Circular Economy Model Germany

A COMPREHENSIVE CIRCULAR ECONOMY FOR GERMANY IN 2045

CONTENTS

FOREWORD

Dear Readers,

Let's start with a positive outlook: by 2045, Germany will have an economic system that ensures prosperity without having to pillage the planet. Using renewable energy, it will make intelligent use of raw materials and resources. Products will be used for a long time, shared, reused and repaired. At the end of their life spans, these products will come full circle, returning to the beginning, where they start once again to enhance the value created by companies and industries. The security of supply in Germany is beyond all doubt. Very little value is lost. Words like wasted resources, waste incineration and pollution of the natural environment can only be found in history books.

Science fiction? Far from it! Let's take a brief look back. In 2009, the WWF published a study entitled "Model Germany. Klimaschutz bis 2050. Vom Ziel her denken" (published in German only; English translation of title: Germany as a Model. Climate action up to 2050. Working backwards from the target). This was the first policy draft that specifically calculated how we can reduce greenhouse gas emissions by 95% and transition to a low-carbon, nuclear-free economy. In 2019, the German government's national climate law finally came into force, followed in 2020 by the decision to phase out coal. Both are very practical roadmaps towards climate neutrality, which has now been moved forward by five years to 2045.

Where do we stand today? To achieve our climate targets and stop biodiversity loss, the energy transition is a first, very big step. But now we have to go even further. What we need now is a circular economy in Germany, so that we can adapt the way we live, do business and use resources to reflect the boundaries set by the planet, which we are currently transgressing with serious consequences. Let's finally make use of all circular economy strategies and give them the necessary political support. Let's set a binding target for how much we want to reduce our raw material consumption and pass a resource efficiency law – one modelled on the German Climate Action Act.

This publication describing our "Circular Economy Model Germany" (CEMG) provides a detailed overview of how the circular economy can succeed in Germany: with the most effective circular economy measures in the key sectors as well as with political strategies for a successful transformation to a comprehensive vision of the future with binding targets and specific instruments.

We only have a small time window. With our linear economic system, we have already inflicted significant harm on our planet. Let's finally get rid of

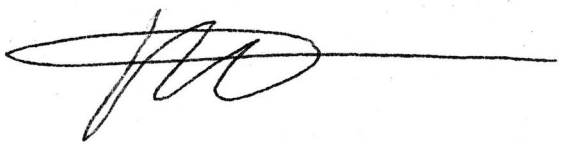
the “make-use-throwaway” principle once and for all. Let’s use the decade to chart the course. The Circular Economy Model Germany outlined here can serve as the roadmap for an organised, structured and successful transition to a comprehensive circular economy. Our most important target group is clearly the German government itself. Our aim is to provide fresh impetus and specific recommendations on how it can shape the general policies for a sustainable economic structure, for example with the Circular Economy Strategy announced for 2024.

In a year-long working process, staff from WWF Germany, Öko-Institut, Fraunhofer ISI and FU Berlin have conceived, calculated and discussed a holistic model for circular economy in Germany. It shows that this path is possible, that it will take us forward and yet lead us away from the irresponsible exploitation of our limited resources.

Thank you for all the support we have received from our project partners and sponsors. An equally big thanks to the members of the Scientific Advisory Board who supported the study with their valuable expertise. Thanks to everyone for your trust and willingness to engage in critical debate.

Heike Vesper
Chief Conservation Officer Transformation & Policy

Rebecca Tauer
Head of the Circular Economy programme at WWF Germany



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TESTIMONIALS

Dr Mechthild Baron
research assistant
German Advisory Council on the Environment

“Conditions and behaviour are interrelated: policymakers have a duty to help shape conditions in such a way that environmentally friendly behaviour becomes attractive and commonplace. Simply designing a product for longevity and recyclability does not by itself lead to a longer useful life. People need motivation, goals and successes to be able to change familiar routines. CEMG dares to take a broad view, shows possible pathways and encourages everyone to set in motion all levers at their disposal – because the circular economy works in many ways, both small and large.”

Dr Ralph Boch
Hans Sauer Foundation
Board of Directors

“The Circular Economy Model Germany project provides important foundations for circular transformations needed in our economy. Knowledge-based recommendations for action are therefore available for central sectors and thus key areas of resource consumption and processing. Seen from the perspective of a roadmap to a circular society, these are important prerequisites for a society-wide transition to a fundamentally different way of managing resources in a circular society.”

Professor Stefan Bringezu
Sustainable Resource Futures research group at the Center for Environmental Systems Research (CESR) at the University of Kassel
Director

"The political goal of limiting German raw material consumption to 7 t per person by 2045 makes scientific sense and is central to living within planetary boundaries. Resource use that is viable for the future must be driven by an ambitious circular economy. The Circular Economy Model Germany has formulated a comprehensive set of CE measures and shown the link between use of resources, climate change mitigation and biodiversity conservation. It is now time for policymakers to take action."

Dr Andreas Bruckschen
Bundesverband der Deutschen Entsorgungs-, Wasser- und Kreislaufwirtschaft e. V.
Deputy Managing Director

"The Circular Economy Model Germany developed by WWF concludes that broad implementation of the circular economy is indispensable for climate change mitigation. This includes high-quality recycling, which requires intensification of collection activities, more investment in recycling facilities and intensive cooperation along the entire value chain. This can only be achieved through cooperation between all stakeholders. The establishment of an advisory board involving experts from all sectors in the drafting of this WWF study served as a model for how to collectively combine ambitious climate goals and raw material security with efforts to safeguard Germany as a business and industrial location.

Alexandra Engelt
DIN Deutsches Institut für Normung e. V.
Head of Strategic Development for Circular Economy

"The crucial strategies for action to implement a circular economy were clearly identified in the study. It is now a matter of implementing them. This is only possible with clear communication between the various market participants. Norms and standards actively contribute to the successful implementation of a circular economy by defining requirements for products, services or processes, ensuring that appropriate information is shared between all stakeholders, and creating acceptance for circular products."

Sophie Herrmann
SYSTEMIQ
Partner

"The science-based study not only shows the quantified potential of a circular economy for Germany, but also provides the impetus needed for a strategy: a systemic view of the levers and action areas of the players in the overall picture – the supply side through the private sector, along the value chains to the consumer demand side – but also how policymakers can establish the necessary framework and thus generate added environmental, economic and social value through transformation. These perspectives were also represented and discussed by the Scientific Advisory Board when drafting the study."

Dr Susanne Kadner
Ecosystems CIRCULAR REPUBLIC
Co-Founder and Head

"The Circular Economy Model Germany offers a variety of interesting insights. I would like to highlight the following in particular: the transition to clean energy and mobility will lead to a significant increase in demand for critical raw materials. However, the most of these materials are currently mined and processed outside of Europe. A circular economy is therefore a central lever to mitigate this supply risk. It is becoming evident that, in addition to the immense potential for climate change mitigation and resource conservation, the transition to a circular economy is an important resilience strategy for our economy."

Dr Adriana Neligan
German Institute for Economic Research (IW)
Senior Economist for Green Economy und Ressourcen

"A circular economy makes a key contribution on the road to a low greenhouse gas economy, as CEMG convincingly confirms. At the same time, it offers economic potential. As shown in an IW survey, companies with circular business models that include the entire product life cycle are more successful. To leverage this potential, it is crucial to formulate practical requirements for a circular economy. This is necessary to ensure that Germany maintains its ability to compete and its potential for innovation."

Dr Claas Oehlmann
BDI Initiative for Circular Economy
Managing Director

"The value-added model of a holistic circular economy is based on a system perspective that encompasses preserving the value of products, materials and resources. Central pillars are appropriate product design and business models oriented towards the circular economy. The goal is to conserve raw materials, reduce CO_2 emissions and decouple growth from the impact on natural capital, while at the same time taking into account the effects on prosperity and employment. One of the key merits of the CEMG project is that it has considered these perspectives."

Dr Marc-Oliver Pahl
German Council for Sustainable Development
Secretary General

"The Circular Economy Model Germany project looked at multiple aspects of circular economy from vastly different perspectives, especially in the most important sectors. In this way, the project has provided key impetus for the planned National Circular Economy Strategy and has brought us closer to the political goal of reducing the absolute consumption of primary raw materials in Germany."

Michael Reckordt
Rohstoffpolitik PowerShift e.V.
Programme Manager

"Mountains of rubbish in parks, cities clogged by cars and the disposal of electronics that cannot be repaired are reminders us how wasteful we are with resources. But neither the reduction of our consumption nor a globally equitable and sustainable use of resources is being addressed in the political realm. WWF's work with the CEMG study and the call for a resource conservation law are important components on the path to a shift in the use of raw materials."

Armando García Schmidt
Bertelsmann Foundation
Senior Project Manager

"We will continue to face more and more crises if we do not change the way we use the Earth's natural resources. The only solution is a serious transition in resource use based on the guiding principle of a circular economy. The Circular Economy Model Germany shows that such a transition cannot be achieved without structural change. However, if policymakers and companies act boldly and pursue innovations now, great opportunities can arise. This is because through circular value creation we can not only become more independent and resilient to crises, we can also lead the way in technology."

Katja Suhr
Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH
Programme Manager

"Circular economy is currently still too expensive because external costs are not reflected in resource and product prices. The CE Model Germany policy blueprint proposes relevant economic incentives and mechanisms, the introduction of which are central to an effective circular economy. The modelling of circular economy measures is also an important decision-making tool for many GIZ partner countries, for example, that have already developed national plans and now need to drive implementation on a practical level."

Professor Henning Wilts
Circular Economy Wuppertal Institut
Director

"The transformation to a circular economy will fundamentally change existing value chains and their principles of coordination. The uncertainties involved must not be used as an excuse to keep the linear throwaway mentality alive, a dead end that is clearly evident for both environmental and socio-economic reasons. The CE Model Germany offers an excellent basis for discussion on how the pace of change could be increased from the current near standstill to the necessary level."

SUMMARY

Raw material consumption has tripled worldwide since 1970. In a country comparison, Germany ranks among the top countries. The excessive consumption of raw materials and resources with disregard for planetary boundaries contributes massively to the triple crisis of global warming, biodiversity loss and environmental pollution. In addition, there are serious social and human rights issues related to the extraction of raw materials. Nothing less than the future of current and future generations is at stake – environmentally, economically and the future of society as a whole.

Our linear economic model is the cause of the high consumption of primary raw materials with all its negative implications. What we need is the implementation of a holistic circular economy (CE) that actively makes use of all circular measures.

Germany's existing laws, political programmes and strategies are too non-binding, incongruent and, overall, nowhere near ambitious enough. Germany lags far behind other European countries in this respect. Expectations are now being pinned on the National Circular Economy Strategy (NCES), which is currently in development.

To describe the transformation required to achieve a comprehensive circular economy, WWF Germany has developed the Circular Economy Model Germany (CEMG) together with Öko-Institut, Fraunhofer ISI and FU Berlin. This brochure consolidates the findings of the two extensive studies (modelling study and policy blueprint).

As part of the **modelling**, the environmental and economic consequences of CE measures were assessed for eight sectors (building construction and civil engineering, vehicles and batteries, information and communication technologies (ICT) as well as household appliances, food and diet, textiles, packaging, furniture and lighting), the products of which are associated with high environmental impacts and have as a result high potential for the necessary transformation. The analyses cover the environmental impact categories of greenhouse gas emissions (GHG), raw material consumption (RMC), total material consumption (TMC), land use and, in some cases, biodiversity, as well as the socio-economic indicators of gross value added, security of supply and labour needs.

As the first comprehensive CE model ever developed for Germany, the CEMG provides a sound, scientific basis for identifying quantifiable targets and setting priorities. Four scenarios are modelled. These clearly show which outcomes can be achieved for the target year 2045, depending on the qualitative

and quantitative characteristics of the measures implemented. When selecting the CE measures to be analysed, particular attention was paid to the range of R-strategies and to the higher R-strategies that prioritise avoiding resource use. The underlying logic is simple: products that are not made in the first place or that last a long time reduce the need for resources and energy.

The result of the CEMG is clear: the transition to a CE is associated with substantially positive environmental impacts in all the impact categories analysed in the study. In addition, our country and our economy will benefit considerably in terms of security of supply, and our dependence on critical raw materials will be reduced in the long term. Key socio-economic advantages arise because the massive follow-on costs of environmental degradation, biodiversity loss and climate change are curbed. Last but not least, the necessary (and possible) transformation of Germany towards a holistic CE also creates opportunities for better quality of life and human health.

The table below (p. 15) shows selected results of the CEMG until 2045 compared to the 2045 Continue-as-Planned scenario. The Continue-as-Planned scenario only accounts for technological and political development pathways that have already been initiated or at least decided on. In addition, the table shows selected figures on monetary benefits and increased resilience resulting from the CEMG measures.

The **CEMG policy blueprint** picks up from where the modelling study left off, charting the path of transformation to a CE and describing various core elements that support each other in the process: (1) Vision and guiding principles, (2) Goals and indicators, (3) Governance, (4) Policy instruments to implement CE measures.

The **vision** includes **five action strategies** that are intended to contribute to the overarching environmental goals such as climate change mitigation and biodiversity conservation: (1) Reduce resource streams, (2) Substitute materials, (3) Slow down resource flows, (4) Intensify product use and (5) Close resource loops.

EFFECT OF THE CIRCULAR ECONOMY

The CE measures modelled in the Circular Economy Model Germany in the sectors of building construction and civil engineering, vehicles and batteries, information and communication technologies as well as household appliances, food and diet, textiles, packaging, furniture and lighting result in substantially positive environmental impacts in all categories analysed compared to the Continue-as-Planned scenario by 2045.

A comprehensive circular economy in 2045 – compared to a "Continue-as-Planned" – ...	
... supports climate change mitigation	
Greenhouse gas emissions (GHG)	• Reduction by an additional 186 Mt CO_2-eq globally (–26%) • Reduction of 10% compared to 1990 levels (additional) or 26 Mt CO_2-eq of hard-to-avoid process emissions from steel, cement and ethylene production
Final energy demand in Germany	• Reduction of industrial energy demand by up to 112 TWh or –17% • Alleviation of shortages in electricity and hydrogen • Reduction in the costs for the expansion of renewable energy and the respective grids
The greatest potential lies in ...	• Less space for housing and offices • Less private transport • More plant-based diets • More efficient data centres • Less consumption of textiles
... protects and preserves resources	
Raw material consumption	• Reduction in RMC –179 Mt (–27%) or TMC –329 Mt (–26%)
Greatest potential lies in ...	• Building construction • Vehicles and batteries • Food
... preserves nature and biodiversity	
Land use	• Additional reduction of 8.5 million hectares of land; this corresponds to 25% of Germany's total area
Biodiversity	• Reduction in the potential loss by 32% in the food sector
Greatest potential lies in ...	• Food and diet • Vehicles and batteries • Textiles
... Increases the resilience of the German economy to supply risks	
Critical and environmentally very harmful raw materials	• Alleviation of supply situation for 29 out of 36 raw materials analysed • More than 50% of demand for palladium, yttrium, dysprosium, neodymium, terbium, cobalt, copper, praseodymium and gallium is met by CEMG measures; 8 of these 9 raw materials are already classified as critical by the EU today..
Follow-on costs (global)	• Avoidance of as much as EUR 157 billion
Greatest potential lies in ...	• Vehicles and batteries • ICT and household appliances
... triggers a structural change in the economy	
Production of secondary raw materials	• Increase of 16% or EUR 860 billion
Freed-up income	• EUR 170 billion When this is primarily spent in the service sector:
Gross value added	• Increase by 14% or EUR 483 billion
Labour needs	• Increase by 11%
... has considerable social benefits	
Labour needs	• Increase by 23% in the production of secondary raw materials
Increase in the percentage of female workers as a result of an increase in work in the service sector	
Improvement of human health due to the reduction in air and environmental pollution	

Table 1

The **ten guiding principles** support the vision and show the need for action at different levels:

1. Set the absolute **reduction of resource consumption** in Germany as the top goal

2. Define **binding resource targets** using climate targets as a model

3. Shape the structural transformation triggered by CE with specific **policy instruments**

4. Create confidence in comprehensive CE in **social alliances**

5. Embrace **education and knowledge** transfer as a key to the transformation

6. Create **incentives for a shift in corporate values**

7. Expand the government's **role model function** in procurement

8. Strengthen **regional value chains** in Germany

9. Provide **funding and carry out research and development** for the transformation to a circular economy

10. Assume **Germany's international responsibility** more fully

The vision and guiding principles intentionally address several levels of the need for action. These would have to be addressed simultaneously to achieve the overall goal of reducing the absolute consumption of raw materials.

To bring about the necessary transition to a CE within planetary boundaries, the CEMG policy blueprint proposes the following **targets and indicators**:

- Raw material consumption (RMC) per capita of **7 t per year** by 2045, of which 2 t biotic and 5 t abiotic

- Reduction in the absolute raw material consumption (RMC) to **~500 million t** by 2045

- For secondary raw materials, we propose a **target of doubling the circular material use rate** by 2030 in line with the European Commission's target, but a minimum increase to 18%.

To ensure that implementation of a holistic CE in Germany is binding, WWF recommends a **governance structure** similar to the Climate Change Act: **a resource conservation law** with appropriate ministry targets.

In essence, the CEMG policy blueprint provides guidance for the **creation of a new social narrative** of CE in Germany. The narrative is intended to make clear that while technological innovations can make an important contribution to the goals of a CE, structural and behavioural change must play a greater role. In other words, **a fundamental change in our current consumption habits and a shift away from an economic model based on disproportionate consumption of natural resources is proposed with the policy blueprint**.

Six framework-setting instruments are defined in the CEMG policy blueprint for implementation of the modelled CE measures and as possible courses of action for achieving a raw material **consumption target and ministry targets**:

1. Funding of CE measures
2. Data governance
3. Environmental taxes and subsidies
4. Circular public procurement:
5. Extended producer responsibility (EPR)
6. Ecodesign for Sustainable Products Regulation (ESPR)

For each sector, specific instruments are further defined and described in detail. Sector-specific characteristics (e.g. opportunities and challenges) are also addressed in the implementation of framework-setting instruments and windows of opportunity identified.

To reduce its demand for raw materials and enable economic activity within planetary boundaries, Germany must tap the potential of a comprehensive CE and develop an ambitious and concrete National Circular Economy Strategy (NCES) to this end. The CEMG provides a plan to achieve this, with practical measures, instruments and impact assessments.

THE FUTURE IS IN OUR HANDS

THE FUTURE IS IN OUR HANDS

Our hunger for resources seems insatiable – and is leading us directly into an unprecedented triple crisis of global warming, biodiversity loss and environmental pollution. The WWF Living Planet Report 2022[1] has clearly shown how large our global ecological footprint is. We are taking much more from the earth than it can sustain. In a comparison of countries, Germany holds a lamentable position at the top. In 2018, for example, we consumed around 13% more resources than the EU average, and globally the figure was as much as 30% higher in 2019.

Raw material consumption has tripled around the world since 1970. The reason is not only the steadily growing population, but above all our increasingly resource-intensive way of life. The continuous overuse not only diminishes the biocapacity of our planet to an ever greater extent, it also denies the Earth any opportunity to regenerate – and thus deprives us of the future.

In Germany, for example, 40% of all greenhouse gas emissions stem from the extraction and processing of raw materials. But that's not all. Our goods and products also need to be transported, supplied, used and disposed of, all of which requires infrastructure. Building and maintaining this infrastructure consumes more energy, water and land. Our valuable ecosystems pay the price. Biodiversity and natural cycles suffer fatal consequences, from the precious forests on land to the valuable habitats under water.

At the same time, there are serious social and human rights abuses associated with the extraction of raw materials. For example, where workers and communities are poorly protected or not protected at all or where the financial and physical well-being of some is paid for by the poverty of others.

High consumption of raw materials also entails risks related to the supply of energy and raw materials and thus endangers Germany as a business location. The coronavirus pandemic and the consequences of the war in Ukraine have clearly shown how dependent Germany is on international markets for the supply of raw materials. It is evident that in view of the growing global hunger for raw materials, especially in emerging countries, Germany's security of supply with key resources is no longer guaranteed.

At the end of the day, there is just one solution: we need to transform our economy and change the way we live. We must stop using resources irresponsibly and economise the use of our limited resources. There is no alternative.

CIRCULAR ECONOMY INSTEAD OF WASTE MANAGEMENT

WWF firmly believes that circular economy (CE) offers a key lever in transforming the economy to mitigate climate change and protect biodiversity. At the same time, we can expect more answers from the CE to important questions of our time, from a secure supply of raw materials to competitiveness and social participation.

What we in Germany have lacked so far for the transformation to a CE is a holistic political vision and a comprehensive strategy. Both are essential prerequisites for change to be successful. This is shown not least by the status quo. Example of waste law: there have been calls for some time to prioritise avoidance and reuse and to pursue recycling only as a last resort. The EU Circular Economy Action Plan also expects this change in prioritisation along the waste hierarchy. The reality is quite different:

at the moment, circular economy is mainly limited to waste management, which is regulated by the Closed Substance Cycle and Waste Management Act (KrWG), among others. And it has a lot of loopholes: companies that produce avoidable waste do not have to worry about being penalised. The waste avoidance goals cannot be quantified. The responsibility for repair-friendly design is still not regulated. This law is no more in line with a real and effective strategy for waste avoidance than the Packaging Act (VerpackG), the primary goal of which is to avoid packaging waste. While the annual amount of packaging waste to be disposed of was as low as 13.6 million tonnes in 1996, it rose continuously, with a few exceptional years, and reached its highest level to date of 18.9 million tonnes in 2018 and 2019. Other attempts to promote a true circular economy in Germany have also failed to live up to their potential.

In short, Germany is not only a long way from a circular economy, it is also a long way from a vision and strategy for CE. Other countries have moved more quickly and are paving the way. Austria, Finland and the Netherlands, for example, have already presented national CE strategies and have gained an edge in international competition. If Germany wants to catch up and drive environmental innovations in the economy and society to make true progress, ambitious political conditions are essential.

THE CORE PROJECT: THE NATIONAL CIRCULAR ECONOMY STRATEGY

This is to be achieved not least through a National Circular Economy Strategy (NKWS), which the German government committed to in its coalition agreement at the end of 2021. The political process for the development of the NCES officially started in April 2023 and is expected to result in the adoption of the NCES by the Cabinet in 2024.

What policymakers have lacked so far in this project is a sound scientific basis for a holistic circular economy in Germany. Only on this basis can we identify quantifiable targets, set priorities and calculate the environmental and socio-economic impacts in a realistic and meaningful way. Without this, we lack the guidance to select the most effective circular measures in the different economic sectors. It provides the compass to set target ranges and creates the conditions for broad acceptance. It also makes it possible to identify suitable policy steering instruments, such as binding targets, fiscal instruments, investments, incentive systems or quotas. In short, a scientifically sound basis with a broad view of CE is indispensable for the strict alignment and the necessary, rapid success of the transformation

WHY CIRCULAR ECONOMY IS ABOUT MORE THAN JUST RECYCLING

In Germany, when we think about recycling, we generally start by looking in the rubbish bin. Here, among the rubbish, is where the cycle begins. We find solace in the fact that we separate our rubbish and collect it separately to give it a new – albeit usually less valuable – life. But this view is limited because even though it may alleviate symptoms, it does not address root causes.

The term "circular economy" may suggest the same kind of circularity in its purely linguistic form. In practice, however, it goes far beyond recycling. CE pursues a holistic approach: it includes raw material production, product design and ranges from careful, intensive and long-lasting use to the recycling of materials at the end of a product's life. As this is exactly what we need for a fundamental transformation, WWF uses the term "circular economy" (CE) rather than plain old recycling.

WWF defines circular economy as a regenerative system, driven by renewable energy sources, that replaces the current linear industrial model of "take – produce – dispose". Materials are instead retained in the economy, products are shared, while waste and negative impacts are prevented. CE generates positive impacts and benefits for the environment and society and functions within planetary boundaries It is achieved by re-thinking our current understanding of growth and consumption.

WWF views the central action strategies of a circular economy as follows:

1. **Reduce resource streams**, for example by avoiding unnecessary products and using materials more efficiently. This means that fewer resources are needed for each production unit.
2. **Substitute materials**, for example by using renewable raw materials as well as technical innovations, where this makes good environmental and social sense.
3. **Slow down resource flows**, for example through longer product use, reuse, repair and durable design.
4. **Intensify product use**, for example through shared or collective use.
5. **Close resource loops**, for example through high-quality recycling, which can be achieved with technical solutions as well as more collection.

CIRCULAR ECONOMY MODEL GERMANY

CIRCULAR ECONOMY MODEL GERMANY

To fill gaps in the scientific basis, WWF asked scientists at the Öko-Institut, the Fraunhofer ISI and the Freie Universität Berlin to use models to calculate which CE measures can contribute to climate change mitigation, resource and biodiversity conservation and to economic goals such as raw material security, gross value added and labour needs. In a second step, the experts, together with WWF, defined specific policy recommendations that can be used to advance the transformation to a CE both quickly and successfully. The scientists were supported in their work by a high-level Strategic Advisory Board. The result was the Circular Economy Model Germany (CEMG).

The CEMG is the first study of its kind to look at and evaluate a comprehensive set of CE policies and measures across a wide range of key sectors in Germany.

RESULTS DOCUMENTS OF THE CEMG PROJECT

SCIENTIFIC REPORTS

The CEMG project consists of three reports: the feasibility study, the modelling study and the policy blueprint..

- The **CEMG feasibility study** contains the methodological and technical foundations of the overall project. It shows where priorities need to be set within the CE framework and identifies specific sectors, products and materials. The study also defines specific CE measures and details which measures have the greatest impact in each of the selected sectors. The feasibility study was completed in June 2022 and forms the basis for the following reports.

- The **CEMG modelling study** estimates the environmental and economic impacts of CE measures and outlines in four scenarios the success that can be achieved if measures are implemented to varying degrees. The study therefore not only enables a comparison between the different CE measures and their use in the respective sectors, but also makes the most important levers visible.

- Based on the results of the modelling study, the **CEMG policy blueprint** provides recommendations particularly for policymakers, but also for economic and social stakeholders. The blueprint will make an important contribution to shaping the NCES by proposing specific recommendations, outlining the policy instruments needed to im-

plement the evaluated CEMG measures and proposing a governance approach for their implementation.

This brochure is a summary of the modelling study and the policy blueprint.

Modelling a comprehensive CE is an ambitious project requiring an entire range of preliminary scientific work. Before we present the key results, we will therefore first briefly outline the essential elements of the CEMG project.

SECTORS AND CE MEASURES ANALYSED

The sectors that are particularly central to a CE and the associated expectations were selected in the feasibility study on the basis of scientific models and analyses. With a view to the environmental and socio-economic impact categories listed below, eight sectors were identified with products associated with high environmental impacts and thus high potential for the necessary transformation.

Building construction and Civil engineering

Vehicles and batteries

Household appliances and Information and communication technologies (ICT)

Food and diet

Textiles

Packaging

Furniture

Lighting

The CEMG study focuses in particular on domestic demand with an emphasis on private consumption.

ANALYSED CIRCULAR ECONOMY MEASURES BY SECTOR

The CE measures were selected in the feasibility study and consolidated in the modelling. The focus was particularly on the highest-level R-strategies (e.g. refuse, reuse, repair, etc.).

Building construction and Civil engineering	Vehicles and batteries
1. Less space for housing and offices 2. Reuse components 3. Extend life span of buildings 4. Lower clinker factor in cement production 5. Use alternative binding agents in cement production 6. Use alternative bio-based and renewable material substitutes 7. Reduce use of structural steel and structural cement through design 8. Reuse structural steel 9. Recycle cement	1. Reduce private individual transport through more • Public transport • Car sharing • Ride sharing 2. Other measures at vehicle level • Smaller vehicles • Longer use phase • End-of-life recycling (EoL recycling) of cars • Remanufacture car components 3. Measures at battery level for electric cars (e-cars) • Reduce battery capacity • Design vehicle batteries for longevity • EoL recycling of vehicle battery • Reuse EoL batteries as energy storage
Household appliances and ICT*	**Food and diet**
1. Extend life span and useful life of devices 2. Remanufacture devices 3. Improve collection and recover more raw materials from end devices 4. Use data centre resources efficiently	1. Switch to a more plant-based diet (including plant-based meat alternatives) 2. Switch to a more plant-based diet through alternative protein sources (biotechnology, synthetic meat alternatives) 3. Prevent food waste
Textiles	**Packaging**
1. Promote longer useful lives of existing textiles, e.g. through fewer items of clothing per closet 2. Change consumer-side forms of use (e.g. sharing economy and product-as-a-service) 3. Promote preparation for reuse (incl. repair) 4. Promote fibre-to-fibre (F2F) textile recycling for cotton textiles	1. Use fewer packaging materials mainly through behaviour-based measures • Reduce product waste • Do without certain products • Unpackaged distribution • Switch to reusable packaging or other reusable containers • Use refillable bags 2. Use fewer packaging materials mainly through technology-based measures • Avoid outer packaging • Less oversized packaging • Avoid other non-functional packaging • Replace rigid packaging with flexible packaging • Reduce grammage or packaging weights • Reduce packaging functions 3. Promote high-quality packaging recycling and the use of recycled material • Design-for-recycling • Optimise separate collection • Increase sorting and recycling efficiency • Increase use of post-consumer recycled content
Furniture	**Lighting**
1. Reuse and remanufacture furniture to a greater degree 2. Ecodesign for durable furniture 3. Use more recycled materials	1. Increase collection rates of used lamps 2. Use more materials from used lamps 3. Use less material in lamp production 4. No decorative lamps 5. Reduction in lamps without replaceable light sources 6. Durable lamp design 7. Lighting-as-a-service

*Information and communication technology

Table 2

IMPACT CATEGORIES

On the one hand, the CEMG examines the potential savings a change in German consumption would have on various environmental impact categories globally and also includes the impacts on our security of supply with critical raw materials. On the other hand, the CEMG also looks at the socio-economic consequences in Germany that are expected in the selected sectors.

With a view to the environmental and supply effects of the CE measures, the focus is on:

- **Greenhouse gas emissions** as a key variable in the fight against climate change
- **The use of raw materials** including both raw material consumption (RMC) and total material consumption (TMC)
- Biodiversity, where **land use** was used as a supplementaryl environmental indicator
- **Security of supply** of essential raw materials as an indication of their considerable economic and environmental importance

EFFECT OF CIRCULAR ECONOMY MEASURES ON BIODIVERSITY – WHAT CAN AND CANNOT BE SAID

- The aim of the CEMG project was to be able to make a statement on the benefits of circular economy for biodiversity conservation.
- There is limited data available. There are not yet suitable evaluation methods.
- It was therefore analysed which evaluation methods are used to assess the interaction between biodiversity and CE measures and which of them will remain relevant in the future. These approaches were applied in individual sectors.
- For example, in the food sector, the analysis was conducted on the basis of the biodiversity footprint and the biodiversity value increment.
- However, a comprehensive evaluation of the effects of CE measures on biodiversity is not yet possible.

In addition to the positive effects of the transformation on the environment and security of supply, the CE measures also necessarily lead to a change in the economy, in industry and companies, but also in the labour market. These socio-economic impacts have so far only been addressed in very broad terms

and with unspecific commitments in terms of new jobs, business models and growth. Here too, the CEMG seeks to make a difference and be as concrete as possible. To this end, the study looks at key areas and makes them tangible:

- **Gross value** added as an indicator of the value of goods and services produced in the production process, and **labour needs** as an indicator of the number of employees in "full-time equivalents" (FTEs). Both were analysed separately by economic sector, and displacement effects were easier to identify by including a wide range of circular measures.

- To make the **costs and benefits** of CEMG measures tangible, the study uses the environmental cost approach and also factors in the costs of inaction. These include foreseeable costs to society, both socio-economic and environmental, if we continue along the planned pathway.

FROM CONTINUE-AS-PLANNED TO CEMG: THE MODELLED SCENARIOS

The CEMG modelling study assumes the status quo. The status quo represents our economy and the sectors analysed as they currently are.

The study models four scenarios with a target date of 2045 on this basis:
(1) Continue-as-Planned, (2) Technology, (3) Behaviour and (4) CEMG. Each scenario features a different quantity and quality of implemented CE measures.

Continue-as-Planned: the Baseline is the Continue-as-Planned scenario. It shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The basis for this is the **2021 Projection Report** that describes the development of greenhouse gas emissions in Germany in the period from 2021 to 2040. Incidentally, the Continue-as-Planned scenario factors in measures and goals that have been announced, even if they have not yet been implemented to any degree.

The names of the scenarios in this condensed version are different from those used in the modelling study. The Continue-as-Planned scenario corresponds to the Baseline 2045 in the modelling study.

Technology and Behaviour: in these two scenarios, the study models the results of different circular economy measures that are implemented with different weightings by 2045. Some are very technology-driven and depend on innovation and technical optimisation. Others are based on changing behaviour, which is influenced by choices made by the users of products and services and by a wide range of regulatory and product policy instruments.

CEMG: the CEMG scenario combines the CE measures of the Behaviour and Technology scenarios. It includes as much of both as possible and thus also leverages synergies. In the CEMG scenario, policymakers pursue ambitious policies to make both production and consumption more sustainable. This scenario goes hand in hand with rapid technological progress and changes in consumer behaviour.

The CEMG refers to the Mixed scenario in the modelling study. As this is the most ambitious scenario, WWF advocates its implementation and does not look at the Technology and Behaviour scenarios for space reasons.

THE POLICY RECOMMENDATIONS

The summary of the policy blueprint in Sections 7 and 8 addresses the findings of the CEMG scenario and outlines which policy interventions are required to implement the measures analysed there. As a guide for the necessary transformation, the blueprint provides a model with recommendations for policymakers in particular, but also for economic and social actors. It identifies quantitative targets and indicators as well as central policy instruments to implement the necessary CEMG measures. It also provides specific recommendations for the shift to a functioning CE and proposes a governance approach for its implementation.

The policy blueprint is intended to make an important contribution to shaping the National Circular Economy Strategy (NCWS), which is planned for spring 2024.

IMPACT OF A COMPREHENSIVE CIRCULAR ECONOMY IN GERMANY

WWF compares a Continue-as-Planned scenario along consumption trends and technological progress with about 50 ambitious but realistic CE measures in key sectors in Germany. The result shows that implementation of the circular economy is very effective across all circular strategies.

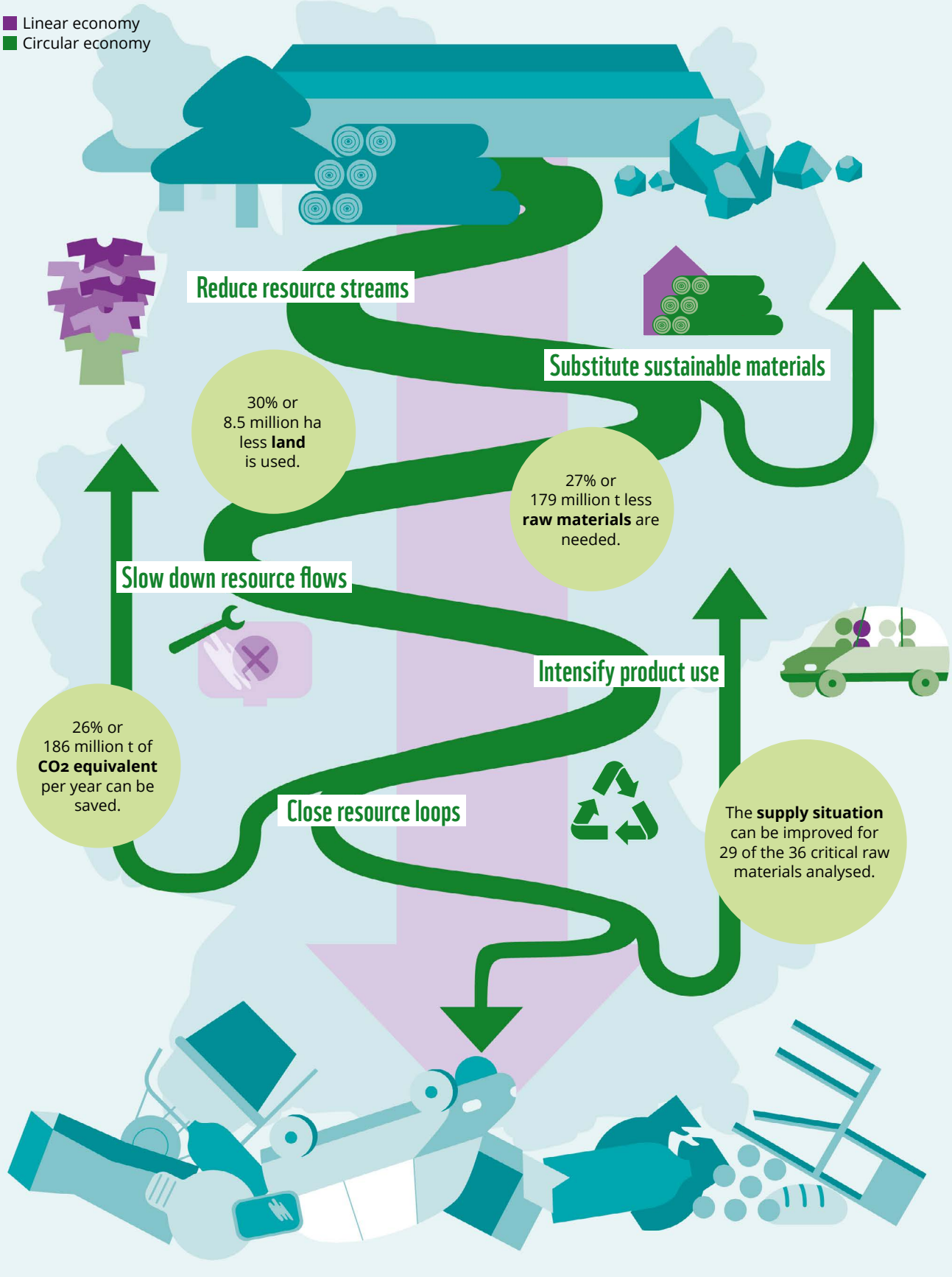


Figure 1

CIRCULAR ECONOMY FOR EFFECTIVE RESULTS

CIRCULAR ECONOMY FOR EFFECTIVE RESULTS

Aren't we already on the right track? After all, the number of new e-cars registered is on the rise, less meat is being consumed, progress is being made in the expansion of renewable energy, albeit slowly, and the buzzword sustainability is the talk of the town. Things may be better today than they were yesterday, but it won't be enough for tomorrow. To keep within our planetary boundaries and ensure a liveable future, resource consumption in Germany must be massively reduced and resource productivity massively increased – but we are still have a very long way to go.

What Germany needs is a major breakthrough. Something that really makes the difference. In the following sections, WWF will show that this is possible – and how – in compact form: by looking at the impact categories, the sectors, the key levers of a CE, the costs of transformation and the concrete policy instruments. For more in-depth information, we recommend subsequently reading the **detailed modelling study**. In this section, we first examine the results of all modelled CE measures in the **four impact categories**.

CIRCULAR ECONOMY BRINGS TRUE CLIMATE BENEFITS

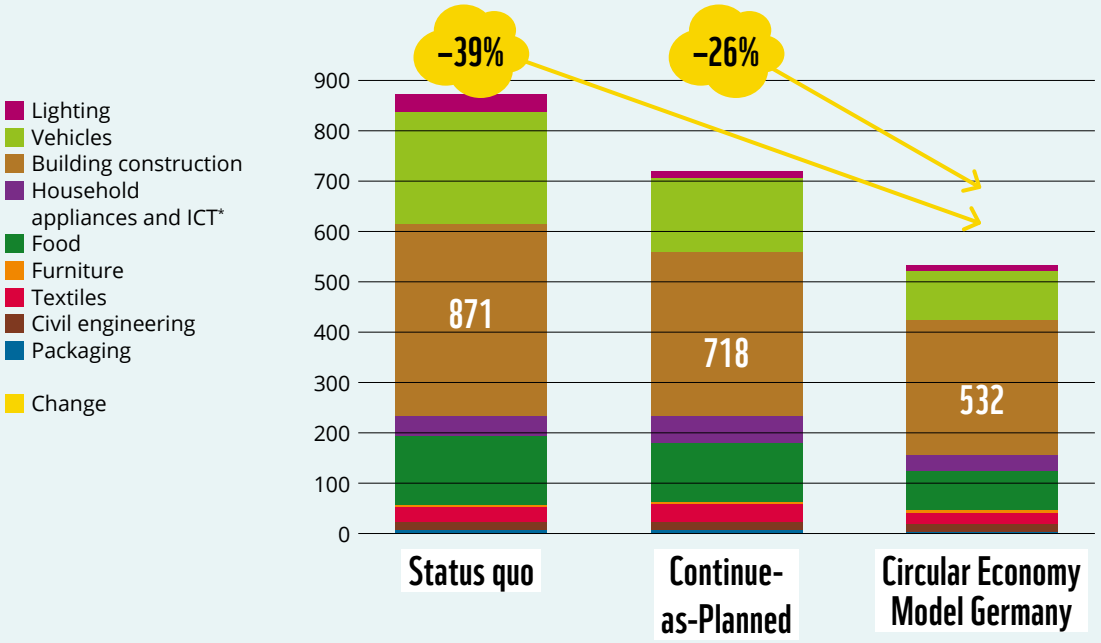
Global warming endangers people and national economies. This realisation is no longer limited to scientists. According to a representative forsa survey conducted in November 2022[2], climate change is the biggest concern for people in Germany, even more so than war and high energy costs. To at least limit the extent of the damage caused by climate change, countries agreed on the 1.5 degree target at the UN Climate Conference in Paris in 2015. But far too little has happened so far. The CEMG measures show viable pathways for decisive success!

Even the **Continue-as-Planned scenario** yields a significant reduction in greenhouse gas emissions (GHG) of 18% or 153 megatonnes of CO_2 equivalents (Mt CO_2-eq) compared to the status quo. This is due to continuing trends in building construction (fewer new buildings due to declining population), vehicles (e-mobility and less private individual transport), lighting (more energy-efficient LEDs) and food (more plant-based diet).

However, Germany will achieve the real – and necessary – difference through the measures in the **CEMG scenario**. By changing consumption and production, an additional reduction in GHG emissions of 26% or 186 Mt CO_2-eq can be achieved here:

GENERAL OVERVIEW OF GREENHOUSE GAS EMISSIONS

The CEMG measures can reduce greenhouse gases significantly.
Circular economy supports climate change mitigation.



*Information and communication technology

Figure 2

- Around 79% of GHG savings can be achieved in the building construction, vehicles and batteries and food and diet sectors alone. Another 18% can be saved in information and communication technologies (ICT), household appliances and textiles.

- With only five packages of CEMG measures, nearly 85% of the GHG reductions can be achieved across all eight sectors studied. They involve less space for housing and offices, less private individual transport, a more plant-based diet (Planetary Health Diet), more resource-efficient data centres and less textile consumption (including new forms of use).

SATALLITE ANALYSIS INDUSTRIAL DECARBONISATION AS A CE CONTRIBUTION TO CLIMATE TARGETS

In addition to the use of energy from renewable sources, a key lever for lower GHG emissions is, above all, lower energy demand per se. As a key actor and polluter, German industry inevitably comes into play at this point. It currently accounts for around a quarter of Germany's total energy demand. Energy-intensive key industries and processes such as steel, cement and ethylene production are particularly to blame. The decarbonisation of these industries is therefore a crucial factor in achieving the European and German climate targets.

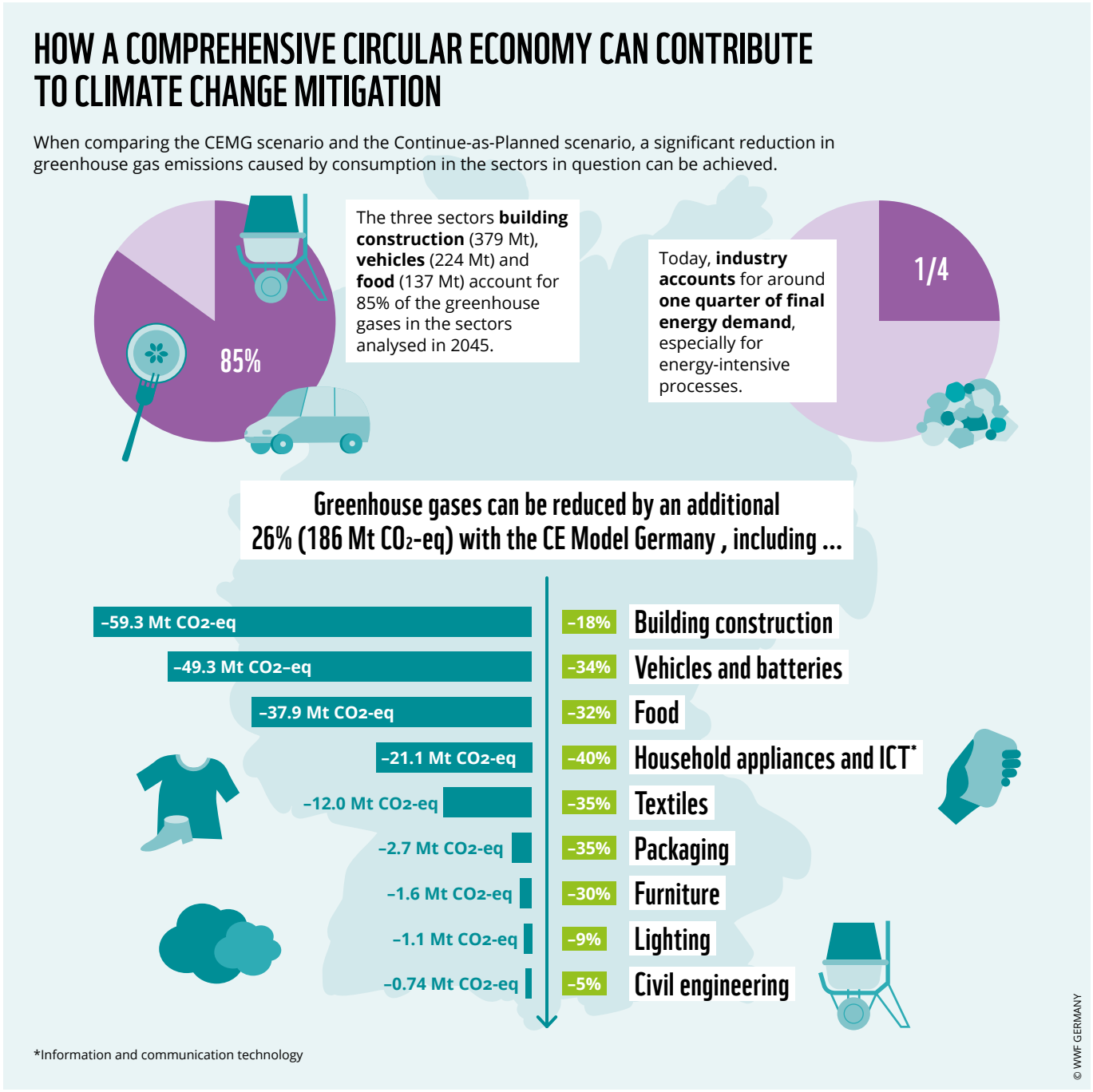


Figure 3

Already in the **Continue-as-Planned scenario**, substantial energy-related GHG savings of around 48% or 89 Mt CO_2-eq can be achieved compared to the status quo by implementing measures that have already been adopted.

But here, too, the more ambitious **CEMG scenario** makes another difference. The CEMG measures can reduce GHG emissions by an additional 26 Mt CO_2-eq compared to the Continue-as-Planned approach. This corresponds to an additional approximately 10% compared to 1990.

The contribution of the CEMG scenarios to reducing hard-to-avoid emissions, i.e. process emissions resulting from chemical reactions in the production process, must also be underscored here. This is an important aspect of achieving the climate targets: reducing process emissions requires significant changes in the production process, the development of new products and the use of car-

SATELITE ANALYSIS CE IN A DECARBONISED INDUSTRY 2045

Today, industry accounts for about a quarter of final energy demand in Germany, mainly due to energy-intensive key industries, products and processes such as steel, cement and ethylene production. CEMG measures reduce demand considerably.

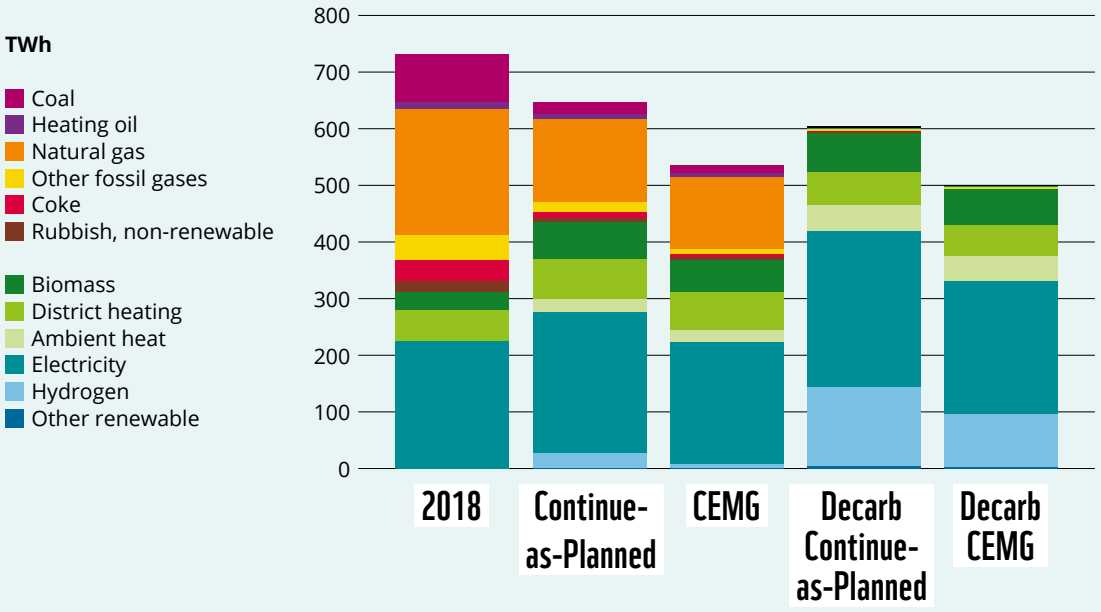


Figure 4

bon capture and storage technologies (carbon capture and utilisation – CCU, and carbon capture and storage – CCS).

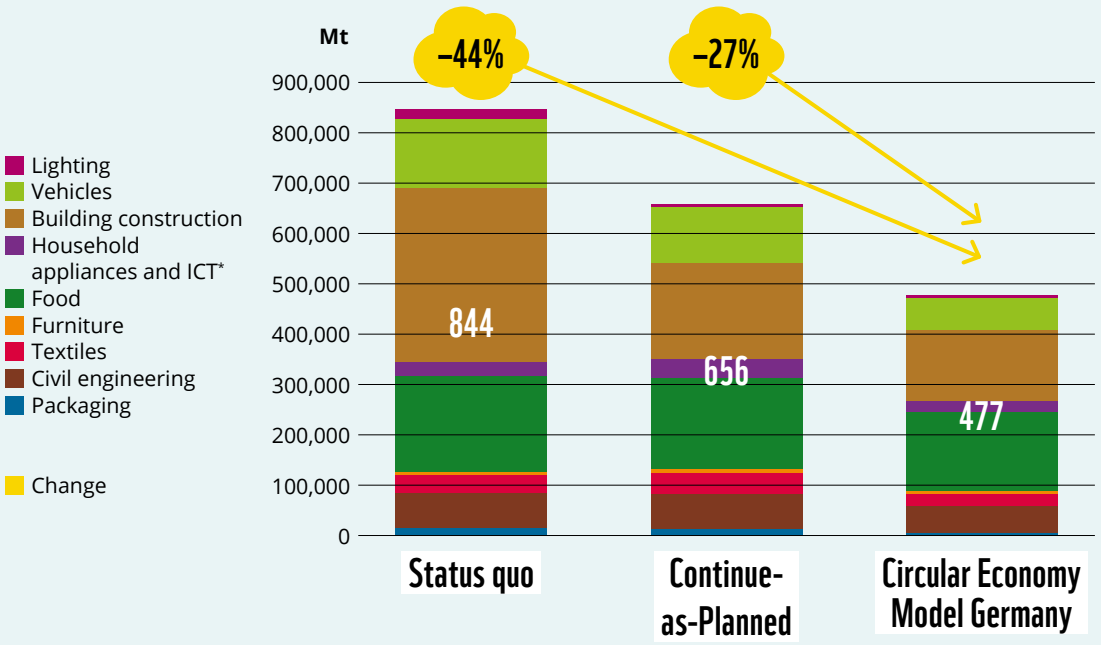
The impact of CE measures results in a clear decrease in final energy consumption of 104 TWh (17%) in 2045 for a decarbonised industry. This suggests that a CE can help reach the goal of a CO_2-neutral and competitive economy: less consumption of secondary energy sources (e.g. electricity and hydrogen) can alleviate shortages in the short term and reduce the costs of expanding renewable energy, grid expansion and imports of secondary energy sources in the long term.

CIRCULAR ECONOMY PROTECTS AND CONSERVES RESOURCES

As described at the beginning, the seemingly insatiable hunger for raw materials is leading us to a triple crisis of global warming, biodiversity loss and environmental pollution. However, raw materials are the starting point of every production process. Without them, there are no goods, commodities or food. But instead of using resources carefully and responsibly, our society is squandering them at a historically unprecedented rate. There is no question that this cannot continue. The question is rather how it can continue. And here, too, the CEMG points the way.

GENERAL OVERVIEW OF RAW MATERIALS CONSUMPTION (RMC)

CEMG measures can reduce the amounts of raw materials for domestic consumption and investment significantly.



*Information and communication technology

Figure 5

For the analysis of the impact category “resources”, the study distinguishes between raw material consumption (RMC) and total material consumption (TMC).

Raw material consumption (RMC) shows the resources needed for domestic consumption and investment. This includes all primary raw materials extracted and imported in Germany minus exported raw materials. Also included are the (converted) raw materials used in semi-finished and finished goods.

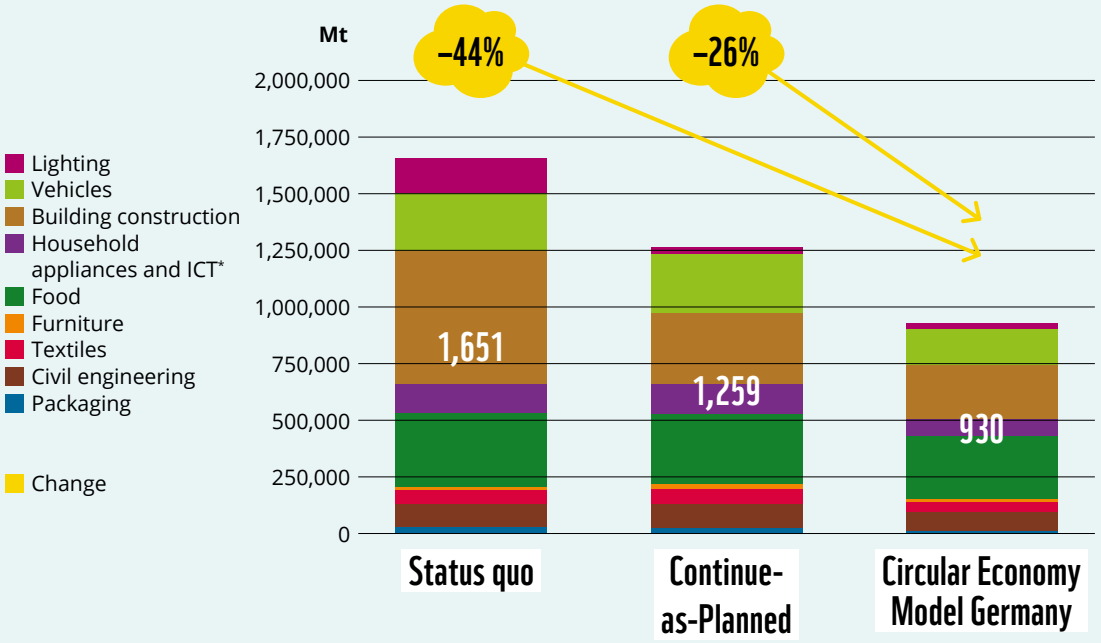
The building construction, vehicles and batteries and food sectors are of particular importance for RMC. As raw material powerhouses, they currently devour around 669 Mt of raw materials annually, which accounts for 79% of total consumption. By comparison: the concrete shaft of the Berlin TV tower weighs around 26,000 tonnes[3]. 669 Mt is therefore equivalent to the mass of 25,730 television towers.

In sectors where a lot of raw materials are used, there is also a lot of potential savings: the three sectors mentioned hold around two-thirds of the total potential savings in raw material consumption. Even in the **Continue-as-Planned scenario**, the current RMC of 844 Mt is therefore reduced by around 22% or 188 Mt due to measures that have already been decided or are at an advanced stage of implementation.

In the **CEMG scenario**, additional savings of around 27% or 179 Mt can be achieved with the relevant measures compared to the Continue-as-Planned scenario. The progress made under the CEMG scenario becomes even more

OVERVIEW OF TOTAL MATERIAL CONSUMPTION (TMC)

If the raw materials include the materials that are produced or have to be transported during extraction, the potential for reduction through the CEMG measures is even greater than for RMC.



*Information and communication technology

Figure 6

evident when compared to the status quo. Here, the demand for raw materials is reduced by around 370 Mt or 44%. This is equivalent to more than 4.5 t per person per year.

The **total material cost (TMC)** not only includes the raw materials that are ultimately consumed, but also, for example, the material that is produced or has to be transported to extract these raw materials. The TMC therefore measures the material flows from used and unused extractions and is thus always higher than RMC.

The saying goes: you can't make an omelette without breaking eggs. But the saying is only partially true. Because especially in the raw materials sector, extraction not only breaks eggs, but has massive effects. On average, less than 1 g of gold is extracted from 1 t of rock. For a standard gold ring of 10 g, therefore, more than 10 t of chemically contaminated mining waste is produced.[4] This example shows that, with regard to environmental impact, only the pure consumption of raw materials can be considered (RMC).

Even in the **Continue-as-Planned scenario**, the current TMC of 1,651 Mt is reduced by around 24% to 1,259 Mt through measures that have already been adopted or are at an advanced stage of implementation. As in the case of raw material consumption, the **CEMG scenario** also makes the crucial difference in total material consumption compared to the Continue-as-Planned scenario. Germany can therefore reduce its total material consumption by an additional 26% or 329 Mt through the recommended measures. This corresponds to the mass of an additional 8,577 Berlin television towers.

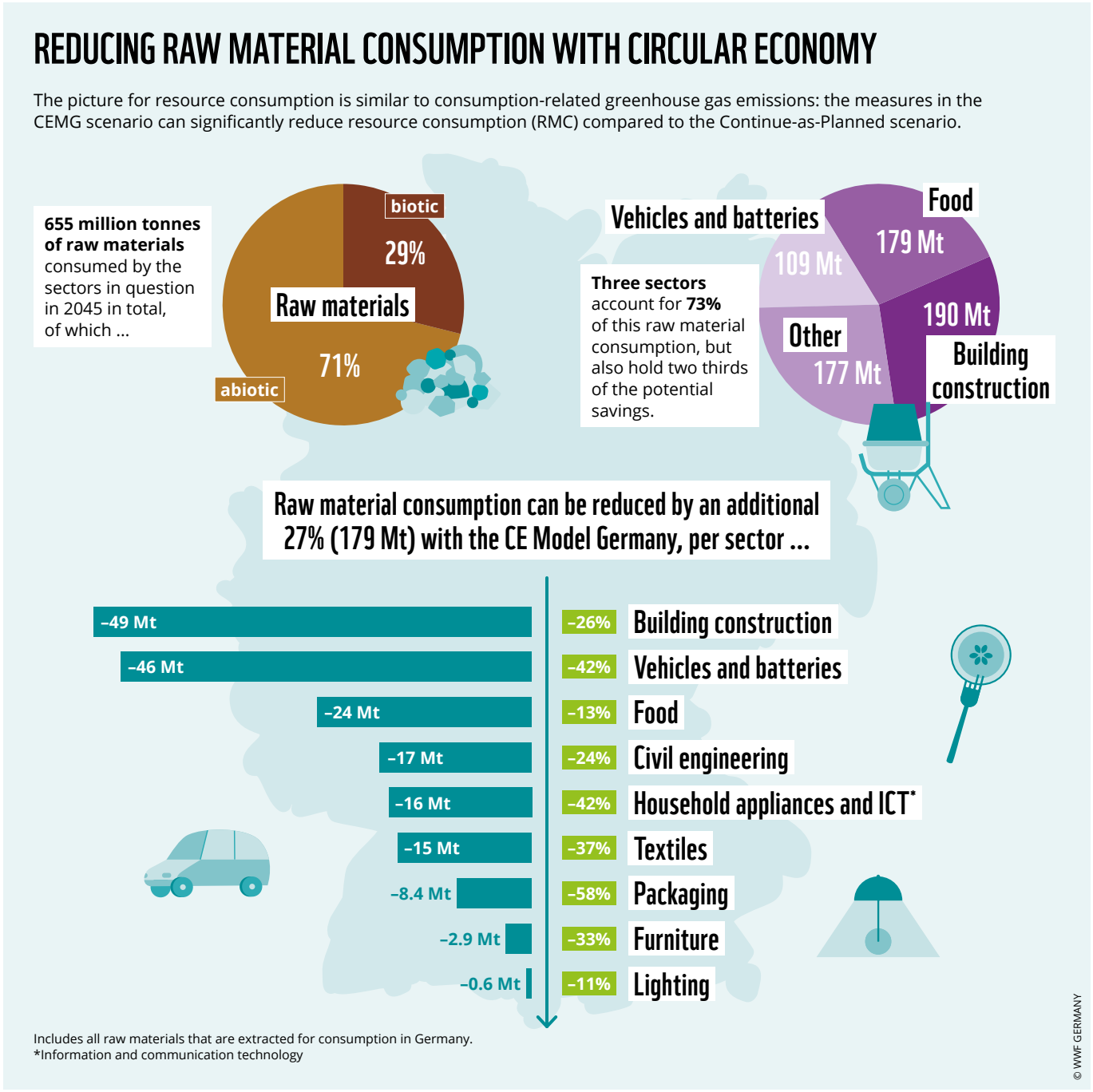


Figure 7

The largest levers for lower TMC are found in the vehicles and batteries sector with –39% or 99 Mt, building construction with –24% or 75 Mt and ICT and household appliances with –41% or 53 Mt.

While the TMC potential in the building construction sector is immediately evident due to the decreasing demand for building materials, it is important to focus on the finer details when it comes to vehicles and equipment. Cars in general and e-cars in particular require a large number of electronic components, just like our everyday devices and appliances ranging from smartphones to dishwashers. For their production, we depend on rare minerals and other, mainly metallic raw materials, which result in an extremely large amount of mining waste when they are extracted. This not only has a massive impact on the TMC, but also has a staggering effect on land use and greenhouse gas emissions.

Ambition motivates: the recommended CEMG measures for RMC and TMC are ambitious but realistic. They show the extensive transformation facing Germany in this area. Their enormous potential should be more than motivating.

CIRCULAR ECONOMY PRESERVES NATURE AND BIODIVERSITY

We depend on land for many reasons and different purposes: for farming, living, working and producing, for transport, leisure activities and much more. How we use the land has consequences from sealing and erosion of soil and the loss of fertile layers of earth to the loss of biodiversity. In a nutshell, using less land is better for everyone.

Germany has a total area of just under 36 million ha. Of this area, 86% or 31 million ha are actively used. Cropland accounts for 36% or 11.1 million ha, forest land for 29% or 9.2 million ha, pasture land for 28% or 8.7 million ha and other land use for 6% or 2.0 million ha. By comparison: only 4.3% or 1.6 million ha of the land is designated for nature conservation[5]. But here, too, the size is relevant. This is because only 0.6% of the area is made up of extensive, unfragmented wilderness areas where nature can thrive largely without human intervention.

The **Continue-as-Planned** scenario only allows Germany to achieve a modest decrease in land use of 2.5. million ha. This is a fairly marginal improvement of 8%.

Only the measures of the **CEMG scenario** represent substantial progress. They bring a considerable additional reduction of around 30% or 8.4 million ha globally. This is equivalent to around a quarter of Germany's total area!

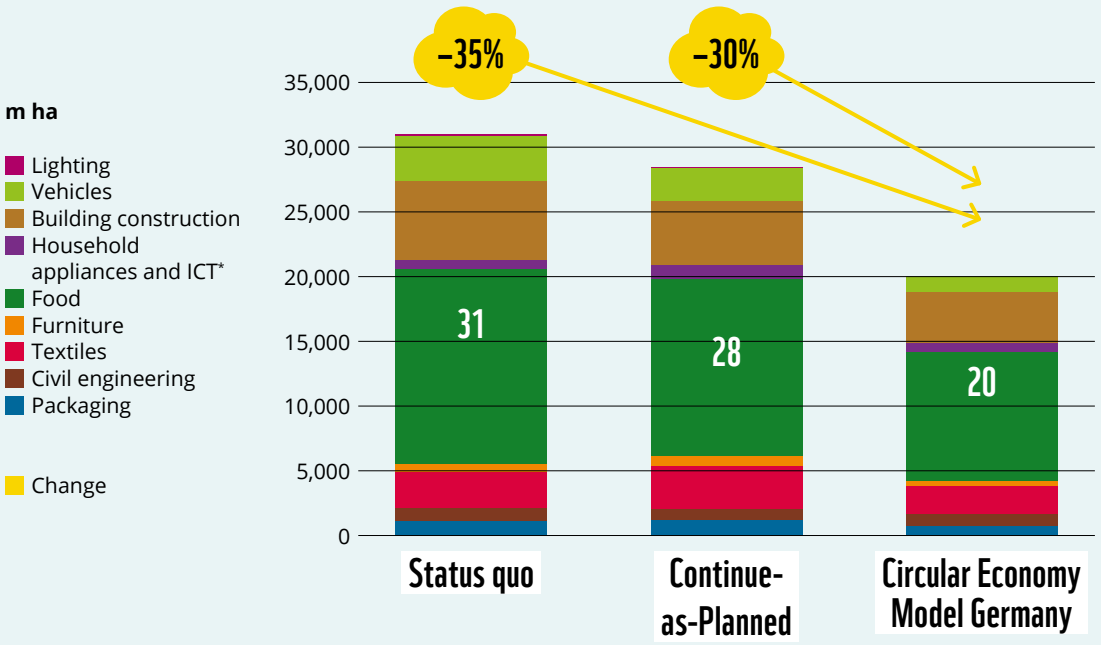
The food and diet sector particularly stands out here: it currently occupies 15 of 31 million ha, nearly half of actively used land. The CEMG measures reduce this area by 27% or 3.6 million ha. This corresponds to an area roughly the size of the German state of Baden-Württemberg.

However, the vehicles (55% or 1.4 million ha) and textile (35% or 1.1 million ha) sectors also offer good levers for reducing land use. In building construction, the contribution of –18% is smaller in relative terms. But the CEMG measures also result in a decline in land use of a relevant 900,000 ha in absolute terms.

With the appropriate political and social framework, this freed-up land then also offers considerable potential for landscape, ecosystem and biodiversity conservation – and ultimately also benefits us humans.

GENERAL OVERVIEW OF LAND USE

The CEMG measures considerably reduce additional land use.
A decisive lever here are dietary habits.



*Information and communication technology

Figure 8

Preserving biodiversity

Biodiversity encompasses the range of species and habitats, including genetic diversity within individual animal and plant species. Biodiversity is the greatest asset of our planet and indispensable for humans. Natural habitats and species provide us with food and drinking water, supply fibres for clothing and raw materials for medicines, regulate the climate – the list is endless. Without biodiversity and ecosystem services, we lack the basis for our existence. The math is simple: the more land we use for consumption and production, the greater the threats to biodiversity. It is not only the quantity that plays a key role, but also the quality, i.e. the type and intensity of use. For example, transport routes, residential areas, industrial estates and energy crops fragment and pave over natural habitats.

An important lever for lowering land use are our dietary habits. Even in the **Continue-as-Planned scenario**, we assume that the trend of reducing the amount of meat in our diet by 1.3% per year will continue until 2045. This alone will reduce the biodiversity value increment by 13%. In the **CEMG scenario**, meat consumption decreases by 4.9% per year – with a biodiversity value increment of 32%.

Evaluates the quality of the land used for food production and compares it with the quality of the natural vegetation originally present on the land.

One thing is becoming more than clear here: if the CEMG measures succeed in using less land, this space could potentially be used for more biodiversity. In any case, it must be ensured that this land also benefits nature – and ultimately us humans.

REDUCING LAND USE: CIRCULAR ECONOMY FOR MORE BIODIVERSITY

Compared to the Continue-as-Planned scenario, the CE Model Germany can significantly reduce land use even more. The food sector accounts for the largest share here and, accordingly, the largest contribution to reducing land use can also be achieved through CE measures in this sector. The vehicle, textile and building construction sectors can also make relevant contributions to reducing land use through CE measures.

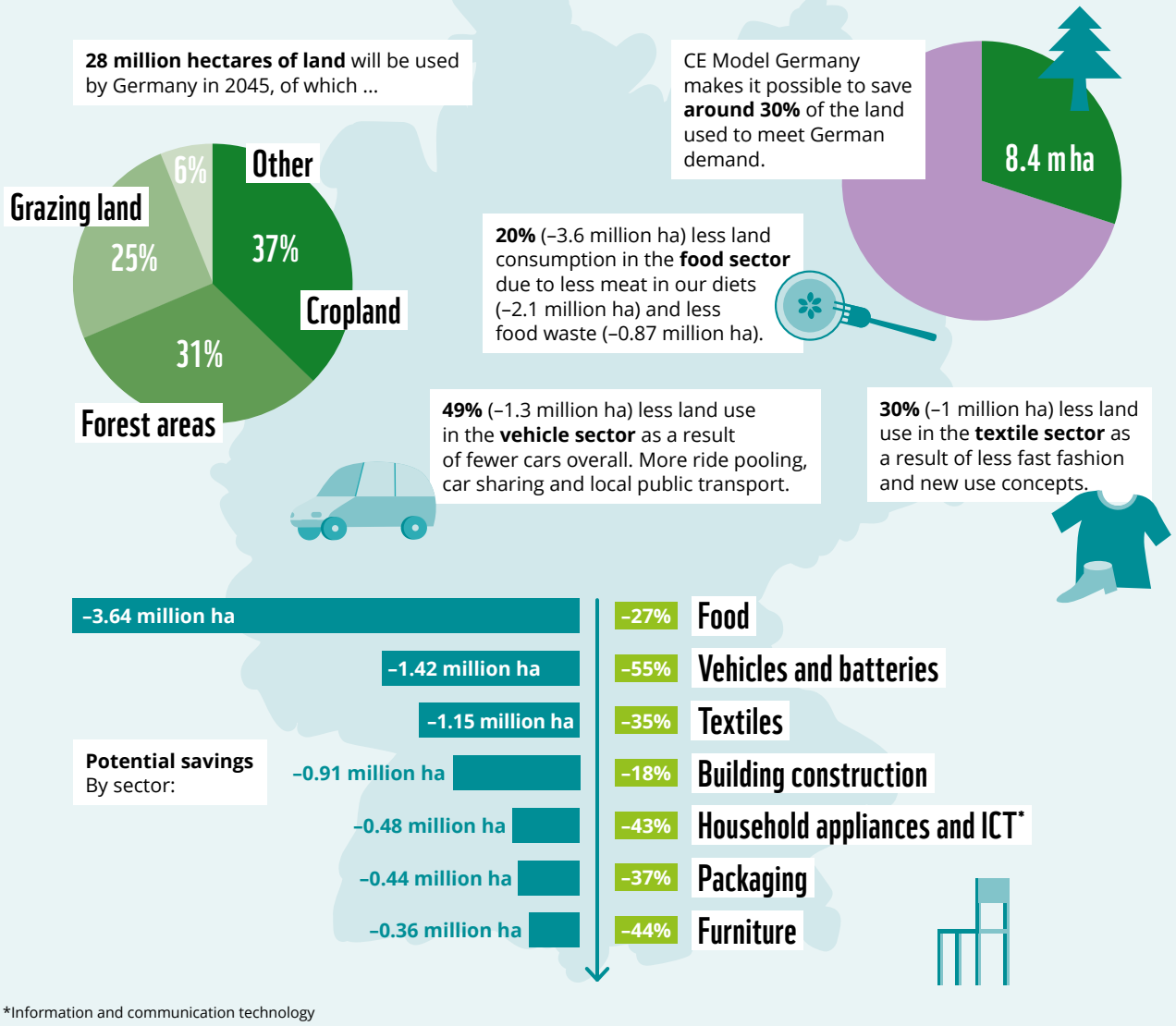


Figure 9

CIRCULAR ECONOMY INCREASES SECURITY OF SUPPLY

The pandemic, Russia's invasion of Ukraine and the increase in protectionist tendencies have shown how vulnerable and fragile Germany's supply chains and the supply of urgently needed critical raw materials are.

These raw materials are not only critical because they are often under the control of autocratic and undemocratic systems. Extracting these materials is usually also associated with considerable damage to the environment and people. They are also critical because a reliable supply is needed to bring about the successful transformation to a CE, especially for the energy transition and e-mobility, but also for information and communication technology and in the food and feed sector, where phosphate in particular plays a major role in fertilisers.

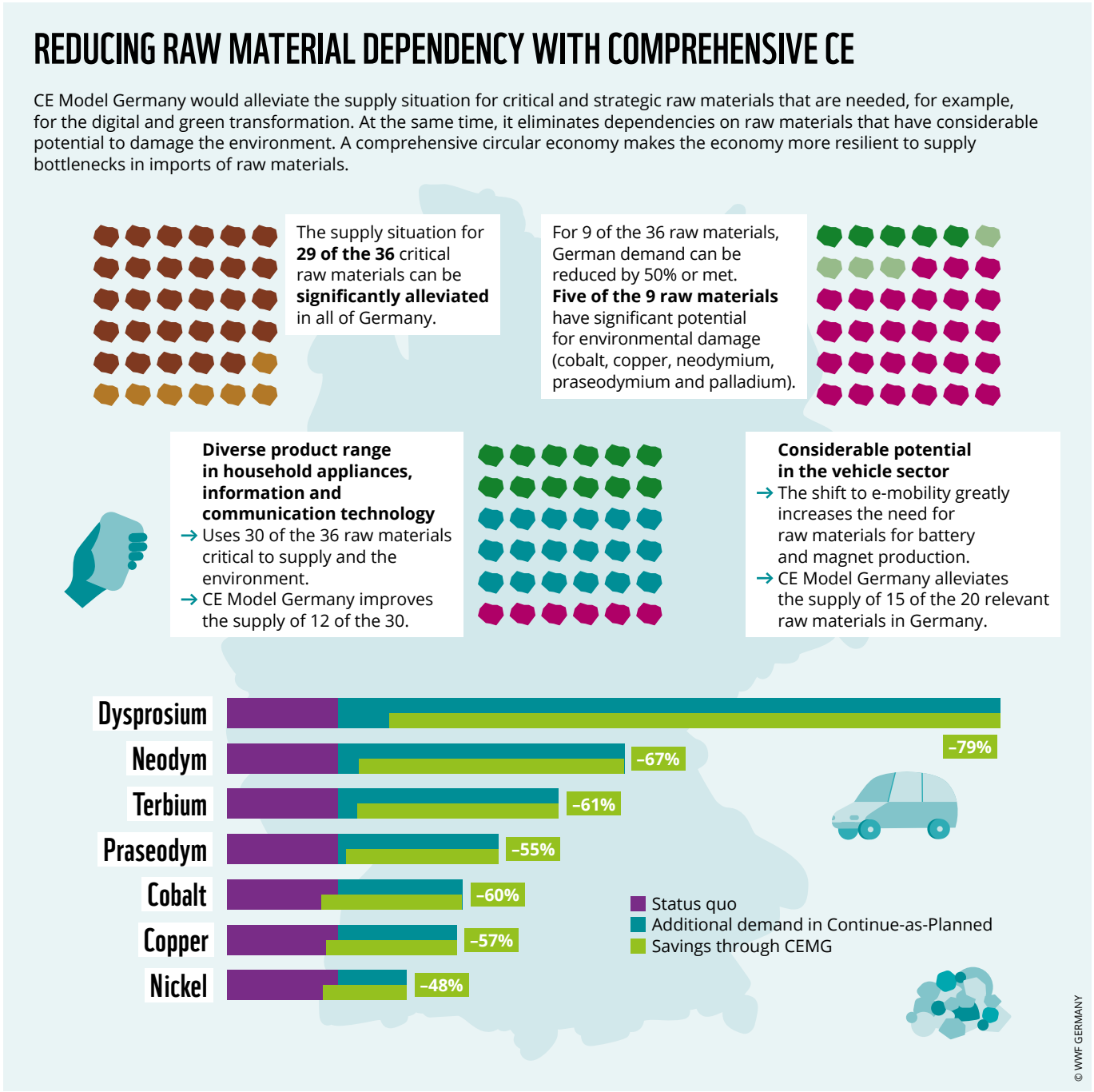


Figure 10

Overall, **most critical and environmentally relevant raw materials** are needed for vehicles and batteries as well as ICT and household appliances. For materials such as dysprosium, neodymium, terbium, praseodymium, cobalt and copper, e-mobility in particular will increase demand by more than 100% by 2045. In the case of dysprosium, which is needed for the production of special magnets, demand will even increase sevenfold.

Forty-three raw materials were analysed because they were either classified as "critical" by the European Commission or because their supply is associated with significant environmental impacts. Since seven of these are not needed to any significant extent in any of the sectors analysed and are imported, the effects of the CE measures on Germany's security of supply were ultimately assessed for the remaining 36 critical raw materials.

SUPPLY SECURITY OF IMPORTANT RAW MATERIALS THROUGH CIRCULAR ECONOMY

The CEMG measures have positive effects on Germany's security of supply. They lead to lower demand and an increased secondary supply of critical and environmentally harmful raw materials.

Raw material	Supply risk	Economic importance	Potential to harm environment	Veränderungspotenzial durch MDCE
Palladium	2.5	5.0	H	+133%*
Yttrium	2.4	3.1	M–H	+90%
Dysprosium	2.4	3.1	M–H	+79%
Neodymium	5.0	3.6	H	+68%
Terbium	2.4	3.1	M–H	+61%
Cobalt	1.6	5.7	H	+61%
Copper	0.2	4.7	H	+58%
Praseodymium	5.0	3.6	H	+55%
Gallium	1.4	3.2	M–H	+55%
Nickel	0.3	4.8	H	+48%
Niobium	3.1	4.8	M–H	+38%
Beryllium	2.4	3.9	M–H	+38%
Aluminium	0.5	6.5	M–H	+31%
Indium	2.4	3.1	H	+26%
Antimony	4.3	4.3	H	+20%
Gold	0.2	2.0	H	+19%
Phosphate	1.0	5.1	H	+17%
Molybdenum	0.9	5.2	H	+16%
Zinc	0.3	4.5	H	+13%
Germanium	1.9	3.5	H	+13%
Gadolinium	2.4	3.1	M–H	+12%
Silver	0.5	3.8	H	+12%
Vanadium	1.6	3.7	H	+11%
Cerium	5.0	3.6	H	+11%
Ytterbium	2.4	3.1	M–H	+9%
Borate	3.0	3.1	M–H	+9%
Quartz sand	0.3	2.6	M–H	+9%
Erbium	2.4	3.1	M–H	+8%
Selenium	0.4	4.5	H	+8%
Bismuth	3.8	3.6	H	+3%
Tellurium	0.7	3.4	H	+3%
Europium	2.4	3.1	M–H	+3%
Lanthanum	5.0	3.6	H	+3%
Tungsten	1.8	7.3	M–H	+2%
Platinum	2.5	5.0	H	+2%
Lead	0.1	3.7	H	+1%
Holmium	2.4	3.1	M–H	+0%
Rhenium	1.0	2.0	H	+0%
Lutetium	2.4	3.1	M–H	+0%
Rhodium	2.5	5.0	H	+0%
Samarium	5.0	3.6	H	+0%
Scandium	2.9	3.7	M–H	+0%
Thulium	2.4	3.1	M–H	+0%

Note: evaluation of criticality by the EU: supply risk (critical for >1), economic importance (critical for >2.8); potential for environmental harm (M-H = medium to high, H = high) as well as potential for change in the CEMG Mixed scenario.
*The potential for change of over 100% for palladium means that the amount of raw material that is saved or can be made available as secondary material exceeds the demand.

Table 3

Specifically, an **assessment** was made **of the potential for change** that can be leveraged through the interplay of the CE measures analysed with regard to raw material demand (measures to reduce demand) and raw material supply (measures for the provision and use of secondary raw materials). This quantification yields insights into the raw material dimension of CE, taking into account supply and demand aspects, insofar as these are affected by CE measures.

Overall, the **CE measures** not only lower relevant demand, but also lead to an increased – and potentially local – supply of economically critical raw materials, as well as raw materials the supply of which is associated with significant environmental risks during extraction. Specifically, the supply situation for raw materials can be alleviated by reducing demand or increasing supply through recycling for a total of 29 out of 36 relevant materials.

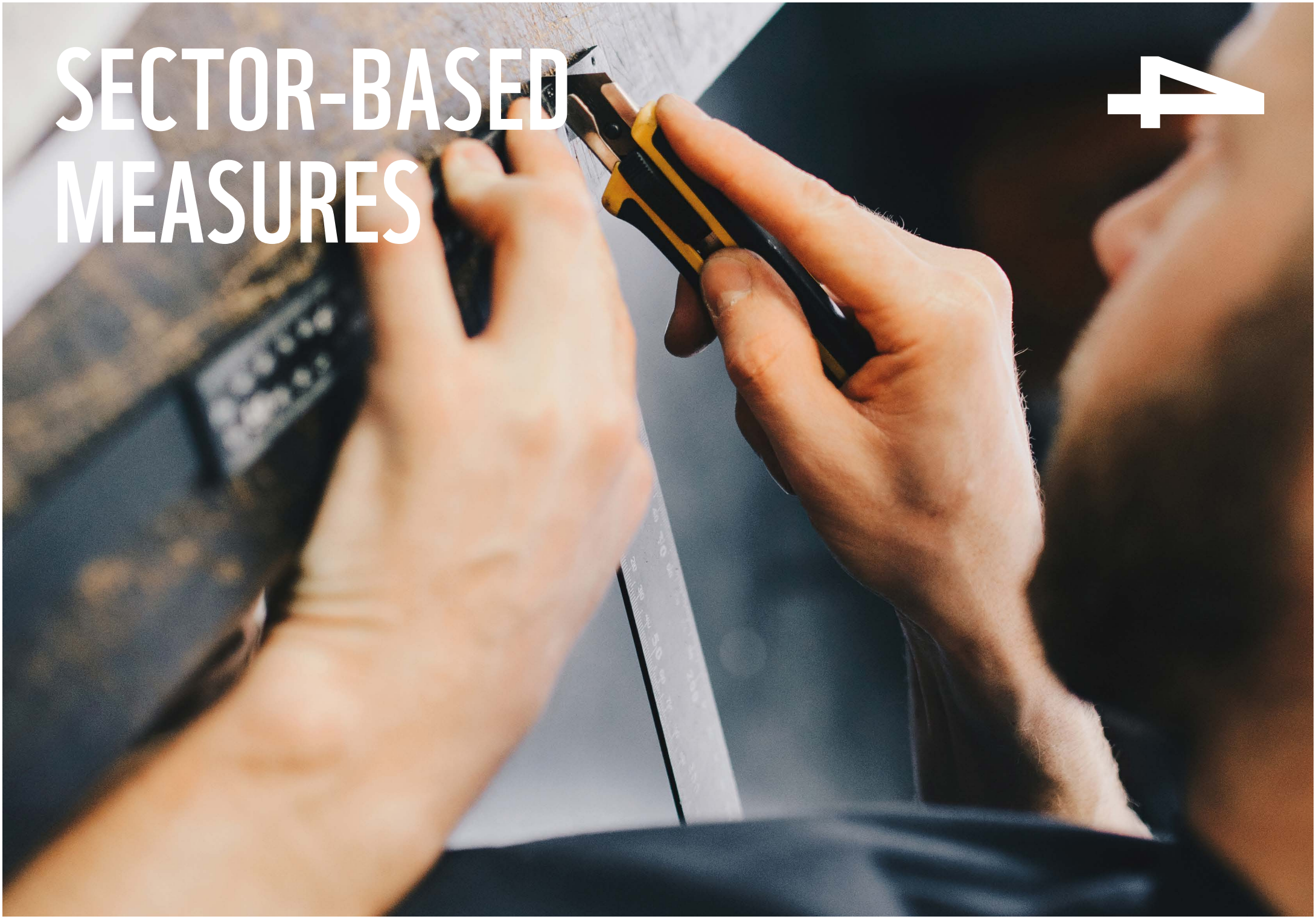
The greatest potential exists for palladium, yttrium, dysprosium, neodymium, terbium, cobalt, copper, praseodymium and gallium. In this area, more than 50% of the assumed demand for the year 2045 can be met by the CE Model Germany through the corresponding CE savings or recycling measures. This is of real importance, as eight of the nine raw materials are already considered by the EU to have a critical supply situation.

The high value of CE measures also contributes significantly to reducing potential environmental damage, as five of the nine raw materials mentioned – cobalt, copper, neodymium, praseodymium and palladium – have particularly high potential for environmental damage.

Dual advantage: the recommended CE measures not only increase Germany's security of supply and pave the way for a circular economy, they simultaneously reduce the often massive impacts on people and the environment that are caused by the extraction of raw materials. It therefore pays off twice if, for example, critical materials are replaced with less critical ones, greater use is made of secondary raw materials and materials and the life span of products is extended.

SECTOR-BASED MEASURES

4



SECTOR-BASED MEASURES

Following the analysis of the individual impact categories in Section 3, in this section WWF Germany takes a closer look at the **eight sectors** analysed and identifies key results and potential for success of the CE measures in the CEMG scenario. It is worth mentioning here as well that the extensive and in-depth details are described in the complete modelling study.

BUILDING CONSTRUCTION AND CIVIL ENGINEERING

Building construction and civil engineering consume vast amounts of resources. The production of cement and steel also generates huge amounts of CO_2 emissions. It can hardly come as a surprise that the sector is therefore one of the top three emitters of greenhouse gases and raw material consumption (RMC). It also has a significant negative effect on land use.

Measures are already planned in the building sector to save energy and resources and minimise waste. However, as can be seen in the figures shown, it is the CEMG measures that make a real difference. Germany can achieve significant changes with these measures.

Modelled CE measures

The nine CE measures modelled for building construction and civil engineering fall into three basic categories:

- More efficient use of residential and commercial areas by adapting them to needs, as well as extending the life span of buildings.
- Less use of energy-intensive building materials through design plus reuse and recycling of components and materials
- Use of more environmentally friendly building materials

Results

In **building construction**, the CEMG measures can reduce greenhouse gas emissions by 18% or 59.3 Mt CO_2-eq compared to the Continue-as-Planned scenario. In the case of RMC, raw material consumption is reduced by 26% or 49.2 Mt, in the case of total material consumption (TMC) 24% or 75.3 Mt are saved, and in the case of land use it is possible to reduce Germany's consumption by 18% or 907,000 ha.

CLEVER & SMART
CIRCULAR ECONOMY IN BUILDING CONSTRUCTION AND CIVIL ENGINEERING

Germany is building. But land is need for building. And building construction and civil engineering consume vast amounts of resources. But that's not all: steel and cement production releases immense quantities of CO_2 emissions. Building construction and civil engineering are among the top three contributors. Does this mean we should build less? Yes, it does but when we do build, it needs to be more carefully planned and more economical: simply smarter.

WE HAD BETTER BUILD ON THIS...

Greatest impact!

Less space for housing and offices
and longer use of existing buildings.
→ Achieves **97%** greenhouse gas and **69%** raw material savings.
→ Fewer buildings means less construction, fewer fixtures, furniture, equipment and heating.

Less structural steel or structural cement
through innovative design
→ Saves 5 Mt of raw materials and 0,6 Mt CO_2 eq.
→ Climate warning: The **production** of cement and steel requires a lot of energy.

More substitution
of environmentally intensive building materials
→ with regenerative building materials or alternative binding agents
→ Important: Regenerative materials like wood are limited and must be produced sustainably.

More recycling of building materials and more cement recycling.
→ More cement recycling achieves **81%** of raw material savings in civil engineering.
→ Otherwise, there is not much to be gained in civil engineering.

REDUCTION

■ Building construction ■ Civil engineering

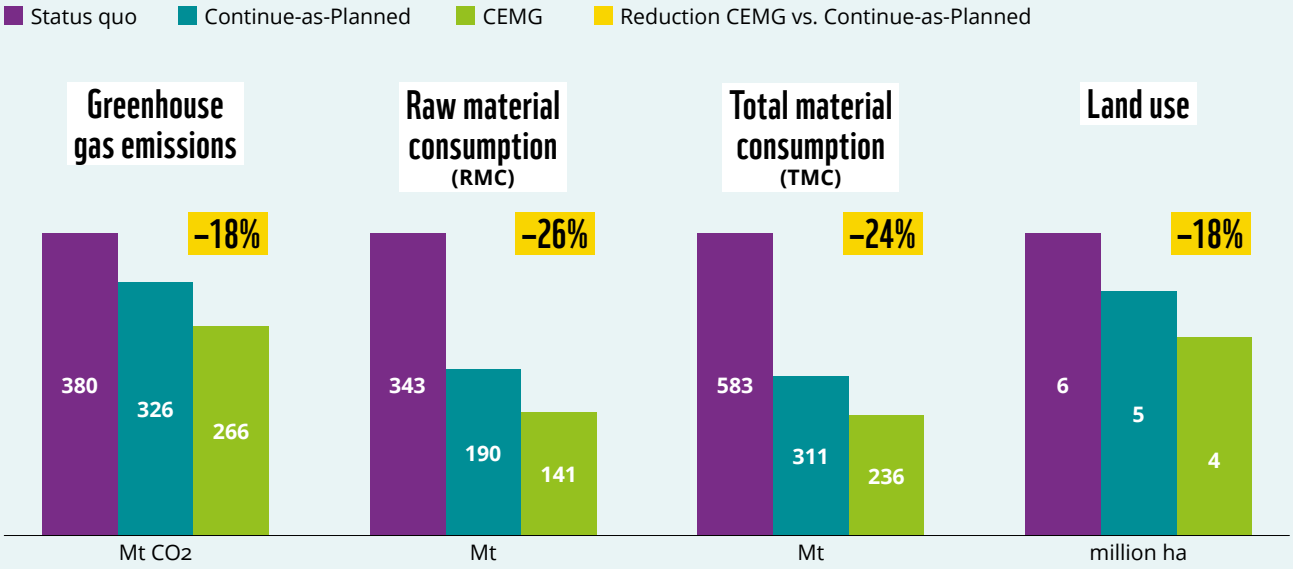
Greenhouse gas emissions
–18% –59 Mt CO_2-eq
–5% –0.7 Mt CO_2-eq

Raw material consumption
–26% –49 Mt
–24% –17 Mt

Land use
–18% –0.9 million ha
–1% –13,000 ha

WHAT CAN CIRCULAR ECONOMY DO FOR BUILDING CONSTRUCTION?

he measures of Circular Economy Model Germany (CEMG) have a great impact overall, but vary in detail. As can be seen in the table, one measure in particular stands out.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO_2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**378.9**		**343,131.0**		**582,970.0**		**6,068.5**	
Continue-as-Planned	**325.6**		**190,232.8**		**310,918.3**		**4,906.0**	
Less space for offices and housing	–57.5	97.0%	–34,094.6	69.4%	–55,642.9	73.9%	–872.1	96.1%
Reuse of building components	–0.1	0.2%	–1,807.0	3.7%	–2,232.4	3.0%	–2.8	0.3%
Extended life span of buildings	–0.4	0.6%	–5,474.6	11.1%	–6,831.2	9.1%	–9.5	1.0%
Reduction in the clinker factor	–0.5	0.8%	–1,840.0	3.7%	–2,564.4	3.4%	–3.2	0.4%
Alternative binding agents for cement production	–0.1	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Use of regenerative material substitutes	0.0	0.0%	–386.1	0.8%	–487.5	0.6%	–0.1	0.0%
Reduction in the use of structural steel through design	–0.4	0.7%	–754.3	1.5%	–1,797.7	2.4%	–16.2	1.8%
Reduction in the use of structural cement through design	–0.1	0.2%	–4,485.5	9.1%	–5,231.6	7.0%	–1.8	0.2%
Reuse of structural steel	0.0	0.0%	–45.9	0.1%	–109.4	0.1%	–1.0	0.1%
Cement recycling	–0.1	0.1%	–268.1	0.5%	–369.4	0.5%	–0.4	0.0%
CEMG	**266.4**		**141,076.7**		**235,651.7**		**3,998.9**	
Reduction CEMG vs. Continue-as-Planned	**–59.3**	**–18.2%**	**–49,156.1**	**–25.8%**	**–75,266.6**	**–24.2%**	**–907.1**	**–18.5%**

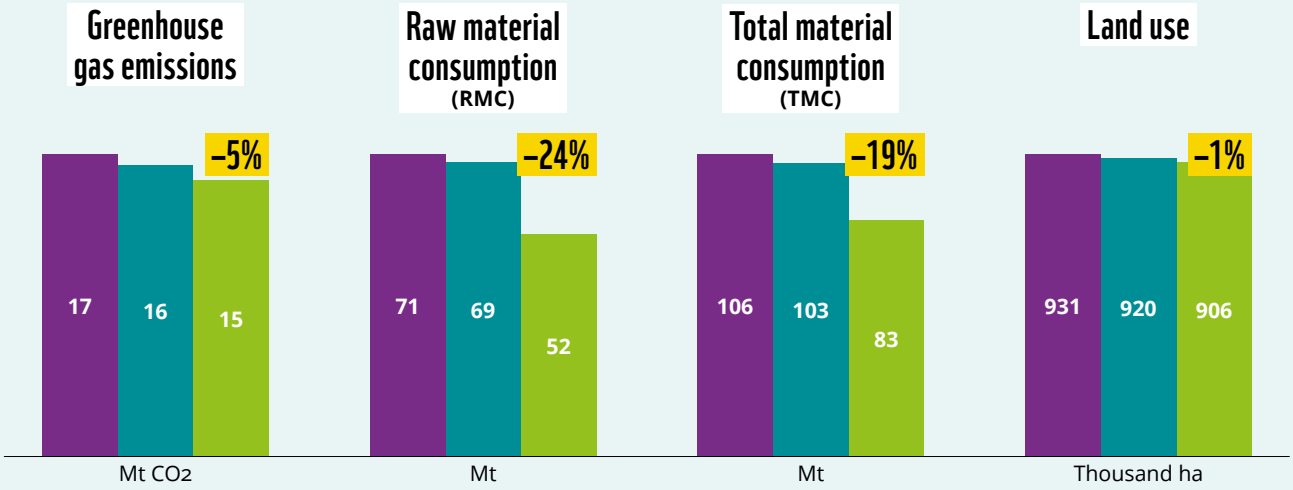
Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 11

In **civil engineering**, there are considerably fewer possibilities, as the potential there is inherently limited. Still, compared to the Continue-as-Planned scenario, CEMG can reduce GHGs by 5% or 0.7 Mt CO_2-eq. 24% or 16.9 Mt can be saved for RMC, 19% or 20.1 Mt for TMC and 1.5% or 13,500 ha for land use.

WHAT CAN CIRCULAR ECONOMY DO FOR CIVIL ENGINEERING?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall, but vary in detail. In the table you can see that one measure has a particularly big impact.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO_2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**16.5**		**71,131.1**		**106,354.7**		**931.3**	
Continue-as-Planned	**15.9**		**69,324.3**		**103,411.8**		**919.7**	
Use of secondary products and residues from industry and construction waste	–0.1	15%	–412.8	2%	–575.4	3%	–0,7	5%
Reduction in the use of structural steel through design (reduced overspecification and lightweight construction)	–0.1	19%	–244.1	1%	–581.7	3%	–5,2	39%
Reduction in the use of structural cement through design (reduced overspecification and lightweight construction)	–0.1	11%	–2,442.4	14%	–2,861.8	14%	–1,0	8%
Use of alternative binding agents in cement production	–0.1	15%	0,0	0%	0,0	0%	0,0	0%
Reuse of structural steel	–0.1	7%	–91.8	1%	–218.8	1%	–2,0	15%
Cement recycling with Smart-Crusher technology	–0.2	33%	–13,729.3	81%	–15,875.0	79%	–4,5	33%
CEMG	**15.1**		**52,403.9**		**83,299.0**		**906.3**	
Reduction CEMG vs. Continue-as-Planned	**–0.7**	**–5%**	**–16,920.4**	**–24%**	**–20,112.8**	**–19%**	**–13.5**	**–1%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 12

Behaviour-based measures are the trump card

The less space is used for housing and office buildings and the more efficiently this land is used, the fewer resources are needed for new construction and use. To fully harness this potential, a change in behaviour is needed above all. How effective the two behaviour-dependent CEMG measures are is evident when we look at GHG emissions. Of the approximately 60 Mt CO_2-eq that can be additionally saved in the CEMG scenario compared to the Continue-as-Planned scenario, approximately 57 Mt CO_2-eq or 97% can be attributed to less use of space for housing and office buildings.

Cement (and steel) are key materials.

With a view to the goal of a climate-neutral economy, it is particularly important to reduce hard-to-avoid process emissions. This can be achieved through optimised, resource-efficient building design or by replacing building materials with significant environmental impacts (reducing the clinker factor, using alternative binding agents or regenerative materials instead of steel and cement), reusing building components and structural steel and using recycled cement. Technological measures also include carbon capture and storage technologies (carbon capture and utilisation – CCU, and carbon capture and storage – CCS).

Increased security of supply

Particularly in the case of steel, the CEMG measures also play a central role in security of supply. This is because critical raw materials such as niobium, molybdenum, vanadium and nickel, as well as zinc for corrosion protection, are used in its production. CEMG measures such as reduced demand for space for housing and office buildings, less use of structural steel and concrete due to design and longer use of existing buildings can reduce niobium demand by 21%, for molybdenum by 10% and for vanadium by 9%. This significantly reduces the supply pressure for the entire German economy.

VEHICLES AND BATTERIES

According to the Federal Environment Agency, the number of motor vehicles in Germany has increased continuously since 1991[6]. The average size of vehicles has grown just as steadily. For example, the number of smaller cars has grown by 2% in the last 10 years, while the number of vans, SUVs and similar vehicles has increased by 80%. As (private individual) transport is a significant "consumer" of raw materials and resources, it has very far-reaching negative implications for land use, greenhouse gas emissions and the environmental development of our country as a whole.

The already initiated and (slowly) ongoing transition from combustion engines to e-mobility will lead to diverging effects in the coming years. On the one hand, there is a greater demand for metals, some of which are critical, for the growing number of electronic components and batteries. To make matters worse, these raw materials cause more waste and damage during their extraction than the base metals of an incinerator. On the other hand, saying goodbye to fossil, CO_2-intensive energy sources has a positive effect.

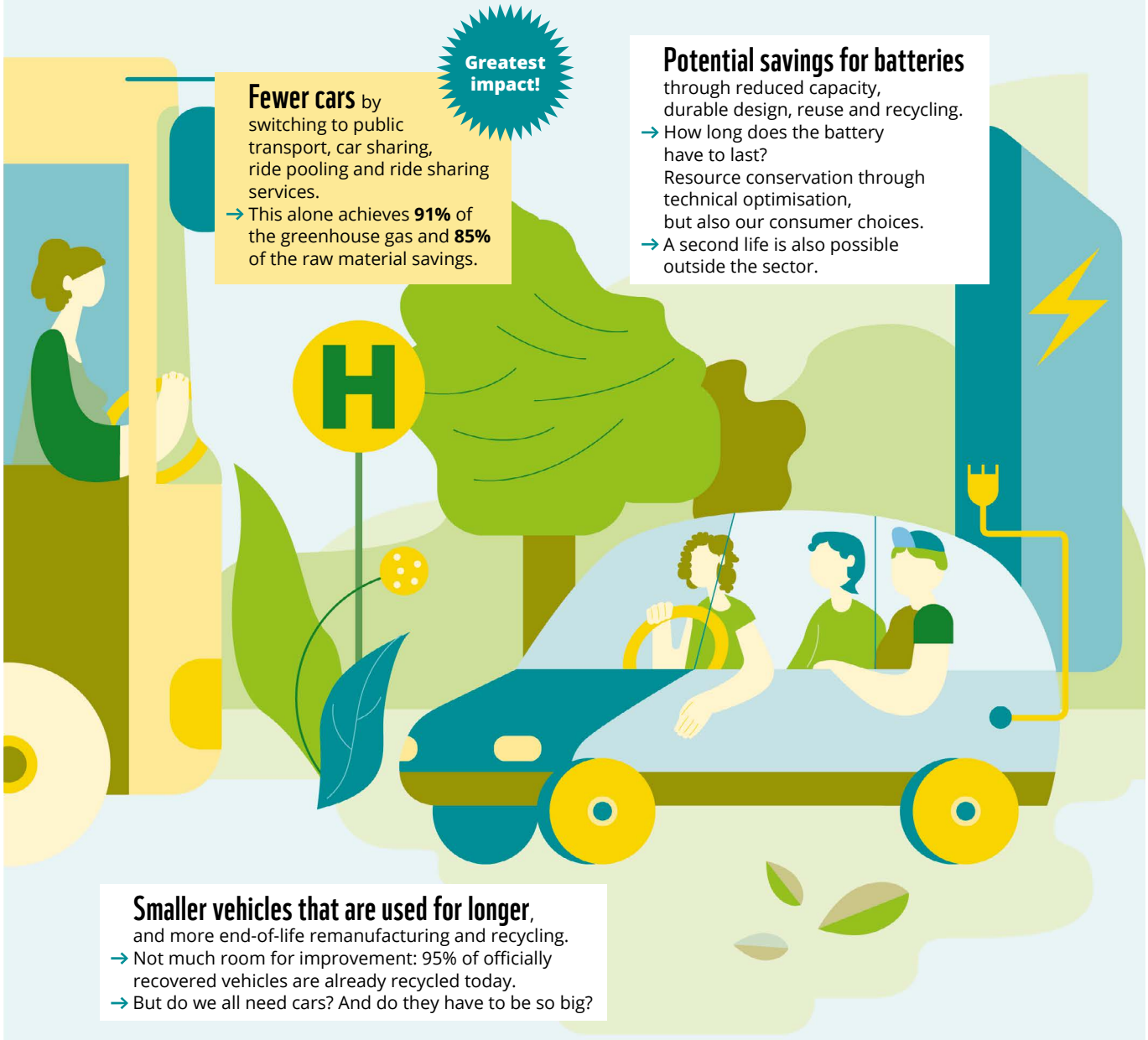
Modelled CE measures

For vehicles and batteries, eleven different CE measures were analysed that lead to less private individual transport (e.g. through increased use of public transport or car sharing), directly and inherently affect vehicles (such as extended useful life and smaller car sizes) or target optimised batteries.

MOVING MORE PEOPLE WITH FEWER VEHICLES
CIRCULAR ECONOMY FOR VEHICLES AND BATTERIES

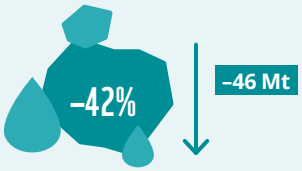
Transport consumes raw materials and land – and harms our climate with considerable amounts of greenhouse gas emissions. Vehicles and batteries are among the top three producers of greenhouse gases and consumers of raw materials. Do we all need a car or do we just want to be mobile? Here, the idea is to find new strategies and consumer habits.

HOW DO WE GET ON THE CIRCULAR PATH TO THE FUTURE?

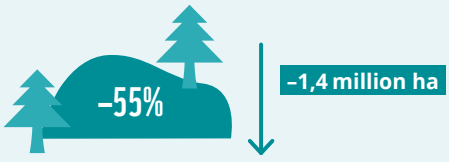


REDUCTION

Greenhouse gas emissions



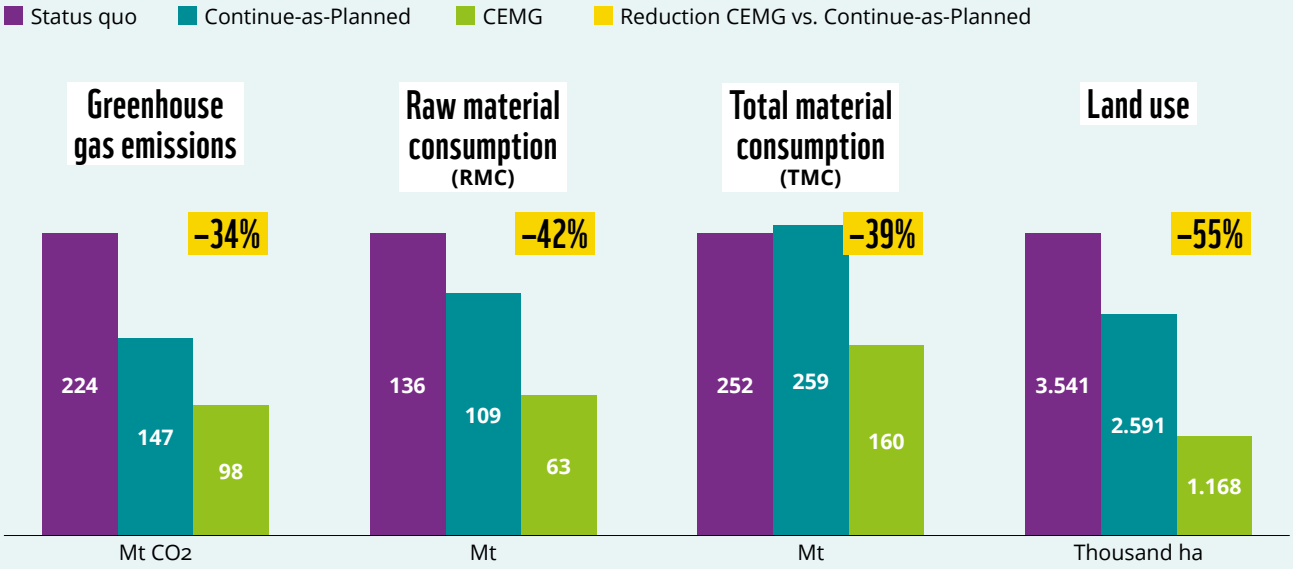
Raw material consumption



Land use

WHAT CAN THE CIRCULAR ECONOMY DO FOR VEHICLES AND BATTERIES?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall.
Some measures also play a substantial role when considering the individual measures in the table.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO_2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**224.3**		**136,344.8**		**252,341.6**		**3,541.2**	
Continue-as-Planned	**146.9**		**109,432.3**		**259,435.9**		**2,590.6**	
Local public transport	–14.0	28%	–10,276.9	22%	–22,467.6	23%	–377.5	27%
Car sharing	–15.2	31%	–14,222.0	31%	–30,281.7	30%	–441.1	31%
Ride pooling	–15.8	32%	–14,448.4	31%	–31,752.6	32%	–440.5	31%
Other measures at vehicle level	–1.6	3%	–1,622.8	4%	–4,061.9	4%	–34.0	2%
Other measures for batteries	–2.7	6%	–5,486.0	12%	–11,323.6	11%	–129.1	9%
CEMG	**97.5**		**63,376.2**		**159,548.4**		**1,168.3**	
Reduction CEMG vs. Continue-as-Planned	**–49.4**	**–34%**	**–46,056.1**	**–42%**	**–99,887.4**	**–39%**	**–1,422.3**	**–55%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 13

Results

With the CEMG measures, Germany can continue to decisively advance the already positive developments of the Continue-as-Planned scenario until 2045. By then, even the negative result for total material consumption becomes positive. The additional successes of the CEMG scenario in concrete figures: -34% or –49.4 Mt CO_2-eq GHG, –42% or 46.1 Mt RMC, –39% or 99.9 Mt TMC and a 55% or 1.4 million ha reduction in land use.

Behavioural changes: car sharing

Increased use of public transport, car sharing and ride sharing have the greatest positive effects in all impact categories and are therefore the central CEMG measure. Companies and policymakers must actively initiate this change in behaviour in order to create the necessary conditions for the general public.

Behavioural changes: size does matter

It may seem trivial, but it's actually catastrophic: larger vehicles devour more resources in production, have higher consumption and require large and heavy XXL batteries. In this case, less is more: it is much better to buy a smaller car than a big SUV. This change in behaviour also holds significant potential savings even though to a lesser extent than the change in car use and the increased use of public transport.

Optimise batteries

The longer an e-car can be used, the better its overall rating in all environmental areas. The battery in particular proves to be a limiting factor. The only clear remedy is a combination of measures from the Technology and Behaviour scenarios: i.e. more innovations and further technical development plus more sustainable behaviour in the choice of car and in driving and charging behaviour.

Increase security of supply

Also with regard to security of supply, the greatest successes can be achieved through less private individual transport and the associated decrease in new car production. The situation for 13 of the 20 raw materials relevant for vehicles and batteries can be significantly improved through the corresponding CEMG measures. For the metals needed for magnets, dysprosium, neodymium and terbium, 53%, 44% and 41% of the demand can be met through savings or recycling. Together with the measures at vehicle and battery level, German demand can be met by as much as 77% (dysprosium), 65% (neodymium) and 60% (terbium).

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND HOUSEHOLD APPLIANCES

The often excessive demand for several electronic ICT devices and household appliances, as well as the often poor product quality or product quality limited by "predetermined breaking points", ensure not only continuously increasing production numbers, but also a shorter average life span and useful life of the devices. More one- and two-person households are also a reason for the high demand, as is the often colossal number of surplus appliances and devices in kitchens, bathrooms and hobby rooms. The consequences are logical: we need more and more material and thus create greater and greater stresses in all areas.

CE Model Germany looks at smartphones, tablets, notebooks, desktop PCs, TVs, washing machines, dryers, refrigerators, freezers and dishwashers. Due to the large number of products and technologies, 30 of the 36 critical raw materials analysed are relevant.

Modelled CE measures

Four specific CE measures were assessed for household appliances and devices in the information and communication technology sectors: extending the life span and useful life of devices, remanufacturing, improved collection and optimised recycling of end-user devices, and resource-efficient use of data centres.

Results

The results of the Continue-as-Planned scenario are alarming. If we waltz into the future this way, we will be piling further damage on top of the already enormous environmental impact – with no prospect of improvement. In contrast, Germany can not only significantly slow down this development with the CEMG measures, but even reverse it! Compared to the Continue-as-Planned scenario, GHG emissions are reduced by 40% or 21.1 Mt CO_2-eq. For RMC the reduction is –42% or 16.3 Mt and for the TMC 41% or 53.0 Mt. Land use can be reduced by 43% or 483,000 ha. Technological measures show the greatest potential in all impact categories analysed.

Data centres make the difference

More resource-efficient use of data centres offers the greatest leverage for savings among all CEMG measures. Seventy-three percent of the total GHG savings potential can be achieved this way alone, with the lion's share coming from the consistent use of electricity from renewable sources. In addition, two efficiency factors are key: lower market growth for servers through the optimised use of IT and lower energy consumption through better air-conditioning technology for cooling server rooms and an adjustment in room temperature.

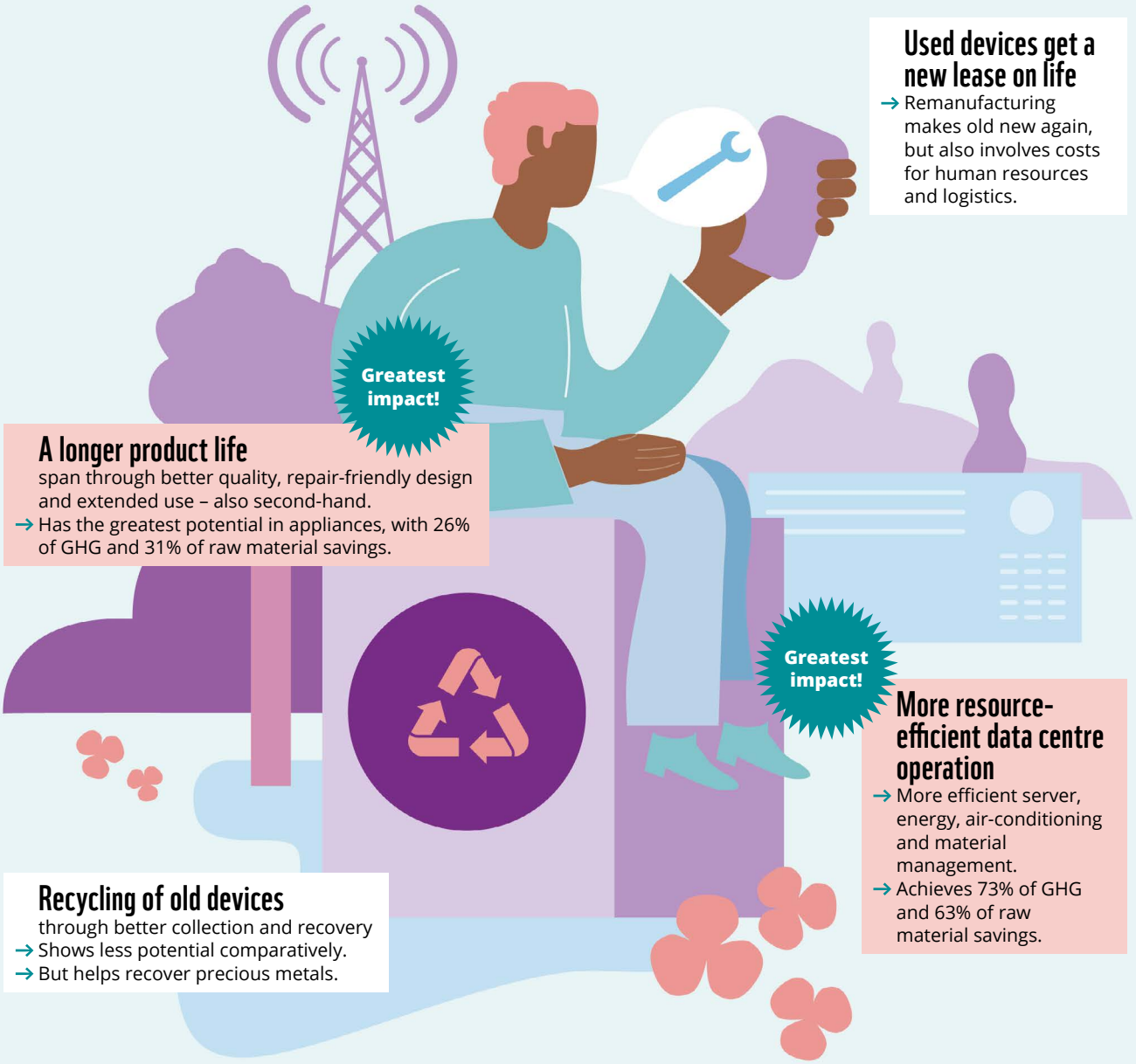
Longer life spans for appliances and devices

More intensive and longer use of devices and appliances is a key CEMG measure to reduce environmental impacts. Remanufacturing, better collection and increased recovery of raw materials are relevant, but fall short in comparison. The importance of longer and more intensive use is shown by the dominance of production inputs. These cannot be compensated for even by energy savings during use and even taking into account inputs for repairs and spare parts.

GOING AROUND IN CIRCLES
CIRCULAR ECONOMY OF HOUSEHOLD APPLIANCES, INFORMATION AND COMMUNICATION TECHNOLOGY

The number of gadgets kept in German cupboards, drawers, shelves … is immense. Much of it usually lies dormant, unused. The CE Model Germany took a look at these gadgets in German households that are really in use and make our lives easier.

HOW IT WORKS …



Used devices get a new lease on life
→ Remanufacturing makes old new again, but also involves costs for human resources and logistics.

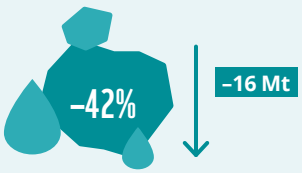
A longer product life
span through better quality, repair-friendly design and extended use – also second-hand.
→ Has the greatest potential in appliances, with 26% of GHG and 31% of raw material savings.

More resource-efficient data centre operation
→ More efficient server, energy, air-conditioning and material management.
→ Achieves 73% of GHG and 63% of raw material savings.

Recycling of old devices
through better collection and recovery
→ Shows less potential comparatively.
→ But helps recover precious metals.

REDUCTION

Greenhouse gas emissions

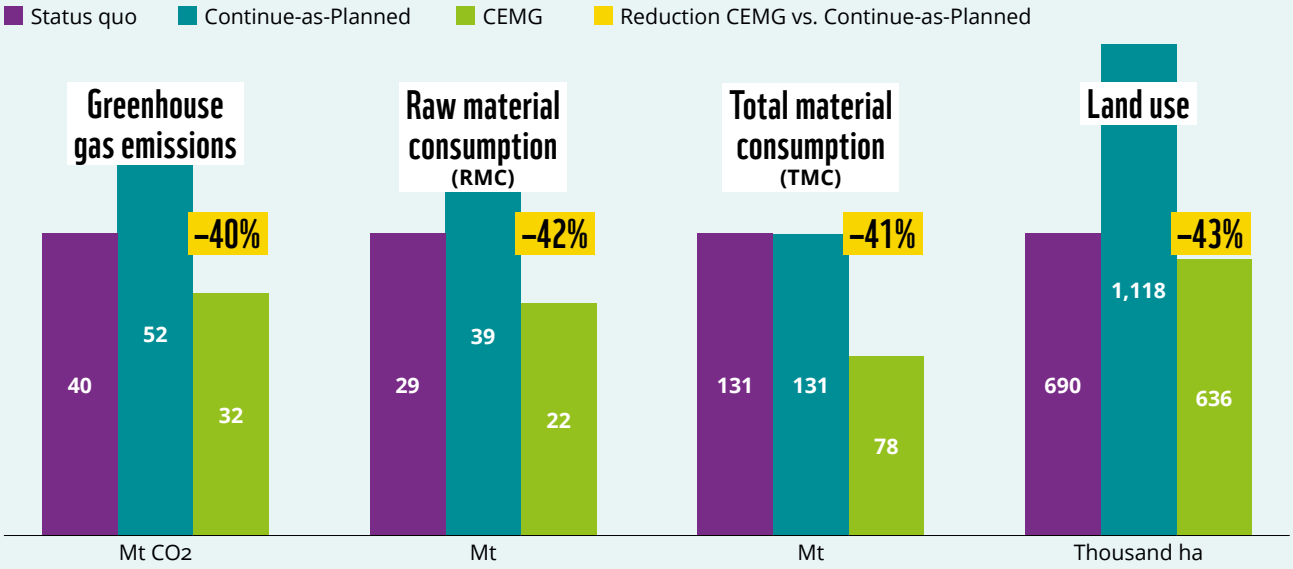


Raw material consumption

Land use

WHAT CAN CIRCULAR ECONOMY DO FOR HOUSEHOLD APPLIANCES AND ICT*?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall.
The comparison shows that two issues in particular play an important role at measure level.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**39.5**		**29,277.3**		**130,973.5**		**689.5**	
Continue-as-Planned	**52.8**		**38,698.5**		**130,564.8**		**1,118.2**	
Extended life span and useful life	–5.5	26%	–5,052.9	31%	–14,197.0	27%	–170.9	35%
Remanufacturing	–0.1	1%	–223.4	1%	–431.5	1%	–8.8	2%
Increased recovery of secondary raw materials	–0.1	0,4%	–724.8	5%	–1,833.0	4%	–5.2	1%
Resource-efficient use of data centres	–15.3	73%	–10,258.3	63%	–36,520.4	69%	–297.7	62%
CEMG	**31.7**		**22,439.1**		**77,582.9**		**635.8**	
Reduction CEMG vs. Continue-as-Planned	**–21.1**	**–40%**	**–16,259.4**	**–42%**	**–52,981.9**	**–41%**	**–482.5**	**–43%**

*Information and communication technology
Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 14

More security of supply

The CEMG measures will improve the security of supply for 12 of the 30 critical raw materials relevant to ICT devices and household appliances. For all of them, German demand can be reduced by at least 5% or met by CE Model Germany. The calculation here is also simple: less demand and more recycling means more security of supply. Quantitative and qualitative optimisation of the collection and recycling of devices is particularly significant for recovering the precious metals palladium and gold. These can be recovered with little loss since they are resistant to corrosion. For example, the palladium demand needed in 2045 can even be exceeded by secondary palladium with 171%.

FOOD AND DIET

The food and diet sector is currently one of the top three contributors to negative environmental impacts caused by GHG, RMC and TMC. A major reason is the current diet in Germany with its large share of animal products (meat, sausage, eggs, dairy products). The negative impacts for land use are also rooted here.

Across all sectors analysed, food and diet currently account for 49% or 15 million ha of total land use. 77% of the biodiversity losses in our diet are due to food of animal origin.

Production-side approaches, such as the expansion of organic farming, the implementation of livestock farming based on the size of the land or the reduced use of pesticides and fertilisers are also important CE levers in this sector. However, these are currently difficult to calculate due to the lack of data up to 2045. However, our food consumption also creates essential impetus for food production here.

Modelled CE measures

In the area of food and diet, three CE measures were analysed that aim at a more sustainable diet within planetary boundaries: switching to a more plant-based diet with plant-based and synthetic meat alternatives and preventing food waste.

Results

The CEMG measures allow crucial successes to be achieved in all impact categories analysed. Specifically, GHG emissions here can be reduced by 32% or 37.9 Mt CO_2-eq compared to the Continue-as-Planned scenario, and RMC by 13% or 23.9 Mt. In terms of land use, it is possible to reclaim 27% or 3.6 million ha.

Save fertiliser and reclaim land

To produce 1 kg of ready-to-eat pork, farmers need about 7 kg of animal feed. It is much more efficient and environmentally compatible to produce plant-based food directly instead of animal feed. This not only reduces the need for fertiliser, but also frees up valuable land. This is because the production of 1 kg of beef requires about 38 m² of land, 1 kg of eggs take up 3 m² and dairy products such as cheese require about 6 m²/kg. In contrast, rice only requires 1.7 m²/kg and vegetables like spinach only 0.004 m²/kg.

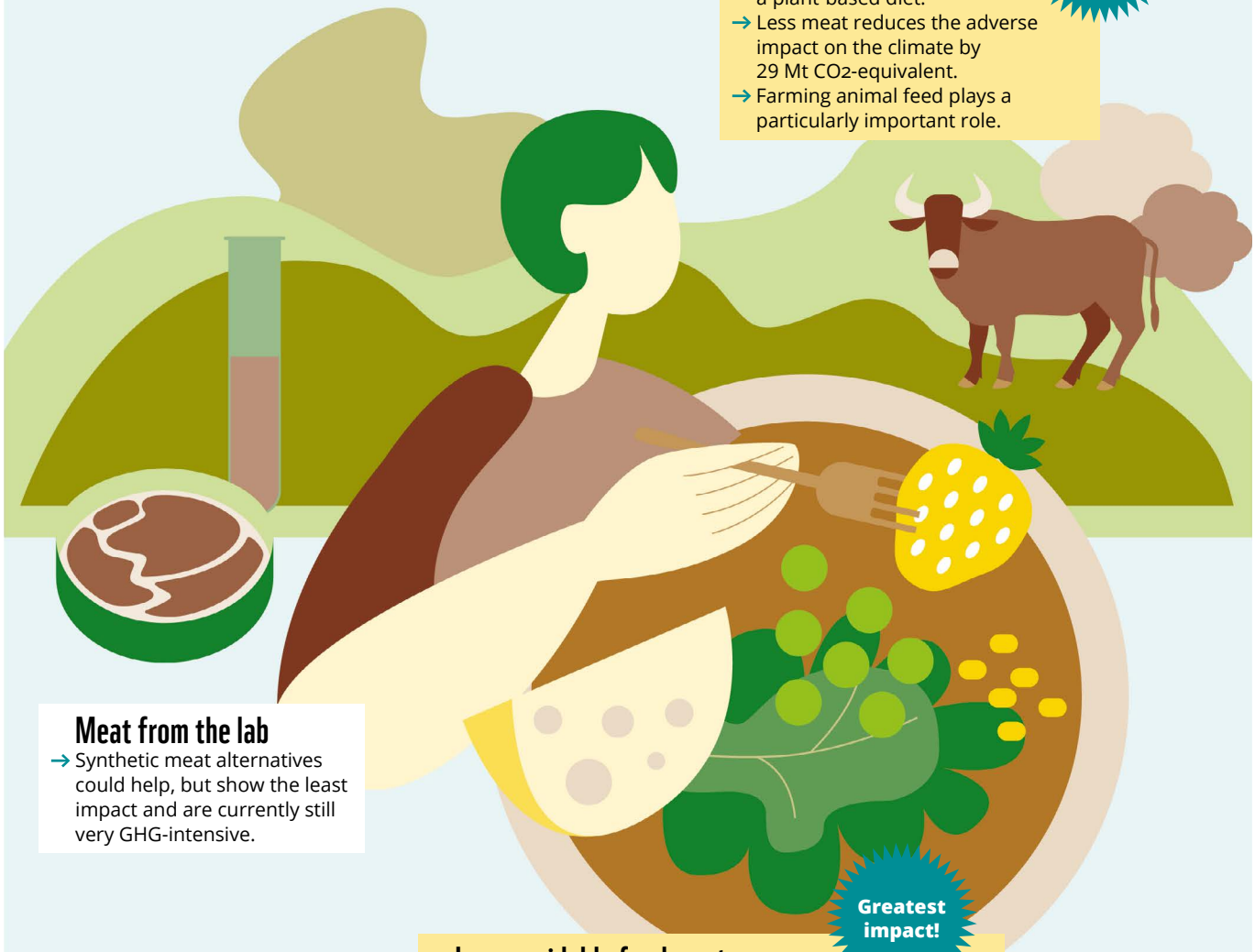
CHANGE EATING HABITS
CIRCULAR ECONOMY FOR DIET AND FOOD

The food and diet sector is one of the top contributors to negative environmental impacts. Meat consumption and the land needed to grow animal feed play a central role in this context because meat uses land and destroys biodiversity.

HOW TO EAT RIGHT ...

Less meat and a shift to a plant-based diet.
→ Less meat reduces the adverse impact on the climate by 29 Mt CO_2-equivalent.
→ Farming animal feed plays a particularly important role.

Greatest impact!



Meat from the lab
→ Synthetic meat alternatives could help, but show the least impact and are currently still very GHG-intensive.

Less avoidable food waste
→ Lowers the overall demand for food.
→ Raw material consumption in particular decreases: –14 Mt.

Greatest impact!

REDUCTION

–38 Mt CO_2-eq

Greenhouse gas emissions

–24 Mt

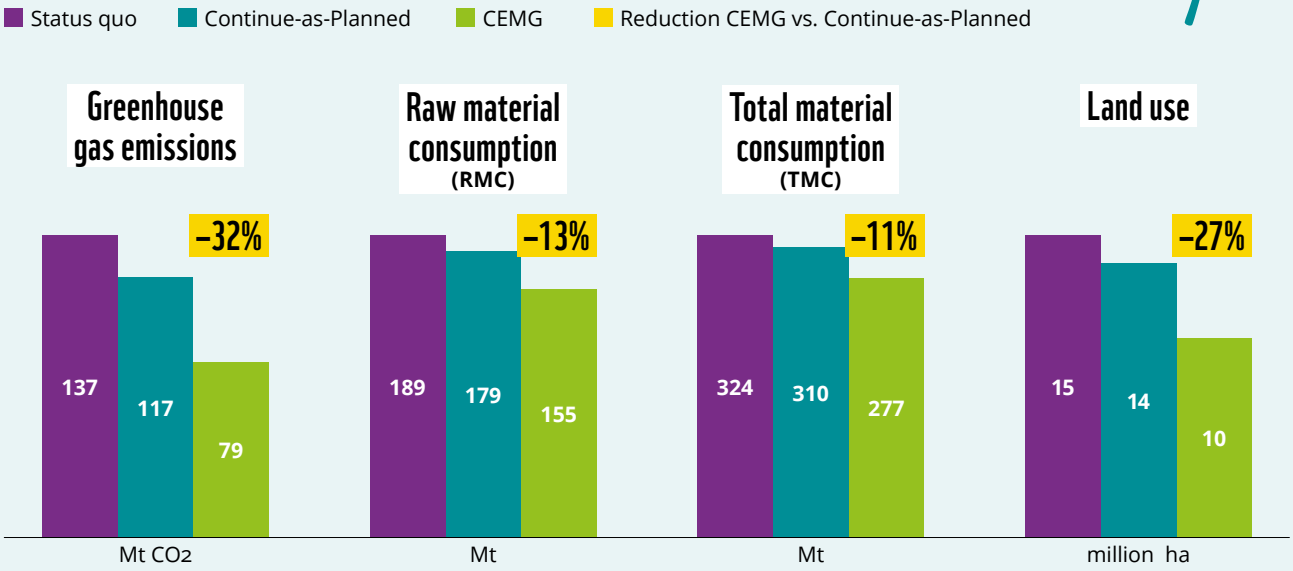
Raw material consumption

–3.6 million ha

Land use

WHAT CAN CIRCULAR ECONOMY DO FOR FOOD?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall.
Two CE measures in particular make a relatively large contribution.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**136.6**		**189,033.9**		**323,711.7**		**15,049.0**	
Continue-as-Planned	**117.3**		**179,036.6**		**310,356.3**		**13,611.9**	
Planetary Health Diet	–28.7	76%	–5,814.4	24%	–6,288.5	19%	–2,147.6	59%
Cellular agriculture	–1.7	5%	–4,402.4	18%	–3,405.7	10%	–624.0	17%
Food waste	–7.4	20%	–13,649.2	57%	–23,595.3	71%	–874.4	24%
CEMG	**79.5**		**155,170.6**		**277,066.9**		**9,965.9**	
Reduction CEMG vs. Continue-as-Planned	**–37.9**	**–32%**	**–23,866.0**	**–13%**	**–33,289.5**	**–11%**	**–3,646.0**	**–27%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 15

Reduce food waste

As part of the study, food losses along the value chain were examined as an additional production input that has to be added to the inputs of consumed food. It is abundantly clear that preventing food waste is a potent and direct lever for reducing environmental impacts. For every gram that is produced but not used, the resources used end up in the bin (and the food has to be bought again). As the WWF study "Das große Wegschmeißen"[7] (published in German; English: The Great Throwaway) shows, Germany wastes over 18 million tonnes of food every year. That is almost one third of current food consumption. 313 kg of edible food lands in the rubbish bin every second.

In-vitro meat is not a solution

Replacing meat with synthetic alternatives currently holds little potential from an environmental perspective. It is also not clear right now when adequate quantities of synthetic meat could be available. Another disadvantage is the relatively energy-intensive production.

Securing the supply of phosphate

Phosphate is mainly needed to produce fertiliser, which in turn is key to the production of animal feed: 93% of phosphate consumed in Germany is used in agriculture. Phosphate, however, has a high or moderate to high potential to threaten the environment and is classed as critical in terms of the security of supply. This means: the less fertiliser we need, the better it is for the environment and the more secure the supply of the important raw material phosphate is for Germany.

TEXTILES

The textile sector is a prime negative example of the current throwaway mentality and its consequences. Entire business models are based on fast and cheap fashion where new collections appear on a weekly basis. The focus is often on people's love of (fast and frequent) shopping. The actual purpose and use of clothing recede into the background.

Germany is one of the five largest producers of textile waste in the EU. In addition to massive environmental damage, the textile sector is also responsible for serious human rights violations in the (mostly far away) production locations of the supply chain. These include, for example, child labour, hazardous working conditions and exploitation.

Modelled CE measures

For the textile sector, four measures were investigated: promoting a longer useful life (fewer pieces of clothing per closet that are worn more often), changing consumption-side forms of use (e.g. sharing economy and product-as-a-service), [see above] promoting preparation for reuse (incl. repair) and fibre-to-fibre recycling (F2F recycling) for cotton textiles. The basic assumption of the study is that textiles consist of 65% man-made fibres, 28% natural fibres from agricultural production and 8% other materials.

Results

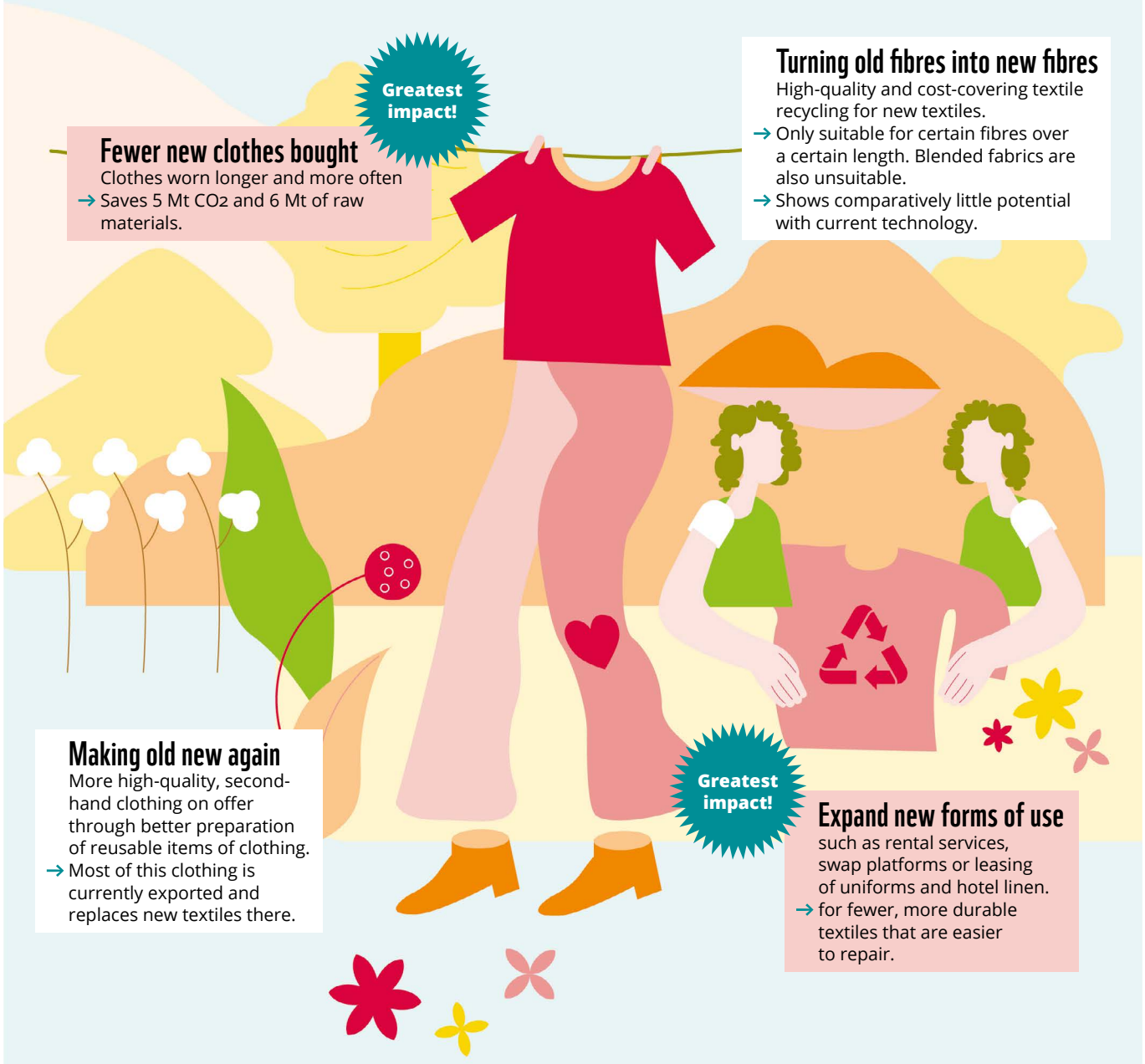
In the Continue-as-Planned scenario, the negative developments in the textile sector remain stable despite a slight trend towards more second-hand clothing. This is also due to the fact that no effective countermeasures have been planned so far. As a result, the environmental impacts increase by 15% compared to today for all impacts analysed.

The CEMG measures, on the other hand, make a decisive difference in all impact categories analysed. Specifically, they reduce GHG emissions by 35% or 12 Mt CO_2-eq compared to the Continue-as-Planned scenario and RMC by 37% or 14.9 Mt. In terms of land use, 35% or 1.1 million ha can be reclaimed.

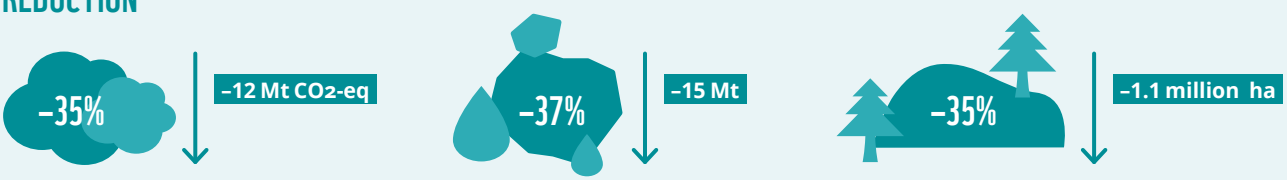
WITH EACH AND EVERY FIBER
CIRCULAR ECONOMY FOR TEXTILES

It has become fashionable in the textile sector to discard clothes quickly. As the mountains of clothing grow, so does the environmental damage – for example, caused by monoculture cotton farming – and massive human rights violations along the supply chains.

THE MATERIAL FOR THE FASHION OF TOMORROW



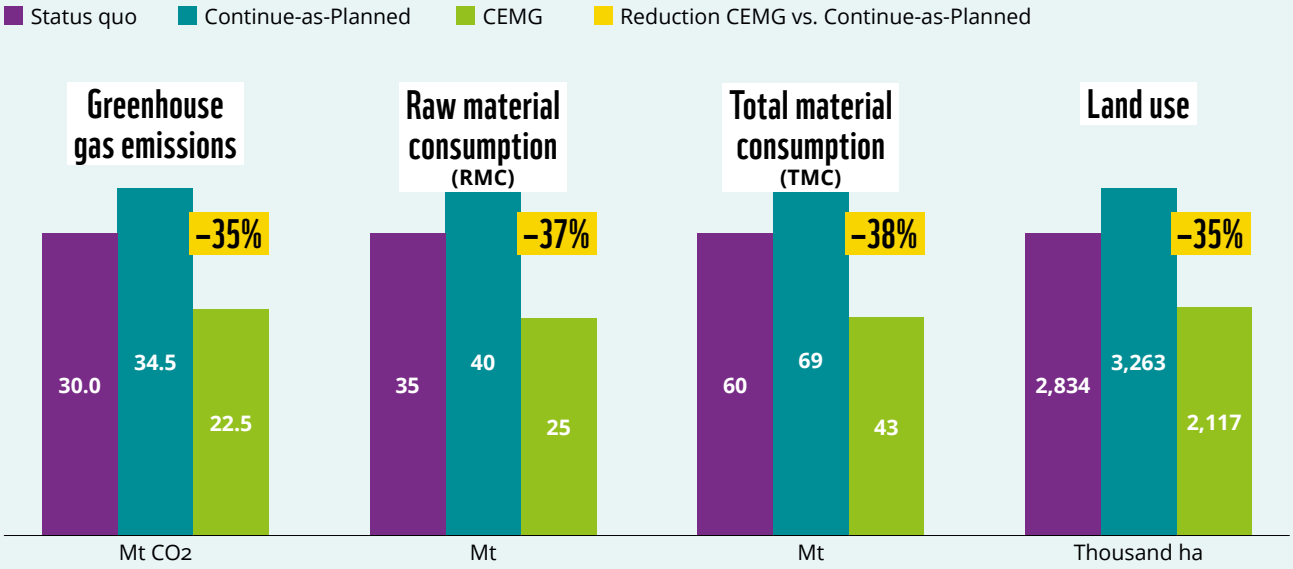
REDUCTION



Greenhouse gas emissions | Raw material consumption | Land use

WHAT CAN CIRCULAR ECONOMY DO FOR TEXTILES?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall.
The comparison shows that a change in consumption plays the biggest role.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**30.0**		**34,693.5**		**59,504.7**		**2,833.7**	
Continue-as-Planned	**34.5**		**39,957.7**		**68,542.5**		**3,263.1**	
Less textile consumption	–5.3	44%	–6,091.1	41%	–10,441.0	40%	–497.8	43%
Change in consumption-side forms of use	–5.3	44%	–6,091.1	41%	–10,441.0	40%	–497.8	43%
Promote preparation for reuse	0.0	0%	–4.7	0%	–7.9	0%	–0.1	0%
Promote F2F textile recycling	–1.5	12%	–2,699.7	18%	–5,094.6	20%	–150.8	13%
CEMG	**22.5**		**25,071.0**		**42,558.1**		**2,116.6**	
Reduction CEMG vs. Continue-as-Planned	**–12.0**	**–35%**	**–14,886.7**	**–37%**	**–25,984.4**	**–38%**	**–1,146.5**	**–35%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 16

Behaviour is the deciding factor

Looking at the different CEMG measures, the longer life (fewer pieces of clothing per closet) and the change in use (e.g. sharing economy and product-as-a-service) have the strongest positive impact. This means that we, as consumers, make the difference with our behaviour. However, this does not mean that the responsibility for change can be shifted to consumers. Policymakers and companies can and must play an active role in creating the conditions for changed behaviour and new consumption and use habits.

Improve the quality of collection

Measures to promote the reuse of textiles hold little environmental potential for Germany because most of the second-hand clothing recovered from old clothes goes abroad. The environmental benefit of used clothing replacing the purchase of new clothes is then also reaped abroad. For this set of measures, it is more important that the quality of collected used textiles is better.

Textile recycling needs a boost

As described in more detail in Section 5 under “Close resource loops”, fibre-to-fibre (F2F) recycling is limited to cotton products. Moreover, it has hardly been practised on a large scale so far because it does not cover costs. Without additional incentives and as long as primary raw materials are much more expensive in environmental terms, but significantly cheaper in monetary terms, little will change.

UNWRAPPING WRAPPING
CIRCULAR ECONOMY FOR PACKAGING

The 83 million people living in Germany are responsible for an amount of packaging waste that is 62,250 times the weight of the Cologne cathedral year after year. There is little to suggest that the use of packaging will be reduced at the moment. But it is possible.

IT'S IN OUR HANDS

40% raw material savings
through high-quality recycling.
→ High-quality recycling and more recycled materials require forward-thinking design and efficient sorting.

Greatest impact!

44% raw material savings
through our behaviour, buying unpackaged goods, reusable or refillable bags.
→ The greatest potential lies with the end consumer of food packaging.
→ No packaging is better than paper packaging. Because less paper for packaging = less land use.

16% raw material savings
→ through less outer packaging or reduction of oversized packaging.
→ Companies can produce smarter and less.

REDUKTION

–3 Mt CO_2-eq

Greenhouse gas emissions

–8 Mt

Raw material consumption

–0.4 million ha

Land use

PACKAGING

In Germany we use too much packaging and create too much packaging waste – every German generates over 225 kg of packaging waste per year[8]. A major change in packaging is not in sight.

Modelled CE measures

In the area of packaging, three sets of measures were analysed: reducing the use of packaging materials through predominantly behavioural and technical measures, as well as promoting high-quality recycling. Packaging from private households and from non-private end consumers (including transport and secondary packaging as well as packaging used in industry and commerce) was examined.

Results

Sad but true: the Continue-as-Planned scenario does not lead to any improvements compared to today. If Germany continues on its current path at the current rate, far too much packaging will be used, which, on top of that, has not been significantly optimised.

If anything is to change, it will not be possible without the CEMG set of measures. Only they can bring change and transformation. Compared to the Continue-as-Planned scenario, they reduce GHG emissions by 35% or 2.7 Mt CO_2-eq, gain 37% or 443,000 ha of land, reduce TMC by 47% or 13.5 Mt, and reduce RMC by as much as 58% or 8.5 Mt.

These figures make it clear that progress is needed in both technology and behaviour. It is the combination that generates synergies and thus yields a greater effect than the sum of its parts.

Reuse makes more sense

If the savings and avoidance potential is achieved, packaging consumption can be reduced by 5.5 million tonnes to 13.3 million tonnes (–29.4%). The greatest potential lies in switching to reusable packaging or extending it to other sectors (transport, shipping, food): 2.5 million tonnes of packaging can be saved through higher quotas for reuse.

Using recycled materials is effective

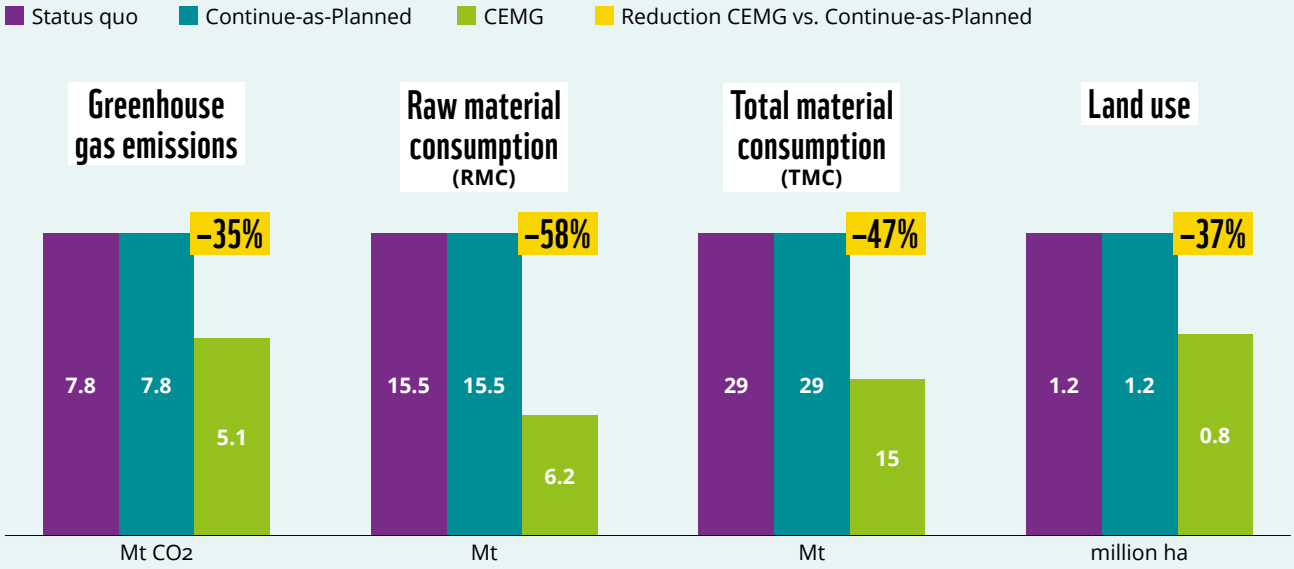
By using recycled materials, not only are fewer primary materials used, but in almost all cases the CO_2 emission factors are also reduced. In the area of technology, in addition to progress in material efficiency (less material for the same output), the assumed increase in the use of recycled materials has a particular impact. The CEMG assumes a projected average increase of 9% to 22% of recycled content.

Critical raw materials also for packaging

Critical raw materials are also used for the production of packaging. For example, the production of glass for containers requires quartz sand as a source of silica on a large scale. The CEMG shows that there is no other measure in any other area that can save as much silica sand as lower packaging consumption through a change in behaviour. In addition to quartz sand, selenium is also used as a dyeing or decolourising agent and cobalt as a blue dye for protection against UV light in the packaging sector. The crucial factor is:

WHAT CAN CIRCULAR ECONOMY DO FOR PACKAGING?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall. In comparison, it becomes clear that both behaviour-based and technology-based measures are of key importance.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**7.8**		**14.6**		**28.7**		**1,196**	
Continue-as-Planned	**7.8**		**14.6**		**28.7**		**1,196**	
Behaviour-driven material reduction	–1.2	44%	–3.7	44%	–5.5	41%	–159	36%
Technology-driven material reduction	–0.5	19%	–1.4	16%	–2.5	19%	–54	12%
Increase in the use of recycled materials and recycling	–1.0	37%	–3.4	40%	–5.5	41%	–230	52%
CEMG	**5.1**		**6.1**		**15.2**		**753**	
Reduction CEMG vs. Continue-as-Planned	**–2.7**	**–35%**	**–8.5**	**–58%**	**–13.5**	**–47%**	**–443**	**–37%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 17

if improvements in behaviour and technology go hand in hand, CEMG measures can reduce Germany's demand for aluminium, silica sand and selenium by 5% to 8% or meet demand.

FURNITURE

Like fast fashion (but also electrical appliances), fast furniture is produced quickly and designed to meet rapidly shifting consumer trends. More and more furniture is being bought with less and less value. The growing sales figures for furniture can be attributed to the greater numbers of people moving house, more single households, increase in the number of home offices, larger living spaces and shifting design preferences based on the latest trends. Due to the high wood content of furniture, the sector has a major effect on the impact category of land use and here in particular on forests.

Modelled CE measures

In the furniture sector, three sets of measures were examined: the first includes more reuse, e.g. through greater use of second-hand furniture and more furniture remanufacturing. Both measures ensure that furniture is used longer or more intensively, or has a "second life". The other two sets of measures include ecodesign for durable furniture and more use of recycled materials.

Results

Similar to ICT and household appliances, textiles and packaging, the environmental impacts in the Continue-as-Planned scenario increase compared to the status quo. There is no trace of progress. On the contrary: the environmental impacts increase between 36% and 45% in all impact categories. This is a massive increase and not acceptable.

Once again, it is the CEMG scenario that makes the difference. In concrete terms, and taking into account all land areas, the CEMG measures reclaim 44% or almost 400,000 ha of land. This is 10% of the total savings potential for forests in all eight sectors analysed.

The positive effects are also evident in the other impact categories. They reduce GHG emissions by 30% or 1.6 Mt CO_2-eq and RMC by 33% or 2.9 Mt.

Slow furniture: use and reuse longer and more intensively

In a comparison of behaviour and technology, behaviour shows higher savings potential in the furniture sector. This is logical because the CEMG measures are geared heavily towards extending the life span of furniture and more intensive use. This automatically reduces the demand for new furniture and the wood needed to make it.

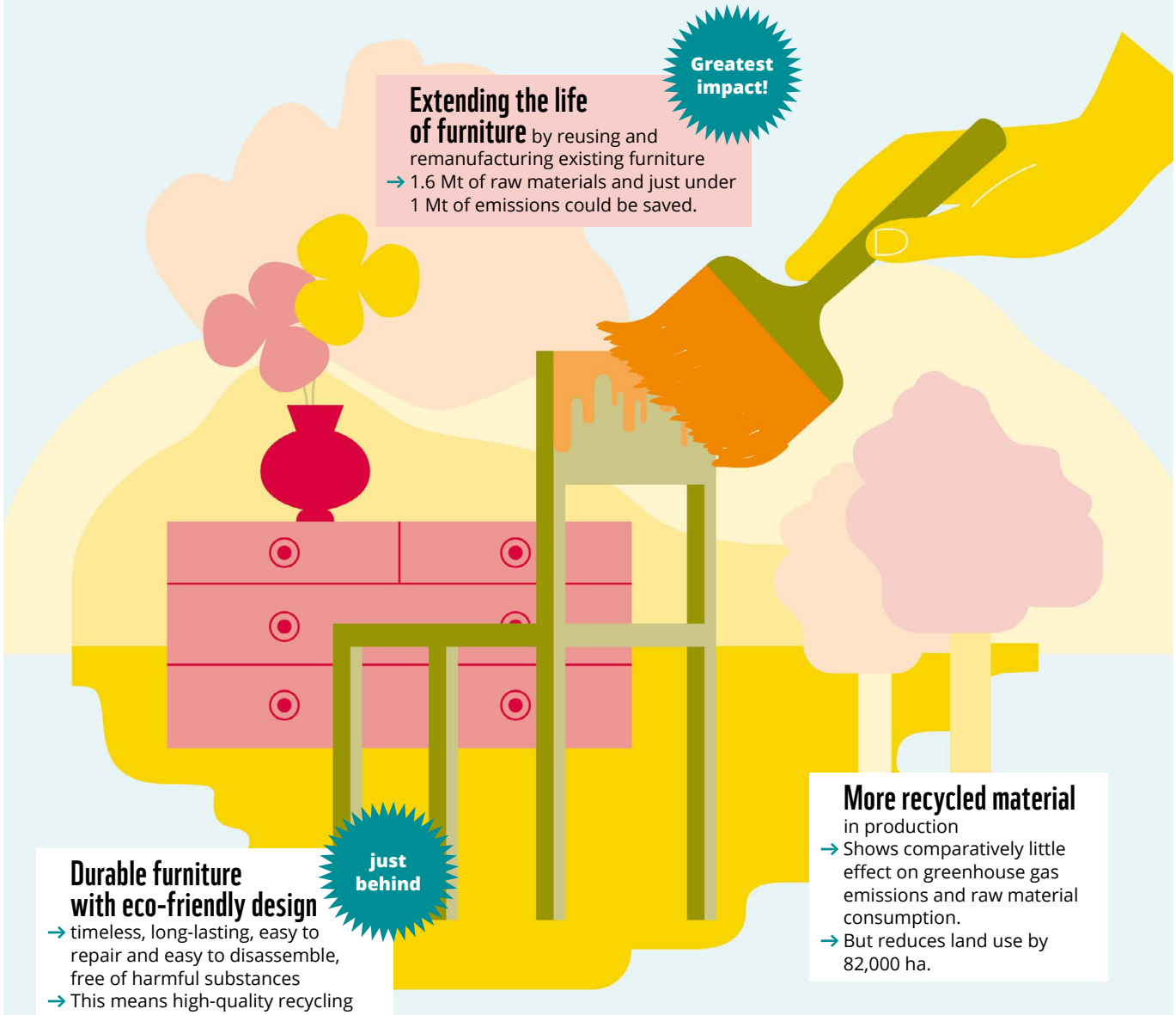
Recycling also pays off for furniture.

Recycling of furniture and the use of recycled material mainly has an impact in the category of land use. Here, this CEMG measure accounts for a quarter of the total effect. In terms of GHG emissions and raw material consumption, the increased use of recycled material reduces the impacts by 3% and 7% respectively.

LONG LIVE OUR FURNITURE
CIRCULAR ECONOMY OF FURNITURE

Germans like to buy new furniture. The trend towards buying furniture more often but of lower quality (fast furniture) goes hand in hand with more people relocating and single households, larger living spaces, shifting fashions and the current trend toward furniture and furnishings for home offices.

YOU CAN REST ASSURED ...



Greatest impact!

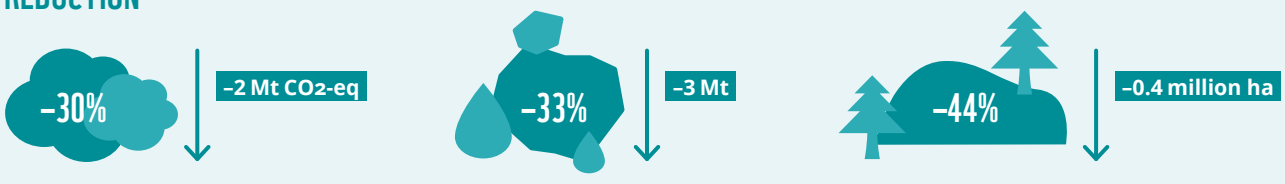
Extending the life of furniture by reusing and remanufacturing existing furniture
→ 1.6 Mt of raw materials and just under 1 Mt of emissions could be saved.

just behind

Durable furniture with eco-friendly design
→ timeless, long-lasting, easy to repair and easy to disassemble, free of harmful substances
→ This means high-quality recycling at the end of its long life.

More recycled material in production
→ Shows comparatively little effect on greenhouse gas emissions and raw material consumption.
→ But reduces land use by 82,000 ha.

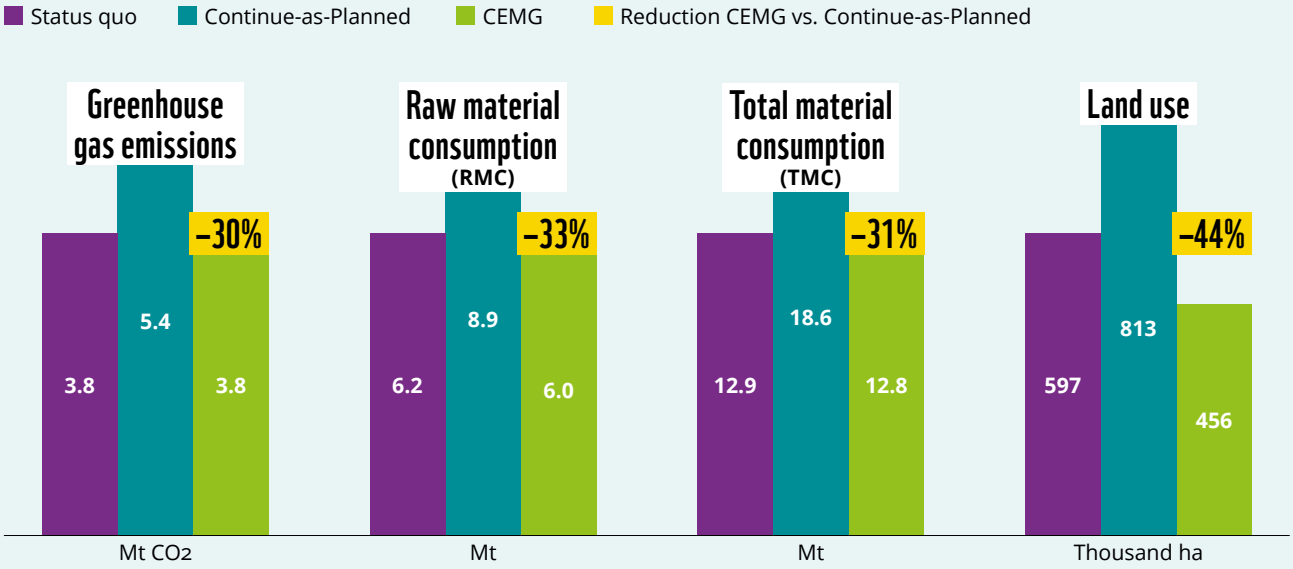
REDUCTION



Greenhouse gas emissions | Raw material consumption | Land use

WHAT CAN CIRCULAR ECONOMY DO FOR FURNITURE?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall.
In comparison, two measures have proven to be particularly important.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO_2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**3.8**		**6,198.5**		**12,939.5**		**596.8**	
Continue-as-Planned	**5.4**		**8,878.1**		**18,625.2**		**813.1**	
More reuse and more remanufacturing	–0.9	55%	–1,559.1	54%	–3,139.5	54%	–166.3	47%
Ecodesign	–0.7	42%	–1,145.0	40%	-2373.2	41%	–109.1	31%
Use of recycled material	0.0	3%	–192.6	7%	–302.1	5%	–82.1	23%
CEMG	**3.8**		**5,981.4**		**12,810.4**		**455.6**	
Reduction CEMG vs. Continue-as-Planned	**–1.6**	**–30%**	**–2,896.7**	**–33%**	**–5,814.8**	**–31%**	**–357.5**	**–44%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 18

Ecodesign increases the security of supply

Of the critical raw materials considered, antimony in particular is used in furniture. It is mainly used as a flame retardant in upholstered furniture. This is one of the reasons why the furniture sector accounts for around 11% of the total antimony demand in Germany. Overall, the CEMG measures can reduce antimony use in furniture by 8%. Of this, 7% is accounted for by the set of measures for ecodesign on its own, i.e. the development, design and manufacture of durable furniture. Conventionally designed furniture has an average life span of only six years. As a CEMG measure, ecodesign doubles this life span and useful life to twelve years. A focus on durable furniture instead of "fast furniture" as early as the production phase thus contributes to a secure supply of the critical raw material antimony, in addition to all other positive effects.

LIGHTING

Since 1997, LED development has revolutionised the way artificial light is created. The incandescent light bulb has become obsolete. An LED requires only a fraction of the energy needed for an incandescent light bulb and uses much less material than its predecessor. With this positive change from a CE perspective, an important course has already been set. Still, the lighting sector still has a high environmental impact, which can and should be reduced.

Modelled CE measures

In the lighting sector, seven measures were examined for all LED and gas discharge lamps (fluorescent lamps, fluorescent tubes) sold in Germany. This only involves the light source itself, i.e. not the lamp as a whole. The individual measures are:

- Increase collection rates of used lamps
- Use more materials from used lamps
- Use less material in lamp production
- Eliminate decorative lamps
- Reduce lamps without replaceable light sources
- Design durable lamps
- Lighting-as-a-service (product-as-a-service)

Results

Since Germany has already started switching to LEDs nationwide and is therefore part of the Continue-as-Planned scenario, we are already seeing clear successes in this sector. These can be further expanded through the CEMG measures. In concrete terms, Germany thus achieves further GHG savings of 8.9% or 1.1 Mt CO_2-eq, reduces RMC by an additional 11% or 0.58 Mt, the TMC by 9.3% or 2.7 Mt and reduces land use by a further 15% or 7,400 ha. If we assume that 17% of the lamps on the market are decorative lamps and reduce this figure by 50%, the demand for primary raw materials will decrease far less than through the other measures. The change in electricity consumption makes the difference here, however, and puts the measure in first place by a long shot.

Design and production as strong levers

LEDs currently have an expected life span of around 25,000 hours. However, research shows that the life span can potentially be increased to over 100,000 hours in the future. This is urgently necessary, because in the Continue-as-Planned scenario Germany will face annual demand of 145 to 200 million lamps in 2045. Better design and higher quality production can make the difference here.

MORE LIGHT, LESS LAMP
CIRCULAR ECONOMY OF LIGHTING

Small light-emitting diodes have cast our lives in a new light. LEDs use a fraction of the original energy and less material. What has remained is the high environmental impact in the overall assessment of the lighting sector. In fact, 17% of all lamps are used solely for decoration, not for lighting.

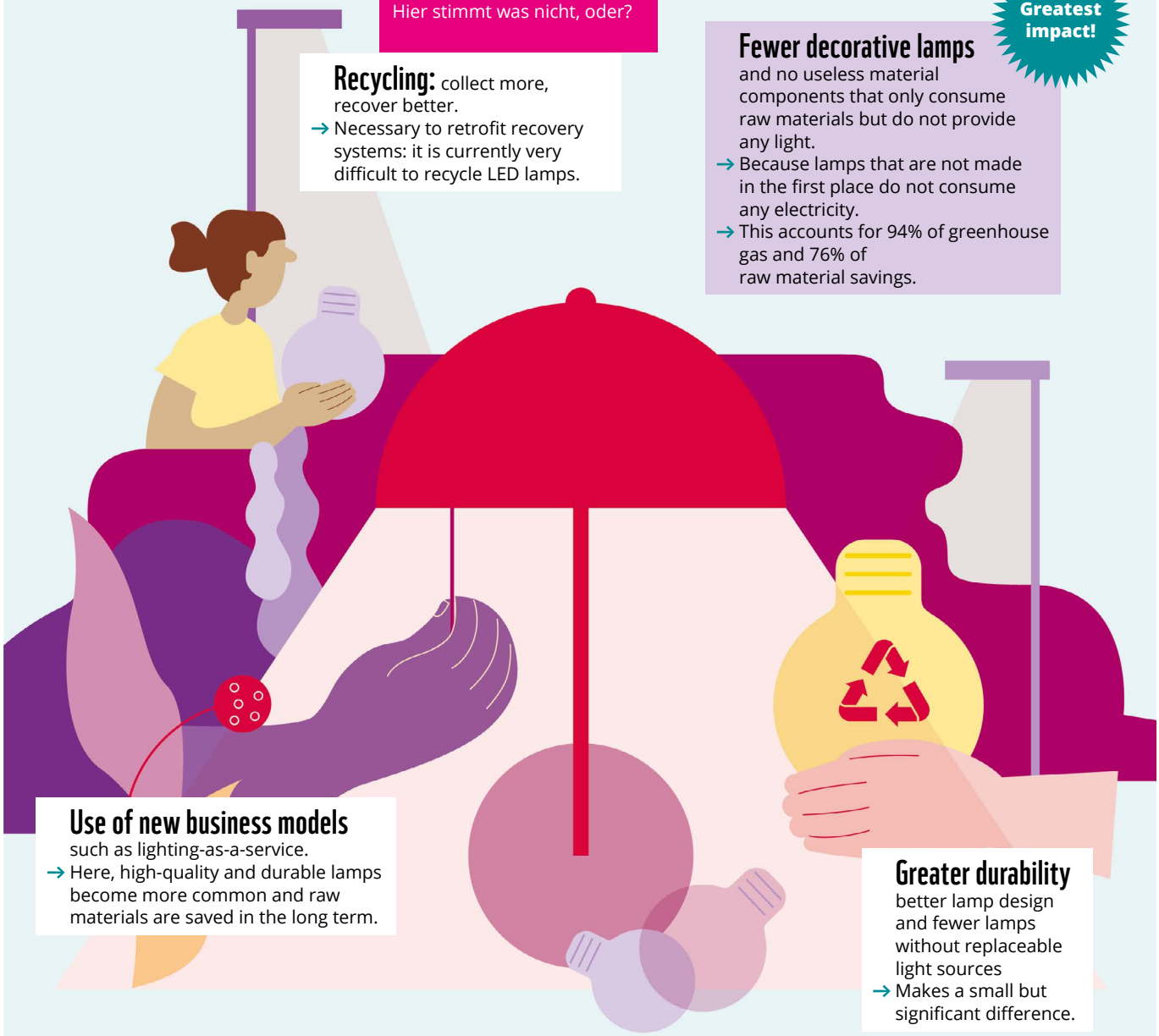
AND THAT IS ILLUMINATING ...

Satzbau> »More« Groß?
Hier stimmt was nicht, oder?

Recycling: collect more, recover better.
→ Necessary to retrofit recovery systems: it is currently very difficult to recycle LED lamps.

Greatest impact!

Fewer decorative lamps
and no useless material components that only consume raw materials but do not provide any light.
→ Because lamps that are not made in the first place do not consume any electricity.
→ This accounts for 94% of greenhouse gas and 76% of raw material savings.

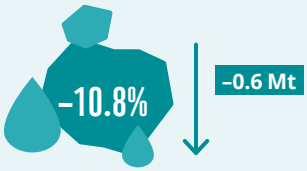


Use of new business models
such as lighting-as-a-service.
→ Here, high-quality and durable lamps become more common and raw materials are saved in the long term.

Greater durability
better lamp design and fewer lamps without replaceable light sources
→ Makes a small but significant difference.

REDUCTION

Greenhouse gas emissions

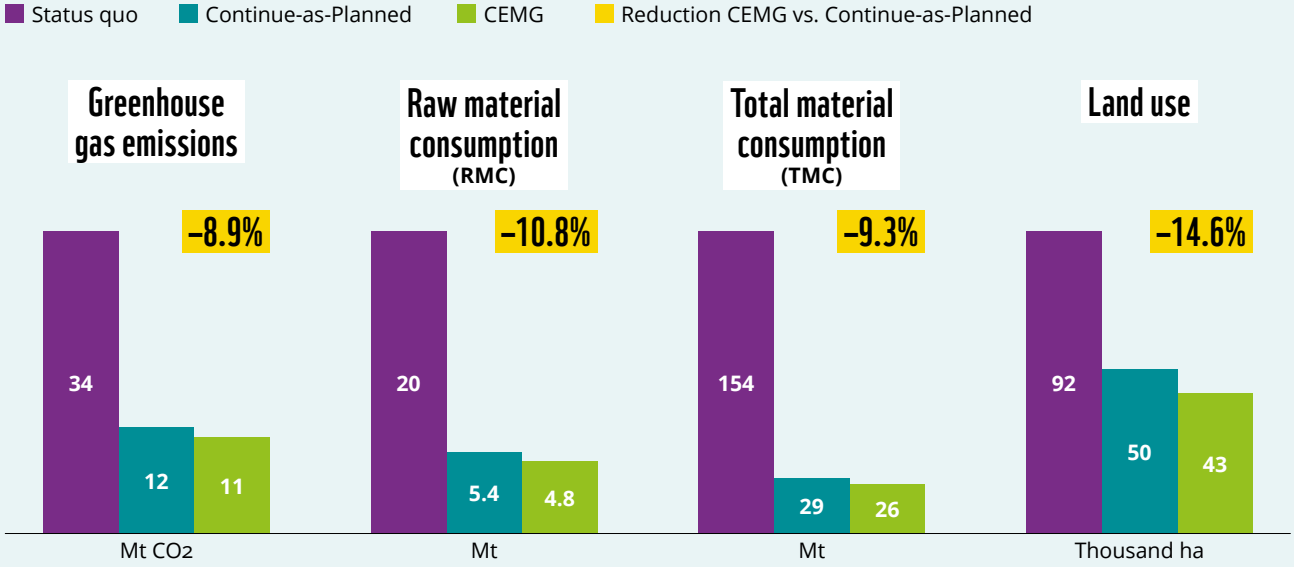


Raw material consumption

Land use

WHAT CAN CIRCULAR ECONOMY DO FOR LIGHTING?

The measures of Circular Economy Model Germany (CEMG) have a great impact overall.
In comparison, one measure shows particularly high potential.



	Greenhouse gas emissions		Raw material consumption (RMC)		Total material consumption (TMC)		Land use	
	Mt CO2	Contribution (%)	kt	Contribution (%)	kt	Contribution (%)	Thousand ha	Contribution (%)
Status quo	**33.9**		**19,622.0**		**153,769.8**		**92.5**	
Continue-as-Planned	**11.9**		**5,380.9**		**28,555.9**		**50.4**	
Increase in the collection of used lamps	0.00	0.5%	–12.3	2.1%	–22.8	0.9%	–0.2	3.4%
Reuse of material from used lamps	–0.02	1.5%	–33.4	5.7%	–65.9	2.5%	–0.8	11.0%
Material savings during production	–0.01	0.7%	–18.8	3.2%	–34.9	1.3%	–0.4	5.1%
Eliminate decorative lamps	–0.99	93.5%	–440.9	75.7%	–2,375.8	89.4%	–3.9	53.5%
Lamp systems with replaceable light sources	0.00	0.3%	–9.1	1.6%	–16.7	0.6%	–0.2	2.3%
Durable lamp design	–0.02	2.1%	–41.9	7.2%	–87.9	3.3%	–1.1	15.3%
Lighting-as-a-service	–0.01	1.3%	–26.0	4.5%	–54.5	2.0%	–0.7	9.5%
CEMG	**10.79**		**4,798.5**		**25,897.4**		**43.0**	
Reduction CEMG vs. Continue-as-Planned	**–1.1**	**–8.9%**	**–582.3**	**–10.8%**	**–2,658.5**	**–9.3%**	**–7.4**	**–14.6%**

Continue-as-Planned scenario corresponds to the Baseline 2045. The scenario shows what we can achieve by 2045 if consumer habits and technological progress continue to develop in line with existing trends. The CEMG refers to the Mixed scenario in the modelling study, the WWF advocates its implementation.

Figure 19

Product as a service

As is the case with mobility and transportation, lighting mainly involves a service rather than the product, which suggests the CEMG measure product-as-a-service. Here, lighting becomes a service. A university or an airport no longer buys the lighting itself, but outsources all lighting to a service provider. For this service provider, it pays off if the installed or serviced lamps shine for as long as possible without needing maintenance. This requires light sources that last a long time, which increases the pressure on manufacturers and creates a market.

Room for improvement in recycling

Eliminating unnecessary (decorative) lights and extending the life span of light sources are the most effective of all CEMG measures. More recycling of materials comes in third place. It is currently difficult to recycle certain components of LED lamps in Germany. Retrofitting the recycling systems can enable more used lamps to be recycled. This increases the availability of secondary raw materials and lowers primary demand. There is also high potential when it comes to critical raw materials.

Effects on the security of supply

Rare metals have spectroscopic properties and are therefore of great importance for the lighting sector. In addition, gallium and indium are important as semi-conductor material for LEDs. Borates and quartz sand are used to produce special glass. Tungsten is needed as an electrode material for gas discharge lamps. The lighting sector is responsible for high to extremely high shares of total German consumption of the imported raw materials gallium (25%), yttrium (50%) and europium (100%). In terms of critical raw materials, increased mechanical recycling is the CEMG measure with the greatest potential. It meets about 30% of Germany's annual demand for yttrium and 14% of its annual demand for gallium.


ALONG THE MOST IMPORTANT 5
CIRCULAR ECONOMY STRATEGIES

ALONG THE MOST IMPORTANT CIRCULAR ECONOMY STRATEGIES

From WWF's perspective, there are five strategies at the core of a comprehensive circular economy. All five are of fundamental importance – and yet have not yet been sufficiently implemented on a broad scale.

The five key strategies are:

1. **Reduce resource streams**
2. **Substitute materials**
3. **Slow down resource flows**
4. **Intensify product use**
5. **Close resource loops**

As cross-sectoral factors, there are two central levers in all these strategies: solutions that are based on technology and solutions that are based on behaviour. Both types of solutions have the same goal but different prerequisites. Technological solutions focus on the technical and production sides. Behavioural solutions focus on sustainable consumption. It is important that "behaviour" is not shouldered by the consumer alone. As with technology, there is a need for political and corporate action to regulate behaviour, which goes far beyond informational tools and should be managed through regulatory and market-based instruments.

In this section, the CEMG measures developed in the study are analysed as examples along the five key strategies and including the two central levers. It is clear that the recommended approach can achieve changes in all areas and, above all, have an impact.

REDUCE RESOURCE STREAMS

When products are not produced in the first place because people can do without them or they can be replaced with smart solutions, the raw materials are simply not needed and the energy for production, logistics, use and recycling can be saved. Avoidance pays off!

However, it is not only possible to reduce resource streams by making demand unnecessary. It also makes a difference when things are re-imagined and shared, when products are better designed and what we need is produced more efficiently with fewer natural resources.

Considerable climate benefits

With a total of 92% of the potential greenhouse gas savings through CE Model Germany, the four sectors of building construction and civil engineering, vehicles and batteries, food and diet and ICT and household appliances offer the greatest lever for the climate. Five sets of measures take centre stage with regard to the CEMG measures. Changed consumption and lower production show the greatest potential where housing and offices can be scaled down in size and the number of cars reduced, where people eat less animal products as part of the Planetary Health Diet, where data centres are operated with greater resource efficiency and fewer textiles consumed. Through these five sufficiency measures alone, Germany can reduce avoidable GHG emissions by 85% in the CEMG scenario.

Slimming down is possible almost everywhere

Avoid food waste: the production, manufacture and transport of food involves vast amounts of valuable resources – spanning land, fertiliser, energy, water and labour. The CEMG measures offer highly effective countermeasures in this area. Avoiding food waste is an important step, because anything that is produced but thrown away unused consumes resources and causes damage without any value in return.

Reduce and optimise packaging: the principle of "as much as necessary, as little as possible" must be practised. The CEMG identifies three sets of measures that make a difference in this area, both from a technological and behavioural perspective (see Table 1, p. 15). Overall, around 30% of packaging materials can be saved under the model assumptions analysed. Of the individual measures considered, the shift to unpackaged systems and reusable systems together contribute just under 50% to the overall decrease.

A small change with a huge impact

At first glance, it may appear over the top to get hung up on details like decorative lights. But appearances are deceptive. Eliminating decorative lights has a greater impact on all environmental impact categories than any other CE measure in the lighting sector. Germany can avoid 94% or just under 1 Mt of the GHG emissions in the Continue-as-Planned scenario. In terms of total material input, this amounts to savings of 89% or 2.4 Mt, and in terms of raw material consumption to 76% or 440,000 t. Land use can be reduced by a massive 53% or nearly 4,000 ha. The reason is only seemingly ordinary: it is simply a matter of avoiding unnecessary electricity use. Because electricity use is the key factor when it comes to lighting.

SUBSTITUTE MATERIALS

Another key strategy is to replace materials that have a major environmental impact with more sustainable alternatives. But beware: when substituting materials, there is no way to avoid a critical individual assessment at product level. Because often enough, bogus solutions are offered that in reality do not lead to improvements, and in the worst case even bring about the opposite.

Replace cement

In cement production, innovative binding agents can be used as an alternative. For example, those based on quartz sand (calcium hydrosilicate; CHS). These alternative binding agents can reduce GHG emissions by 30% to 50% compared to those from conventional cement production. However, since the alternative binding agents are currently still comparatively expensive, they are hardly used. The low market share is also the reason for the low potential reduction under the CEMG.

Not always clear cut: wood in the construction sector

Renewable raw materials such as wood can replace emission-intensive materials such as steel and cement in the construction of single-family homes, for example – and they also have the potential to store CO_2. But wood and similar materials do not come free of charge, and the areas available for growing them are limited. Since the 1960s, global production of wood-based materials for the construction and furniture sectors has increased nearly 15-fold. This is why simply substituting wood for steel and cement is not a universal cure-all. This strategy only makes sense if we monitor how much sustainable wood is available in forests. In other words, ensuring that forest ecosystems are not destroyed by excessive logging. When using wood as a building material, it is also crucial that the manufactured buildings and products are durable and that they are designed with reuse in mind right from the start.

Germany summary: Beck-O'Brien, M., Egenolf, V., Winter, S., Zahnen, J., Griesshammer, N. (2022). "Alles aus Holz – Rohstoff der Zukunft oder kommende Krise; Ansätze zu einer ausgewogenen Bioökonomie." WWF Germany.

When packaging is only greenwashed

A classic example of what appears to be a solution involving material substitution is replacing plastic packaging with paper-based composites, which consist of paper mixed with plastic and/or aluminium that are difficult or impossible to separate. This composite packaging is often advertised with the claim "less plastic". However, since only the paper content is usually recyclable, the rest ends up being incinerated. This has a negative impact especially where easily recyclable plastic packaging is being replaced.

Synthetic meat is not a solution

The CEMG takes a broad view of the term "material" and looks at replacing meat with synthetic alternatives (in-vitro meat, often called "lab-grown meat"). The media generally shows meat alternatives in a positive light. However, they have a relatively limited influence on diet-related environmental impacts. All forecasts indicate that synthetic meat will not make a real difference even by 2045, based on availability and market volume alone. Under certain circumstances, it can even increase the potential for greenhouse gases because a relatively large amount of energy is required for its production. From a CEMG point of view, lab-grown meat is not a true alternative. Giving up meat and choosing vegan or vegetarian alternatives is clearly better and more effective.

SLOW DOWN RESOURCE FLOWS

If the flow of necessary resources is slowed down, the resources remain in circulation longer and fewer new resources need to be "replenished" at the source. This slower speed can be achieved, for example, through a longer useful life: through more conscientious behaviour and reuse, better design for more longevity or through repair and remanufacturing.

A lot of potential in repair and remanufacturing

In repair and remanufacturing, most of a product, individual components or parts of the product are reused. This makes it possible, for example, to upgrade a used product to the quality standard of a new product.

If, for example, the seat of an armchair has become worn, it can be reupholstered. Although resources are also needed, e.g. for the use of tools and spare parts, they are needed to a much lesser extent than would be needed to make a new product. If furniture is remanufactured and reused more often in Germany, our country can reduce GHG emissions by another 16% or 0.9 Mt Co_2-eq with these CEMG measures compared to the Continue-as-Planned scenario. Raw material consumption improves by an additional 18% or 1.6 Mt. In terms of land use, the measures free up 21% or 166,300 ha of land. This is equivalent to the areas of Berlin, Cologne and Frankfurt combined. The main difference here is the lower demand for wood, as less new furniture is needed.

Remanufacturing also plays a role in allowing products and components to be used for longer. For the modelled measures, remanufacturing leads to annual savings of 0.15 Mt CO_2-eq in 2045, which is a lot, especially considering that only the selected nine ICT and household appliances were analysed.

Reject the throwaway mentality: use things as long as possible

Not many trousers, shoes, smartphones or pieces of furniture are disposed of because (and when) they are worn out or broken. They are usually thrown out much earlier and for completely different reasons. But the longer a device is used, the less often a new one has to be produced and paid for. The strategy's savings potential of using ICT devices and textiles longer is evident in all the impact categories analysed. 26% and 44% of the CEMG's total GHG emission savings can be achieved this way. For raw material consumption, the figures are as high as 31% and 41%, and for land use 35% and 43%. That really is a tonne!

INTENSIFY PRODUCT USE

When people use products more intensively, they make more effective use of the resources that went into making them. This is also true when people share things. Many things that people buy are only needed occasionally – classic examples are ladders, lawn mowers, drills and other tools. If four families living on a street or four residents living in a house share products they only use from time to time, these products only have to be made once and not four times.

Use and ownership are not the same. In this simple truth lies enormous potential for the circular economy and a viable (as well as liveable) future.

Progress for mobility

When people move from one place to another, the heart of the matter is the movement itself and not the means of movement. Public transport, a shared (e.g. borrowed) car or car pooling serve the same purpose. Public transport, car sharing and ride pooling are efficient modes of transport with considerable environmental leverage. Together, this can save 45 Mt CO_2-eq GHG emissions, over 91% of the climate potential for this sector. Whether they are developed depends in many cases on people's behaviour and to what extent policies can have a steering effect on them and services can be created. In other cases, more intensive use requires technological advances such as more efficient car batteries with longer life spans. Behaviour and technology: both levers have a significant effect.

Product-as-a-service still has to demonstrate its worth

As a sub-sector of the sharing economy, product-as-a-service (PaaS) models are often seen as a cure-all in the circular economy. Items such as clothes, electronics or furniture can be used temporarily as a service rather than bought, focusing on the outcome (e.g. number of loads washed) rather than the product itself (e.g. the washing machine). This prevents infrequently used items from accumulating in households and ensures that they are used more intensively. In the CEMG modelling, however, the market potential of PaaS was only calculated very conservatively, as services are limited and the future of scaling and establishing PaaS models is currently uncertain.

Together to the finish line

The strategy of more intensive use has a large overlap, of course, with the strategies of avoidance and slowing down resource flows through reuse and recycling. All lead to the need for fewer new products. Together, these strategies open the doors to the future wide open.

CLOSE RESOURCE LOOPS

Where raw materials can be kept in circulation, they continually replenish the flow of resources at the source. Recycling is an important strategy to save primary raw materials. However, the potential for environmental benefits is lower than with avoidance, reuse and recycling, because the recycling process very often results in the loss of some of the resources or leaves unusable waste. On the other hand, recycling also consumes new resources. In addition to energy, water and chemicals, this also involves the necessary machinery.

So even if recycling is not the first choice, it remains a central lever for circular economy. This is because by providing secondary raw materials, it reduces the need for new primary raw materials and thus generates relevant environmental benefits. Another advantage is that the products do not remain in the environment at the end of their life cycle, where they pose a major threat to flora, fauna and soil quality.

Profound advantages in civil engineering

Recycling has positive potential, for example, in an area that has rarely been mentioned so far: civil engineering. In this case, cement recycling (using smart crusher technology) can reduce raw material consumption by a further 13.7 Mt and total material consumption by 15.9 Mt in the CEMG scenario compared to the Continue-as-Planned scenario. This is 19% of the total current raw material consumption in civil engineering and 81% of RMC savings for this sector. But it is also clear that there is room for improvement. Specifically, when the cement is not needed in the first place because, for example, more rainwater can seep into the ground instead of draining into the newly built sewage system.

Recovering critical raw materials

In the area of devices such as smartphones, computers and servers, but also household appliances, CEMG measures can recover important and critical raw materials, e.g. gold and palladium, through better collection and optimised recycling. Both are precious metals which, due to their corrosion resistance, can be recovered from the devices with relatively low losses if handled properly. In the case of palladium, the potential is over 100% (i.e. the supply of recycled material exceeds demand), as the high recovery rate is accompanied by the assumption of a sharp decline in demand. It is assumed that demand will decline because palladium is currently used primarily in the production of catalytic converters for cars, which will no longer be necessary with the switch to e-mobility.

Challenges and potential for LED lamps

Currently, around 90% of the materials in used lamps can be recycled. The high value is explained by the relatively recycling-friendly material composition of the still widely used florescent bulbs, which are mainly made of glass. The switch to LED lamps poses a number of challenges in addition to many recycling benefits. Technological progress in recycling facilities is needed to ensure that the plastics and electrical components used in LEDs can be recycled with sufficient resource efficiency. If this succeeds, 30% of the annual demand for yttrium and 13% of the annual demand for gallium can be recovered

from used lamps in the CEMG scenario. Both raw materials are essential for the production of white light LEDs.

Destiny is determined at the very outset

For high-quality material recycling, it is crucial that materials and product design are designed with this in mind from the start. Recyclability must be a mandatory requirement as early as the design stage. It is also essential that the recycled products are free of toxins and impurities. This is because these substances are often retained during recycling. However, impurities are not only found in packaging, but also in furniture and building components (e.g. chemicals for flame retardants) or plastic components for vehicles, appliances and textiles (e.g. plasticisers).

BEHAVIOUR AND TECHNOLOGY GO HAND AND HAND

Behavioural and technological measures in the CEMG scenario are not an either-or proposition. On the contrary, they work best when combined. In most cases, they enhance one another. And often enough, one is essential for the other to succeed.

This is the case, for example, with vehicles and batteries, where, beyond technological progress, it also depends on people's behaviour, whether they not only want to use a car but also own it, whether they share it with others, travel together or use public transport from the outset. It is important to stress here that behaviour is not necessarily an individual choice, but needs a set of prerequisites, such as a functioning, well-developed public transport system based on electricity and renewable energy sources.

When it comes to the use of furniture, textiles or appliances, the two levers must also be integrated. Consumers should use products for a longer period of time and, if necessary, prioritise repairs over new purchases. In this context, sustainable behaviour must be encouraged by general conditions that allow the effort and expense of a repair or more expensive initial purchase to prevail over linear business models. On the technological side, however, the products must also be designed to allow for longer life span and to be easier to repair, remanufacture or ultimately recycle.

Behaviour and technology should never be pitted against each other. They are on the same team and both have key roles to play in securing the future.

MORE BENEFITS THAN COSTS FOR SOCIETY

MORE BENEFITS THAN COSTS FOR SOCIETY

The modelled CE measures yield significant environmental, economic and social benefits if the totality of all CEMG measures, including the application of all circular strategies, are implemented. This requires a fundamental transformation in consumption and production. It is clear, however, that this fundamental transformation of the economy, industry and business, will also entail changes to the labour market.

This section therefore aims to outline the benefits and costs of this transformation to a circular economy. Of particular importance in this context is the assessment of the economic costs that will arise if Germany does not act, acts too late or takes insufficient action. At the same time, the socio-economic impacts of a circular economy, including displacement, are also discussed.

For Germany, the changes in demand and production methods of the products manufactured in the eight modelled sectors were analysed for their impact on:

- the associated **gross value added** (as an indicator of the value of goods and services produced as part of the production process)
- **labour needs** (as an indicator of the number of employees in "full-time equivalents")

The added value associated with domestic demand for the goods produced and the respective labour needs represent about 15% of the total value added and 20% of the total labour needs. The results, while informative, should therefore not be interpreted as an impact assessment of a CE for the economy as a whole in Germany.

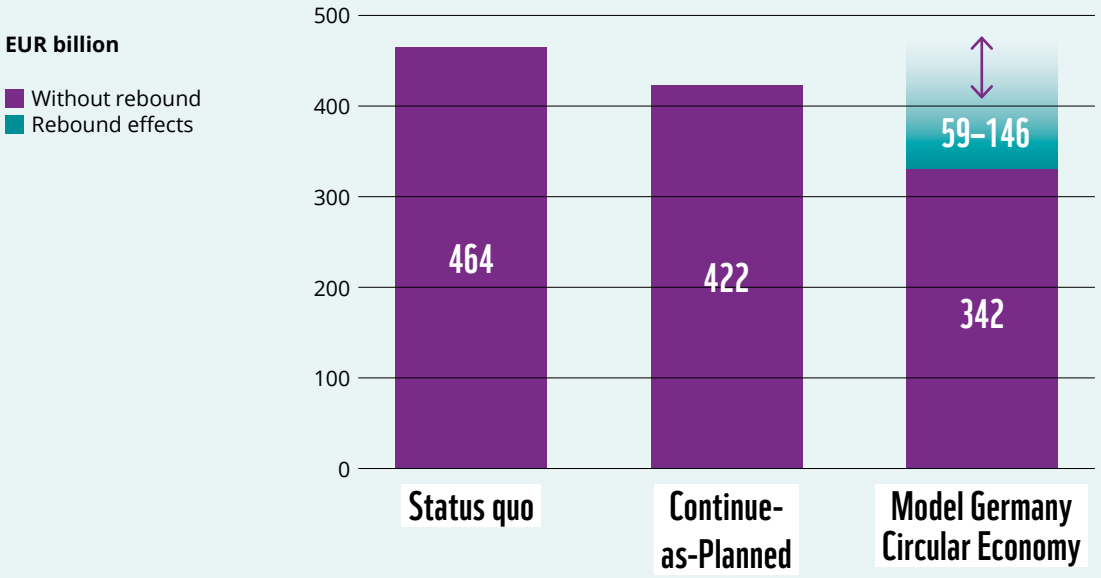
See Section 3.5 in the modelling study.

To make the **costs and benefits** of CEMG measures tangible, data was collected and the environmental cost approach was used to monetise GHG emissions from direct emissions and land-use changes (excluding food). In addition, economic costs and benefits were considered based on the assessment of supply risks and relevant literature analysed.

The environmental cost approach was used to assess the costs and benefits of the modelled CE measures in terms of their potential for avoiding follow-on economic costs. The goal was to put the short-term displacement effects in the areas of gross value added and labour needs into a broader, economic perspective to illustrate the need for environmental transformation.

IMPACT ON GROSS VALUE ADDED

The effects of the CEMG measures on the gross value added result from changes in demand (in Germany) in the sectors analysed. Depending on the extent of the rebound due to freed-up income, structural changes and potential growth occur.



Rebound refers to the rebound due to freed-up income.

Figure 20

GROSS VALUE ADDED AND WORKFORCE REQUIREMENTS

CONTINUATION OF TREND UNTIL 2045

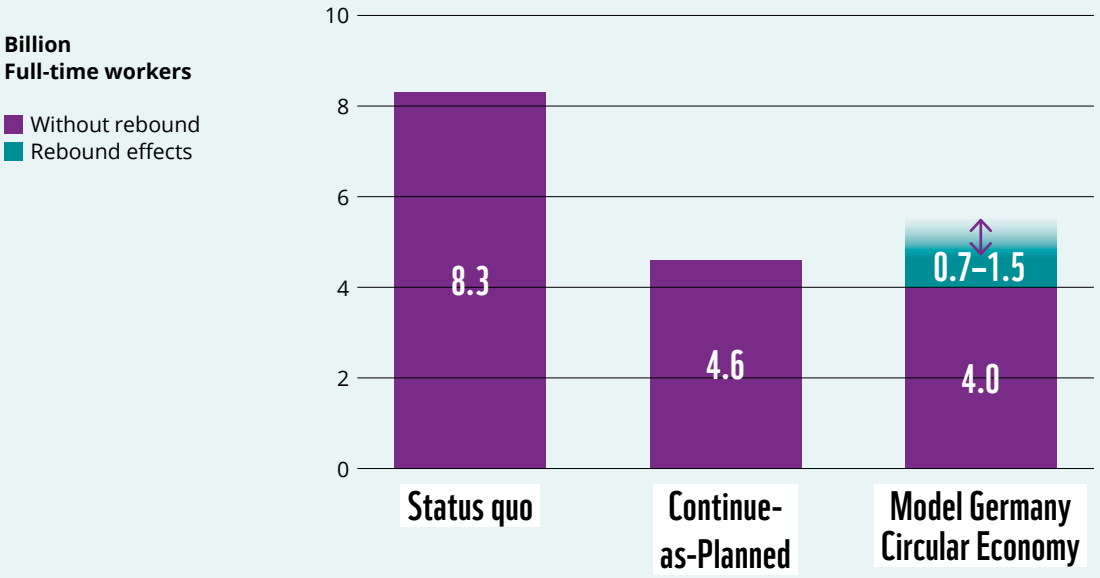
The results must be interpreted in the context of a trend that will continue until 2045.[9]

In the Continue-as-Planned scenario, demographic change, among other factors, leads to a significant decline in demand in some of the sectors analysed, especially in building construction. This decline more than compensates for the additional demand in other areas, such as ICT, vehicles, furniture and textiles. As a result, the gross value added generated by domestic demand in all eight sectors declines by 9%, from EUR 464 billion to EUR 422 billion compared to today.

In addition, labour productivity is assumed to be significantly higher in 2045 than it is today. This means that the same added value can be achieved with significantly fewer workers, for example due to digitalisation. The economy can thus grow steadily, even though labour needs continue to decline due to demographic change. It is important to emphasise that the modelled declines in demand in the study only lead to labour needs of around 4% less in the Continue-as-Planned scenario compared to the status quo. The declining labour needs do not mean a departure from the goal of full employment. On the contrary, it is a mitigating aspect, as it reduces the gap between the required and available skilled and unskilled labour.

IMPACT ON JOBS

The effects of CEMG measures on jobs result from changes in demand (in Germany) in the sectors analysed. Depending on the extent of the rebound due to freed-up income, there will be structural changes and a potential increase in jobs.



Rebound refers to the rebound due to freed-up income.

Figure 21

EFFECTS THROUGH CEMG MEASURES

The implementation of the necessary CEMG measures changes added value and labour needs mainly through a decrease in the level and structure of demand. For example, the level of demand decreases due to a longer life span and more intensive use of products. As a result, fewer new products need to be produced, which affects both gross value added and labour needs. Behaviour-based measures, which prioritise avoidance, show a greater impact than technological measures, which mainly focus on substitution.

The entirety of the CEMG measures leads to a further reduction in gross value added of 19% compared to the Continue-as-Planned scenario. Labour needs decrease by 16%. These decreases occur especially in the sub-sectors that are considerably affected by the CE transformation but urgently need to be transformed to reduce environmental impacts and the costs to society.

INCOME IS FREED UP

In total, the modelled CE measures free up to EUR 170 billion in income. Income is freed up when it does not have to be spent on the consumption of goods in the eight analysed sectors. For example, smartphones can be used for longer periods of time due to informed behavioural choices and improved technological conditions. This eliminates the need to buy new products and frees up financial resources.

The freed-up income increases gross value added and creates higher labour needs if it flows into other areas of consumption and has an effect there. In the best case, these would be services that are associated with a relatively low environmental impact. These include, above all, services from the areas of healthcare, education, culture and leisure.

Taking into account the rebound effects of freed-up income, gross value added is increased by 14% compared to the Continue-as-Planned scenario, while labour needs rise by 11%. The decrease in gross value added and labour needs is therefore overcompensated compared to the Continue-as-Planned scenario.

However, it is also conceivable that people make the conscious decision to work less because they need less money for less consumption, not to own a car or make do with a smaller living space. A voluntary 4-day work week, more time for socialising or low-cost outdoor activities in nature do not lead to an increase of the gross value added, but do increase the quality of life and have a positive effect on health, which in turn reduces costs for both the individual and the community.

REBOUND EFFECTS DUE TO FREED-UP INCOME

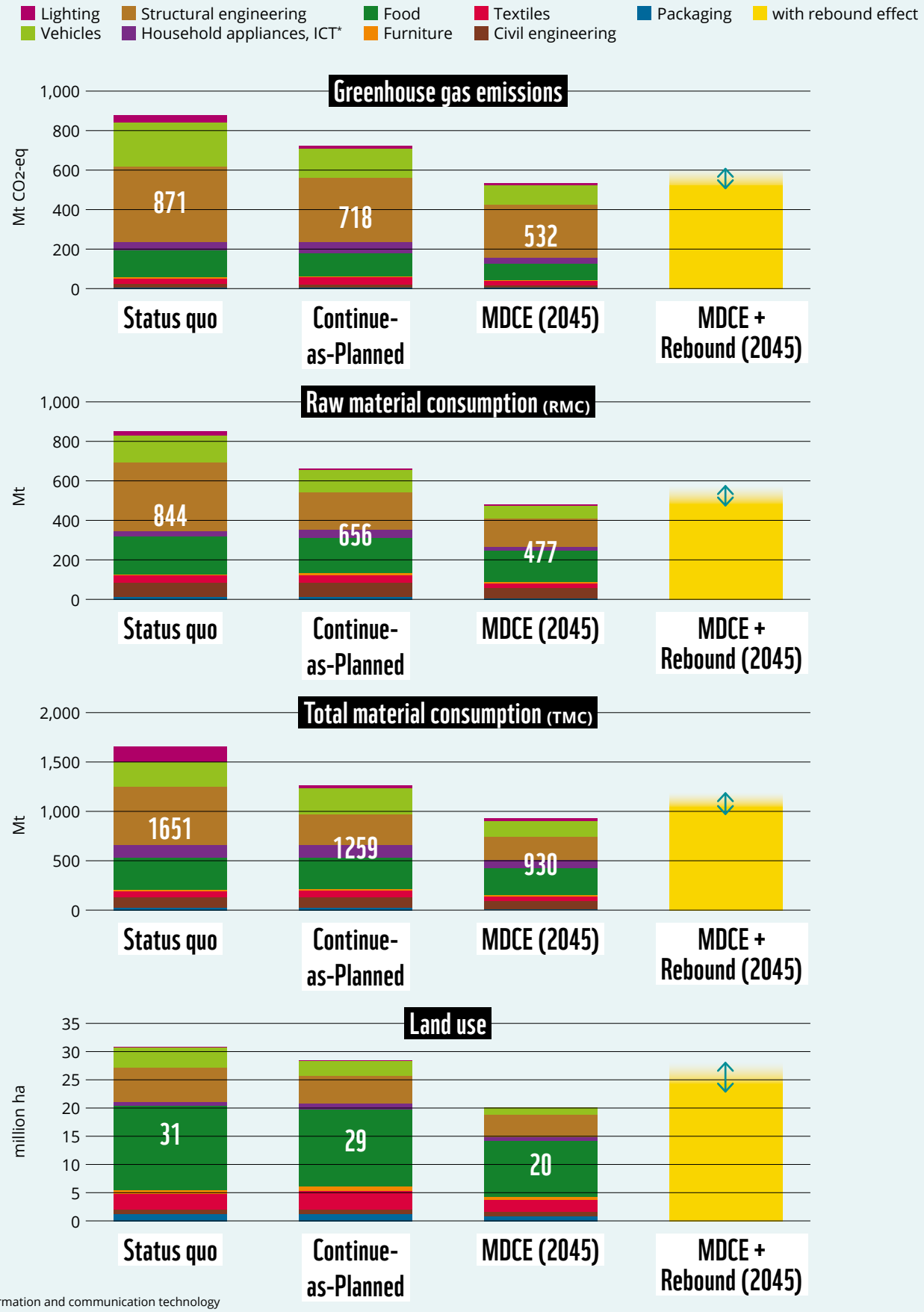
Rebound effects (also called ricochet effects) can occur after efficiency measures have been successfully implemented. In this case, the lower resource consumption expected as a result of the increase in efficiency is weakened or does not even occur at all. In extreme cases, the absolute resource consumption can even be higher than before the efficiency measure was implemented, which is then referred to as a "backfire effect". Rebound effects happen when people or companies react to efficiency gains by changing their behaviour, and the resources saved are used in a way that results in additional resource consumption.

Rebound effects can be seen both at consumer level and company level. They can have a direct effect (as a direct result of the increase in efficiency), for example, when a car is driven more often because it uses less fuel, or clothes are bought cheaply at a second-hand shop, but not to replace new clothes but in addition to them, which does not lead to fewer new clothes being bought. However, rebound effects can also have an indirect effect (immediately and over a longer period of time). The savings from lower fuel consumption or inexpensive second-hand clothes frees up income that can be used for other additional consumer goods.

The CEMG focuses on rebound effects due to freed-up income. Assuming that the available production factors (labour and capital) are the same for all CEMG scenarios, disposable income is the same. Depending on the CEMG scenario, lower spending leads to different amounts of freed-up income, which can be spent elsewhere, leading to higher production and environmental impacts there. From a macroeconomic perspective, it is conceivable that the disposable income that is freed up is spent by private households (consumption), companies (investments) or the government.

EFFECTS OF THE CEMG WITH AND WITHOUT REBOUND

The extent of the rebound effect on the environmental impact categories depends on where the freed-up income is spent. If it is spent in sectors with low environmental impacts, the effect remains limited.



*Information and communication technology

Figure 22

REBOUND AND ENVIRONMENTAL IMPACT CATEGORIES

The degree to which the rebound effects influence the environmental impact categories of GHG emissions, raw material consumption and land use depends on where the freed-up income is spent. If it is spent in sectors with low environmental impacts, the effect remains limited. The effects are greater if the money is spent on resource-intensive products from sectors that were not analysed in the CEMG study.

Assuming that the freed-up income is spent in sectors with a low environmental impact, the following picture emerges:

- Without rebound, the CEMG measures achieve a **GHG reduction** of 26% or 186 Mt CO_2-eq. With rebound, there is a moderate decrease to 163 Mt CO_2-eq. This means that 3% fewer GHG emissions are saved.

- In terms of **raw material consumption (RMC)**, the CEMG measures reduce Germany's emissions by 27% or 179 Mt compared to Continue-as-Planned measures. Even with the rebound effect, the CEMG measures still make a difference and achieve savings of 150 Mt.

- The CEMG measures reduce **total material consumption (TMC)** by 26% or 329 Mt compared to the Continue-as-Planned scenario. With the rebound effect, the CEMG measures still achieve substantial savings.

- In relative terms, the rebound effect has the biggest impact on **land use**. The savings from implementation of the CEMG measures compared to the Continue-as-Planned scenario decrease from the original level of 30% or 8.5 million ha to 6.1 million ha with rebound.

To harness the positive effects of the circular economy, it is therefore not only necessary to establish individual measures, but also to fundamentally rethink how we do business and live our lives. The costs of inaction are simply too high.

INACTION IS COSTLY

The costs of transformation always include the cost of inaction, i.e. the external costs to society, such as those arising from further increases in temperatures, more and more intensive heavy rainfall, increasingly severe storms and growing air pollution. All of these are already affecting Germany to a considerable extent.

The consequences include damage to property and buildings as well as crop failures due to drought, floods or tornadoes, premature deaths due to heat in built-up cities, loss of biodiversity and species extinction, lower labour productivity due to air pollution and more frequent sick leave, polluted ecosystems due to high resource consumption and chemicals, less land for holidays and recreation due to algae infestations and pollution, declining security of supply due to low water levels in rivers – and the list goes on.

AVOIDING POTENTIAL ENVIRONMENTAL COSTS

With the CEMG measures, the enormous negative costs resulting from a CE transformation that is either rejected by society or inadequately implemented can be significantly reduced. At the same time, CEMG measures achieve direct environmental and economic benefits.

AVOIDING THE COSTS OF CLIMATE CHANGE

In the CEMG study of the costs of climate change, GHG emissions were used as a key indicator, and both direct emissions (e.g. from energy use in production and transport) and indirect emissions from changes in land use (e.g. for growing animal feed for livestock) were identified.

The study concludes that 26% or EUR 147 billion of the climate impact costs attributable to direct GHG emissions can be avoided by implementing the measures of the CEMG scenario. If the rebound effect is included, the results deteriorate, although not significantly. This reduces the prevented environmental costs from direct GHG emissions in the CEMG scenario by 12% or EUR 18 billion.

For indirect GHG emissions, i.e. involving changed land use, the CEMG scenario saves EUR 10.7 billion in costs. In contrast, the impacts of the rebound effect are very clear in the case of indirect emissions. Assuming that the freed-up disposable income is spent in consumption sectors not covered by CE measures, the saved climate impact costs are reduced by approximately 60% to just EUR 4.5 billion.

DIRECT BENEFITS OF THE CEMG MEASURES

The benefits of the CEMG measures compared to the measures in the Continue-as-Planned scenario are summarised in Table 4.

Something that must be clearly understood: avoiding external costs and reaping the benefits of a comprehensive circular economy represents a potential opportunity. It is not a given but must be earned by implementing the measures outlined in the CEMG.

DIRECT BENEFITS OF THE CEMG MEASURES

The benefits of the CEMG measures compared to the measures in the Continue-as-Planned scenario can be summarised as follows:

Area	Direct benefit
Environmental savings (without rebound)	
GHG emissions (global)	lower by 186 Mt CO_2-eq EUR 157 billion in avoided costs
GHG emissions (share of German industry)	Additional 10% savings compared to 1990 or 26 Mt CO_2-eq of hard-to-avoid process emissions EUR 20.5 billion in avoided costs
Final energy demand Germany	Up to 112 TWh or 17% lower Electricity and hydrogen shortages are alleviated
Demand for raw materials (RMC)	179 Mt (savings)
Total material requirement (TMC)	329 Mt (savings)
Land use	8.5 million ha (land gain)
Biodiversity (potential loss)	32% lower (in the food sector)
Less biodiversity loss and pollution of ecosystems	
Economic benefits	
Income in Germany	EUR 170 billion of freed-up income
If the freed-up income is used in service sectors with low environmental impact:*	
Added value	+14% (incl. rebound) EUR 70 billion in economic and public services (incl. rebound)
Labour needs	+11% (incl. rebound)
Resilience of the German economy to supply risks	
Production of secondary raw materials	+16% or EUR 860 billion
Critical raw materials	50% of Germany's demand is provided by effects of CEMG measures for palladium, yttrium, dysprosium, neodymium, terbium, cobalt, copper, praseodymium and gallium. 8 of these 9 raw materials are already classified by the EU as critical.
	Alleviating the supply situation for 29 of the analysed 36 raw materials
Social benefits	
Labour needs in the production of secondary raw materials in Germany	+23%
Higher percentage of female employees due to an increase in work in the service sector	
Improvement in global health	

*In some sectors, both indicators would still be negative, especially in those sub-sectors that urgently need to be transformed to reduce environmental impacts and social costs, e.g. primary production and mining.

Table 4

ANALYSIS AND OUTLOOK

Die Kosten-Nutzen-Abwägungen, wie sie im Rahmen des MDCE-Vorhabens durchgeführt wurden, sind wichtige Impulse für den politischen Handlungsbedarf auf dem Weg zu einer sozial-ökologischen Transformation. Der bloße Vergleich der ermittelbaren und aufgeführten Kosten und Nutzen wäre aber zu kurz gegriffen.

In einer umfassenderen Perspektive geht es nicht darum, ab wann es sich lohnt, mit der ökologischen Transformation zu beginnen. Es ist davon auszugehen, dass Handeln definitiv rentabel und Nichtstun in jedem Fall teurer ist. Der gesamtgesellschaftliche Nutzen einer CE ist deutlich höher als die damit einhergehenden Kosten.

Aufgabe der Politik ist es, die negativen Kosten, die durch keine oder ungenügende CE-Maßnahmen entstehen, über gezielte Interventionen zu verringern und damit gleichzeitig den benötigten Strukturwandel zu gestalten. Dass und wie dies möglich ist, soll im folgenden Kapitel dargestellt werden.

7

POLICIES FOR SHAPING THE TRANSFORMATION

POLICIES FOR SHAPING THE TRANSFORMATION

Transformation is a comprehensive process of socio-economic, political and cultural change, a way to further develop and realign the economy and society. Targets and indicators, instruments and measures are needed. Transparency must be guaranteed and consensus established. Clearly defined responsibilities, control and monitoring mechanisms and an institutional framework for resolving conflicts are needed.

If structural change succeeds, our country will gain in economic, environmental, social and geostrategic terms. It will have a better future, become more resilient, more liveable, more competitive and avoid high economic costs. The CE Model Germany (CEMG) offers the necessary measures to achieve this goal, provided they are interlinked and systematically implemented.

CREATING THE PREREQUISITES

To actively and successfully **shape the transformation**, however, Germany **needs** not only ambitious goals and functioning measures, but above all **political leadership**. At the core is the goal of defining a binding and reliable framework for companies and consumers that creates acceptance and makes active participation possible in the first place.

Consumers can decide to take public transport because it has been extensively promoted by policymakers and is the best alternative. Consumers can have their electrical appliances repaired because they get a bonus for doing so. Companies design their products for longevity because ecodesign is mandatory, or they ship their products in reusable packaging because it is required by law. And this is how change happens bit by bit and becomes automatic, the new normal.

ELIMINATING BARRIERS

We already have a comprehensive legal and political framework at national level that aims to mitigate climate change and conserve resources. These include the Federal Climate Change Act and its instruments as well as the Federal Circular Economy Act with its ordinances. The protection of natural resources can also be found, at least in parts, in regional planning laws

A regulatory framework also already exists at European level, for example in the area of product standards (Ecodesign Directive, European standards for

motor vehicles, specifications for chemical safety, etc.), in relation to companies (e.g. CSR standards), for manufacturing processes, climate change mitigation and resource conservation in trade agreements.

However, this regulatory framework has proven to be insufficient. It is not enough to eliminate the barriers that prevent implementation of the necessary CE measures.

THESE FACTORS HINDER IMPLEMENTATION OF THE CIRCULAR ECONOMY:

- Externalisation of environmental costs
- Lack of infrastructure for circular products and processes
- Lack of investment (e.g. in research and development) for a circular economy
- Lack of transparency in terms of sharing information and data in value chains
- Long-term path dependencies due to investments in linear technologies
- Lack of common standards for circular products

We therefore need to develop new instruments and strengthen those that are already in place. At the same time, gaps in the framework of binding regulations must be closed and economic incentives for resource conservation and circular economy measures must be developed.

IMPETUS FOR SHAPING CE POLICIES

In this and the following section, we at WWF Germany aim to show policymakers the possibilities for political action and give specific recommendations for a successful transformation. Our intention is also to provide impetus and suggestions for the necessarily ambitious design of the National Circular Economy Strategy (NCES).

This strategy should already include the guiding principles, narratives and meta-narratives needed for successful political, social and economic transformation, re-defining Germany's future and its path to the future.

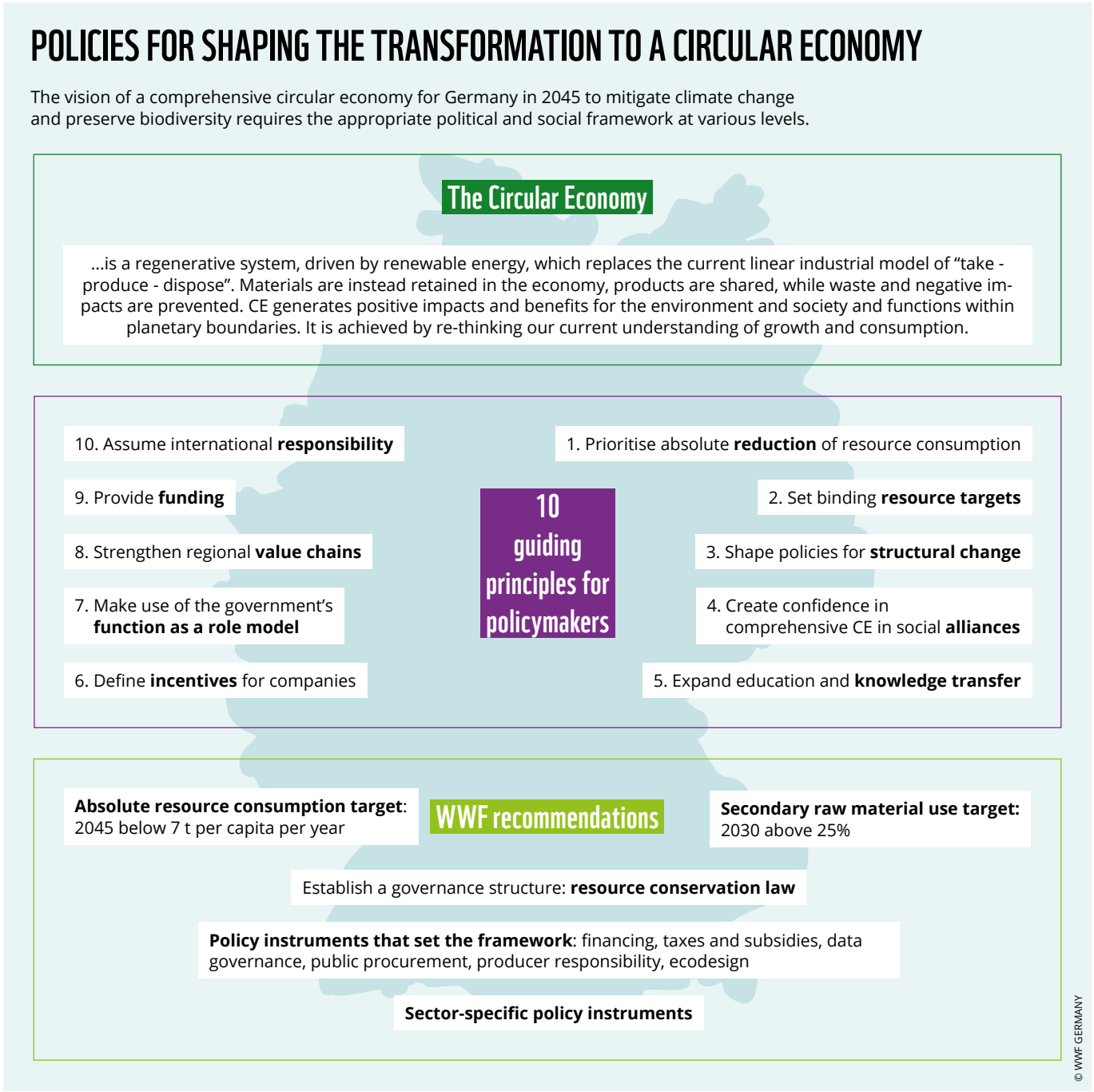


Figure 23

The CEMG provides the key elements for achieving this goal: **vision** and **guiding principles**, targets and **indicators**, as well as a **governance approach**, which are described in this section. It also provides specific **policy instruments** that have an overarching impact or are tailored to the eight sectors analysed.

VISION AND GUIDING PRINCIPLES

Vision and guiding principles point the way and serve as a roadmap. They provide direction and act as a compass. This is useful because not everything can be planned and regulated down to the last detail. What is important is that the direction and the principles guiding Germany are clear. The vision and guiding principles are also important because alternative growth and consumption narratives require more than just technological progress.

In WWF's vision for the CE (see Section 1), a central aspect is the rigorous implementation of all circular economy strategies. In particular, the highest-level R-strategies, e.g. refuse, reuse, repair, etc., must be strictly applied and implemented. To date, these strategies have received far too little attention in terms of both innovation and policies. Moreover, a CE is clearly defined as a lever for environmental protection and climate change mitigation, because it is not an end in itself.

R-strategies for reducing the consumption of natural resources and for recycling materials include: (1) Refuse, (2) Rethink, (3) Reduce, (4) Reuse, (5) Repair, (6) Refurbish, (7) Remanufacture, (8) Repurpose, (9) Recycle, (10) Recover

Germany should be guided by ten central principles:

PRINCIPLE 1: ABSOLUTE REDUCTION OF RESOURCE CONSUMPTION IS THE TOP GOAL

Every year, Earth Overshoot Day marks the day when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year. In 2023, Germany reached this day on 4 May, just four months into the year! If the world's population consumed as much as people in Germany, we would need 2.9 planets.

While there are successes, they are often only illusory: for example, total raw material productivity grew by 12% between 2010 and 2018, but more was produced while raw material consumption remained the same. The sticking point: not only is the necessary and comprehensive decoupling of economic growth from material and energy consumption insufficient, it is also taking place under false pretences. We need to consume more efficiently, but, more importantly, we need to consume fewer raw materials.

To reduce Germany's biotic (renewable) and abiotic (non-renewable) resource consumption to an environmentally acceptable level, the goal must therefore be absolute savings. We need environmentally acceptable maximum limits that can serve as a target value for reduction.

PRINCIPLE 2: DEFINE BINDING RESOURCE TARGETS USING CLIMATE TARGETS AS A MODEL

Like climate targets, resource targets are also crucial for the future of our planet. They must be given equal importance and prioritised in all sectors. Political strategies should fundamentally commit to reducing resource consumption in absolute terms – regardless of whether the strategies aim to shape sustainability, biomass, raw materials, construction, transport or consumption in detail.

The goal of saving resources is also important as a framework because it is interlinked in many ways and in direct causality with many impact categories, like climate and biodiversity. The extraction and processing of natural resources is responsible for more than 90% of global biodiversity loss and about half of global greenhouse gas emissions. This is why the effects of imported goods should also be included in the overall accounting of German consumption. To this end, consumption-related GHG reductions must be included in the national climate targets.

PRINCIPLE 3:
SHAPE THE STRUCTURAL TRANSFORMATION WITH SPECIFIC POLICY INSTRUMENTS

Making and using products generates external environmental and social costs that must be factored in to mitigate climate change and conserve resources. This also helps to eliminate advantages of resource-intensive technologies and practices that distort competition. The necessary instruments can be found in a CE-aligned financial and tax policy that promotes investments in circular business models, reduces environmentally harmful subsidies and imposes costs on resource-intensive production and consumption patterns.

At the same time, ambitious minimum regulatory standards for products must be established, digitalisation and data access must be made possible and manufacturers must bear a significant share of the environmental costs of their products.

The aspect of social justice is also crucial for government environmental policies to be accepted and successful. Social policies must protect lower-income groups and address distributional effects.

A triad of regulatory law, market-based instruments and consumer outreach is needed to shape structural change with specific policy instruments.

PRINCIPLE 4:
LEVERAGE SOCIAL ALLIANCES

Changing social norms and standards, paradigms, values and information flows is a far more profound lever for change than mere technical optimisation and innovation. This is why as many members of the public as possible must be involved through dialogue forums, direct participation, education and networking, and encouraged to become agents of change themselves. This should happen within the framework and with the help of environmental, social and development organisations, youth associations, trade unions, cultural institutions, etc.

Conflicting values can be discussed through participation and collaboration, and regional and cultural traditions integrated. The goal is find a new definition of prosperity that depends less on material resources and more on immaterial goods. Sufficiency is an attractive goal when more time, a greater sense of community or personal empowerment win out over consumption. This is the added value and “profit” CE offers for each and every one of us.

PRINCIPLE 5:
EDUCATION AND KNOWLEGE ARE KEY TO THE TRANSFORMATION

Education and public outreach are essential elements to support civil society and promote its concerns. This is especially true when it comes to creating awareness of the negative environmental, social and economic consequences of our current linear lifestyle and consumption habits.

Policymakers must create opportunities for people to reflect on how they live, to make informed choices and to change their personal lifestyles. For this to happen, education must go beyond what schools, pre-schools and day care centres offer. It also involves places for informal learning and everyday education, i.e. family, residential communities, out-of-school educational opportunities and youth peer groups. In this context, education campaigns and programmes for self-directed learning and activities play a role, as well as the opportunity to share ideas and develop creative ideas.

In addition, the CE framework gives rise to specific training and qualification measures, for example to strengthen the skilled trades when more repairs and better (i.e. more environmentally friendly, more efficient and longer-lasting) designs are needed as part of the transformation.

PRINCIPLE 6:
CREATE INCENTIVES FOR A SHIFT IN CORPORATE VALUES

At the moment, it is more attractive financially for many companies to engage in environmentally harmful practices. By contrast, pioneers of circular materials or business models are too often hindered by financial or regulatory hurdles. According to the OECD, the market penetration of circular business models is currently only 5% to 10%.

In general, companies do not want to be perceived as a problem, but as part of the solution. This is not least important for sales success in a society that is increasingly geared towards sustainability and promises significant advantages in the search for new employees and qualified professionals. Advantages also arise when profits and market shares are threatened by supply bottlenecks, increased production costs and changing demand structures.

In addition to reliable planning, a level playing field, i.e. fair competition, is crucial for companies. This can be ensured by instruments such as global extended producer responsibility (EPR), a tax system that favours circular solutions or the internalisation of external costs.

PRINCIPLE 7:

EXPAND THE GOVERNMENT'S FUNCTION AS A ROLE MODEL IN PROCUREMENT

Using its market power, the public sector can make an important contribution to the transition to a circular economy. To be credible and pave the way for other actors, the government should therefore lead by example.

The federal, state and local governments must set an example and provide hard facts, e.g. in the circular design of sustainable public procurement. To this end, sufficient financial resources must be made available and staff must be trained accordingly. The specifications must have a mandatory character. Experience shows that voluntary recommendations are not sufficient.

PRINCIPLE 8:
STRENGTHEN REGIONAL VALUE CHAINS IN GERMANY

The implementation of the CE leads to stronger national and regional value chains because a circular economy works best when it is organised at local level where distances are short. As a result, new value is added domestically and new jobs are created. To this end, everyday products must be increasingly produced regionally, e.g. by agriculture and food processing companies. Another positive effect for added value at national and regional level is that the transformation increases demand for services, e.g. for repair, reusability, remanufacturing, public transport and energy performance contracting.

Raw materials should also come from regional value chains but when this is not possible, they should originate from sustainable supply chains.

PRINCIPLE 9:
FUND RESEARCH AND DEVELOPMENT OF THE CE TRANSFORMATION

Transitioning to a CE requires numerous investments, for example because infrastructure needs to be built for repair, reuse and recycling, but also to use secondary raw materials or to develop circular products. To achieve this, private sector funding must be made available.

In the EU Taxonomy Regulation, the transition to CE is one of six key objectives. It is intended to stimulate and mobilise investment, but it has not been a relevant factor for investors and lenders because so far, no specific criteria have been defined. The existing instrument needs to be adjusted so that it is effective.

In addition to private investment and public procurement, government seed funding should also trigger the necessary developments. These funds can advance research and development of circular products, processes and technologies as well as social alliances, education and knowledge transfer.

PRINCIPLE 10:
ASSUME GERMANY'S INTERNATIONAL RESPONSIBILITY MORE FULLY

Resource flows are global material flows. In a globalised world, there are countless interdependencies between worldwide economic flows. The implementation of a CE can therefore not succeed at regional, national or European level alone. Germany must assume responsibility beyond its own national borders and beyond the EU. To this end, sustainable supply chains must be established and environmental aspects added to existing instruments such as the Supply Chain Act. Export regulations, especially for problematic "products" like waste, must be strictly applied and grey areas eliminated. Where development funds are directed, they should be much more closely linked to the waste hierarchy and strengthen the local value chains of the target countries as part of a holistic CE.

For high-priority product streams such as batteries, Germany must actively develop global take-back and incentive schemes. CE principles must be firmly

enshrined in trade agreements. Global agreements such as the international treaty on plastics or the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes should be supported and further developed to achieve an internationally agreed absolute resource reduction target. Finally, it is essential to harmonise international standards.

THE POLICY FRAMEWORK

Based on the vision and guiding principles, key elements are analysed in more detail below.

SET GOALS, CREATE TRANSPARENCY

We need **targets and indicators** for the shared guiding principle. These targets and indicators offer reliable planning and investments, create transparency, promote acceptance, facilitate a strategic focus and, finally, enable monitoring and communication of results achieved or not yet achieved.

Looking at the wide range of indicators for a CE, it becomes clear that a strategic focus is advisable. If not, the instruments and measures will diverge where they are supposed to be come together and will point in different directions.

As outlined in principles 1, 2 and 3 above, targets for absolute **resource consumption (RMC)** should serve **as key indicators** and be at the centre of a CE's target system.

Fixed limits for key indicators are drivers and catalysts of change. This is shown not least by the example of climate change, where the formulation of an easily understandable and communicable 1.5 °C target has increased the importance and effectiveness of the project.

The targets for maximum resource consumption must be in line with the scientific basis for global limits, and they must be realistic, i.e. actually achievable.

Based on the **policy blueprint** study and with regard to the identified potential of the CEMG measures, WWF proposes three targets for Germany that must be achieved by 2045 or 2030:

1. Per **capita raw material consumption** (RMC) of 7 t per year by 2045 (of which 2 t biotic and 5 t abiotic). This corresponds to a reduction of 9 t or 56% compared to the current German per capita raw material consumption of 16 t. The target of 7 t also lies within the scientifically established corridor for sustainable global per capita raw material consumption of 5 to 8 t annually. Countries like Austria have already formalised a 7 t target in their circular economy strategy.

2. Reduction in absolute raw material consumption (RMC) to around 500 million t, which is a reduction of 62% from the current consumption level of 1,300 million t.

The outlined CEMG measures in 8 sectors lead to savings of around 370 Mt by 2045 compared to the status quo. They thus contribute just under half (45%) of the reduction required to achieve the sustainable corridor.

3. **Doubling the current circular material use rate** (CMU) to 25% by 2030. This corresponds to the current target set by the European Commission. Currently, 12% of all raw materials used in Germany are secondary raw materials. The minimum should be a CMU rate of 18%. Austria, for example, has already enshrined this target in its circular economy strategy.

A LAW FOR RESOURCE CONSERVATION

Defining resource policies for a circular economy is a multi-level task involving different national and European stakeholders. The responsibility for product standards or for shaping foreign trade, for example, lies primarily at EU level, while federal states and municipalities are responsible for procurement and urban land use planning. In addition, non-governmental stakeholders, especially companies and their associations, must also be involved to ensure success.

The high degree of institutional independence and basic private-sector freedoms, as well as the objective need to involve many different stakeholders, mean that strategy processes have so far tended to be consensus-oriented. Up to now, a win-win situation has been needed in most cases, but this can often only be achieved in measures with a low level of intervention, such as instruments for promotion, coordination or information. Given these conditions, however, there are no instruments with a high level of intervention. **However, these are necessary to push through a CE. To resolve this impasse, WWF Germany believes that a resource conservation law modelled on the Federal Climate Change Act would be a good idea**. Within this framework, our country can define a binding reduction target, which is then broken down further into **interim and ministry targets**.

The Federal Climate Change Act as amended in 2021 was used as a basis for drawing up the report

The law could require the ministries responsible to develop their own **individual strategies** to achieve these goals. If the goals are not achieved, the ministries would be required to develop and implement emergency programmes.

It would be up to the ministries to decide which instruments to use and how to involve the federal states and municipalities to achieve the goals in their area of responsibility. We can assume that this would ensure that instruments would be used which have a greater level of intervention than before.
This approach could also counteract the fragmentation described above. The current patchwork of political strategies, programmes and laws could be resolved and the individual ministries could be motivated to proceed with shared responsibilities and greater coherence.

A monitoring mechanism is also important. Similar to the Federal Climate Change Act, monitoring can be the responsibility of an independent body. In the case that sub-targets are unlikely to be achieved, this body could also trigger the mandatory emergency programmes.

The advantage of "organising" the use of raw materials under an appropriate law, in addition to limiting environmental impacts, is that we can counteract social (distribution) conflicts and supply shortages.

POLICY INSTRUMENTS DEFINE THE FRAMEWORK

Policy instruments set a political framework for resource-efficient production and consumption overall and pave the way for the sector-specific instruments used in the sectors analysed by the CEMG (and presented in the next section).

We propose six areas for framework-setting instruments. They remove barriers and even initiate measures that go beyond those of the CEMG as trailblazers, "enablers" and catalysts.

1. Financing of CE measures
2. Data governance
3. Environmental taxes and subsidies
4. Circular public procurement
5. Extended producer responsibility
6. Ecodesign for Sustainable Products Regulation (ESPR)

All instruments can be implemented within 5 years, with the exception of the ESPR.

FINANCING OF CE MEASURES

A circular economy requires a structural transformation that leads to new business models such as product-as-a-service or repair services, among others, and fundamentally change or systematically expand existing business models. This requires the creation or expansion of infrastructure (e.g. collection systems), processes (e.g. repair platforms) or technologies (e.g. digital, proactive equipment maintenance).

A wide range of financing instruments and lending structures are important levers for the shift to a circular economy:

- **Loans** with preferential conditions for targeted (and necessary) business activities
- Financing vehicles such as **CE bonds** as a type of transformation bond or CE-linked loans similar to sustainability-linked loans
- Adjustments to existing **financial market regulations**, e.g. investment regulations, insurance, etc.
- Establishment of **public-private partnerships** (PPPs) for the targeted use of public funds to mobilise private funds

It is important that these instruments primarily benefit circular activities of the higher-level R-strategies (reduce, reuse, repair, remanufacture, etc.) and do not just address recycling and waste measures as has been the case so far. The EU taxonomy already provides an instrument that can be used for financing private investments at preferential conditions if it is first made stricter (see Section 7, Principle 9, Vision and guiding principles).

Both for the taxonomy and for the issuance of green bonds etc., data on environmental impacts along the value chain is urgently needed. It is the function of a legal framework and data governance to make this data available.

DATA GOVERNANCE

Having product-related CE-relevant information available is an important prerequisite for circular business practices. The data needed includes, for example, content, product status, information on maintenance and repair and environmental impacts along the entire value chain.

Stakeholders need this information to be able to make sound decisions on design, use, repair and recycling. Currently, however, this data is neither collected nor shared to the necessary extent. Moreover, many environmental policy instruments, spanning recycling quotas, environmental taxes, green public procurement and eco-labels, depend on this data. Although there are already some information requirements, they are extremely incomplete and do not cover relevant groups of products and stakeholders.

A policy framework is essential for the necessary standardisation, processing and dissemination of data. This includes establishing requirements to collect and share data, data standardisation with electronic product passports and setting up and operating (product) data platforms for data sharing.

Collecting and making data available almost inevitably raises concerns and objections related to complexity, inputs and additional costs, trade secrets or commercial law. Even though these concerns need to be taken seriously, the reasons for them are usually not compelling. For example, an electronic product passport can help to simplify information requirements. Moreover, the information requirements are particularly important at the beginning of the value chain, which means that small and medium-sized enterprises usually do not have to collect new data. When it comes to trade secrets, a clear distinction can be made between private and public data.

ENVIRONMENTAL TAXES AND SUBSIDIES

Taxes are another important way to achieve a steering effect to promote environmentally friendly technologies and behaviour. It is a mechanism that has not been used often enough to date. In an EU comparison, environmental taxes (i.e. taxes with an environmental steering effect) account for only 4.12% in Germany, below the EU average of 5.42%.

The distorted relative prices of primary and secondary raw materials are a barrier to circular economy in many sectors. Taxes and subsidies can create a level playing field for competition that no longer rewards environmentally harmful behaviour. The market distortion occurs because not all costs associated with the extraction of raw materials, for example, are shouldered by the respective companies, but are externalised and imposed on society. This is particularly the case for imported raw materials. One example is the production of plastic from the imported, primary raw material petroleum instead of domestically produced, secondary raw material (recycled products).

Four measures are recommended for shaping financial and tax policies to promote a circular economy. The proposals for the first three measures can be implemented in a short timeframe if the political will to do so exists.

1. **Increase the use of environmental taxes**: no taxes in the German financial system are classified as environmental taxes. Instead, the system employs excise taxes (e.g. energy tax) or transportation taxes (e.g. vehicle tax) to achieve a steering effect. That said, there are already specific proposals, for example, to introduce taxes on the consumption of problematic materials (e.g. primary building materials), on problematic practices such as the backfilling of construction waste or an environmental registration tax for motor vehicles that takes into account weight as well as CO_2 emissions.

2. **Grant tax breaks**: to motivate environmentally friendly behaviour, lower sales tax is recommended. These reductions act in addition to taxes on environmentally harmful behaviour or resource consumption. Fully or partially reduced sales tax could include areas such as repair services, substitute products for milk and meat and merchandise or returns that are not destroyed but instead donated to charitable organisations.

3. **Eliminate subsidies**: the elimination of subsidies and tax regulations that entail resource-intensive practices and technologies remains a key tax policy. Examples can be found in the reduced sales tax on animal products, commuting allowances, the tax benefits of using a private car for company purposes or the tax exemption for jet fuel.

4. **Improve constitutional foundations**: in addition to the possibilities for environmental taxes, the improvements also involve the tax on resource use not only at the point of consumption, but at an earlier stage in the value chain. This is advisable not least with a view to distributional equity. Currently, 76% of taxes in Germany that can be categorised as environmental taxes are paid by private households, and only 9% by manufacturing companies.

Measures in the area of taxes and subsidies almost inevitably lead to objections and concerns, which, however, usually do not turn out to be compelling. For example, additional tax revenue can be used to provide targeted support for low-income earners. The same applies to subsidies. A progressive structure is recommended to achieve social impacts in addition to the necessary environmental benefits. To impose environmental taxes that affect companies' use of resources, action would have to be taken at European level to ensure fair competition, possibly through border tax adjustments.

CIRCULAR PUBLIC PROCUREMENT:

The public sector can make a major contribution to CE in terms of procurement. To strengthen the circular economy, a procurement obligation to give preference to products with low environmental impact was introduced to the German Circular Economy Act in 2020. Since then, government procurement offices (but not those of the federal states and municipalities) are required to give preference to products that take into account aspects of the circular economy (e.g. use of recycled materials, durability, ease of repair, reusability, recyclability or use of raw materials) when procuring or using materials and consumer goods, as well as in construction projects and other contracts. However, the regulation does not apply if this would result in unreasonable additional costs.

In a European comparison, Germany lags behind in circular public procurement. The reasons include in particular the lack of prioritisation over other criteria and goals of public procurement, the non-binding nature for the federal states and municipalities as well as the absence of quantified and integrated criteria. Another important aspect is that procurement authorities need expertise and must invest time and effort to be able to assess environmental aspects accordingly.

Specific recommendations:

1. **Make circular procurement mandatory** not only at federal level, but also for the federal states and municipalities, so as to increase legal certainty and reduce bureaucracy in procurement procedures.

2. **Make it mandatory to include life cycle costs** and costs to society as a whole, initially by further developing the general administrative regulation "AVV Klima" into a regulation focusing on procurement of climate-friendly services and products ("AVV Nachhaltige Beschaffung") that also includes circular criteria.

3. **Develop sector-specific guidelines** and standards for procurement authorities with integrated criteria, tools and data.

4. Set fixed targets for circular procurement in the ministries, building on experiences from other countries.

5. Specify circular indicators for monitoring to capture the contribution circular economy makes to climate change mitigation and make this communicable.

EXTENDED PRODUCER RESPONSIBILITY

Extended producer responsibility (EPR) systems stipulate that producers and distributors be held responsible for collecting used and defective goods of a defined product group and for recycling them properly. This involves both the organisation and the costs of collection and recycling.

EPR systems are considered to be an essential element in enabling producers to share in the cost and effort of effective separate collection, proper disposal and the resulting costs, and to ease the financial and organisational burden on other stakeholders such as the government, municipalities and consumers.

The policy requirements for EPR systems include:

- **EPR systems should be mandatory and regulated by law**. Non-compliance must result in penalties that come with a higher cost than the costs associated with EPR compliance. Experience shows that voluntary EPR systems do not produce satisfactory results.

- **Terms and stakeholders must be clearly specified and defined**. This applies in particular to the terms "manufacturer" and "producer". Only then is it possible to clearly assign responsibilities. This also applies to the different product groups.

- **Responsibilities and targets must be ambitious, achievable, measurable** and assigned to a clearly defined group of stakeholders to prevent grey areas and loopholes.

- **The targets must be periodically readjusted and the level of ambition successively raised**. This is because EPR systems are well suited to achieving defined target values, but less well suited to stimulating continuous improvement beyond mandatory target values.

Important: one key aspect of EPR implementation and a crucial aspect for CE is that Germany does not stop at the collection and proper recycling of waste materials. Instead, policymakers should clearly **prioritise the highest levels of the already mentioned R-strategies**, e.g. through approaches such as eco-modulation.

ECODESIGN FOR SUSTAINALBE PRODUCTS REGULATION (ESPR)

The EU Ecodesign Directive sets the framework for establishing minimum requirements for products related to energy consumption. On 30 March 2022, the European Commission proposed a further development of the directive leading to an Ecodesign for Sustainable Products Regulation (ESPR). The regulation will address circular economy requirements more intensively (e.g. longevity, reuse, reparability as well as design for recycling, resource efficiency, use of recycled materials).

However, the planned ESPR has a crucial weakness in the area of environmental cost rates, which are used to calculate product-related costs to society and derive eco-design criteria. The **EU cost** rates are simply too low and are also significantly below the environmental cost rates recommended by the Federal Environment Agency.

One example is the area of CO_2 emissions. Here, the negative environmental impacts are generally calculated by the EU based on the prices for emission

certificates in the EU Emissions Trading System. However, this is significantly below the level of the actual costs of damage to the national economy.

To ensure that ambitious minimum requirements for product circularity are established on the mass market, the least life cycle cost approach, which serves as the main basis for deriving ecodesign criteria, must take into account not only the costs for consumers, but also as many environmental costs as possible.

08

SECTOR-SPECIFIC POLICY INSTRUMENTS

SECTOR-SPECIFIC POLICY INSTRUMENTS

For the policy blueprint, specific instruments for the modelled sectors were identified and analysed in addition to framework-setting policy frameworks. The focus is on the way these instruments should be designed so that they have the greatest possible impact and can efficiently implement the measures of the CEMG (see Table 1 in Section 1). The framework-setting instruments include public procurement, ecodesign and producer responsibility. They are partially addressed and specified in more detail in this sector-specific analysis.

This section describes the top instruments for each sector in condensed form. The long version of the **policy blueprint** contains a detailed description of how each instrument was designed and outlines existing experiences and positions of various stakeholders in Germany and abroad, prerequisites for their introduction in Germany and relevant processes and suitable timelines. In addition, instruments other than just the top selection are presented.

BUILDING CONSTRUCTION AND CIVIL ENGINEERING

The top four instruments for the building construction and civil engineering sector make it easier to exchange rental housing, better integrate resource conservation in building regulations, define binding requirements for public procurement and introduce a primary building material and excise tax on cement.

Making it easier to exchange rental housing

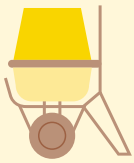
People's circumstances and the space they need change several times over the course of their lives, whether they move in with partners or friends, start a family, lose a loved one or change their place of residence. In practice, every move usually involves giving up an old lease with more affordable rent. New leases tend to be significantly higher. This is a considerable barrier and prevents living space from being used efficiently and in line with needs.

It could be made easier to exchange rental housing at national level under tenancy law. In addition to allowing the tenant to transfer the lease to a new tenant, the landlord's right to object on reasonable grounds could be regulated more leniently. New tenant clauses are sometimes already included in leases today.

The result would be more efficient use of existing living space, less need for resource-intensive new construction while simultaneously alleviating the housing shortage.

SECTOR-SPECIFIC POLICY INSTRUMENTS

The most important policy instruments for implementing the CE measures are described for each sector.

Building construction and civil engineering	**Vehicles and batteries**
 • Easier exchange of rental housing • Integration of resource conservation in building regulations • Binding requirements for public procurement • Introduction of a tax on primary building materials	 • Adjustment of the German Road Traffic Regulations • Support for public transport • Changes to vehicle tax • Introduction of a mileage-based passenger car toll system • Support for second life for vehicle batteries
Household appliances and ICT*	**Food and diet**
 • Minimum ecodesign standards • Stronger consumer rights: warranty, burden of proof and guarantees • Fiscal approaches • Extended producer responsibility (EPR): eco-modulation and extension of producer responsibility for collection and recycling	 • Adjustment of sales tax rates to promote a plant-based diet • Public procurement • Development of an educational campaign for sustainable food systems • Sustainable Common Agricultural Policy (CAP) for closed cycles
Textiles	**Packaging**
 • Minimum ecodesign requirements under ESPR • Extended producer responsibility (EPR): collection, recycling and reuse targets coupled with EPR fee modulation • Export regulations: clear definition and criteria for differentiating textiles for reuse and textile waste	 • Resource tax for packaging • Obligation to offer unpackaged and eco-friendly reusable systems • Tax on packaging containing materials that cannot be recycled to a high quality
Furniture	**Lighting**
 • Minimum ecodesign requirements under ESPR • Extended producer responsibility (EPR): collection, recycling and reuse targets coupled with EPR fee modulation	 • ESPR: revision of the currently valid life span requirement, taking into account existing test standards for light sources, standardisation of components and interfaces and other quality requirements • Public procurement • Investment programmes for research, development and retrofitting

*Information and communication technology

Table 5

Integration of resource conservation in building regulations

As outlined above, targets for absolute resource consumption should become the key indicators and be at the centre of a CE's target system. This must also be reflected in building regulations.

Today, the development of city centres is already prioritised. In the context of urban land-use planning, it must be examined whether abandoned areas, vacant lots, etc. can be built on instead of developing new areas on the outskirts of urban centres that require large amounts of resources. In the long term,

regional planning and especially urban structures should also be transformed from the perspective of resource use. This includes more efficient use of land, faster redevelopment of land and shorter distances (which reduce the need for transport infrastructure).

The integration of resource conservation in building regulations could be realised at national level as part of an amendment to the Federal Building Code (BauGB). The resource-related terminology for planners would have to be clarified in advance. The proposal to integrate resource conservation into building regulations could, if necessary, be linked to new regulations that arise in the context of climate change adaptation.

It would also make sense in the context of this instrument to promote programmes on resource-efficient planning and flagship projects.

Binding requirements for public procurement

In 2020, 17% of revenue generated by the primary construction industry was attributable to public-sector customers. The public sector can thus exert considerable influence and, within the framework of public procurement, stipulate requirements on, for example, building materials, the use of secondary materials, documentation, the reuse of building components and the useful life and life span of buildings. The criteria and support materials developed for this purpose have not been applied consistently to date. Germany's share of environmentally compatible procurement is below the EU average.

In the context on this instrument, the Qualitätssiegel Nachhaltiges Gebäude (Sustainable Building Quality Label) should be made a binding requirement for public procurement by the German government, the federal states and municipalities. The label is awarded following a comprehensive and integrated assessment of a building that includes aspects of resource conservation. The label is also a prerequisite for KfW funding.

This could be legally implemented through a requirement for procurement in the area of buildings in the regulation on the award of public contracts analogous to Section 67 (procurement of energy-related services) or in the German Construction Contract Procedures (VOB). The requirement could be incorporated into public procurement law.

Budgets at federal state and municipality level require the approval of the majority of the federal states to go into force. The federal states would be involved in a corresponding change to the ordinance regulating the award of public contracts through the Federal Council.

Introduction of a tax on primary building materials

The relationship between the prices of primary and secondary building materials distorts competition because the costs of significant environmental impacts in the extraction of primary building materials can be externalised and shared communally. Furthermore, construction waste is often not processed for reuse but instead wasted as backfill material.

Taxing primary building materials would provide incentives to replace them with recycled materials. According to an estimate by the Federal Environment

Agency, this would increase the cost of building by only 0.3%. As an excise tax, it would have no impact on competition, would not constitute a trade barrier for intra-EU trade in goods and could be introduced at national level. The prerequisite is that it be applied to final consumption.

Currently, 12.5% of primary building materials can already be replaced by recycled materials. This ratio is likely to rise to 25%–50% by the middle of the century according to estimates by the Federal Environment Agency. In addition to a tax on primary building materials, a tax or a ban on backfilling would also be advisable.

To achieve the greatest possible steering effect, the tax revenue from the tax on primary building materials should be channelled into a funding programme for the use of recycled materials in the construction sector.

Other instruments

Furthermore, **we propose advisory services and support measures for dividing up living space,** as well as **instruments that limit land sealing**.

VEHICLES AND BATTERIES

The top 5 instruments for vehicles and batteries in terms of the CEMG are: changes to the German Road Traffic Regulations (Straßenverkehrsordnung - StVo) and vehicle tax, support for public transport and second life for vehicle batteries and the introduction of a mileage-based passenger car toll system.

Changes to the German Road Traffic Regulations

The German Road Traffic Regulations currently serve primarily to ensure a smooth flow of motor vehicle traffic. The result is a strong focus on the needs of motor vehicles. At the same time, the German Road Traffic Regulations severely restrict the use of roads by other and less resource-intensive means of transport. To give municipalities greater scope for strengthening resource-saving transport solutions, the German Road Traffic Regulations must be revised to include environmental protection, climate change mitigation and road safety as key objectives.

A comprehensive reform of the German Road Traffic Regulations is part of the coalition agreement of the current legislative period. However, delays and different ideas about transport policy are calling the project into question to some extent. Moreover, in the current discussions, it is highly likely that only individual aspects of the problems described will be addressed.

Timely and effective implementation of the reform of the German Road Traffic Regulations requires political will at the level of the federal government.

Support for public transport

To support public service effectively, the range of services and overall customer experience must be improved, the frequency of services increased and certain areas made more accessible. These measures are cost-intensive. It is therefore essential that the German government and federal states provide the necessary

funds. To achieve a broad steering effect, the funds could be supplemented by measures such as more intensive management of parking spaces or a city centre toll. Expanding local public transport is mainly a municipal responsibility but can be strongly supported by the German government and the federal states. Expanding the long-distance public transport system is heavily dependent on funding from the German government. Nationally valid minimum standards should be defined and established to make rural areas accessible.

Changes to vehicle tax

Current vehicle tax takes CO_2 emissions and drive types into account and thus incentivises consumers to buy low-emission vehicles. However, it does not yet have a steering effect on the use of smaller and thus more resource-efficient vehicles. As previous emission and cubic capacity classes are becoming obsolete due to advances in e-mobility, a reform of the taxation system seems logical considering the high market penetration of e-drives.

In this case, the vehicle footprint would be a suitable measure, as it is related to both resource consumption and the use of transport routes and parking spaces. In addition, tax incentives could be introduced to encourage the long-term use of electric vehicles, for example by gradually reducing vehicle tax as the vehicle ages.

Introduction of a mileage-based passenger car toll system

A mileage-based use fee for passenger cars would be a suitable successor model to the existing energy and petroleum tax. This tax already acts as a de facto mileage-based tax for vehicles with internal combustion engines but is receding into the background due to the electrification of drive systems. A mileage-based passenger car toll could also compensate for the expected sharp decline in revenue from the petroleum tax.

The amount of the toll must be set at a level that provides clear incentives for the use of alternative modes of transport, including car sharing and ride pooling. The introduction of a toll of this kind requires that the toll amount be determined based on kilometres driven in a defined period. Since vehicles must be tracked for this purpose, data privacy aspects must be taken into account.

Support for second life for vehicle batteries

The reuse of used e-vehicle batteries has high potential for saving resources, as many batteries are still suitable for use as stationary power storage units for several years after their initial use in vehicles. This kind of second life could replace the production of a new battery for the purpose of power storage and thus save valuable resources.

In view of the rapid progress of e-mobility, the legal and organisational conditions for this repurposing must be established early on and relevant models promoted.

In addition to requirements for repairability, it is also important that the instrument gives preference to second-life solutions in public procurement and promotes power storage solutions. Of central importance is free access to battery diagnostic data from the battery management system (BMS) for owners and repurposing providers. This access must be guaranteed by the manufacturers, if necessary, it must be required by law.

A basic prerequisite for the introduction of the instrument is that the new EU Batteries Regulation announced for 2023 enters into force. In addition to many other aspects relating to vehicle batteries, this directive also regulates some aspects of collecting battery diagnostic data.

Other instruments

Other instruments in the area of vehicles and batteries are the commuting allowance that should be converted into a mobility allowance, and company car tax, where clear incentives should be created for the use of small vehicles and alternative transport solutions.

ICT AND HOUSEHOLD APPLICANCES

The CEMG's top four instruments in the area of electrical and electronic equipment for information, communication and household use are ecodesign under the ESPR, strengthening consumer rights in relation to warranties, burden of proof and guarantees, extended producer responsibility (EPR) and fiscal incentives.

Minimum ecodesign standards under the ESPR

The life span and useful life of electrical and electronic equipment has been constantly decreasing in recent years, while the number of new devices sold has steadily increased. Minimum life span requirements are now coming into focus to ensure higher quality standards and extended durability. Furthermore, there should be a general, overarching right to repair. The current proposal of the European Commission is an important step in this direction. However, Germany should ensure that the proposal is supplemented and strengthened by non-discriminatory access to repair and maintenance information, tools and spare parts for manufacturer-independent repair shops. An independent registry for technically qualified repair shops could provide the appropriate framework for this.

It is also important that a mandatory durability and repairability index is introduced. This should be implemented at EU level for all electrical and electronic equipment. What is needed is additional information beyond ambitious minimum requirements, such as the ability to be dismantled, the prices of spare parts and the cost and effort involved in repairs. It is also important not to ignore software-related causes for a shortened life span. This data could also become an integral part of digital product passports.

The political consensus on the new ecodesign rules expected for the first quarter of 2024 offers a good opportunity to integrate an ambitious CE perspective into product-specific minimum standards.

Stronger consumer rights

Longer warranty periods, which are based on the expected life span of devices and appliances, are an important incentive for sellers and manufacturers to offer more durable goods. The burden of proof for warranties has repeatedly proven to be a sticking point when consumers must prove that they are not responsible for the malfunction of the device or appliance. Currently, the reversal of the burden of proof only applies for six or 12 months for purchases

after 1 January 2022. Longer warranty periods are being called for by many stakeholders, such as environmental and consumer groups and scientific institutions. Norway and Iceland have warranty periods of five years, and three years in Sweden. The Netherlands and Finland have tied warranty periods to the expected life span of devices and appliances. France and Portugal have already extended the reversal of the burden of proof to two years.

Since it will be difficult in the near future to introduce an extended warranty period and mandatory warranty information from the manufacturer about the product at EU level, the German government should become active in national legislation. The approaches have already been assessed from a legal standpoint and confirmed. No new prerequisites are needed for implementation.

Fiscal incentives

Economic and fiscal instruments to support low-cost repairs include reducing or exempting second-hand businesses, repair service providers and remanufacturing companies from sales tax. Other incentives can include granting a repair bonus, subsidising costs (personnel, materials, rent, advertising) and offering tax credits to consumers.

The fiscal instruments contribute to the prolonged use of products and components, reduce environmental impacts and promote circular business models that would not be very competitive without support. They should be implemented nationwide.

It is important that these instruments are applied beyond electrical and electronic devices, e.g. also for furniture, textiles, shoes, etc., and that sufficiently large budgets are made available.

The environmental, economic and social benefits of the above-mentioned measures have been described several times. The instruments do not require any special preconditions and can be implemented by the German government before the next amendment to the VAT Act is implemented in 2024.

A legal opinion would need to be drawn up in the near future to examine how the repair bonus and subsidies for personnel costs, repair materials, rent and costs for public relations can be uniformly designed and implemented throughout Germany. The implementation of the instruments should be accompanied by a major communication campaign.

Extended producer responsibility (EPR)

EPR systems aim to internalise negative environmental costs and give manufacturers more responsibility for managing the product life cycle.

Germany is transposing the EU Directive on the collection, disposal and recycling of waste electrical and electronic equipment (WEEE Directive) into national law through the new Electrical and Electronic Equipment Act (ElektroG). Here, eco-modulation offers considerable economic steering opportunities to improve recyclability, but also greater waste prevention through reusability, durability and repairability. The level of modulation should prioritise these higher levels of the waste hierarchy and account for a significant share of a product's retail price. It is important to cushion social disadvantages for lower-income households and earners and ensure that the transformation

to higher-quality electrical and electronic equipment for the mass market is socially equitable.

The German government should start the process of reforming the Electrical and Electronic Equipment Act after the EU Waste Framework Directive is adopted in 2023.

Other instruments

Other instruments in the area of ICT and household appliances can be found in **public procurement** and more transparency for the **resource-efficient use of data centres**.

FOOD AND DIET

The top four food and diet instruments are found in sales tax rates for plant-based diets, public procurement, an educational campaign for sustainable food systems and a sustainable Common Agricultural Policy (CAP) for closed-loop systems.

Adjusting sales tax rates

According to estimates, raising sales tax on meat products from today's level of 7% to 19% would reduce meat consumption by around 11%. If the instrument were applied to other animal products, milk consumption could be reduced by 9.4%. At the same time, the consumption of fruits and vegetables would increase by 1.7% and 4.2% respectively. On the cost side, the adjustment of sales tax for consumers would lead to additional costs per person and per year of EUR 6.80 (for meat) or EUR 20.70 (for all animal products). Eliminating sales tax on fruits and vegetables could more than compensate for this effect. Consumers could then save EUR 29.80 per person and per year – a net reduction of EUR 9.10.

Instead of an across-the-board tax increase on animal products, the adjustment could also be based on the environmental impact of the individual food. Alternatively, there could be exceptions for certain products (e.g. regional organic products). If it is not possible to implement changes in sales tax for meat and animal products, it would be a good idea to introduce an animal welfare tax to differentiate prices between animal and plant products.

There are no special preconditions for changes in the sales tax rates of product groups. Relevant sales tax rates could be set by the German government. In April 2022, the European Commission's VAT Directive was amended. A zero tax rate on essential goods such as food became possible as a result.

Public procurement

The German government and the federal states could redesign award criteria for food services in public institutions (e.g. schools, government institutions, in some cases hospitals) in such a way that measures that support a circular food system are promoted and sustainability is no longer edged out by pure price considerations. In return, vegetarian and vegan alternatives could be offered with greater frequency and at lower cost. The optimal approach would

be to follow the EAT-Lancet criteria for sustainable and globally viable dietary habits.

Quotas for domestic organic food or regionally produced products would also reduce time and effort, for example in the area of transport, and help closing regional material cycles. Criteria for biodiversity-friendly procurement would also have a positive impact (e.g. food with low environmental impact, avoiding food that destroys ecosystems or accompanying measures to prevent food waste).

The prerequisites for quotas for vegetarian/vegan and organic meals in public institutions are in place. Quotas for a certain percentage of organic food are already mandatory or a goal in many federal and state public institutions. To the extent permitted by current legislation, they could be supplemented by the responsible bodies with further criteria relevant to the cycle, such as waste or regional products. In the case of quotas for regional products, the situation is more complicated, as there is less experience available on how regional products can be defined in conformity with EU law.

Development of an educational campaign for sustainable food systems

According to the report of the Federal Ministry of Food and Agriculture to the European Commission, 59% or 6.5 million tonnes of food waste along the value chains stems from households.

To avoid food waste due to incorrect storage, preparation or overly high aesthetic standards, consumers need knowledge and information. This is also true for the health, environmental and social impacts of diet as motivation to change individual behaviour.

Relevant aspects of knowledge should also be integrated into school curricula. The knowledge can be of a theoretical or practical nature, e.g. through school gardens or communal cooking classes. In 2018, the avoidance of food waste was an integral element of the general curricula only in the states of Berlin and Brandenburg.

Digital formats create new opportunities to easily reach target groups. It is also important to note that information campaigns do not have to be limited to schools, but should focus on as much of society as possible.

Sustainable CAP for closed cycles

The Common Agricultural Policy (CAP) is the central agricultural policy steering instrument within the European Union. Due to insufficient reform efforts, the CAP has been criticised for not sufficiently supporting the transformation of agriculture. In particular, the continued flat-rate direct payments and an insufficient level of environmental ambition require substantial adjustments to the CAP, both in the current funding period and for the CAP from 2028 onwards. Due to their enormous volume, CAP funds are an important instrument to also promote circular agriculture.

The CAP is based on two pillars. The first pillar includes direct payments to farms. The second pillar (30% of the CAP) includes funds to support rural development and agri-environmental programmes, as well as payments for

farms in disadvantaged areas. In the negotiations for the next CAP period at EU level, the German government should work on strengthening the second pillar and also the conditionality and eco-regulations of the first pillar. Among other things, the latter help to ensure that first-pillar funds contribute more to more sustainable agriculture. For the next funding period, however, the goal must be to move away from land-based flat-rate direct payments and to link all payments to more direct services provided by farms.

Other instruments

Other instruments in the area of food and diet include reducing the **use of pesticides** in accordance with the strategic goals, the tax on excessive **nitrate pollution** and a tax for better **animal welfare**, **support for organic farming**, **introduction of an ecosystem services law** and, finally, **reduction of food waste** and the **establishment of quality standards** worthy of their name.

TEXTILES

The top three instruments for this sector are ecodesign under the Ecodesign for Sustainable Products Regulation (ESPR), collection, recycling and reuse targets coupled with Extended Product Responsibility (EPR) fee modulation and regulating exports using clear definitions and criteria for separating textiles for reuse vs. textile waste.

Minimum ecodesign standards under the ESPR

The textile sector is a prime example of the current throwaway mentality (fast fashion). This sector is responsible for considerable damage in all impact categories analysed and is a negative example of how environmental and social costs are externalised to other parts of the world. Extending the life span and useful life of clothing is the most effective way to counteract this and reduce the impact of the textile sector on the climate and the environment. Mandatory minimum standards must define conditions for durability, repairability, reusability and recyclability as well as recycled content and pollutant content that textiles must fulfil at a minimum to be sold on the European market. Detailed material lists and care labels must be provided and microplastics avoided at all stages of the life cycle.

The design of circular textile products must be accompanied by a profound change in business models, as most companies in this sector are optimised for the linear economy. Small and medium-sized enterprises should be supported in implementing design standards.

The instrument should be accompanied by information and education campaigns to explain price changes, the benefits and importance of durable clothing and care instructions.

The EU's forthcoming Ecodesign for Sustainable Products Regulation offers an opportunity to integrate minimum standards. It is of fundamental importance that the product-related regulations are developed uniformly at EU level instead of each member state establishing specific, possibly different criteria. The German government should exert influence at EU level in 2023, both dur-

ing the definition of textile-related regulations and in political consultations for the ESPR.

Targets for collection, recycling and reuse (EPR coupling)

Germany should introduce a binding EPR system for textiles and set quotas for specific targets for textile collection, recovery, reuse and recycling. Producers and distributors should not only be responsible for the organisational and financial aspects of meeting the individual targets, but also for the achievement of the overall goals. An ambitious measure could be environmentally modulated charges for longevity. In this case, the manufacturers themselves can determine the system costs to be paid through appropriate product design (e.g. good recyclability or recycled material content).

As far as the necessary separate collection of textiles is concerned, different targets could be set for different categories of textiles. A repair target is also recommended. There are many measures that can support EPR effectiveness, such as fees on a progressive scale based on the number of new items placed on the market each year.

Currently, France is the only EU member to have introduced a mandatory EPR system for textiles. Sweden and the Netherlands are currently in the process. As part of the upcoming revision of the Waste Framework Directive in 2023, the EU plans to introduce regulations on extended producer responsibility for textiles with eco-modulation of fees. The updated directive must then be implemented ambitiously in Germany.

It is also recommended that a significant share of contributions to EPR systems be used for waste prevention measures and preparation for reuse. The key to success for this instrument is that the benefits achieved are shared by the entire industry and are not focused on collection and recycling.

Export regulations

Between 2000 and 2019, Germany was one of the top five textile exporters in the world. The fate of exported used textiles is highly uncertain. The most important lever to mitigate the environmental damage associated with exports is a clear definitional distinction between textiles for reuse and textile waste.

A set of criteria should be developed for this purpose. One criterion that would make (customs) controls verifiable would be the way textiles are shipped: whether pressed into bales or washed and neatly sorted/folded. It is imperative that sorting takes place at the source, i.e. before the textiles are exported.

The export of used textiles should be stopped when the recycling and waste treatment capacities of the recipient country are unknown. Only used clothing that actually replaces new clothing should be allowed to be exported to (non-European) countries. One of the prerequisites for using the instrument is the development of sorting and recycling capacities in the EU as well as in the destination countries, even if the textiles are only for reuse. Relevant processes and opportunities include the UN Environment Programme's (UNEP) Sustainable and Circular Fashion framework, the EU Strategy for Sustainable and Circular Textiles (2022) and the revision of the EU Waste Shipment Regulation.

Other instruments

Other important instruments in the area of textiles mentioned by the EU are **regulating the destruction of unsold or returned goods**, banning false advertising about sustainability (**green claims**), the **digital product passport** and measures to counter **microplastics pollution caused by textiles**. At national level, the toolbox includes **public procurement**, **fiscal instruments**, a change in **awareness and increasing consumer information**.

PACKAGING

The top three instruments for this sector are a resource tax on packaging, a requirement to offer unpackaged systems and eco-friendly reusable systems and a tax on packaging materials that are difficult to mechanically recycle to a high enough quality.

Resource tax on packaging

A resource tax on packaging makes it more expensive to use more packaging materials. It thus reduces unnecessary (excess) packaging and promotes alternatives to single-use packaging made from primary resources (e.g. eco-friendly reusable systems, strategies for marketing unpackaged goods and the use of post-consumer recycled materials (PCR). The tax must be paid by the initial distributors and importers of packaging, and it must be proportional to the weight of packaging materials used. The tax rate per unit of weight would be set in such a way that a steering effect is achieved or at least can be expected. The long version of the policy blueprint contains a table with proposed tax rates for all packaging per kilogram of packaging material and tax rates depending on the recycled content.

The considerable income from the tax of initially around EUR 34 billion would be used to develop and support increased use of unpackaged systems and reusable systems. At least in the long term, it would be advisable to adopt an EU-wide resource tax for packaging.

For the tax to be successfully introduced, an obligation to label or report the materials used (e.g. using a digital product passport or a digital watermark) would be a prerequisite. This measure would also have a positive effect on design for recycling and the recycling of used packaging materials.

Requirement to offer unpackaged systems and eco-friendly reusable systems
A good and probably necessary addition to the packaging resource tax is a requirement to offer unpackaged products and reusable packaging to meet the respective targets for the use of reusable packaging in the current draft of an EU Packaging and Packaging Waste Regulation (PPWR).

Eliminating packaging and refilling eco-friendly reusable containers prevents resource consumption and waste. This must therefore be prioritised over recycling. Reusable systems are eco-friendly if they achieve high circulation rates, use containers produced with low energy consumption that can be recycled to a high quality, reduce transport expenses through regional structures and use resource-optimised systems for cleaning.

With regard to unpackaged systems, the main priority must be to ensure that the entire logistics chain functions without packaging to the greatest extent possible. For example, if it is not possible to transport goods without packaging, only standardised and optimised reusable packaging should be used.

A requirement to offer unpackaged systems will trigger a surge in new logistics models for sales of unpackaged products. In addition to the many environmental benefits, the instrument will also strengthen regional supply chains and added value.

Initial reports on the implementation of the requirements set out in the German Packaging Act (VerpackG) for take-away packaging show that it appears likely that the regulations will soon need to be made stricter. There is increasing criticism of the possibility to switch from single-use plastic food packaging to other materials, such as primary aluminium, which are sometimes much more harmful to the climate. The generous exemptions and the lack of quota requirements have also been the subject of criticism. In addition, many municipalities do not monitor implementation of the regulations on mandatory reusable packaging at all, or monitor it too inadequately due to a lack of staff capacity.

The introduction of the proposed instrument presupposes that product groups for which reusable packaging or no packaging is mandatory are defined in advance. Undisputed areas, such as reusable B2B transport packaging, reusable packaging for beverages and dairy products, and unpackaged products, for example for fruit, vegetables, baked goods, sausage, cheese or meat, can be stipulated in the regulation itself right from the outset. A decision-making committee must be established to include other product groups in the regulation.

Tax on packaging that cannot be recycled to a high quality

Today, packaging is already increasingly designed to be efficiently recycled into high-quality secondary raw materials in mechanical recycling processes. However, there are still significant numbers of non-recyclable products, especially in the area of plastic packaging.

Existing proposals for a tax on packaging materials that cannot be mechanically recycled to a high quality include a public fund that all distributors would have to pay into. The Zentrale Stelle Verpackungsregister (ZSVR), which is a government agency responsible for the central packaging register, is proposed as the fund's manager. The dual systems have proposed a private fund in where the contributions are collected and passed on to an independent fund operator (e.g. the ZSVR). If the right framework is established, the goal of the instrument can also be achieved this way.

The amount of the tax must be weight-based, equal for all materials and based on whether the desired steering effect is achieved. WWF Germany proposes EUR 1.50 per kg of packaging material for packaging that is less than 90% recyclable. It is advisable not to impose a one-sided charge on individual materials so that no materials are treated preferentially or discriminated against. The income generated from this tax should be used specifically to promote the high-quality use of recycled materials, to further develop sorting and mechanical recycling processes and to expand the recycling infrastructure.

The tax must be approved by the European Commission. The prospects for approval should be good if the tax is designed transparently and the free exchange of goods between the EU countries is guaranteed, including the possibility for companies from all EU countries to apply for funds for measures to support the system.

The tax on packaging that cannot be recycled to a sufficient quality can be used independently of the other two instruments in the packaging sector. However, a combination of the three instruments reduces the risk of misdirected incentives such as the increased use of non-recyclable packaging to reduce the amount of material. If the tax cannot be implemented as a fund model, a surcharge for non-recyclable packaging could be included in the resource tax for packaging.

Other instruments

There are many supporting instruments in the packaging sector. These include:

- Extending the scope of the **Packaging Act regulations to include all packaging products**
- Regularly **adjusting recycling quotas**
- **Banning materials** that make high-quality recycling difficult
- **Supporting unpackaged and reusable systems**

- Introducing **nationwide recycling containers**
- Mandatory **instructions for correct separation of recyclables**
- More efficient **sorting**
- Digital **packaging passport**
- Including waste incineration plants in a **functioning emissions trading system**

FURNITURE

The top two instruments for the furniture sector are Ecodesign for Sustainable Products Regulation (ESPR) and targets for collection, recycling and reuse coupled with the Extended Product Responsibility (EPR) fee modulation.

Minimum ecodesign standards under the ESPR

As with textiles, the furniture sector is a prime negative example of the current throwaway mentality and how environmental and social costs are externalised. To counteract this trend, furniture must be more durable, easier to repair and recyclable to a high quality at the end of its life.

Durability, repairability and ease of disassembly are prerequisites for resource-efficient, long-term use. They create the practical preconditions for repairs and make it possible to recycle high-quality materials in the required quantity and quality.

In terms of material recycling, ecodesign requirements should also address the problem of frequently used composite materials and the wide range of materials used in furniture. It is also advisable to integrate quotas for recycled material into design specifications (e.g. in the form of a secondary wood quota in certain wood products). By contrast, joining and bonding techniques that are counterproductive for recycling could be banned, as could certain paints, flame retardants, adhesives and pollutants.

Availability of spare parts, durability, mandatory information on the expected life span, information on care and maintenance, information on the origin of sustainable materials and a material inventory (e.g. in the form of a digital product passport) are other useful measures. In a study[9] prioritising potential product groups for the first work plan in ESPR, furniture came in second behind textiles in the relevance of its environmental impact.

As already outlined for textiles, it is of fundamental importance that product-related regulations for the furniture sector are developed uniformly at EU level. The German government should exert influence at EU level in 2023, both when the EU regulations are being defined and in political consultations for the ESPR.

Targets for collection, recycling and reuse (EPR coupling)

As in the textile sector, Germany should also introduce a binding EPR system for furniture and set specific target quotas for collection, recovery, reuse and recycling. Producers and distributors should not only be responsible for the organisational and financial aspects of meeting the individual targets, but also for the achievement of the overall goals.

This requires definitions that identify producers and distributors just as clearly and unambiguously as the system-relevant products. It is also necessary to regulate how costs are covered, as the profits from secondary raw materials in Germany are not sufficient to cover the costs of sorting facilities. Additional payments may be needed for cost-effective operation and the necessary innovations.

Separate collection is essential to achieve the targeted high level of reuse of used furniture. The region of Flanders in Belgium has about 20 years of experience in using instruments to build infrastructure for reuse and reprocessing. The French EPR system has included furniture since 2012. The distributors finance the collection and disposal, where the amount of the fee depends on the category, size and above all the weight of the furniture. The Federal Environment Agency currently recommends that the furniture sector should not be additionally negatively impacted by different approaches in different EU countries and therefore prioritises an EU-wide coordinated approach – even if the system is specifically designed at national level. Germany could therefore follow France's example and draw up an EPR for furniture without waiting for a specific, favourable moment at EU level. This process could start as early as 2023.

Other instruments

Other instruments in the furniture sector are found, for example, in **public procurement**, in fiscal measures to support **repair**, **remanufacturing and sales of second-hand products** and in **increasing the recycling of waste wood**.

Important when combining strategies: since furniture consists of around 90% wood, wood composites or other biogenic raw materials such as rattan and bamboo, the National Bioeconomy Strategy and the National Biomass Strategy, two relevant strategies that are currently being developed, can be leveraged. The Bioeconomy Strategy will be implemented by the Bioeconomy Council in 2023. The National Biomass Strategy (NaBiS) is currently being developed by three ministries (Federal Ministry for Economic Affairs and Climate Action (BMWK), Federal Ministry of Food and Agriculture (BMEL), Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV).

LIGHTING

The top three instruments for lighting are Ecodesign for Sustainable Products Regulation (ESPR), public procurement and investment programmes for research, development and retrofitting.

Minimum ecodesign standards under the ESPR

The currently applicable ecodesign regulation for light products is the regulation (EU) 2019/2020, which has been in force since 1 September 2021. Its aim is to gradually ban inefficient and short-lived light products from being placed on the market. In addition, the EU is working on further developing the Ecodesign Directive and related regulations under the ESPR.

In this context, it is particularly advisable to carry out a critical review of the currently applicable life span requirements, taking into account existing test standards. In addition, mandatory standards should be set for components and interfaces for low-threshold repair and possible replacement of light sources, and quality requirements further adapted for ambitious ecodesign (e.g. light colour and colour rendering index).

The ongoing ESPR process allows Germany to push for the introduction and revision of standards to reach ambitious CE targets. In addition, the German government should influence how the methodology for ecodesign requirements is further developed and advocate binding and ambitious environmental cost rates to calculate product-related social costs and define product-related ecodesign criteria.

Public procurement

Procurement for public institutions at federal, state and municipal levels account for a significant part of the demand for lighting. One important instrument is therefore the sustainable design of calls for tenders. Lighting systems that are as efficient and durable as possible must be used, well maintained and collected and recycled at the end of their life spans. In addition, smart lighting control can make a significant difference in public institutions.

Since these measures are often accompanied by high initial costs, lighting-as-a-service (as product-as-a-service or contracting) can offer a solution. In this case, a provider handles both the upgrade to more efficient lighting systems and the maintenance and replacement of defective lamps or light sources, as well as the electricity costs incurred. Calls for tender should include mandatory requirements for recycling criteria, e.g. the use of renewable energy sources and the collection and recycling of uninstalled or replaced lighting.

Lighting-as-a-service is still a small but already growing market. In Germany, the model somewhat stagnated in recent years, but gained in importance again due to rising energy prices. More and more case studies have shown the potential of switching to this model for public institutions. Existing barriers to contracting should be gradually removed by systematically publicising existing pilot projects and setting up new pilot projects for public swimming pools or universities, for example.

Investment programmes for research, development and retrofitting

The requirements of a CE also pose major technical challenges for the lighting industry in terms of manufacturing methods and recycling. New developments and innovations must be implemented under considerable time pressure.

Financial support could be provided through existing programmes. At national level this could be achieved through a new focus on lighting and CE in the Federal Environment Ministry's Environmental Innovation Programme. At European level, the Horizon Programme offers opportunities for funding.

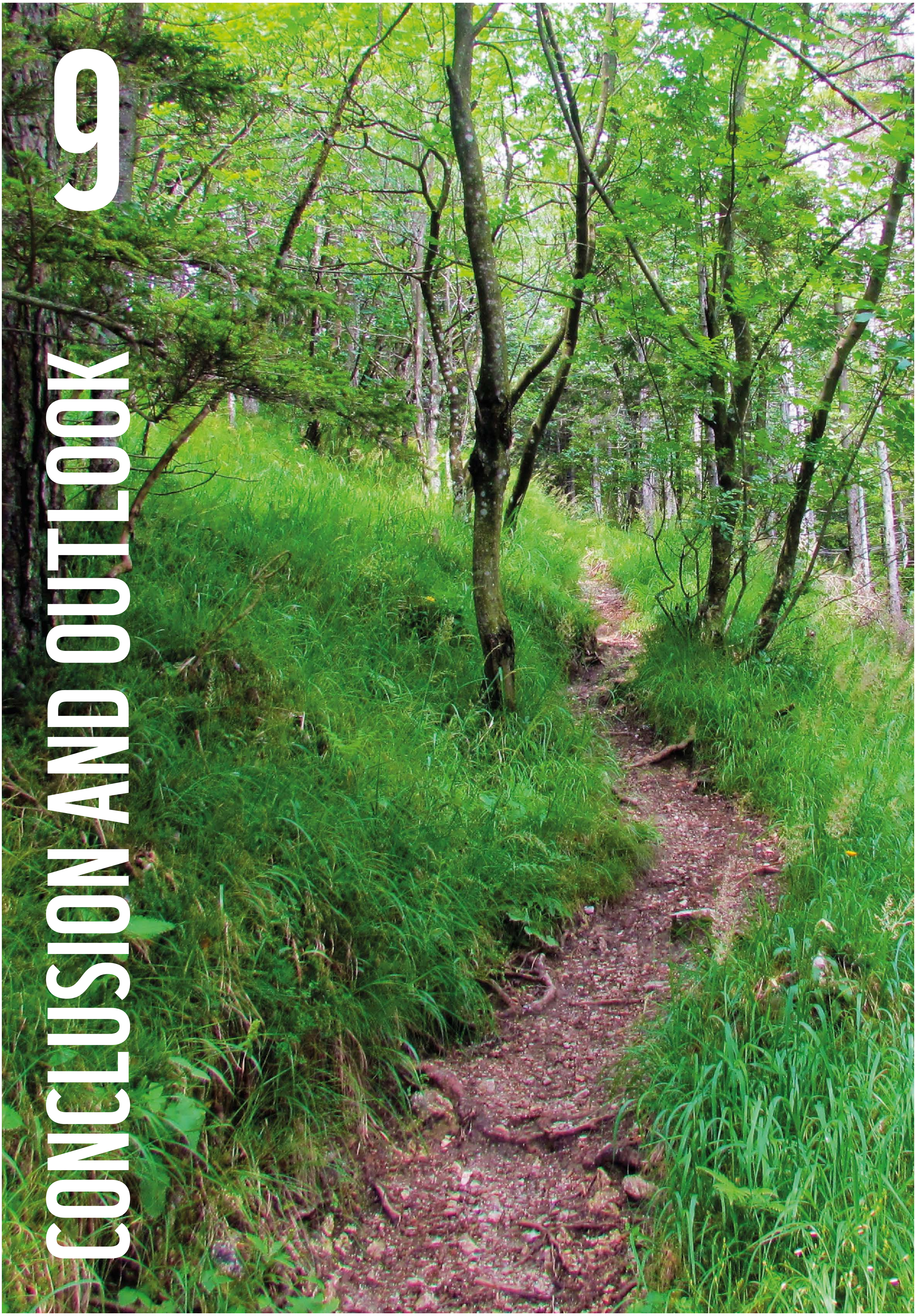
Completed projects of the Environmental Innovation Programme are already having an impact on helping to establish a circular lighting sector.

For this policy instrument to be successful, financial resources must be available and there must also be a strong, innovative industry. In this regard, Germany has a stable lighting industry as well as a well-developed waste and recycling management sector and is therefore well placed to set up targeted investment programmes.

Other instruments

The following instruments could also be considered in the lighting sector: the establishment of **take-back schemes for individual or collective manufacturer returns** in the German Electrical and Electronic Equipment Act (Elektrogesetz), incentives for **supplementary collection by manufacturers** themselves and **deposit systems for lamps**.

9 CONCLUSION AND OUTLOOK



CONCLUSION AND OUTLOOK

"Our hunger for resources seems insatiable – and is leading us directly into an unprecedented triple crisis of global warming, biodiversity loss and environmental pollution." The first words of this brochure also preface the conclusion and the outlook, but with an important difference. The word "seems". This is because the Circular Economy Model Germany shows that there is definitely a viable path to the future with circular economy. The triple crisis, because it has been caused by humans, can also be prevented by humans.

How this can be accomplished, where Germany needs to start, what measures, instruments, innovations and behavioural changes are necessary is shown by WWF together with Öko-Institut, Fraunhofer ISI and FU Berlin. The CE measures of the CEMG are the pillars of a genuine and holistic CE that respects planetary boundaries. And we have no alternative if the people in our country want to continue to lead fulfilling lives and if our companies want to operate successfully.

A milestone for Germany and the NCES

To secure the future, Germany must develop a comprehensive strategy for how to successfully transition to a holistic CE. The CEMG analyses eight sectors with products that are associated with high environmental impacts and resource dependencies and that have high potential for the necessary transformation as a result. In extensive impact models, more than 50 measures were identified across all R-strategies and analysed for their potential for environmental and socio-economic impact categories.

The CEMG, with its wide range of issues and complex interrelationships, is the first CE study of this scope ever conducted for our country. It is thus a milestone in the CE discourse, the development of a National Circular Economy Strategy (NCES) and its implementation.

Benefits for people, the environment and the economy

What the study clearly shows: the path to a CE gives rise to considerable positive environmental impacts, which can be seen in all of the impact categories analysed with no exceptions. The measures and instruments of the CEMG scenario make the necessary difference. They reduce greenhouse gas emissions to a large extent, save considerable amounts of raw materials, decisively reduce the need for resources and land.

From an economic perspective, the CEMG sustainably reduces the dependence of our national economy on critical resources. For companies, it creates the opportunity to address effective CE measures at an early stage, thereby

developing relevant competitive advantages and securing economic success for the future.

Last but not least, the necessary transformation of Germany towards a holistic CE also creates opportunities for better quality of life and human health. This can be achieved if we can change our behaviour in the context of sufficiency and with respect for planetary boundaries and find or rediscover old and new alternatives.

Shaping structural change

It is clear that the behaviour-based CE measures are by far the greatest lever. The study thus provides key impetus for social dialogue on the future economic structure.

Overall, the analysis of costs and benefits in the modelling and policy blueprint shows that both the economic and social benefits of CE are significantly higher than the associated cost and effort. However, this analysis also shows the need for structural change in those sectors that are responsible for major environmental impacts today.

Without acceptance in society, the necessary restructuring of the economy cannot succeed. This is why existing and emerging conflicting goals must be addressed with the help of a broad set of social policy instruments and accompanied by honest social dialogue.

Specific policy recommendations for action are available

The lack of implementation of a sustainable economy within planetary boundaries to date is attributable to a number of market failure mechanisms. They can all be addressed through a holistic CE. To overcome these barriers, consistent and ambitious political action is needed. In addition to the lack of coherence in existing resource strategies, there is not only a lack of a common overarching vision of circular economy, but also a lack of commitment to implementation.

The policy blueprint developed as part of the Circular Economy Model Germany project provides an extensive basis with a comprehensive vision of the future, key requirements and a practical toolbox of policy instruments.

It is now important to discuss the findings of the CEMG project and implement the specific recommendations in the process towards the NCES and beyond.

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GLOSSARY

GLOSSARY

AVV Klima: general administrative regulation (Allgemeine Verwaltungsvorschrift, AVV) on the procurement of climate-friendly services applies to the award of public contracts by federal authorities.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal: the Convention of 22 March 1989 establishes global regulations on the permissibility and control of waste exports.

Baseline: the baseline is the Continue-as-Planned scenario in the modelling study. It shows what Germany can achieve by 2045 if consumer habits and technological progress develop in line with existing trends. *(See > Section 1)*

Biocapacity: the ability of ecosystems to produce biologically beneficial material and absorb waste produced by humans under current conditions.

Biodiversity value increment: biodiversity value increment (BVI) refers to the difference in biodiversity quality on land used by humans compared to the natural biodiversity originally found on the land.

Car sharing: car sharing means that cars are used collectively by several people. This way, not everyone has to own a car and the overall number of cars is reduced.

CEMG scenario: the Circular Economy Model Germany scenario depicts what Germany can achieve if all circular economy measures recommended in the CEMG are implemented. Corresponds to the Mixed scenario in the modelling study.

Circular material use rate (CMU): indicator that measures the percentage of material that can be reused and returned to the economy in relation to the total material input.

Clinker factor: clinker is the most important component for making cement a hydraulic binding agent. The clinker factor represents the percentage of clinker in cement. The more clinker there is, the more CO_2 is emitted during cement production.

Closed Substance Cycle and Waste Management Act: the Closed Substance Cycle and Waste Management Act (Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Bewirtschaftung von Abfällen (KrWG) regulates the promotion of circular economy in Germany to protect natural resources and to ensure that waste management is environmentally compatible.

Common Agricultural Policy (CAP): the European Union's Common Agricultural Policy defines rules for agriculture in the countries of the EU. The CAP is based on two pillars: direct payments to farmers and common market schemes for individual products as well as rural development.

Continue-as-Planned scenario: *See > Baseline*

Design-for-recycling: a product is planned and developed from the outset to ensure that, at the end of its life cycle, it can be recycled as efficiently and completely as possible to the highest quality.

Dual system: the dual systems (e.g. Der Grüne Punkt, Interseroh+ etc.) organise the collection, sorting and recycling of used packaging throughout Germany.

EAT-Lancet criteria: criteria set by the EAT-Lancet Commission for a science-based > Planetary Health Diet that protects human health and respects planetary boundaries.

Ecodesign: a systematic and comprehensive approach to designing products with the aim of reducing environmental impacts over the entire life cycle through better product design.

Ecological footprint: the amount of land on earth necessary to sustain a person's lifestyle and standard of living. This includes land that is needed, for example, to produce clothing, food and everyday goods, to provide the energy needed, but also to break down the waste generated or sequester the carbon dioxide released by these activities.

Eco-modulation: using EPR fees *(see > EPR)* to incentivise more environmentally conscious packaging design and decentivise less environmentally friendly alternatives.

Electrical and Electronic Equipment Act [ElektroG]: the Electrical and Electronic Equipment Act stipulates, among other things, that waste electrical equipment may not be disposed of with household waste, but must be collected separately and recycled.

Energy performance contracting: the service provider pays the costs for measures to increase efficiency, rehabilitation or modernisation. The customer receives a guarantee of the promised savings on energy, electricity and water. Financing is provided through the energy costs saved.

Environmental Innovation Programme: the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) supports companies in innovative large-scale pilot projects that are well suited for demonstration purposes and that have the potential to reduce harm to the environment under this programme.

EPR (extended producer responsibility): extended producer responsibility means that producers are responsible for their products – starting with design, through distribution and return to proper disposal or recycling.

ESPR (Ecodesign für Sustainable Product Regulation): this revision of the existing EU Ecodesign Regulation aims to create a broad framework for products sold on the EU internal market to promote more energy-efficient, durable, repairable, reusable and recyclable designs. The exact wording of this regulation is currently being discussed at EU level; the European Commission submitted a proposal on 30 March 2022.

EU Packaging and Packaging Waste Regulation (PPWR): on 30 November 2022, the European Commission presented its proposal for the Packaging and Packaging Waste Regulation, which will replace the current Packaging and Packaging Waste Directive (PPWD). It aims to reduce the environmental impact of packaging with measures along the entire life cycle.

Fibre-to-fibre (F2F) textile recycling: with F2F recycling, textiles are recycled in such a way that the recovered recycled fibres can be reused for textile products.

Governance approach: governance is a form of political control. In contrast to traditional forms of governing, it represents a form of control based on coordination and close interconnection of the political decision-making levels.

Horizon Europe programme: EU framework programme for research and innovation. The goal is to build a knowledge- and innovation-based society and competitive economy and to contribute to sustainable development.

International treaty on plastics: by 2024, a legally binding UN agreement to end plastic pollution in the environment and oceans is expected to be adopted at the UN Environment Assembly (UNEA).

Least Life Cycle Costs (LLCC): an approach that assesses the total cost of a product over its life cycle including all production, use and recycling processes. This can include environmental costs and costs to society. LLCC describes how measures are prioritised that have the lowest overall costs along the value chain.

Linear business models: in linear business models, value is created by selling products. Producing durable, modular or recyclable products therefore tends to become less appealing.

Local public transport system: local public transport system is the collective term for public transport services that operate on rail or road on a regular timetable that anyone can use.

Mt CO_2-eq: the "megatonne of CO_2 equivalent" is a unit of measurement to standardise the climate impact of different greenhouse gases (CO_2, methane, nitrous oxide, etc.)

National Bioeconomy Strategy: In its cabinet decision of January 2020 on the National Bioeconomy Strategy, the German government set out goals, guidelines and action areas on how policymakers can help the economy and society move towards a sustainable and bio-based economy.

National Biomass Strategy: with its National Biomass Strategy (NABIS), the German government aims to systematically direct biomass flows and thus ensure that biomass is used in the best possible way and pressure on natural areas is reduced.

NCES: the National Circular Economy Strategy (NCES) will be developed in dialogue between the German government and key business and civil society partners in 2023, after which it will be adopted by the cabinet and implemented.

Packaging Act (Verpackungsgesetz, VerpackG): act concerning the distribution, take-back and high-value recycling of packaging. The Packaging Act aims to protect the environment and ensure fair competition. The Packaging Act requires producers to assume responsibility for the entire life cycle of their packaging.

Planetary Health Diet: provides guidelines on sustainable and healthy eating within planetary boundaries. It recommends more plant-based instead of animal-based ingredients. (-> *EAT-Lancet criteria*)

Post-consumer recycled content (PCR): materials (secondary raw materials) recovered from previously used products in the course of material recycling (as opposed to post-industrial or pre-consumer recycled materials).

Product-as-a-service (PaaS): a model focused on selling an underlying service or product function rather than the product itself (possibly including maintenance and service).

Qualitätssiegel Nachhaltiges Gebäude (QNG): the "Qualitätssiegel Nachhaltiges Gebäude" (Sustainable Building Quality Label) is a governmental quality label for buildings. A prerequisite for being awarded the national Sustainable Building Quality Label is proof that the requirements for the environmental, socio-cultural and economic quality of buildings have been fulfilled.

Raw material consumption (RMC): is comprised of domestic raw material extraction and imports minus the raw materials used for the production of exported goods.

Recycled material: secondary raw material obtained during waste recycling. Today, recycled material usually means plastic recyclate. (*See > Section 37*)

Remanufacturing: industrial remanufacturing, e.g. of used appliances or car components, which are disassembled, cleaned, tested, refurbished and assembled into a product as good as new.

Repurposing EoL batteries: over time, e-vehicle batteries lose capacity and can no longer meet the high requirements for e-vehicles. They can be used at the end of their first life cycle (End of Life; EoL) for other purposes (Second Life; SL) and reduce the production of new batteries in these areas.

Resilience: describes resilience in the sense of the ability to endure challenging situations without lasting impairment.

Ride pooling: commercial transport services for the shared use of a vehicle by passengers whose points of origin and destination are in a similar direction.

Ride sharing: refers to the traditional form of car pooling where an individual offers to give other people a ride on part or all of the route, either free of charge or in exchange for a share of the costs.

R-strategies: key approaches for the success of the transformation to the circular economy. Based on Reduce-Reuse-Recycle, the framework was expanded to (1) Refuse, (2) Rethink, (3) Reduce, (4) Reuse, (5) Repair, (6) Refurbish, (7), Re-manufacture, (8) Repurpose, (9) Recycle, (10) Recover.

Sharing economy: part of the circular economy. Refers to the collective use of items by sharing, swapping, lending, renting or gifting as well as service referrals.

Smart crusher technology: extracts cement from concrete rubble that can be reused or recycled as a binding agent and to improve limestone.

Structural cement: a form of exposed concrete where the surface is sculpted. Common design element used in the architecture of façades, gable walls, balconies, staircases, etc.

Sustainability linked loan: a loan product that creates financial incentives for sustainable business practices by tying the interest margin to sustainability criteria.

Total Material Consumption (TMC): the TMC not only includes the raw materials that are ultimately consumed, but also includes, for example, material that is produced or has to be transported when these raw materials are extracted.

WEEE Directive: the WEEE Directive (2012/19/EU) sets out requirements for the disposal of waste electrical and electronic equipment (WEEE). The fundamental principle here is the product responsibility of producers.

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In keeping with its character as a summary, this publication largely omits references to sources of the studies on which it is based, making use of them only when it helps to understand what is being presented. Detailed lists of sources can be found in the long versions of the studies mentioned above. Some of the values shown in the tables and figures contain differences due to rounding.

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