Deutschland, Umwelt, Innovation, Beschäftigung, Karlsruhe.

GIB/ARGUS 2009: Die wirtschaftliche Bedeutung der Recycling- und Entsorgungsbranche in Deutschland: Stand, Hemmnisse, Herausforderungen, Berlin, http://www.argus-statistik.de/dokumente/Recycling_und_Entsorgungsbranche_lang.pdf (22.4.2016).

Henkes, Walter 2010: Kirchturmdenken, in: Recycling Magazin (8), p. 24–25.

Institut der deutschen Wirtschaft Köln 2010: Anteile der Sekundärrohstoffe in Deutschland, Cologne.

International Synergies Limited (ISL) 2015: National Industrial Symbiosis Programme (NISP), Birmingham, http://www.international-synergies.com/projects/national-industrial-symbiosis-programme/ (22.4.2016).

Lebensministerium Österreich 2012: Zukunftsdossier „Alternative Wirtschaftsweisen", Vienna.

McDonough, William; Braungart, Michael 2002: Cradle to Cradle: Remaking the Way We Make Things, New York.

McKinsey 2016: Circular Economy: Werte schöpfen, Kreisläufe schließen, Berlin, https://www.mckinsey.de/sites/mck_files/files/20160125_circular_economy_germany.pdf (22.4.2016).

Monier, Véronique; et al. 2014: Development of Guidance for Extended Producer Responsibility, Final Report for the European Commission – DG Environment, Brussels.

Poppe, Erik 2014: Reparaturpolitik in Deutschland: Zwischen Produktverschleiß und Ersatzteilnot, Berlin, http://www.reparatur-revolution.de/wp-content/uploads/Studie_Reparaturpolitik-in-Deutschland-2014.pdf (22.4.2016).

Prognos 2009: Der Abfallmarkt in Deutschland und Perspektiven bis 2020, Berlin.

Reuter, Markus; van Schaik, Antoinette; et al. 2015: Simulation-based Design for Resource Efficiency of Metal Production and Recycling Systems: Cases – Copper Production and Eecycling, E-waste (LED Lamps) and Nickel Pig Iron, in: The International Journal of Life Cycle Assessment 20 (5), p. 671–693.

Siddharth Prakash; Dehoust, Günther; et al. 2016: Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen „Obsoleszenz", UBA-Texte 11/2016, Dessau.

Statista 2016: Anteil sekundärer Rohstoffe an der Produktion von Kupfer, Aluminium und Rohstahl in Deutschland im Jahr 2014, Hamburg, http://de.statista.com/statistik/daten/studie/259779/umfrage/recyclinganteil-bei-der-produktion-ausgewaehlter-metalle-in-deutschland/ (22.4.2016).

Tukker, Arnold; Tischner, Ursula 2006: Product-services as a Research Field: Past, Present and Future: Reflections from a Decade of Research, in: Journal of Cleaner Production 14 (17), p. 1552–1556.

Umweltbundesamt (UBA) 2014: Die Umweltwirtschaft in Deutschland, Dessau-Roßlau, https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/hgp_umweltwirtschaft_in_deutschland.pdf (22.4.2016).

UBA 2015: Verwertungsquoten der wichtigsten Abfallarten, Dessau-Roßlau, https://www.umweltbundesamt.de/daten/abfall-kreislaufwirtschaft/verwertungsquoten-der-wichtigsten-abfallarten (22.4.2016).

UBA 2016: Elektrogeräte werden immer kürzer genutzt, Dessau-Roßlau, https://www.umweltbundesamt.de/sites/default/files/medien/376/dokumente/pi_2016_05_obsoleszenz.pdf (22.4.2016).

UBA/ BMUB 2015: Jahresbericht über die Altfahrzeug-Verwertungsquoten in Deutschland im Jahr 2013, Dessau/Bonn.

UNEP 2013: Metal Recycling: Opportunities, Limits, Infrastructure: A Report of the Working Group on the Global Metal Flows to the International Resource Panel, http://www.unep.org/resourcepanel/Portals/24102/PDFs/Metal_Recycling_Full_Report.pdf (22.4.2016).

Van Rossem, Chris 2008: Individual Producer Responsibility in the WEEE Directive, Lund.

Wilts, Henning 2016: Nachhaltige Innovationsprozesse in der kommunalen Abfallwirtschaftspolitik, Hamburg.

Wilts, Henning; Wolff, A.; et al. 2014: REUSE – One Step Beyond, Vortrag im Rahmen der 46. SCUPAD-Konferenz „No Time to Waste: Planning to Reduce, Reuse and Recycle", 16.–18.5.2014, Salzburg.

World Economic Forum: The Global Competitiveness Report 2014 – 2015, Davos.

Xerox 2015: Xerox 2011 Report on Global Citizenship – Company Profile, Norwalk, http://www.xerox.com/corporate-citizenship/2011/company-profile.html (22.4.2016).

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