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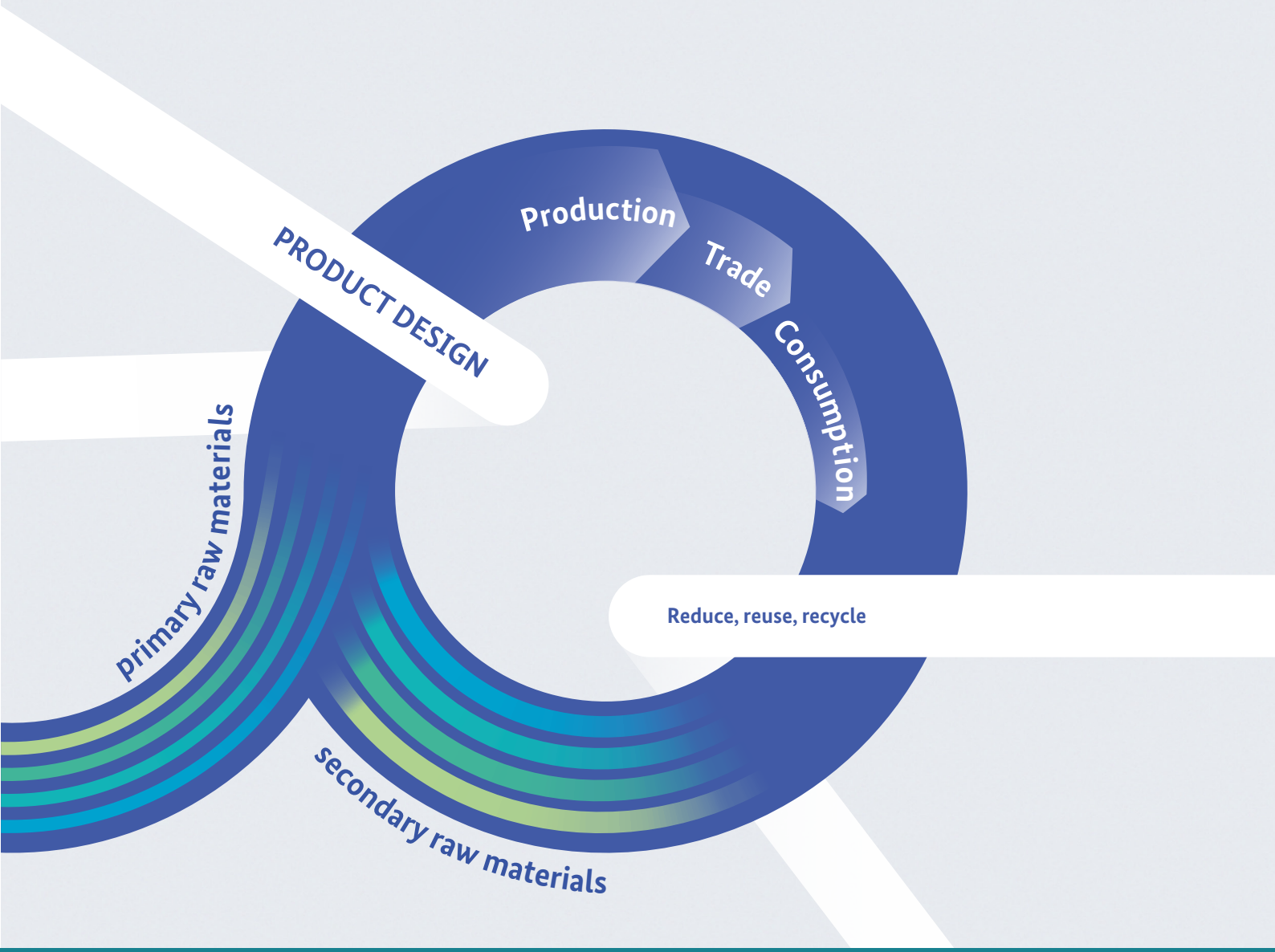

The National Circular Economy Strategy

Imprint

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1. The vision for a circular economy

The circular economy[1] is not only essential to achieving our climate and environmental policy goals, it also creates tremendous opportunities for growth, employment and competitiveness. The transition to a circular economy has an important role to play in securing the supply of raw materials. It increases the resilience of supply chains and the economy by making greater use of secondary raw materials and improving resource efficiency. And it lowers the demand for primary raw materials. The circular economy also offers considerable additional and low-cost opportunities to decarbonise industry with technologies that are already available today. It has the potential to encourage the development of new technologies and business models, thereby creating more added value and boosting productivity throughout the economy. This gives rise to tremendous opportunities, particularly when combined with the rapid deployment of digital technologies. the circular economy can become a key factor driving the success of the German economy in international competition. We want to harness Germany's innovative strength to modernise the economy so that value is mainly created in circular processes and far fewer new resources are needed. The Federal Government has therefore undertaken to make economic processes more circular and resource efficient. The National Circular Economy Strategy (NCES) aims to drive this process forward.

According to the coalition agreement, the overarching goal is to reduce the consumption of primary raw materials and close material cycles. The strategy establishes the necessary medium- to long-term environmental and industrial policy framework to advance circular economy practices, in particular by defining core goals and specific measures. This charts the course and creates incentives for the development of the necessary technological innovations and new business models.

The NCES is guided by the principle of preserving the value of raw materials and products for as long as possible, using materials efficiently and keeping them in circulation for as long as possible. This will ultimately strengthen the resilience and innovative power of Germany as a centre for industry. A life cycle approach is essential to upholding these principles – starting with product design, production, consumption and logistics through to recycling, repairability and reuse. All stages of value creation are geared towards circularity in the process. This guiding principle is in line with the EU Circular Economy Action Plan and supports the goals of the German Sustainable Development Strategy. The NCES was developed in an extensive participatory process to create a broad basis for the transition to a circular economy. The strategy will also be implemented together with stakeholders from industry and civil society.

2. Tackling climate change, protecting the environment and capitalising on opportunities for value creation and competitiveness

Germany has committed to achieving net greenhouse gas neutrality by 2045. The circular economy is a key factor in achieving this goal, as well as in protecting the environment and biodiversity and thus our natural foundations of life. This is particularly true when it comes to decarbonising industry. Almost a quarter of Germany's greenhouse gas emissions come from the industrial sector. Most of these emissions stem from key industrial sectors during raw material extraction and the production and

conversion of intermediate products. In the chemical industry and in machine and vehicle manufacturing, this figure lies between 60 and 80 percent[2]. the circular economy in industry has the potential to reduce greenhouse gas emissions by around 30 to 50 percent by the year 2050 and to simultaneously increase added value[3]. An integrated approach to climate change mitigation and the circular economy can reduce avoidance costs per tonne of CO_2 for steel, concrete, cement and plastics by 45 percent[4] by 2045.

By closing material cycles for all types of raw materials – from construction materials to critical industrial metals – the circular economy makes a significant contribution to securing the supply of raw materials for our industry, can significantly lower Germany's reliance on imports in future and makes it possible to reduce critical dependencies on certain raw material suppliers. In a time marked by crises and wars, this will be crucial in making value and supply chains more resilient and strengthening Germany's competitiveness as a place to do business.

The increased use of circular economy practices can help industry achieve its climate targets faster, more effectively and cost-efficiently. Apart from conserving primary raw materials, carbon cycles, which capture carbon dioxide from industrial processes or from the atmosphere as a raw material, also contribute to reducing the use of fossil resources. A Carbon Management Strategy was developed for this purpose. Our NCES thus establishes the circular economy as a central pillar of climate change mitigation. In future, its contribution to reducing greenhouse gas emissions will be systematically integrated into national goals, models and action plans to fight climate change.

A circular economy presents tremendous economic opportunities. Economic and scientific studies impressively demonstrate its potential for innovation, value creation, new circular business models and security of supply. The Federation of German Industries (BDI) and the consulting firm Deloitte forecast an annual increase in gross added value in the German economy of 12 billion euros and the creation of 117,000 new jobs by 2030. McKinsey estimates the global market potential for circular consumer goods at 650 billion euros per year in the medium term (2030).

To tap this potential, producers must include the costs for future waste and recycling, as well as the costs for recovering the raw materials this waste contains, in their business calculations.

The NCES builds on Germany's industrial strength. "Made in Germany", a product label that traditionally stands for intrinsic value and durability, will gain new appeal as "Circularity made in Germany". A circular economy not only changes the nature of production and paves the way for new business segments, it also enables new forms of value creation and creates viable jobs for the future. The key to a successful economic policy lies in a clear and reliable framework that accelerates the necessary investments and innovations. By adopting the NCES, the Federal Government is creating this framework to ensure an economically successful, fair and socially just transition. Germany, as a hub for industry and technology and with its leading role in circular economy technologies, is well-positioned to further expand its technological leadership and become a global leader in the field of circular economy. This also presents an opportunity to ensure that new jobs are safe and humane from the outset and to set international standards with good labour practices.

Since key decisions are made at EU level, we are working in Brussels to ensure the successful implementation of the Circular Economy Action Plan. Product sustainability requirements should be

defined throughout the EU in dialogue with manufacturers. However, we also want to leverage the NCES to drive the global transition to a circular economy with the aim of protecting our natural resources, helping to keep temperatures within the 1.5 degree limit and expanding the markets for innovative technologies and business models in our industries. The circular economy must always be framed in the context of international trade relations and rules. It is important to ensure that extra paperwork is kept to a minimum for all measures and, in particular, to speed up market penetration of innovative, climate-friendly technologies.

3. Transformation goals and indicators

The NCES aims to make Germany climate-neutral, more competitive and economically resilient by 2045 and to achieve the goals of the German Sustainable Development Strategy. The NCES contains one guiding principle, three strategic goals to formalise this principle and indicators that are used to measure whether the central levers for a circular economy are being effectively harnessed. These form the basis for NCES implementation, monitoring and evaluation.

Guiding principle: Reduce primary raw material consumption

In line with the goals of the Germany Sustainable Development Strategy, the Federal Government's aim with the NCES is to create the framework for significantly reducing the quantity of primary raw materials used for consumption and investment in Germany, including the necessary upstream supply chains abroad, by the year 2045. To achieve this goal, the proposal of the UNEP International Resource Panel for a target under the UN Sustainable Development Goals (SDGs) to achieve an average intensity of raw material consumption of 6–8 tonnes per capita per year worldwide by 2050 serves as guidance. The guiding principle will be reviewed every five years, starting in 2030, with the involvement of industry, and adapted if necessary. The following will be considered in particular in the review:

- Changes in raw material demand, raw material costs and raw material availability.
- General material-specific conditions.
- Environmental, economic and social impacts of key measures.
- Raw material consumption resulting from necessary investments.

Primary raw material consumption will be quantified at national level using the raw material consumption (RMC) indicator. This will not entail any extra paperwork for companies or private households.

Goal 1: Close material cycles

The EU target of doubling the percentage of secondary raw materials in the total quantity of all raw materials used by 2030 will be addressed at national level and supported by measures in all major material flows (circular material use rate (CMUR) indicator). The prerequisites for this are sufficient

availability of recycled materials, their quality and consumer acceptance, as well as a supporting market analysis.

Goal 2: Increase the security of raw material supply and raw material sovereignty

In line with the EU targets set out in the Critical Raw Materials Act, the aim is for the EU's production capacities to be able to meet 10 percent of the demand for strategic raw materials in the EU and 40 percent of the demand for processed raw material products. The goal for the EU's recycling capacity is to meet 25 percent of the demand for strategic raw materials by 2030. The aim is for no more than 65 percent of any raw material to be sourced from a single third country. Germany supports these goals nationally with the NCES through effective measures. Our focus in particular is on raw materials that are strategically relevant for German industry.

Goal 3: Prevent waste

The aim is to lower the per capita volume of municipal waste by 10 percent by 2030 and by 20 percent by 2045 compared to 2020 levels. As part of a comprehensive circular economy, the NCES focusses on reducing waste volumes at the first waste hierarchy level. Reducing municipal waste by closing cycles can help tap valuable resources.

4. Introducing new technologies, facilitating investments and strengthening the economy

The transition to a circular economy requires technological innovations and investments that are initiated, quickly launched and scaled by the measures in the NCES. Research and development programmes will be designed to support ecosystems for innovations and test, pilot and scale technologies and business models. The start-up community, which is becoming increasingly important in the circular economy, will also play a major role. The focus will be on efficient product design, the use of digital technologies and biotechnology for the circular economy, lightweighting, resource efficiency in production and the various types of reuse and further use (reuse, repair, recycle). Rebound effects will also be considered. The potential of digital technologies, artificial intelligence (AI) and biotechnology will also be systematically leveraged in the process. This will be achieved through the following measures and initiatives:

- Application-oriented funding programmes for investments and research and development (R&D) to advance (leap) innovations and boost the competitiveness of German companies in the field of circular economy.
- A policy framework that provides planning certainty and the conditions for the necessary investments and long-term competitiveness.
- Initiative to train specialists in circular technologies, innovations and business models.
- Targeted measures to accelerate investments in circular economy, including reducing regulatory barriers to these investments.

- Push for investment and innovation together with the private sector: the government will establish a platform for circular battery design in collaboration with industry and scientists.

A law to improve the framework for testing innovations in regulatory sandboxes and to promote regulatory learning (ReallaboreG) will also be used to stimulate investment in the circular economy and unlock the potential for new technologies. The circular economy is already incorporated into many R&D and funding programmes. In addition to the further development of existing programmes, the NCES aims to strengthen and deepen interministerial dialogue and cooperation between the federal government, the Länder (German federal states), companies and civil society to optimise the programmes, thereby significantly increasing the impact of the available funds for circular economy.

5. Fully leveraging the potential of digital technologies

Digital technologies are a central factor in the success of the transition to a circular economy. They increase transparency, improve process optimisation and enable new forms of collaboration between companies. In a circular economy, physical material flows must be represented by digital data streams. Companies will become part of dataspaces that support the circular economy. Industrial competitiveness and technological leadership will be increasingly defined by the ability to organise and coordinate data relationships. Digital technologies can contribute to closing cycles and increasing resource efficiency. They enable new circular economy business models, such as platforms and product-as-a-service solutions. The broad portfolio of Industry 4.0 solutions creates new opportunities for optimising industrial processes at all stages of production, but also for waste management, collection logistics and sorting and remanufacturing systems. To tap the potential of digital technologies, targeted measures are needed:

- Promotion of the Digital Product Passport (DPP) as a central tool: work at EU level to ensure that the DPP is enshrined in all important EU product regulations by 2030 and that the conditions for its practical use are created.

- The Digital Product Passport initiative is designed to promote DPP lighthouse projects in key sectors with particularly high relevance in terms of environmental protection and occupational safety. Sectors of particular importance to the circular economy that are predominantly made up of small- and medium-sized enterprises are set to benefit.

- Work at EU level to provide targeted information to consumers on all aspects of the circular economy – from product attributes through to repair options and shared use.

- New digital services promote, facilitate and strengthen consumption of durable products, repair (for example by providing instructions) and second-hand use (for example on user-friendly platforms). This will provide a wide range of affordable products and services for consumers.

6. Realigning product and system design

The course for durability and recyclability will be set early on in the product development and design stage. This is where the promise of quality and the intrinsic value of “Made in Germany” can come into

play. The principles of design for circularity are the minimal use of raw materials, modularity, durability and repairability. The targeted use of digital technologies can also contribute here. One example is product-as-a-service solutions, which are based on product rental and offer maintenance, repair and upgrade services as part of their business model.

Specific measures and initiatives – with a view to the internal market in large parts of the EU – include:

- Ambitious and rapid further development of EU product regulations as part of the Ecodesign Directive and the new Ecodesign for Sustainable Products Regulation. The focus is on quality, longevity, material efficiency, non-toxic substances wherever possible, durability, modular design, repairability, remanufacturing and recycling.

- Rapid adoption by the European Commission of suitable circular economy provisions for all product groups covered by the Ecodesign Regulation, as well as support for the European Commission work programme, which is currently being developed.

This will be accompanied by targeted research to improve knowledge about recyclable and durable products.

7. Significantly increasing the use of recycled materials for key material flows and product groups

Closing material cycles using recycled materials that contain as few contaminants as possible is an important component of the circular economy. The European Union is increasingly focussing on minimum recycled content targets, for example in the construction, automotive and packaging sectors. For example, the new European Battery Regulation (EU) 2023/1542, which entered into force in mid-August 2023, stipulates minimum shares of recycled content for certain metals. Similarly, the proposed EU Packaging Regulation (procedure (2022/0396)) sets mandatory targets for minimum recycled content in plastic packaging[5]. The aim is to establish and expand well-functioning markets for secondary raw materials. The Federal Government is striving to create a level playing field with primary raw materials, stable sales markets for secondary materials and cost-efficient solutions in the EU. To this end, dynamic and reliable material- or product-specific requirements for minimum recycled content are an important framework for investments and new technologies.

In the medium to long term, minimum targets for recycled material content at EU level will be further developed and supported with the involvement of industry. Minimum requirements for recycled materials must be market-oriented, reliable and not overly bureaucratic, they must send clear market signals and ensure a safe return on investment. The prerequisites for this are sufficient availability of recycled materials, their quality and consumer acceptance, as well as an accompanying market analysis that also evaluates possible impacts of minimum targets for recycled content on competitiveness.

Examples include:

- Other minimum EU recycled content targets in plastic products in addition to the existing regulations (Packaging Regulation, Single-Use Plastics Directive) with the aim of gradually increasing the share of post-consumer recycled content[6] coupled with an increase in sorting and recycling capacities.

- Minimum EU requirements for the use of recycled materials in plastics production, broken down by material type (polymer-specific requirements).

- Material-specific EU targets for the use of recycled content in components with technology metals (similar to the EU Battery Regulation).

To achieve recycled content targets efficiently, it must be determined whether to introduce an EU certificate trading system in the interest of cost efficiency. This would allow companies that exceed their targets to sell certificates to companies where switching to secondary materials would involve higher costs.

In parallel to this kind of legal framework, we also want to improve the general supply-side conditions for increasing sorting and recycling capacities, for example by eliminating barriers to the use of recycled materials through standardisation. The existing EU targets to increase the use of recycled materials in Europe are the benchmarks here, in particular the target of doubling the circular material use rate or the target of the EU Critical Raw Materials Act (CRMA) to cover 25 percent of strategic materials with recycling capacities in the EU.

8. Setting standards and norms for the circular economy

Standards and norms make methods, processes, products and services reliable and comparable and define basic requirements for them. They are essential to the quality and consumer acceptance of circular products – both nationally and internationally. This is particularly true for secondary raw materials. Setting standards also creates better opportunities on international markets and boosts competitiveness. Given their relevance to industrial policy, the global integration of value chains and the German industry's reliance on exports, it is therefore extremely important that standards are set at European and international level and that national stakeholders participate in standardisation processes. An important foundation was laid with the Standardization Roadmap Circular Economy, which DIN, DKE and VDI developed together with experts from business, science, politics and civil society.

The following measures, in particular, will be taken to improve standardisation for the circular economy:

- Ensuring that the circular economy is prioritised for standardisation. This applies to the German Strategy Forum and the European Forum for Standardisation. The goal is to complete the work identified in the Standardization Roadmap Circular Economy and subsequent standardisation activities within the next two to five years.

- Driving forward important action areas, including: standardisation for the DPP and Industry 4.0 to integrate the circular economy; maintenance of products and necessary information; product-specific support for horizontal standards in functional stability, repairability, reusability, remanufacturing and recyclability of the DIN EN 4555x series for electrical products; strengthening reuse systems through standardisation; quality standards for the scalable use of high-quality secondary raw materials, especially for plastics; standards for determining the durability of textiles; requirements for the product properties of reused components.

- Supporting strategic participation of German experts in European and international standardisation processes, ensuring links to existing standardisation bodies. Support will be given for incorporating the perspectives of our partners in the Global South, and those of SMEs and NGOs. International standards will be developed in the newly established industry-independent committees, including CEN/TC 473 Circular Economy or CEN/CLC/JTC 24 Digital Product Pass, as well as the existing ISO/TC 323 Circular Economy.

9. Developing circular economy legislation

The NCES will also contribute to the further development of the instruments of circular economy legislation to increase waste prevention and recycling. To this end, the Federal Government is pursuing a range of legislative projects at national and European level. Important projects include:

- More high-quality recycling of waste electrical and electronic equipment to keep valuable resources in circulation: an amendment to the German Electrical and Electronic Equipment Act (ElektroG) will make it easier for consumers to return their waste appliances to retailers. This also includes providing much better information to consumers.

- Better use of the recycling potential of commercial waste: an amendment to the German Commercial Waste Ordinance (GewAbfV) will make the regulation even stricter and easier to enforce, improve official monitoring of the separate collection of commercial municipal waste, as well as construction and demolition waste, and ensure that the minimum requirements for recycled content are met during preprocessing.

- Avoiding packaging, establishing uniform criteria for the recyclability of packaging and setting minimum requirements for recycled content: this will take place as part of the final regulation on packaging and packaging waste to be adopted at the end of the year.

- Keeping mineral substitute building materials in circulation more effectively and promoting their use as high-quality, quality-assured recycled building materials: an End-of-Waste Ordinance for Mineral Substitute Building Materials will contribute to the goal of increasing the use of secondary raw materials. This will regulate the prerequisites for mineral substitute building materials to lose their status as waste. This product status increases marketability and supports the broader use of substitute construction materials, for example in building construction. It must be ensured that people and the environment are protected in the process.

- Increasing the quantity and quality of separately collected organic waste: biowaste recycling makes an important contribution to climate change mitigation and resource efficiency. A review is being performed for the new version of the Biowaste Ordinance to determine whether specifications and criteria for the separate collection of biowaste can be defined with the aim of increasing the quantity and quality of separately collected biowaste.

- Prioritising recycling of untreated or slightly treated wood as a material: the planned new version of the Waste Wood Ordinance (AltholzV) will prioritise the reuse of untreated or slightly treated wood for material purposes.

- Ensuring that the European Emissions Trading System (ETS) also explicitly includes circularity, thus creating an incentive for the economically viable use of carbon dioxide.

In future, the plan is to further develop the instrument of extended producer responsibility (EPR), which emerged from the polluter-pays principle and is established for the waste streams of packaging, used electrical/electronic devices, end-of-life vehicles, waste batteries and single-use plastic products. To this end, existing EPR regulations will be further developed with a view to creating incentives for recycling-friendly design. This approach will be pursued primarily at European level due to the EU internal market.

10. Using public procurement as a lever

Public procurement is a key demand-side lever for the federal, state and local governments to promote the circular economy. The cheapest option in the short term is not always the most economical in the long run. Taking into account the results of the public procurement reform package, the concept of circular procurement will be formalised to fulfil the public sector's function as a role model and to leverage the market potential. This will be tackled together with the Länder for all government procurement processes at federal, state and local level. By 2030, all legal requirements will be consistently and effectively geared towards circular procurement. The following measures in particular will contribute to these aims:

- Taking into account the results of the public procurement reform package, preparations are under way to issue a new General Administrative Regulation on the Procurement of Climate- and Environmentally Friendly Services (AVV Klima and Umwelt): it will replace the AVV Klima and the Timber Procurement Policy and bring together requirements that have not yet been defined or have been defined elsewhere. This will involve a review of how the requirement to take account of life cycle costs as an award criterion for determining the most cost-effective tender, which is already included in the AVV Klima, can be better reflected in procurement practice.

- Drafting of binding guidelines for resource efficiency and circularity for planning and construction services procured by the Federal Government as part of construction projects: publicly procured construction services will take resource efficiency, durability and reuse or repurposing into account as early as the needs assessment stage and incorporate them into the planning process.

11. Designing resource-efficient and circular buildings and building materials

The construction and building sector accounts for by far the highest resource consumption in Germany in quantitative terms. The construction sector is therefore of central importance for the circular economy. The guiding principle, wherever possible and economically viable, is the continued use, conversion and expansion of buildings and structures. It is necessary to increase building refurbishment and conversion with the aim of preserving buildings as a whole. Construction waste and components must be collected and recycled separately for high-quality recycling. Where possible and economically

viable, material recycling will take priority over backfilling. New buildings must be designed from the outset to be durable, easy to renovate, low in harmful substances and their components easy to recycle. In addition, climate-friendly, resource-efficient building materials, including renewable raw materials and recycled building materials, will be used to a much greater extent. Cost increases for building and housing will be avoided. To this end, inefficient standards will be eliminated and possibilities for reducing costs will be rigorously leveraged, for example by using local, environmentally friendly building materials, innovative technologies, digital technologies and efficient planning strategies.

The Fedderal Government must pursue the following measures to implement these guidelines:

- Continued dialogue with the Länder on how to facilitate the expansion and renovation of existing buildings and how dismantling can be taken into account in the planning stage.

- Fully exploiting the potential of digital technologies. The introduction of a digital resource passport for buildings will help achieve this aim. It will document the materials and products used and show which natural resources were used as primary and secondary raw materials. It will serve as a basis for efficient resource use and circularity in the construction and building sector in future. It will provide information on which components can be reused and how dismantling can be carried out without causing damage. The data on existing structures will also be used to enable more urban mining.

- Greater use of innovative and low-emission building materials such as recycled concrete, cement substitutes or building materials made from plant material such as paludiculture plants or hemp.

- Increased use of wood for building as part of the Federal Government's timber construction initiative.

- Development of material-efficient and recyclable building materials by implementing the Federal Government's Lightweighting Strategy.

- More research funding for climate- and environmentally friendly and modular construction, as well as for sorting and recycling technologies.

12. Promoting consumption of durable goods

Many goods, such as small electronic devices, furniture and clothing, are currently only used for a short time and then quickly replaced. This requires resources and results in a high volume of packaging and transport. For this reason, a framework must be created that favours the long-term use of high-quality products. The NCES supports the goal of the German Sustainable Development Strategy to continuously reduce the use of raw materials for private household consumption by 2030 (compared to 2010). Important measures include:

- Reduction in the amount of packaging material for shipping products bought online by improving environmentally friendly reuse systems for shipping.

- Suitable incentives to reduce returns in online retail without restricting the right of withdrawal.

- The EU directive on a “right to repair” is an important new EU framework that will be effectively implemented together with our European partners in the interest of the environment and consumers.

- Support for sharing and rentals: this includes business models such as tool hire, furniture for temporary housing, rental shops, clothing hire, etc. Support will also be given for creating financial incentives for the implementation of circular product-as-a-service models that reduce resource consumption.

13. Creating economic incentives, improving financing

The aim is for economic and market-based instruments to create incentives that favour closed cycles in production and consumption. Investments will be stimulated and the capital markets mobilised for the transition to a circular economy. The following measures, among others, are intended to contribute:

- The Federal Government has tasked the Kreditanstalt für Wiederaufbau (KfW) with setting up a raw materials fund to support innovative and sustainable raw materials projects both abroad and in Germany. This can involve the extraction, processing and recycling of critical raw materials. The Federal Government wants to lower its dependence on critical raw materials. These are of particular importance for the technologies and uses required for the green and digital transitions, as well as for the aerospace, security and defence industries. The raw materials fund is intended to ensure diversified financing for projects along the entire value chain of critical minerals.

- Government start-up funding for research and development, as well as for pilot systems and processes for the recovery of critical raw materials and technology metals.

- The KfW Development Bank will increasingly act in future as an innovation and investment bank as well as a co-venture capitalist for companies in all areas of the circular economy.

- If there is insufficient collateral for loans for circular business models, a review will determine whether to use transformation guarantees to bridge any remaining gaps in collateral.

- Financing of investments and start-ups needs a clear basis for evaluation. To this end, sustainable evaluation and rating methods for investments in circular economy should be developed or improved.

14. Promoting the circular economy in Europe

With an extensive set of rules and overarching strategies for the extraction and use of raw materials, production and waste flows, the EU sets a framework for the actions of the Member States. In addition to the EU Circular Economy Package, the EU Circular Economy Action Plan (CEAP) should be mentioned here, as well as the Critical Raw Materials Act (CRMA), which aims to secure critical raw materials in Europe through new recycling requirements, for example. All initiatives contribute to achieving the goals of the European Green Deal.

With the NCES, the Federal Government supports the goals of the CEAP, such as the legally binding targets for waste recycling with specific targets for certain materials. The goal of doubling the share of materials that are recycled in the EU and returned to the economy by 2030 will be adopted and enshrined as an overarching national goal by the NCES. European processes will not be duplicated, but national scope for action used instead. At the same time, the NCES describes Germany's central positions for strategic measures to further develop the circular economy at European level.

The NCES aims to make Germany a pioneer in circular economy and provide impetus for the further development of the EU-wide framework. At EU level, the introduction and further development of the following measures in particular are essential:

- Ecodesign product standards on circularity and a European Commission work programme with this aim.
- Improved access to financing for the transition to circular economy at EU level. This applies in particular to technologies that address the beginning of the value chain (resource efficiency, product design).
- Definition of standards for circularity in the relevant standardisation bodies at EU level.
- Review of the introduction of separation requirements for strategic metals (e.g. rare earth metals) from waste.
- Targeted further development of product responsibility schemes.
- An end to landfilling of untreated municipal waste throughout Europe.
- Providing practical information on occupational safety and health for activities involving critical raw materials that must be designed to be safe due to their carcinogenic effects, including information on technical rules for hazardous substances, information from the German Social Accident Insurance (DGUV) and at European level on initiatives such as the Roadmap on Carcinogens.

15. Fostering global cooperation

For many years, the Federal Government has successfully advocated for resource efficiency and the circular economy to be leveraged internationally to solve the global environmental crises, both at the G7 level with the G7 Alliance for Resource Efficiency (ARE) and at the G20 level with the G20 Resource Efficiency Dialogue. In the international climate negotiations, Germany is committed to ensuring that the considerable, but as yet largely untapped, climate change mitigation potential of resource efficiency and circular economy is given greater consideration. These processes are being further advanced. The following measures are also important at international level:

- Establishment of a circular economy as a lever for international climate action and biodiversity conservation, adequate integration into climate and environmental negotiations and global advancement of the measures necessary for its practical implementation.

- Progress in raw materials and recycling partnerships in all parts of the world.
- Implementation of the goals of the G7 Berlin Roadmap with specific steps and formats.
- Promotion of the process of the G20 Resource Efficiency Dialogue (RED) work plan initiated under the Indian presidency in 2022.
- Strengthening of bilateral cooperation with key stakeholders, for example in circular economy dialogue with the People's Republic of China, Brazil, Japan, Indonesia and India.
- Support for the Federal Government's partner countries in the Global South as much as necessary and appropriate to help shape a global circular economy and, in this context, develop their own economies in the interest of a socially equitable and environmentally friendly transition in order to enable sustainable jobs and economic development.
- Support to ensure the negotiations on the UN plastics agreement come to an ambitious conclusion.
- More financing for circular economy measures, including through Multilateral Development Banks (MDBs) and the private sector, as necessary and appropriate.

16. Implementation of the NCES: Platform for circular economy, Roadmap 2030, monitoring, financing

The NCES formulates goals and measures for a resource-efficient circular economy and describes a path for transformation. The following steps are planned for implementation of the NCES:

- Establishment of a circular economy platform where the specific implementation of the NCES will be jointly planned with and supported by stakeholders and experts.
- Development of a Roadmap 2030 to specify in detail the projects and timetables outlined in the NCES.
- Establishment of a monitoring and evaluation system that reports on the implementation status of the goals and measures.
- Decisions on financing as a basis for the implementation of measures.

Implementation of the NCES requires a joint, regular dialogue between the federal, state and local governments, industry, civil society, cultural and scientific organisations on the progress made in achieving goals and implementing measures, but also on further necessary steps or the adaptation of specific instruments. The circular economy platform is intended to provide a forum for this dialogue.

When implementing the NCES, the Federal Government's budgetary and financial policy requirements as well as the available funds must be considered.

1. Transformation towards a resource-efficient circular economy

1.1 The circular economy is key to transforming the economy as a whole

The German economy is to become climate-neutral by 2045. This is a necessary prerequisite for safeguarding the foundations of life, ensuring the long-term competitiveness of the German economy and maintaining prosperity. In 2022, Federal Chancellor Olaf Scholz launched an Alliance for Transformation. The aim was for the Federal Government to engage in dialogue with business, social partners, civil society and the scientific community about how to achieve social and environmental change – a transformation – in Germany. A circular economy was identified as a key element in this transformation and was discussed at the fourth high-level meeting on 23 January 2024. The National Circular Economy Strategy (NCES) sets out how the Federal Government intends to create the framework for a resource-saving circular economy and harness its potential for sustainability and creating new value.

1.2 Current raw material use and triple planetary crisis

Current raw material use

Climate change, biodiversity loss and environmental pollution are threatening the foundations of human life in many areas. Current raw material use is one of the main reasons for this. The United Nations International Resource Panel (IRP) estimates that the extraction and processing of material resources accounts for over 55 percent of global greenhouse gas emissions, around 40 percent of air pollution[7] and more than 90 percent of biodiversity loss.[8] Reducing the demand for raw materials can therefore help counteract the triple planetary crisis. A resource-saving circular economy is essential for this. However, only if solutions from all relevant policy areas, such as energy and transport, are complemented by a comprehensive and consistent circular economy approach can these three crises be successfully addressed.

For Germany, the Federal Statistical Office reported that in 2020, the extraction of raw materials from the environment and imports of raw materials totalled 1,287 million tonnes. In addition, 613 million tonnes of semi-finished and finished goods were imported. In total, 611 million tonnes of material remained within the domestic economy in Germany after accounting for all resource and goods flows, their transformation within the economy and the resulting emissions.[9]

Current resource use presents significant challenges. Driven by the growing global population and rising levels of prosperity, global material extraction[10] increased from around 30 billion tonnes in 1970 to approx. 107 billion tonnes in 2024.[11] The global average per capita demand for materials rose from around 8.4 tonnes in 1970 to an estimated 13.2 tonnes in 2024. This sharp increase in resource use is leading to a significant rise in associated environmental impacts, making an urgent shift towards reducing resource demand necessary. There are major differences between high-income countries and poorer nations: the demand for raw materials in high-income countries is about 13 times higher than in

low-income countries.[12] Reducing resource demand in high-income countries is essential in enabling a good quality of life for all within planetary boundaries.

To develop suitable options for reducing resource use in the German economy, material flows must be examined. Looking at the sources and pathways of the resources used in Germany, three key observations stand out (Fig. 1):

- Germany imports many material resources and exports many goods. In terms of total material flows, imports are dominated by fossil raw materials. Although imports of strategic and critical metals are small compared to base metals such as iron and steel, copper and aluminium, they are of central importance, for example in the context of the energy and mobility transition. A significant share of fossil raw materials and biomass are used for energy purposes and are therefore no longer available for circularity.

- A large proportion of resources in Germany are used in buildings, infrastructure and durable consumer and capital goods, where they are locked in for the long term. This human-made resource stock, known as the anthropogenic material stock, is expanding by around 600 million tonnes annually (see above) and is a secondary source of raw materials that can be systematically managed through urban mining; unlocking its potential is crucial. However, large quantities of raw materials are also used for the manufacture of short-lived products, such as packaging.

- The share of the total amount of material used in Germany that is accounted for by secondary raw materials (the circular material use rate or CMUR) is relatively low compared to other strong economies and currently amounts to around 13 percent.[13]

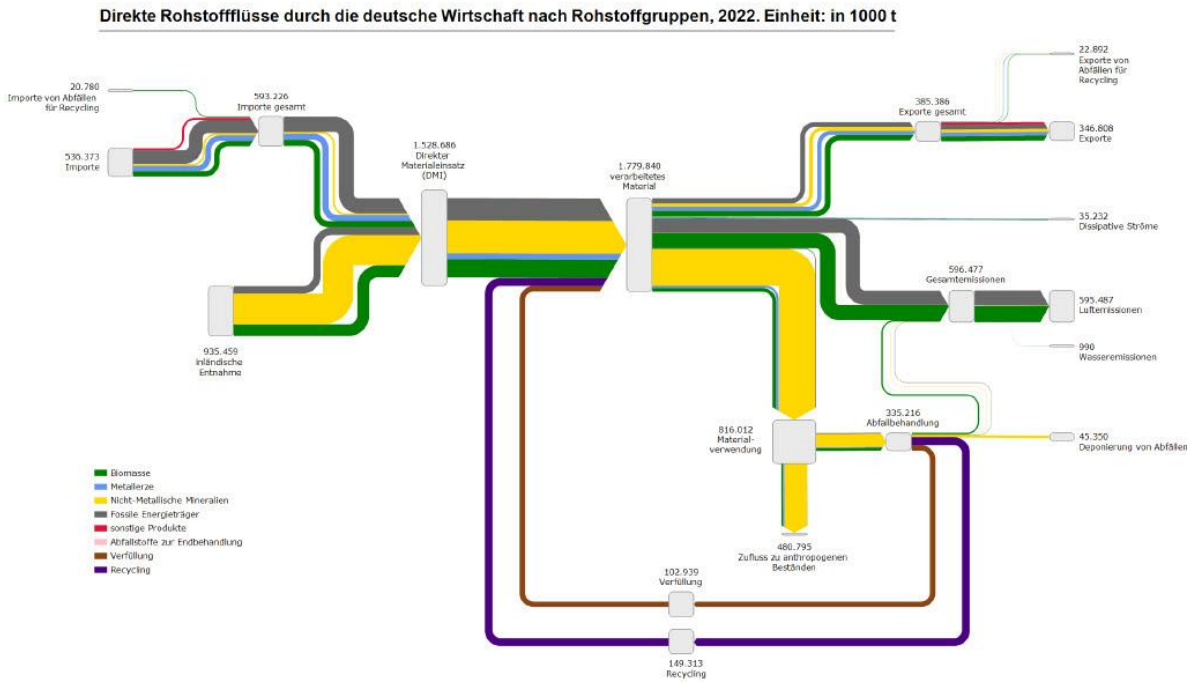

Figure 1[14] Direct material flows through the German economy by raw material category, 2022. (Source: German Environment Agency, Resources Report 2026, forthcoming.)[15]

In Germany, the total mass of primary raw materials required for private and public consumption, as well as investments in equipment and construction, amounted to approximately 15.3 tonnes per capita in 2021, measured as raw material consumption (RMC – primary raw material use for consumption and investments, also known as the material footprint).[16] This figure takes into account the raw material equivalents of foreign trade.[17] [18] This material footprint is relatively high by international standards[19] and has not shown a clear downward trend since 2010 (Fig. 2).

An important metric for assessing the sustainability of raw material use is the decoupling of environmental impacts and economic growth, in other words, whether raw material demand and environmental impacts increase at the same rate as economic growth (no decoupling), at a slower rate (relative decoupling), do not increase at all or even decrease (absolute decoupling). In Germany, absolute decoupling of economic growth and raw material use, along with the associated environmental impacts, is defined as a policy goal in the German Sustainable Development Strategy (DNS) and is also central to the German Resource Efficiency Programme (ProgRess).

To date, no clear absolute decoupling of primary raw material use for consumption and investments (RMC) from economic growth, measured by gross domestic product, has been observed (see Fig. 2).[20]

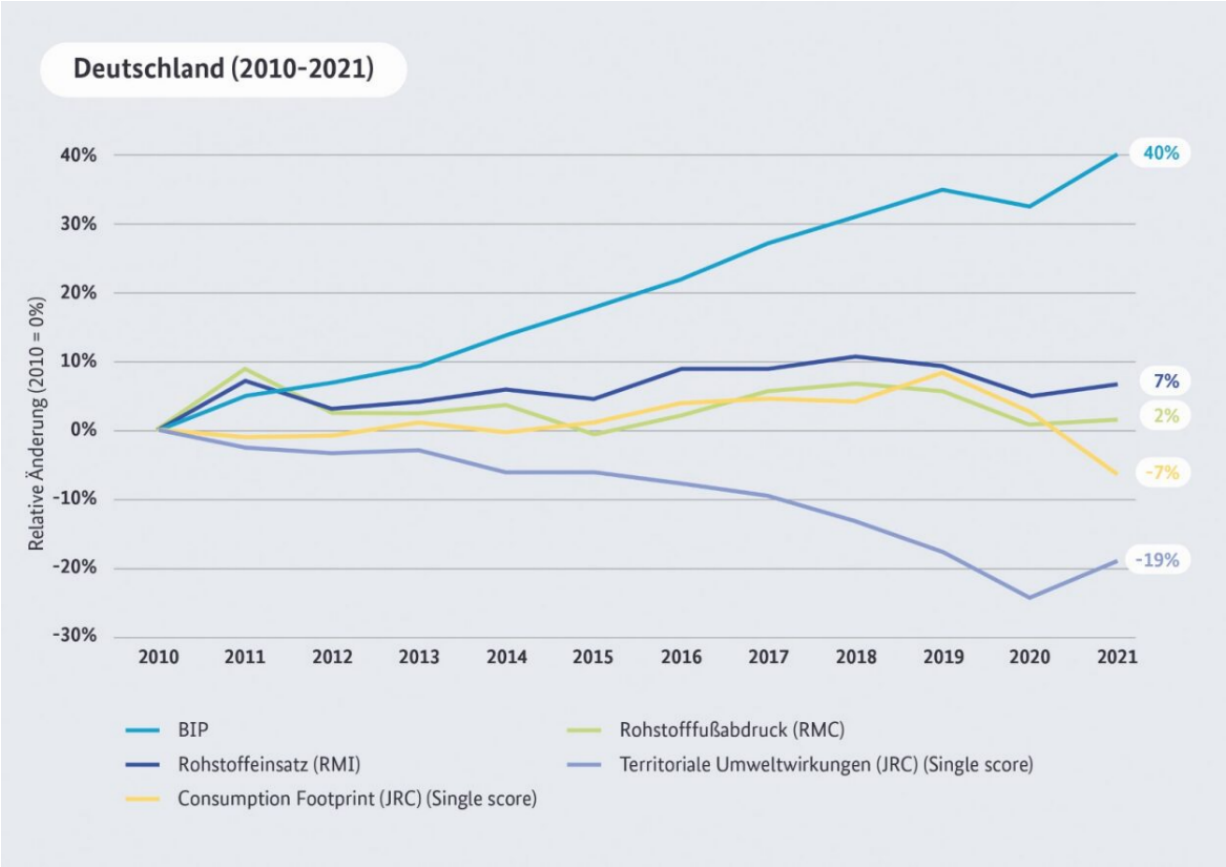

Figure 2 Economic growth, raw material input, raw material consumption and environmental impacts[21] (domestic and footprint) over time. (Source: Destatis 2024[22] and Joint Research Centre (JRC) 2024)[23]

1.3 Vision of a circular economy

In view of the challenges described in Section 1.1, the Federal Government aims to achieve a circular economy by 2045. The NCES describes the transformation pathway and is guided by the following vision:

In 2045, the idea of circular economy shapes **economic thinking and action**. Thanks to circularity, the German economy has expanded and secured its technology leadership and global market position. Companies design circular, durable and easily repairable products, which are sold using new business models. Each of the raw materials used is returned to a specifically tailored cycle at the end of the product's life. Only minimal amounts of waste are produced. Fossil raw materials have largely been replaced by sustainable raw materials. All major markets are dominated by the demand for durable products that can be flexibly adapted to new requirements. Companies implement innovations, for example through modular product designs and software updates, ensuring that product longevity and short innovation cycles complement each other. The sale of products is supplemented with rental models, in which customers use modern products, and maintenance, repair and take-back at the end of use are part of the service. It is cost-effective for companies to manufacture products with minimal material input and long lifespans, and for consumers to use these products for a long time and have them repaired when needed.

Circularity is a guiding principle in **product design**. Products are designed to be resource-efficient, contain minimal pollutants, and have a long service life, using recyclable raw materials and substances. Components can be replaced and software updates installed. After the first use phase, products and components are reused (for example, through repair) or prepared for reuse and made available for another use phase. Components and materials that can no longer be used are recycled to a high standard. Other forms of recovery, particularly energy recovery and waste disposal, are limited to waste that requires the safe removal or destruction of pollutants and contaminants, where reuse or material recovery is not feasible, thus making such cases an exception in quantitative terms.

Material cycles are largely closed, and there is a stable market for recycled materials. The use of recycled content (secondary materials recovered from waste) with minimal pollutants in the production of new products is the standard. Secondary materials with minimal pollutants are also recovered on a large scale and at stable prices, including through the targeted management of anthropogenic stocks (urban mining). International markets for secondary materials have led to investments in sophisticated collection and take-back schemes and to advancements in recycling technologies. Recycling technology that is "Made in Germany" contributes to the security of raw material supply for the European internal market. Where new raw material input (RMI) is required in production, primary raw materials that are as sustainably sourced as possible are used. The demand for primary raw materials in Germany has fallen significantly as a result of this and in conjunction with the energy, mobility and food transitions. The negative social and environmental impacts associated with raw material extraction have noticeably decreased, and it is ensured that secondary material recovery poses minimised risks to employment.

Digitalisation is a well-established enabler of the circular economy. Production processes are digitalised and provide product-specific data that can be shared, processed and modified along a transparent value chain. Traceability of materials is guaranteed. There is a high degree of transparency thanks, for instance, to the mandatory exchange of information on product content, repair and maintenance

information, environmental impacts, etc. within the value chain, while upholding antitrust limits and implementing open source solutions. This high level of transparency leads to decisions on the design, use, repair and recycling of electrical and electronic devices and information and communication technology (ICT) that are suitable for the circular economy.

Companies (including small and medium-sized enterprises or SMEs) are well informed about all technological options for resource efficiency and circularity and have the necessary qualifications. On this basis, they plan investments and continuously improve their production processes.

The most important material flows are circular, for instance in construction. Priority is given to the conversion, expansion and continued use of buildings and structures. Where necessary, this is supplemented by new builds designed and constructed in line with circular economy principles and climate-friendly standards. The building stock constructed from 2030 onwards is designed sustainably and in line with circular economy principles, with digital documentation. Embodied emissions arising from the production and maintenance phases are reduced as far as possible. The flexible conversion and continued use of buildings enables housing solutions adapted to different life stages as well as optimal adjustments to changing requirements for office and commercial spaces. The trend of a steady increase in soil sealing has been reversed. Resource-efficient construction methods are standard in building construction and civil engineering, including the use of renewable raw materials. When buildings are dismantled, recovered components are reused for as long as possible. The anthropogenic stock is an important source of raw materials for the construction industry. Partner countries of German development cooperation contribute to circular economy. Germany, the EU and other partners have supported them in their transformation efforts. Partner countries that were previously dependent on raw material exports have diversified their economies and invested in sustainable economic sectors. Germany has supported its partners in leveraging the potential of the circular economy, for example through economic and industrial policy advice, cooperation and capacity building. The necessary financing options are adapted to the needs of public and private actors in the partner countries. They have received support in developing the required resource-efficient infrastructure.

1.4 Contribution to climate action and decarbonisation of the economy

To fulfill its commitment to the Paris Agreement on climate change, Germany legally enshrined its climate targets in the Federal Climate Action Act (*Bundes-Klimaschutzgesetz*, KSG) in 2019, including – following an update of the KSG – the goal of achieving greenhouse gas neutrality by 2045.

This goal cannot be achieved solely through energy savings and the transition from fossil fuels to renewable energy in the energy, transport, industry and building sectors, but will also require an accelerated shift towards a circular and climate-friendly economy in Germany.

The energy and resource transitions must be closely aligned: globally, more than half of all greenhouse gas emissions stem from the extraction and processing of raw materials.[24] In Germany, the industrial sector accounts for almost a quarter of greenhouse gas emissions, around 50 percent of which are attributable to the production of steel, concrete, cement and plastics.[25] Across the economy, synergies can be leveraged internationally by combining the energy transition and the resource transition to

achieve a truly circular economy. Thanks to the circular economy, industry can be decarbonised more quickly, securely and cost-effectively.[26] The specific decarbonisation potential for the industrial sector alone – whether in Germany, Europe or globally – amounts to approximately 30 to 50 percent by 2050, if all ten R-strategies are systematically applied.[27] The R-strategies cover the entire life of a raw material or product, from resource extraction to product use and end-of-life. Their overarching goal is to reduce the consumption of primary resources and promote the use of secondary raw materials (see Section 3.1).

The circular economy has enormous potential for climate change mitigation. However, this potential is not reflected in the greenhouse gas emissions inventory reports submitted under the United Nations Framework Convention on Climate Change (UNFCCC). In the source category on "Waste and Waste Water" (CRF – Common Reporting Format – 5), only direct emissions are reported which arise directly from waste treatment in landfills or from biological treatment processes of waste and wastewater. The very relevant greenhouse gas reductions that arise through circular economy practices in areas such as energy and industry are not included in this category to prevent double counting. As a result, the actual carbon dioxide (CO_2) reduction potential of the circular economy is not adequately conveyed in climate reporting. A study commissioned by the Federal Ministry for Economic Affairs and Climate Action (BMWK) on the climate action potential of the circular economy (*Klimaschutzpotenziale der Kreislaufwirtschaft*)[28] provides a differentiated analysis showing that recycling already achieves annual greenhouse gas savings of around 60 million tonnes. Germany's circular economy and waste management sector are therefore already reducing greenhouse gas emissions by at least 100 million tonnes compared to the 1990 baseline. If the full potential of the circular economy is leveraged at all levels, an additional climate change mitigation potential of around 80 million tonnes of CO_2 equivalent (CO_2-eq) could be achieved by 2030, including around 35 million tonnes in the metal production, chemicals and cement sectors.

Decarbonising the economy and achieving greenhouse gas neutrality requires a strategic and long-term transition of procedures and production processes. To trigger the necessary investments and drive transformation, reliable and stable frameworks, efficient fiscal policy approaches such as carbon pricing, regulations on targets, guarantees of origin and certificates, and targeted support for innovation are required. These measures incentivise changes in key technologies, innovative processes and collaborations. Stable frameworks not only encompass taxation issues but must also ensure sufficient scope for reinvestment and entrepreneurial risk mitigation, as well as fair market access.

For production processes, achieving a greenhouse gas-neutral economy will involve not only transitioning to processes based on renewable energies and raw materials and restructuring production processes, it will also require the transformation of entire value chains in line with circular economy principles. These value chains must preserve the physical qualities of the products and raw materials until the end of the use phase while remaining competitive. This demands sustainable, innovative product design geared towards the circular economy. In combination with circular economy concepts, a decarbonised economy can compete internationally if the necessary technologies can be scaled and the specific greenhouse gas reduction costs can be significantly reduced. Additionally, in many areas – such as the recycling of certain raw materials – these technologies have already reached an advanced stage of development. Circular economy can help accelerate the pace of transformation and achieve

medium- and long-term reduction targets. At the same time, the future commercialisation of these technologies in global markets offers the potential to create additional value in the medium and long term. Their scaling also leads to cost-cutting effects.

Studies indicate that combining circular economy principles with decarbonisation – rather than relying solely on the decarbonisation of primary production – could significantly reduce the abatement costs per tonne of CO_2 for steel, concrete, cement and plastics in the demand sectors of buildings, vehicles and packaging by 2045 (see Fig. 3).

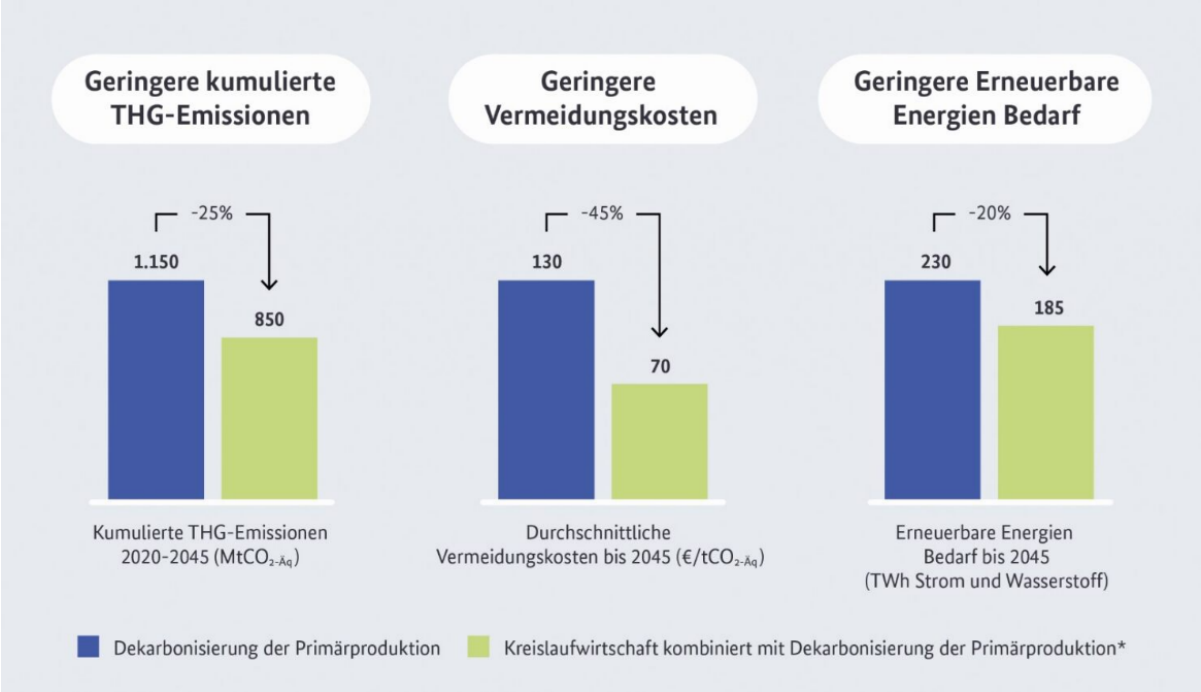

Figure 3 Mitigation potential of combining circular economy principles and decarbonisation of primary production in Germany. (Source: Agora Industrie and Systemiq, 2023)[29]

A key factor in accelerating the reduction of greenhouse gas emissions through a circular economy is the simultaneous activation of all R-strategies (see Section 3.1). This includes avoiding demand for existing and new products by providing the functions associated with the products in alternative ways, reducing raw material use in production (R0-R2), extending the lifespan of products or components (R3-R7) and improving recyclability (R8-R9). The transition to a greenhouse gas-neutral economy through circularity can be driven by various strategies, such as:

- One important lever is increasing resource efficiency in production (R2), for example, by minimising material losses, implementing lightweight concepts in product design or optimising material quality. Compared to improvements in industrial energy efficiency, material efficiency advanced much more slowly in the past, even though raw materials account for a significantly larger share of the costs in the manufacturing sector.[30] This slower progress is partly due to the diversity of raw materials used, requiring a higher number of individual measures. Additionally, many SMEs still lack a clear overview of the total costs associated with raw material consumption. Optimised product design that prioritises material efficiency and circularity can significantly reduce raw material and energy use,

thereby lowering greenhouse gas emissions. Given critical raw material dependencies and competing uses, there is an urgent need for action in this area (see Section 0).

- High-quality circularity (R8) enables energy-intensive primary raw materials to be substituted with recycled materials, which generally cause significantly lower greenhouse gas emissions during production. The share of secondary raw materials in German industry is only around 15 percent, partly due to the frequent lack of quality standards and requirements for recycled materials. However, this substitution has been common practice for many years in some industries, such as paper and glass manufacturing or steel and metal production. The potential CO_2 savings per tonne of material range from up to 80 percent for plastics to 95 percent for aluminium[31] (see Fig. 4):

Figure 4 CO_2 intensity comparison of primary and secondary production. (Source: Agora Industry, data from Wood Mackenzie and S&P Global Platts Analytics) [32]

This requires an absolute increase in the supply of high-quality recycled materials that have minimal pollutants and are as low-emission as possible. To achieve this, approaches must be developed for each action area that align with broader societal goals and take into account the global interconnectedness of German industry (see Section 2), such as the climate-friendly steel initiative outlined in the BMWK concept Lead markets for climate-friendly basic materials.

While the efforts of the steel industry to achieve greenhouse gas neutrality in primary production will reduce the CO_2 intensity gap between primary and secondary materials, the steel industry must still transition to a circular economy if it is to achieve greenhouse gas neutrality. By improving resource efficiency and optimising recycling, energy and raw material requirements can be significantly reduced compared to today's blast furnace-based steel production. For plastics, CO_2 emissions from the currently dominant end-of-life thermal treatment can be lowered – for example, by using bio-based and biodegradable plastics. These emissions account for around 50 percent of a plastic product's life cycle emissions[33] (see Section 4.10). To achieve this, technical processes such as additive separation must be continuously developed and scaled. In addition, environmental impacts should be factored into pricing more effectively so that secondary raw materials can better compete with primary raw materials (see Section 3.5).

the circular economy can make a substantial contribution to achieving climate targets. At the same time, the success of the overall transformation and, in particular, the energy transition will require additional raw materials as well as improved recycling technologies in many areas, for example wind turbines, photovoltaic systems and heat pumps (see Section 4.6).

In sectors where it is difficult or not possible to abate emissions, complete decarbonisation is a lengthy process or, based on the current technology, not possible due to insufficient technological maturity, high energy requirements or poor economic viability of climate measures. The potential of carbon capture and storage (CCS) and carbon capture and utilisation (CCU) technologies for achieving greenhouse gas neutrality is particularly evident in technically unavoidable CO_2 emissions. The aim of the Federal Government's Carbon Management Strategy (CMS) is therefore to establish a framework for the use of technologies to capture and transport CO_2, and either store it safely and permanently (CCS) or utilise it (CCU) in Germany. The necessary legal framework for this is defined in the updated Carbon Storage Act (*Kohlendioxid-Speichergesetz*, KSpG), the ratification of the London Protocol and the amendment to the High Seas Dumping Act (*Hohe-See-Einbringungsgesetz*, HSEG).

CCU refers to the use of captured CO_2 as a raw material to help meet industrial carbon demands without relying on fossil sources. Apart from several promising pilot projects, there are currently no large-scale industrial projects for the application of CCU technologies in Germany. Since CCU applications particularly lead to positive climate effects when they use renewable energy and ensure long-term CO_2 storage in products or closed-loop systems, the potential of CCU currently remains limited. In the future, however, with greater availability of green energy, CCU could play a significant role in the transformation of the chemical industry.

Carbon will remain indispensable even in a greenhouse gas-neutral energy and economic system, as it is necessary for applications such as the production of plastics and other chemical products. Defossilising the chemical industry will require a comprehensive strategy to ensure the industry's carbon requirements are met sustainably, incorporating aspects of the circular economy, sustainable biomass use, CCU and import opportunities. The strategy should also take into account the experience gained from the NCES, the National Hydrogen Strategy and the implementation of the CMS. Overall, it is crucial to establish reliable conditions for the use of biogenic carbon, including at European level.

The Federal Government considers the following cascade approach to meeting carbon demand to be appropriate, given the limitations of various approaches:

- Reduce production volume through alternative processes and materials and, particularly for plastics, material efficiency.
- Expand mechanical and chemical recycling.
- Prioritise use of available quantities of sustainable biomass for material applications and help meet carbon demand through CCU.

1.5 Contributing to a secure and resilient raw material supply

In addition to its contributions to climate change mitigation and resource conservation, ensuring a secure supply of raw materials for German industry is a key objective of the NCES. The resilience of supply chains has become a major challenge and risk management issue for many companies as a result of the COVID-19 pandemic, Russia's war of aggression in Ukraine and other disruptions in global supply chains. Since many areas of German industry are dependent on raw material imports, often sourced from only a few countries, diversifying sources is of strategic importance for a secure supply of raw materials. In this context, secondary raw materials are playing an increasingly important role.

This applies in particular to raw materials such as rare earths and lithium, which are considered critical to the entire EU economy and have strategic importance for key environmental, digital and defence technologies, such as wind turbines and electric mobility. The European Commission anticipates that by 2030, demand for rare earths will increase sixfold and for lithium even twelvefold.[34] At the same time, circular economy solutions for many of these critical raw materials are still in their infancy: only 6 out of more than 30 critical raw materials in the EU have a recycled materials use rate of over 20 percent, while most remain below 5 percent.[35]

The EU regulation to ensure access to a secure and sustainable supply of critical raw materials (Critical Raw Materials Act, CRMA) stipulates that by 2030 the EU should be in a position to extract 10 percent of its annual consumption of strategic raw materials, process 40 percent and generate 25 percent through recycling. The NCES will support the implementation of these goals through its measures. Furthermore, in some areas, the NCES serves as a national programme to enhance resource efficiency for critical raw materials and promote the increased use of secondary raw materials, in line with Article 26 of the CRMA.

At national level, the issue of securing raw material supply is primarily addressed in the Federal Government's Raw Materials Strategy, which describes recycling as one of three key pillars of raw material supply. The key issues paper on the planned revision of the strategy names a number of specific starting points, which are also reflected in the individual action areas of the NCES, such as securing the demand for recycled raw materials through public procurement or leveraging digitalisation to enhance circularity, for example, through digital product passports (DPPs).[36]

As part of the Federal Government's 2020 Raw Materials Strategy, the Dialogue Platform on Recycled Raw Materials was established under the direction of the German Mineral Resources Agency (DERA). This platform has developed concrete measures to ensure a secure and sustainable supply of secondary raw materials from recycling for German industry. These measures are also incorporated into the NCES action areas, for example, the promotion of recycling-friendly product design and the introduction of incentive schemes for the use of recycled raw materials. The platform's focus is on metallic raw materials and industrial minerals.[37]

It is essential that implementation of the NCES, takes account of and is aligned with the aforementioned national, European and global approaches to raw materials policy in order to establish responsible and sustainable raw materials supply chains.

1.6 Prosperity, competitiveness and sustainable economic growth

The Federal Government wants to create conditions that allow Germany to unlock the vast potential of the circular economy in securing prosperity, value creation and stable jobs in Germany and Europe. Various studies have concluded that the growth opportunities offered by the circular economy are considerable. Circular business practices could lead to an annual increase of 12 billion euros in Germany's gross value added by 2030.[38] Other estimates suggest a global market potential of 650 billion euros per year for consumer goods within a circular economy in the medium term (by 2030).[39] Thanks to its pioneering role in research, technology and industrial expertise, Germany has the potential to become the leading provider of circular economy technologies and circular production processes. The NCES outlines measures to harness the significant value creation and employment potential of such innovative technologies and business models – especially for SMEs. Products, services and technologies that support the circular economy offer key competitive advantages for German companies.

In the long term, positive effects on the labour market can be expected, with a shift away from resource- and energy-intensive sectors towards secondary production, recycling, repair and general services. This shift may also bring structural changes in employment, including with regard to income, qualifications and job profiles. These developments must be monitored closely in order to identify and address potential policy challenges at an early stage. The Federation of German Industries (BDI) and the consulting firm Deloitte forecast an annual increase in gross value added in the German economy of 12 billion euros and the creation of 117,000 new jobs by 2030.

The transition to comprehensive circularity will make the German economy better prepared for the future. The continuous structural transformation required by 2045 should be accompanied by social policy measures to ensure that the resulting adjustments and benefits are distributed fairly across society. In addition, the necessary conditions must be created to ensure that sustainable consumption is and remains affordable for all consumers. Innovative solutions such as prioritising use over ownership and repair over disposal pave the way for new business models and can reduce the burden on consumers.

The International Resource Panel has forecast that low- and middle-income countries could particularly benefit from an ambitious approach to resource policy if they implement a broad range of measures to improve resource efficiency, decouple economic growth from environmental destruction and promote sustainable production and consumption. This would lead to economic growth of around 10 percent on average while also reducing global resource extraction by 47 billion tonnes annually by 2060. Accordingly, a global circular economy presents an opportunity for Germany's development cooperation partner countries to pursue sustainable economic growth and achieve their climate and environmental goals.

1.7 The NCES as a framework

The Federal Government coalition partners have agreed to draw up a National Circular Economy Strategy that will consolidate existing raw material policy strategies. The Strategy will provide a framework that links up goals and measures relating to circular economy practices and resource

conservation from all relevant strategies. This approach will harness synergies while also identifying any conflicting objectives and proposing solutions. At the same time, the strategies that contribute to the goals of the NCES need to remain independent. Strategies relevant to raw material policy include the German Raw Materials Strategy mentioned in Section 1.5. The latter strategy establishes the use of secondary raw materials as a central pillar of sustainable raw material supply. The objectives and measures of the German Resource Efficiency Programme (ProgRess) have been incorporated into the NCES, along with additional resource efficiency measures. Other key pillars for the circular economy include: the National Bioeconomy Strategy (NBÖ Strategy, objective is to sustainably extract and use biological raw materials, as well as biological and biotechnological processes), which aims to achieve a circular bioeconomy and focusses on the natural circularity of biogenic resources; the Federal Government's Lightweighting Strategy, which aims to improve circularity and recyclability in lightweighting and harnesses the potential of material-efficient, sustainable lightweight technologies to conserve resources and promote climate action; and finally, the Carbon Management Strategy, which focusses on closing carbon cycles and utilising carbon that was previously emitted as CO_2. The use of secondary raw materials is also embedded in the definitions of climate-friendly (low-CO_2 or CO_2-free) basic materials.

In addition, the NCES supports the National Security Strategy, which adopts a broad security perspective that includes resource policy, considering critical dependencies and supply security as part of security policy. In addition to the strategies relevant to raw materials policy, which are brought together in the NCES, the German Sustainable Development Strategy (DNS) also serves as an important starting point and framework for the NCES (including targets 8.4 and 12.2).

2. Guidelines, goals and indicators

2.1 Guidelines for a sustainable circular economy

The transition to a circular economy is a key requirement for achieving the legally established climate objectives, the goals of the German Sustainable Development Strategy (DNS), biodiversity conservation, the reduction of pollution on our planet and the future competitiveness of the German economy. Accordingly, the circular economy must be designed to contribute as effectively as possible to these goals. This translates into the following concrete guidelines for the circular economy:

- Absolute reduction in primary raw material consumption and the associated environmental impacts, particularly greenhouse gas emissions and biodiversity loss, while also considering the economic challenges and opportunities involved.
- Respect for planetary boundaries.
- Decoupling economic development from raw materials use and its environmental impacts both domestically and abroad.
- Waste prevention while minimising the introduction of pollutants into the environment.

- No international shifting of social consequences and environmental effects through the NCES.
- Optimisation of the entire product life cycle.
- Establishment of a circular economy with minimal pollutants: new products must be designed to have minimal pollutants. In the production of secondary raw materials, pollutants present in products already in circulation must be removed under safe conditions for workers and disposed of in an environmentally friendly manner. The enforcement of existing agreements, such as the Basel Convention, will be strengthened so that hazardous waste is not exported.
- Reduction of dependence on raw material imports – particularly with regard to raw materials that the European Commission has classified as critical or strategic. The NCES therefore supports the existing and future approaches of national and European raw materials policies aimed at creating responsible raw materials supply chains.
- Creation and safeguarding of future-proof, high-quality jobs in a sustainable, climate-neutral economy.
- Enhancement of competitiveness through circular business models that are fit for the future.
- Increasing innovative capacity by ensuring functional competition while maintaining transparency and cooperation models: a key advantage of the circular economy over linear economic practices is the significantly increased transparency of the value chain, which is supported by digital technologies such as digital product passports (DPPs) and infrastructure.
- Circular consumption patterns: the NCES will encourage circular consumption patterns in line with key strategic approaches such as reduce, refuse and rethink.
- The transition to a circular economy should be socially just, for example it should take into account the polluter-pays principle and the vulnerability of certain population groups.
- Contribution to the raw materials transition: The circular economy must contribute to replacing fossil raw materials with sustainable raw materials. A resource-efficient circular economy is essential even for sustainable raw materials, as some of these are only available in limited quantities, such as sustainable biomass.

2.2 Guiding principle and goals

The guidelines can be divided into a guiding principle and three overarching goals:

- **Guiding principle:** Reduce primary raw material consumption
- **Goal 1:** Close material cycles

- **Goal 2:** Increase raw material sovereignty and the security of raw material supply
- **Goal 3:** Prevent waste

The guiding principle and objectives are intended to help ensure that the NCES promotes circular economy in line with the guidelines. Given the complex requirements of a comprehensive circular economy, in addition to the overarching goals given here, specific goals are defined for the various action areas and cross-cutting issues and presented in the relevant sections. Indicators will be used to check whether the key levers for a circular economy are being activated in relation to the guiding principle and overarching goals:

Guiding principle: Reduce primary raw material consumption

In line with the goals of the German Sustainable Development Strategy, the Federal Government's aim with the NCES is to create the framework for significantly reducing the quantity of primary raw materials used for consumption and investment in Germany, including the necessary upstream supply chains abroad, by 2045. To achieve this goal, the proposal of the UN's International Resource Panel for a target under the UN SDGs to achieve an average intensity of raw material consumption of 6 to 8 tonnes per capita per year worldwide by 2050 serves as guidance. The guiding principle will be reviewed every five years, starting in 2030, with the involvement of industry, and adapted if necessary. The following will be considered in particular in the review:

- Changes in raw material demand, raw material costs and raw material availability.
- General material-specific conditions.
- Environmental, economic and social impacts of key measures.
- Raw material consumption resulting from necessary investments.

Primary raw material consumption will be quantified at national level using the raw material consumption (RMC) indicator. This will not entail any extra paperwork for companies or private households.

Through the Sustainable Development Goals (SDGs) and the 2030 Agenda, the international community has set itself the target of achieving sustainable management and efficient use of natural resources by 2030 (Target 12.2). International organisations such as the International Resource Panel and the World Economic Forum have calculated that a global demand for primary raw materials of 6 to 8 tonnes per capita per year in 2050 is compatible with planetary boundaries.[40] The Federal Government is guided by this. Considering the current baseline value is 15.3 tonnes per capita (2021),[41] the guiding principle gives an ambitious value of 6 to 8 tonnes, requiring a successful transition to circular economy practices and greenhouse gas neutrality by 2045. Almost a quarter of our current raw material demand is solely attributed to fossil fuels, which will become largely redundant once greenhouse gas neutrality is achieved, making a significant contribution to the proposed target. Lightweighting technologies that save materials and optimise weight, the refurbishment of existing buildings and the measures

introduced to decarbonise industry will also make a major contribution to lowering demand for raw materials through innovations and new processes.

Significantly reduced raw material consumption (raw material footprint) will not be achieved solely through the measures of the NCES or the prevention and recovery of waste but will require embedding the intended transformation as a cross-cutting task in other policy areas and corresponding programmes (see Section 1.6). Several studies and scenarios demonstrate that this goal is achievable, including the RESCUE study[42] by the German Environment Agency (UBA) and the Model Germany Circular Economy study[43].

Goal 1: Close material cycles

- The EU target of doubling the use of secondary raw materials in terms of their share of total material use by 2030, compared to the baseline in 2021, will be addressed at national level and supported by measures in all major material flows (CMUR indicator). Key prerequisites for this are sufficient availability of recycled content, its quality and market acceptance, as well as complementary and consistent market analysis.

- The quality of currently inadequate recycling processes will be significantly improved.

The EU target of doubling the use of secondary raw materials in the terms of their share of total material use, which is being adopted nationally through the NCES, is also challenging and requires not only an increase in the quantity and quality of recycled content, but also the strengthening of circular business models, consistent waste prevention and an extension of the useful life of products. In this respect, reducing the consumption of raw materials also contributes to this goal, since a doubling cannot be achieved through improved waste management and recycling alone.

The target will be measured using the Circular Material Use Rate (CMUR) indicator. The CMUR is one of the European Commission's key circular economy indicators and data on this is regularly collected by Eurostat. The European Commission has set the target for the 27 EU Member States of doubling the CMUR compared to its 2021 value by 2030. In 2022, the EU-wide CMUR stood at 13 percent (Eurostat, 2023). This means the target CMUR for the Member States in 2030 is 26 percent. In Germany, the CMUR was 12.7 percent in 2021, roughly in line with the European average.

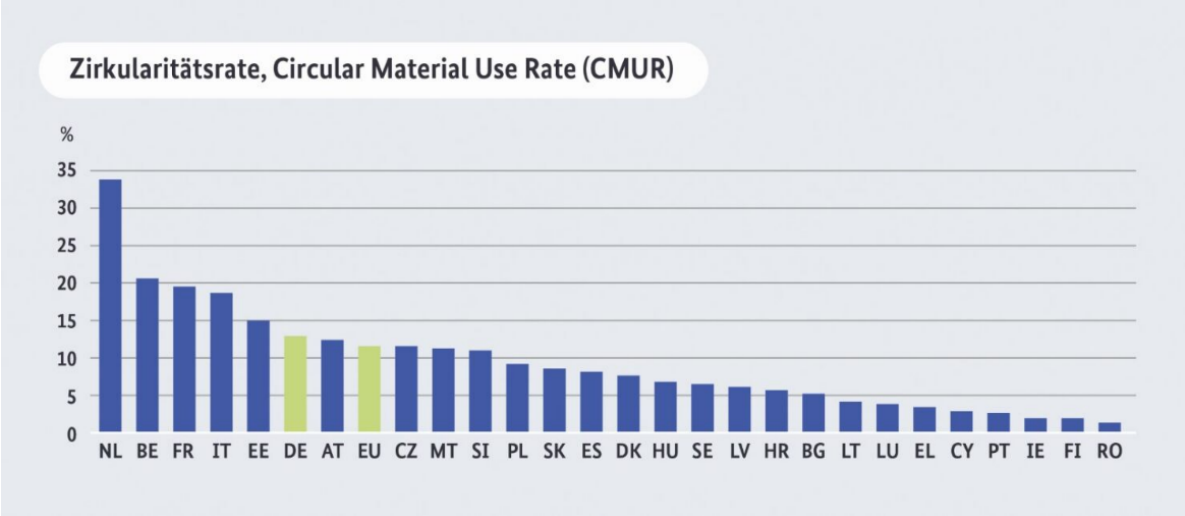

Figure 5 Circular Material Use Rate (CMUR),[44] (Source: Eurostat, 2023)

Goal 2: Increasing raw material sovereignty and security of raw material supply

With the NCES, we want to strengthen security of raw material supply in line with European targets. Germany imports a significant share of its raw materials and is highly dependent on critical and strategic raw materials. In order to mitigate the associated risks and improve raw material resilience, the following goal is defined:

- According to the EU benchmarks set out in the Critical Raw Materials Act (CRMA), EU production capacities must be able to meet 10 percent of demand for strategic raw materials in the EU and 40 percent of demand for processed raw material products. The EU's recycling capacity must be able to meet 25 percent of the demand for strategic raw materials by 2030. No more than 65 percent of any raw material is to be sourced from a single third country. Germany supports these goals nationally through the NCES with effective measures.

The aim of increasing the security of raw material supply and increasing independence from raw material imports through the use of secondary raw materials requires further development of waste collection and recycling infrastructures across entire value chains. Circular product design and circular business models need to be strengthened; it is not enough to intervene only at the end of the value chain and to improve recycling. In addition, relevant processes and secondary raw materials themselves are often associated with much higher costs than conventional approaches, making economic viability an even greater consideration. This requires the promotion of responsible and sustainable raw material supply chains, ensuring that, alongside economic considerations, social and environmental sustainability principles are taken into account along the entire value and supply chain. Progress towards increasing the use of secondary raw materials will be documented through the DIERec indicator[45] (direct and indirect effects of recycling) in relation to primary raw material input (RMI).

Goal 3: Prevent waste

- Lower the per capita volume of municipal waste by 10 percent by 2030 and by 20 percent by 2045 compared with 2020 levels.

The global Sustainable Development Goals (SDGs) aim to substantially reduce waste generation by 2030 through prevention, reduction, recycling and reuse (SDG 12.5). In 2020, Germany generated 613 kg of municipal waste per capita.[46] In line with a comprehensive circular economy, we are focussing on reducing this waste volume at the first tier of the waste hierarchy. This goal is ambitious, but appears achievable given the prevention targets for individual material flows that are currently being discussed or have already been agreed at national and international level. The forthcoming EU Packaging and Packaging Waste Regulation (PPWR) (procedure 2022/0396)[47] requires Member States to reduce per capita packaging waste by 5 percent by 2030 compared to figures reported by the Commission for 2018. A 15 percent reduction is targeted for 2040. Measures to reduce waste are diverse and address not only the public sector but also business, industry and consumers. The Waste Prevention Programme (AVP) of the Federal Government, with the involvement of the Länder (German federal states), and its update provide a good overview of this.

2.3 Assessing the impact of the circular economy on the environment, climate, economy and society

The guiding principle refers to the quantities and origin of the raw materials used. To assess the resulting environmental and socio-economic impacts of circular economy, the following indicators are considered:

Indicators for assessing the environmental impact of circular economy

- Since the circular economy is intended to make a substantial contribution to climate change mitigation, suitable indicators for measurement will first be developed.
- The systematic consideration of the role of the circular economy in national targets for the reduction of greenhouse gas emissions set out in the Federal Climate Action Act (KSG) and the underlying calculation methods. Greenhouse gas emission reductions through circular economy practices will also be recorded using the DIERec methodology.
- A suitable indicator will also be developed for the contributions of the circular economy to biodiversity conservation and the protection of natural carbon sinks.
- Global environmental impact will be assessed using the consumption footprint indicator (see Section 1.2)

Indicators for assessing the socio-economic impact of circular economy

- The indicator on patents related to recycling and secondary raw materials, the data for which is collected by Eurostat, will be used to illustrate the innovation impact of the NCES.
- The proportion of employees subject to social security contributions in Germany working in the circular economy[48] as a percentage of the total number of people employed is also reported by the Federal Employment Agency and will be included in NCES reporting. Further insights into the nature

and quality of employment in the circular economy are provided by indicators on income, skill requirements and education and training.

Additional indicators for sustainability of the circular economy

- To track progress towards decoupling economic growth and raw material use, the NCES includes the indicator for raw material input productivity, which is established in the German Sustainable Development Strategy (DNS) and the German Resource Efficiency Programme (ProgRess II and III). The goal set in the DNS of maintaining the positive trend achieved between 2000 to 2010 until 2030, which corresponds to an annual increase in raw material input productivity of 1.6 percent, contributes to achieving the guiding principle of the NCES.

3. Cross-cutting issues

3.1 The R-strategies

Recycling at the end of product life cycles, which is already well established in Germany, plays a key role in the circular economy, but it is not sufficient on its own. The circular economy must begin during the design, production and use phases of products, as well as in lifestyles and business models.

The NCES is therefore based on a ten-step R-hierarchy, which ranks basic circular economy strategies according to their potential to increase circularity and thus complements the waste hierarchy established in the Circular Economy Act (*Kreislaufwirtschaftsgesetz*, KrWG). The upper tiers of the R hierarchy, R0 to R2 (refuse, rethink and reduce), focus on prevention approaches aimed at consumers, including those working in public procurement, who can reassess their need for products and services, and at manufacturers, who can rethink products and services and design them to be circular in their production and use. The middle tiers, R3 to R7 (reuse, repair, refurbish, remanufacture and repurpose), contain approaches that help extend the lifespan of products and individual components and enable them to be used more intensively. R8 and R9 (recycle and recover) focus on optimising recycling and other forms of recovery.

The aim is a fundamental shift from the linear to the circular: from circular product design and resource-efficient production to sustainable consumption. Business models should be designed with circularity in mind in order to transform global value and supply chains sustainably. Depending on the specific action area, different R-strategies will be most effective. The goals of the NCES can only be achieved through measures spanning the entire range of R-strategies, with the participation of all relevant stakeholders.

3.2 Product design for circularity and longevity

3.2.1 Current situation

The design of a product plays a key role in its environmental impact throughout its entire life cycle and its circularity. The choice of materials, how they are combined and assembled, is determined at the product design stage. The design and manufacturing phases, in particular, offer significant potential to optimise material use, for example, through lightweighting. These decisions have a major influence on the lifespan of a product, which can be extended by taking into account R-strategies R3-R7 (reuse, repair, refurbish, remanufacture and repurpose) (see Section 3.1). They also affect the risks faced by workers in repair and/or recycling processes and the recyclability of a product (R8).

Considering the entire life cycle from the initial design stage provides the key conditions for creating a product that is safe to manufacture, use and recycle, as well as durable and circular (safe and sustainable by design). The use of energy-efficient artificial intelligence offers significant opportunities in various phases of product development, such as idea generation, circular design, simulation and optimisation.

Product-as-a-service concepts, based on product rental and offering maintenance, repair and upgrade services as part of the business model, also have potential. These business models include reuse systems and initiatives to establish innovative collection and take-back schemes for products, product components or materials so that they can be reused or recycled.

The entire life cycle of a product must be considered from the design stage. This can be achieved through legally binding minimum requirements for products to ensure the required minimum level of repairability, recyclability, use of recycled materials, absence of pollutants and product quality/longevity. Currently, the Ecodesign Directive (2009/125/EC) and the new Ecodesign for Sustainable Products Regulation (ESPR)[49] provide a legal framework for product design. In addition, voluntary sustainability and environmental labels offer companies the opportunity to demonstrate higher ambition levels with regard to circular products. These labels provide guidance for product suppliers and businesses on how the more environmentally beneficial products within a product group are designed under current frameworks and thus set an example for ambitious product design.

Furthermore, raising consumer awareness (see next section) and training relevant professionals (in design and product development) can be supported and further developed.

3.2.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 0, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

To achieve these goals, the following measures, among others, are required at national or EU level:

Ambitious minimum legal requirements at EU level: By 2030, increase the material efficiency (an indicator in production processes that measures the ratio of the amount of material in a product to the amount of material used to manufacture it) of all products regulated under the Ecodesign Directive and

the Ecodesign for Sustainable Products Regulation (ESPR). Additionally, develop the regulation's information requirements and partial bans on the destruction of products into a more comprehensive ban on destruction. Product destruction should only be permitted under specific conditions, such as safety concerns, health risks or environmental damage.

Improving frameworks for circular products and business models: Engage in dialogue with the Länder and education providers to ensure that knowledge about ecological design, longevity and product design for reuse and recycling is integrated into and disseminated through relevant vocational training programmes, degree programmes and further training. This will facilitate the practical implementation of more circular products and business models.

Guidance for manufacturers through the formulation of voluntary ecological product standards: The Blue Angel ecolabel already sets requirements for products made from recycled materials (paper, plastics and concrete) and for reuse systems, as well as material efficiency requirements for many other product groups. These requirements should be applied when selecting new product groups and given greater consideration when revising existing ones.

3.2.3 Measures

To achieve these goals, the following measures, among others, are required at national or EU level:

Strengthening professional fields

Opportunities to acquire circularity-related skills (see Section 0). When it comes to product design, the aim is to enhance vocational training and degree programmes by focussing more on skills related to developing and designing circular products and business models. Relevant fields include business administration, product design, chemistry, engineering, materials science, safety engineering, plant engineering and skilled trades.

Regulatory measures / setting product standards

Regulatory measures at EU level: Resolute, ambitious and rapid development of product regulations under the Ecodesign Directive and Ecodesign for Sustainable Products Regulation (ESPR), particularly regarding material efficiency, minimisation of pollutants, durability and longevity, repairability, refurbishability, recyclability and increased use of recycled materials. The focus is on improving regulations in these areas while ensuring that rules are practicable, implementable and do not hinder fair competition.

Digital product passport (DPP): Developing and introducing DPPs, ensuring the necessary conditions for data availability, sharing and security. Providing support to businesses, including in the implementation and upholding the data minimisation principle.

Promoting circularity within voluntary product standards via sustainability and environmental labels: This includes, particularly for the Blue Angel label, expanding material efficiency requirements when selecting new product groups, revising existing ones and updating the environmental product standards defined within them.

Supporting research

Advancing technical solutions and design approaches by analysing the factors influencing their longevity and potential conflicting goals.

3.3 Sustainable consumption and trade

3.3.1 Current situation

Until a few decades ago, the common approach to raw materials involved long product lifespans, maintenance, repair and reuse, but in recent decades this has increasingly given way to a linear economy with a high volume of waste. In industrialised countries and emerging economies, highly resource-intensive lifestyles have become dominant, characterised by the rapid turnover of a large number of consumer goods (such as electronic equipment, furniture and clothing) and a corresponding increase in waste.

Existing offers, pricing and methods used by suppliers to stimulate consumption and ease of availability influence consumption just as much as fashions and conventions. The internet allows consumers to quickly and easily access information about products and services, and also to research aspects relevant to sustainability. Retail and online trade serve as key interfaces between manufacturers and consumers. Both retail channels have clear potential for optimisation in terms of the range and presentation of sustainable products, as well as the environmental impact of packaging (including for shipping), transport, the management of unsold goods and, in online trade, the volume of returns. The growing direct manufacturer-to-consumer sales model via online platforms presents new challenges, including in the areas of consumer protection and market surveillance.

3.3.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Reduce per capita **consumption-related greenhouse gas emissions**, which currently stand at 10.35 tonnes per year, by at least 50 percent by 2030 compared to 2010 (National Programme for Sustainable Consumption, 2021 decision)[50].

- Continuously reduce the **use of raw materials for private household consumption**, which is reflected in the consumption indicator of the German Sustainable Development Strategy (12.1.b)[51], by 2030 compared to 2010.

- Increase the **market share of environmentally friendly products** with a credible ecolabel (indicator 12.1.a of the German Sustainable Development Strategy) to at least 34 percent by 2030; in 2022, the share was 13.9 percent.

- **Strengthen repair businesses** by increasing the number of employees and total revenue.

3.3.3 Measures

For consumption to use fewer resources and become part of a comprehensive circular economy, we need to establish political frameworks that provide suitable incentives and guidelines, facilitate voluntary resource-saving behaviour and support sustainability pioneers in business and civil society.

Measures to promote repair, strengthen ecolabels, increase the transparency of environmental claims and improve resource saving in online trade are crucial.

To achieve these goals, the following measures, among others, are required at national or EU level:

Strengthening ecolabels and the transparency of environmental claims

Facilitating the consumption of material-efficient products (durable, easy to repair or refurbish, using recycled and recyclable materials) through appropriate product labelling and sustainability certification.

- **Further developing the Blue Angel label in terms of resource conservation:** The Blue Angel product portfolio already includes several quality criteria clearly aimed at resource conservation, such as recycled paper, products made from recycled plastic, reusable packaging, reusable cup schemes and car sharing. The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) continuously expands the Blue Angel portfolio and publishes new quality specifications and award criteria, for example for catering and canteen operations, recycled concrete and paper carrier bags.

- **Considering ecolabels for resource-efficient software:** Resource-efficient software requires less hardware capacity, reduces energy consumption and extends hardware lifespan. When the public sector commissions the development of software products, the award criteria of the Blue Angel ecolabel for Resource and energy-efficient software products (DE-UZ 215) should be applied.

- The Federal Government **certification comparison platform *Siegelklarheit***[52], which helps identify good and trustworthy sustainability and environmental labels, is expanded to cover additional product groups, also with regard to their circularity, and regularly updated. This also applies to the underlying international database *Sustainability Standards Map* of the International Trade Centre (ITC) of the World Trade Organization (WTO)/UN Trade and Development (UNCTAD), which is supported by the Federal Government, and also includes business-to-business standards.

Promoting repair

In addition to supporting economic instruments, administrative, technical and logistical barriers to repairs – both for consumers and independent repairers – should be reduced.

The new EU directive on the right to repair creates a new and innovative framework for a Europe-wide right to repair. This framework must be fleshed out and implemented effectively at national level and in collaboration with our European partners. This includes complementary national measures aimed at

strengthening the right to repair for consumers and repairers through instruments that facilitate repairs and improve the product range. Complementary measures are:

- **Funding programme:** The Federal Government has launched the funding programme *Reparieren statt Wegwerfen* (repair rather than throw away) to support a shift in mindset and move away from the throwaway mentality in society. In the first phase, funding is provided for repair cafés and other voluntary initiatives, enabling consumers to repair their own devices and use them for longer. The funding programme for repair infrastructure was launched in 2024 and is planned to continue until 2028.

- **Ensuring repairers have access to spare parts in Germany:** This instrument aims to help facilitate unbureaucratic and non-discriminatory access to repair and maintenance information, tools and spare parts for repairers (repair businesses, skilled individuals and repair initiatives such as repair cafés). We need to examine to what extent a new legal regulation can facilitate access to spare parts for repairers. The goal is to ensure that no repairer is excluded from manufacturers' spare part supplies. Deliveries of spare parts should be as smooth, unbureaucratic and fast as possible to facilitate product repairs.

- **Reviewing suitable repair funding instruments:** Examining the extent to which funding instruments for repairs could help extend the lifespan of devices, considering various financing models. In addition, support will be provided for public awareness campaigns that inform consumers about the importance of longer product use.

Reducing the negative environmental impact of online trade

Online trade turnover has increased significantly in recent years, with some negative effects on the environment.

Environmental protection in online trade: In cooperation with all relevant stakeholders in online trade, necessary measures for sustainable consumption and reducing the environmental impact of online trade will be jointly developed and implemented. Specific necessary measures include reducing returns rates, improving product labelling and modifying shipping packaging practices, including reusable packaging.

3.4 Standardisation

3.4.1 Current situation

Ambitious European and international standards can provide important impetus for circular economy. Given the global interconnectedness of value chains and German industry's reliance on exports, alongside national standards the setting of standards at European and international level is also of great importance. The recently established German Strategy Forum for Standardisation at the Federal Ministry for Economic Affairs and Climate Action (BMWK) is tasked with identifying standardisation topics and projects of strategic relevance for the German economy and competitiveness in future fields.

It also ensures strong participation from German experts in European and international standardisation bodies, particularly in these fields. The Strategy Forum also mirrors the High-Level Forum established under the EU Standardisation Strategy.

The Standardization Roadmap Circular Economy, [53] developed by the German Institute for Standardization (DIN), the German Commission for Electrical, Electronic & Information Technologies (DKE) and the Association of German Engineers (VDI) in collaboration with experts from industry, the scientific community, politics and civil society, identifies existing standardisation needs. Its key topics align with the priorities of the EU Circular Economy Action Plan (CEAP): digitalisation, business models and management; electrotechnology and ICT; batteries; packaging; plastics; textiles; and construction and municipalities. The strategy also defines the need for action in five cross-cutting topics: sustainability assessment, life extension, end-of-waste, digital product passport (DPP) and recyclability. The following aspects should be considered in standardisation:

- Technical standards for designing for circularity at material, product and process levels, particularly concerning reusability/reuse schemes, repairability, refurbishability, lifespan, recyclability and the use of secondary raw materials that have minimal pollutants.
- Quality standards for the scalable use of secondary raw materials.
- Technical standards for waste management.
- Technical standards for providing and exchanging digital data in keeping with the data minimisation principle (for example, digital product passports).
- Environmental and sustainability assessments of products and processes, as well as consumer information.

3.4.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goal applies to this action area:

Standardisation efforts should be conceived in European and international terms from the outset to prevent the build-up of trade barriers that could arise from unequal transitions towards a circular economy.[54]

3.4.3 Measures

Implementation of the Standardization Roadmap Circular Economy

The BMUV-supported Standardisation Roadmap Circular Economy identified 221 standardisation needs through a large-scale stakeholder participation process. Since 2023, DIN, DKE and VDI have been

systematically advancing the implementation of these needs, a process expected to take two to five years. The BMUV and the BMWK are supporting the project.

Key topics include:

- **Digital product passport (DPP):** Technical norms and standards support the further development of the DPP. The European Commission has already tasked European standardisation organisations with advancing the development of a harmonised DPP system by the end of 2025. This will cover horizontal topics such as access rights management, interoperability, formats and data processing. In addition to the DPP's horizontal structure, which is currently being developed, there are numerous sector-specific standardisation topics in the context of the circular economy that should be addressed at European level in the short to medium term. These include the definition of standardised structures for life cycle-relevant data, the harmonised provision of recycling-relevant information in the plastics sector (for example, recycled content based on standardised calculation methods, and pollutants) and, in the textile sector, the creation of a data basis on maintainability, separability and recyclability for material selection and use. The Federal Government is working to ensure that the perspectives of stakeholders from the **Global South**, particularly SMEs, are better considered in this process. (see also Section 6)

- **Design for circularity:** As part of a European Commission standardisation mandate implementing the Ecodesign Directive 2009/125/EC, initial product standards are already being developed, for instance in the electrical engineering sector by 2024. Further sector-specific norms and standards at material, product and process levels should be developed in the short to medium term with German participation. Essential aspects include assessing recyclability and recoverability, repairability, reusability, functional durability, upgrade and refurbishment options, as well as evaluating the share of reused components and recycled materials.

- **Sustainability assessments of products and processes:** To enable sustainability assessments of products and processes, measurable indicators should be defined in standardisation processes in the short term. All relevant aspects must be taken into account, including supply chains, design, production, product use, repairability and end-of-life. The European Commission draft safe and sustainable by design assessment framework also provides guidance.

- **Circular construction industry:** Current European-level standardisation efforts focus on establishing the general framework and definitions for circular construction by around 2026 and addressing dismantling, reuse/recovery (use of secondary raw materials), circularity assessment of buildings and digital building resource passports by around 2027.

- **Circularity in textiles:** In the textile industry, quality standards should be developed in the short to medium term in line with the ecodesign requirements. Overarching issues include defining longevity for the individual product groups (longevity index), measuring or determining consumption data and product components, and evaluating textile waste and the materials recycled from it.

- **Reusable packaging:** Specific norms and standards are required to support implementation of the requirement to offer reusable packaging. In the short term, standardisation projects should be initiated, for example to define hygiene and quality standards for packaging-free and reusable solutions, or to draw up standardised requirements for the compatibility of reusable packaging in take-back, return and refurbishment processes.

Standards review

Participation in European and international standardisation processes

Through standardisation, national interests and ideas must be incorporated into the technical implementation of current European legislation at an early stage. This applies, for example, to the Ecodesign for Sustainable Products Regulation (ESPR) and the EU directive on the right to repair.

We need to strategically expand the participation of German experts in European and, above all, international standardisation processes, particularly regarding standards processes that are central to the transition to a circular economy. The perspectives of partners in the Global South, as well as SMEs and non-governmental organisations, must be taken into account.

Horizontal standardisation needs are being developed within the newly established cross-industry and cross-sectoral bodies founded in 2023, such as CEN/TC 473 Circular Economy and CEN/CLC/JTC 24 Digital Product Passport, as well as the existing ISO/TC 323 Circular Economy.

3.5 Economic instruments and financing

3.5.1 Current situation

The current insufficient level of circularity is partly due to price signals caused by the externalisation of environmental costs. The costs of environmental impacts from raw material extraction and processing or waste disposal are externalised and not reflected in product prices. As a result, natural resources are overused, and more waste is generated than is sustainable for overall societal welfare, the climate, and the environment.

Economic instruments can provide market-compatible incentives for circular consumption and production patterns and support investments. Accordingly, the European Commission's Circular Economy Action Plan also includes the explicit goal of promoting economic incentive instruments.[55]

Over time, the share of environmental taxes in total tax revenue in Germany fell from 12.2 percent in 2005 to 7.6 percent in 2021. In 2021, total revenue from environmental taxes reached 68.2 billion euros.[56] At 1.8 percent, the share of environmental taxes in Germany's GDP in 2021 was also below the EU average of 2.24 percent.[57] The main focus is on pricing CO_2 emissions, which also creates incentives for more efficient resource use and increased use of recycled content.

Financing instruments are also key drivers in the transition to a circular economy, supporting new technologies, products and business models. The goal of the NCES is to place the circular economy on a level playing field with the current linear economy. The transition to a circular economy involves combining financing instruments and economic instruments, for example in order to gradually increase the share of secondary raw materials in overall raw material consumption while simultaneously reducing the costs of providing secondary raw materials and increasing their quality.[58] The German Sustainable Finance Strategy already aims to support the circular economy.[59] At European level, the European Commission has developed criteria for investments in the circular economy as part of the taxonomy for sustainable activities.

At federal level, research funding remains the primary focus. However, there is a lack of instruments to channel public and private funds and scale offers of circular resources, products and business models. The Federal Government should therefore aim to design funding programmes and financing instruments that can foster synergies for achieving the economic, environmental and social goals outlined in the NCES. To this end, the development of instruments to implement the NCES builds on experience with the conditionality of funding. Additionally, there is a significant need for research into the extent of private capital market investments in the circular economy. At present, regular, systematic data collection on the development of annual private investment only exists for recycling. According to Eurostat, only 0.9 percent of private investment and gross value added in Germany were linked to circular economy sectors.[60]

Existing market shortcomings lead to reduced returns on investment or increased risks for businesses operating in a circular economy approach. Specific shortcomings include the aforementioned unpriced positive externalities in circular business models and negative externalities in linear ones. Lack of information is also a barrier due to insufficient data and a lack of forward-looking reporting and appropriate methods for assessing the impact of circular economy, such as product-as-a-service schemes.[61] Businesses seeking to engage in circular economy practices also face market entry barriers, primarily due to a lack of financial resources and complex legal requirements, but also because of inadequate logistical infrastructure and distribution partners.

Moreover, investing in the transition to circular economy infrastructures requires high initial costs. SMEs in particular lack financial resources. Additionally, financial instruments for risk distribution, such as green bonds, are underutilised.[62]

3.5.2 Goals

The Federal Government should aim to create incentives for the transition to a circular economy that are as market-compatible as possible. Establishing a level playing field[63] will generate incentives for businesses to invest in circular processes, products and services based on economic interests. Waste legislation, which is currently focussed on hazard prevention and therefore largely regulatory in nature, should be supplemented by economic instruments to facilitate scaling of circular business models. Waste should not only be disposed of safely but increasingly seen as a potential secondary raw material. Appropriate price signals should also incentivise consumers to adopt circular consumption patterns, for

example by choosing more durable products. The design and implementation of economic instruments should therefore adhere to the following guiding principles:

- **Prices better reflect external effects (externalities):** The environmental and climate costs of extracting, using and disposing of raw materials are to be factored into market prices more systematically to improve resource allocation. A first step has already been taken with the introduction of the EU Emissions Trading System (ETS). However, since the ETS does not affect the material use of fossil primary raw materials in industry, there are still few price signals to incentivise a reduction in their use. A shadow price to monetise climate and environmental impacts should also be considered at national level, for example in public procurement in the construction and building sector (see Section 4.8.4).

- **Economic incentives must consider global competition:** Measures to address environmental costs must not disadvantage domestic market participants. The relocation of production processes abroad leads to such measures being circumvented and thus has no positive environmental effects at all. Border adjustment mechanisms at European level, analogous to the Carbon Border Adjustment Mechanism, are under review.

- **The various instruments, including economic instruments, must be appropriately coordinated:** Since incorporating climate and environmental costs into market prices affects both businesses and consumers, a consistent alignment of the different instruments is required. Coordination and dovetailing with compensatory social measures must also be ensured.

- **Circularity as a criterion in funding programmes:** Just as climate action has already been integrated into some funding schemes, circularity should be a fundamental criterion in suitable funding programmes going forward.

3.5.3 Measures

To achieve these goals, the following measures, among others, are required at national or EU level.

In line with the German Sustainable Finance Strategy, the NCES will support the mobilisation of private investments from a linear economy towards circular value creation. The following steps are envisaged:

- **Financing the transition through targeted use of public funds to catalyse greater private investment in circular economy:** The transformation requires significant financial investment in the circular economy. Essentially, the majority of this must be provided by private investment; public funds can only provide impetus, incentives and support. Public-private partnerships should be considered as a means of generating financial resources for the transition to a circular economy with reduced risk. However, the priority is to continue to drive sustainable finance forward ambitiously.

- **Enhancing transparency, risk management and reporting:** The risk management of financial market and corporate actors depends on the transparency of the financial markets. Practical digital solutions will therefore be supported to implement European reporting obligations that simultaneously

reduce bureaucracy (for example, further development of the German Sustainability Code and establishment of the associated IT infrastructure).

- At **EU level**, **thermal waste recovery** should be **comprehensively included in EU emissions trading**.

Under the NCES, the following concrete measures will also be pursued to create incentives for an accelerated transition towards a circular economy through economic and financial instruments. Regarding financial instruments, coordination at European level is particularly important in view of the single market. Funding programmes for specific action areas are addressed in the relevant sections. Suitable funding programmes will be examined to determine whether and how it might be appropriate and feasible to open them up to circular economy measures.

Establishing a raw materials fund

The Federal Government has tasked KfW with setting up a raw materials fund to support innovative and sustainable raw materials projects both abroad and in Germany. This may include the extraction, processing and recycling of critical raw materials. The Federal Government wants to lower its dependence on critical raw materials. These are of particular importance for the technologies and uses required for the green and digital transitions, as well as for the aerospace, security and defence industries. The raw materials fund is intended to ensure diversified financing for projects along the entire value chain of critical minerals. The raw materials should be “critical” in the sense set out in Critical Raw Materials Act (CRMA).

The raw materials fund differs significantly from existing funding instruments by enabling diversified financing, particularly with equity instruments, thus allowing the Federal Government to participate indirectly in strategic raw materials projects through KfW. This means that no grants will be provided for individual projects; instead, the government will participate indirectly in relevant projects via KfW as a shareholder.

Observations show that even after a successful raw material exploration phase, banks are often very reluctant to engage in long-term investments in this area. The same applies to investments in recycling processes and facilities, especially when new, less established processes are involved. Many processes previously funded by the Federal Government, for example through research and development programmes, never reach an industrial scale.

The raw materials fund will provide support by increasing the creditworthiness of companies or projects, particularly in the early stages, through Federal Government participation as a shareholder, facilitating financing via the free capital market. This will leverage private investment through government participation. The fund to support the extraction, processing and recycling of strategic raw materials domestically and abroad will play a role in securing the supply of critical raw materials.

At the same time, a broad economic incentive is needed to promote specific recycling technologies and approaches. The fundamental problem is that, as things stand, some recycled raw materials (such as lithium or rare earths) are usually more expensive than primary raw materials, making recycling economically unviable in many cases. The economic approach aims to promote competition for the best

solutions. Further processing must also be considered, and resilient supply chains be viewed as a whole. This means factoring in the planning of facilities and the demand for recycled raw materials. The Federal Government is developing proposals for funding instruments, particularly to support the entire recycling infrastructure. This support will be provided by KfW in the form of R&D funding and similar financial instruments.

Incentive systems for improved circularity

The European Commission is increasingly focussing on mandatory minimum recycled content targets in sectors such as construction, automotive and packaging. There is a need to promote and expand the use of recycled content targets, for example in the plastics sector (see Section 4.10). In practice, the effort required for companies to meet such targets varies. To enable them to do so as efficiently as possible, the feasibility, benefits and drawbacks of supplementing these targets with a certificate trading system will be examined at European level. The aim is to allow companies that exceed the targets to sell corresponding certificates to companies that would incur significantly higher costs if they switched to secondary materials. A key factor will be the establishment of clear frameworks to prevent greenwashing and stop financially strong companies simply buying their way out.

Government start-up funding for the recovery of critical raw materials and technology metals

High-quality recycling and the recovery of critical raw materials are only economically viable for businesses if as many constituents as possible, such as those from waste electrical and electronic equipment, can be recovered in high yields and in a marketable quality. Effective sorting and recycling technologies already exist for many materials, including those developed in funding programmes of the Federal Ministry of Education and Research (BMBF) such as r4, which focusses on the provision of economically strategic raw materials. However, price trends are still too volatile for the necessary investments, even though more and more businesses are seeing resilient supply as a critical factor. A government start-up funding programme is planned for pilot plants and processes for the recovery of critical raw materials and technology metals.

Pilot initiatives: Circular Rural Regions and regulatory sandboxes

The circular economy offers opportunities for rural areas. Therefore, the Federal Government launched the Circular Rural Regions pilot initiative as part of the Territorial Agenda 2030 and will support five German model regions from 2024 to 2027 in the development and advancement of concepts and implementation of circular economy measures.[64] In addition to spatial development, advancement and implementation, circular economy concepts will also be promoted on an industry-specific basis. In the spirit of a model regulatory sandbox approach, opportunities for circular economy practices in complex operations, such as hospitals, will be tested under practical conditions.

Circular Cities and Regions Initiative

The Circular Cities and Regions Initiative (CCRI) was launched and funded by the EU as part of the Circular Economy Action Plan. It focusses on implementing the circular economy in Europe's cities and regions.

Facilitating access to financing for the circular economy transformation

The transition to a circular economy will require considerable investment. Therefore, actors, structures and processes that finance such projects and develop the necessary expertise are of crucial importance.

- Strengthening access to finance for the transition to a circular economy via promotional banks: promotional banks will act as transformation banks in the future. The state-owned promotional bank KfW will take on a stronger role as an innovation and investment bank and a co-investor of venture capital, particularly for the circular economy, utilising financial instruments in support of all R-strategies. In cooperation with the development banks of the Länder, KfW will establish and expand region-specific co-venture capital instruments to further increase the focus on the circular economy. The European Investment Bank (EIB) will be strengthened and supported in its work to prioritise the transition to a circular economy and expand its triple strategy of awareness raising, finance and advisory support.

- Supporting pilot projects: The implementation of the NCES will be accelerated through support for pilot projects, for which appropriate coordination structures will be established as part of a circular economy platform (see Section 7.2).

Create incentives for private investment in circular economy

Public investment in the circular economy is not enough. The majority of necessary investments must come from private capital. It is therefore essential to create incentives for private investment in the circular economy. A specific action area is investment in new infrastructure for sorting and recycling, such as for decommissioned renewable energy systems or waste batteries.

- Leveraging private investment: Instruments based on the Joint Initiative on Circular Economy (JICE)[65] will be used to leverage private investment by reducing financing risk through public risk capital (see the German Bundestag study on leveraging the capital base of the European Fund for Strategic Investments (EFSI) and compatibility with European primary law).[66] This will enable additional private and public investments in the circular economy both in Germany and abroad. Private investors will also be encouraged to establish financial instruments, particularly venture capital funds, for circular economy transformation.

- Transformation guarantees: If sufficient collateral is unavailable for loans for transformative, particularly circular, business models, a review will determine whether transformation guarantees should be used to close any remaining gaps. Such an instrument could make it easier for financial institutions to lend, particularly to SMEs. As a positive side effect, the guarantee could reduce the equity capital requirements for loans on the part of the lending institution. The targeted support of securitisation efforts in the context of investments in circular products and processes is also under review.

- Premiums for circularity: Incentive instruments such as premiums or bonuses for the targeted promotion of sustainable alternatives to conventional products (for example, energy-efficient products) have proven effective in the past. Accordingly, an assessment will be made of which demand-side instruments for consumers are suitable for which circular products. One option could

be grants for durable or particularly easy-to-repair products, which are less frequently purchased, especially by lower-income households, due to slightly higher upfront costs, even though the total cost of ownership would be lower in the long term.

Further developing financial market instruments

The specific challenges of transitioning to a circular economy will also require innovative financing instruments that specifically account for the time span between a product's manufacture and when it becomes waste, which marks the starting point for potential secondary raw material recovery. Possible approaches include:

- Futures for the right to recycle: The development of financial market futures as tradeable products, granting the right to recycle, for example, renewable energy systems such as heat pumps, photovoltaic installations and wind turbines at a specified future date. It is expected that it will be possible to monetise such rights in the future, as in this way companies will be able to secure access to scarce or valuable materials early on, increasing the independence of their supply chain. Additionally, such an instrument would channel funds towards design for circularity, as it would facilitate access to the raw materials embedded in these systems and devices. Product groups such as renewable energy systems and waste batteries from electric vehicles are particularly suited for futures trading, as they typically have very long service lives and either lock in significant amounts of material in a system or there are a large number of similar products on the market. However, implementing such an instrument is complex and involves risks for both suppliers and buyers. Its introduction should be explored in dialogue with the financial sector.

- Circular impact bonds: Another financing instrument is circular impact bonds, also known as pay-for-success bonds. Investment disbursement occurs only when a measure proves successful. The feasibility of expanding these bonds to suitable action areas of the NCES will be assessed.

- Evaluation methods for circularity: Evaluation methods for circular business models and financial projects are not yet sufficiently developed. The focus should be on developing evaluation and rating methods, for example specifically for financing start-ups and mid-sized investments (ranging from 0.5 to 10 million euros) that effectively help promote the circular economy. These are particularly interesting for SMEs that require external financing but are too small for institutional investors who are explicitly seeking investment options for green funds. In collaboration with the financial sector, we will explore the further development of evaluation methods for circularity.

Incorporating the Global South

Mobilising private investment in circular value creation is not only important within the European single market. The Global South also lacks the necessary frameworks, financial incentives and financial market infrastructures to provide targeted price incentives. In view of global value chains, adequate capacity building is crucial, and the German Sustainable Finance Strategy explicitly provides for this.[67] In this context, the measures outlined above are also to be considered for the Global South so that the Federal

Government can actively support its partner countries in their efforts to implement circular economy measures.

3.6 Pollutant removal

3.6.1 Current situation

Pollutant emissions into air, water and soil along value chains can have harmful environmental and health effects. Circular business practices can fundamentally mitigate these impacts. However, achieving closed-loop cycles poses specific challenges for the removal of pollutants.

The Circular Economy Act (KrWG) establishes a five-tier hierarchy for waste management measures (see Section 0). When applying the waste hierarchy, priority should be given to the measure that best ensures the protection of people and the environment. Waste recovery is mandatory if technically feasible and economically reasonable. Additionally, waste must be disposed of in such a way that it is not likely to pose a threat to public welfare. Recovery processes must ensure that pollutants do not accumulate in material cycles.

One challenge for the circular economy is the high-quality recovery of products to which, for functional or technical reasons, substances carrying certain risks have been added. In some cases, these products only become waste after a long period of time (for example, several decades in the case of building insulation), making it often difficult to determine whether and to what extent they are contaminated with pollutants. If information is not retained throughout a product's life cycle, determining the impact at the product's end-of-life stage often requires complex analyses. If it cannot be ruled out, with reasonable effort, that waste contains or is contaminated with pollutants, the waste must be disposed of, in line with the precautionary principle. To maximise the potential for pollutant removal during recycling, it is important to further develop assessment tools for waste management that are aligned with material safety evaluation methods. In the long term, materials with certain negative properties should not be used at all and recyclability should be given greater consideration at the design stage.

3.6.2 Goals

As part of the Green Deal, the European Commission also published both the Chemicals Strategy for Sustainability and the EU Action Plan Towards Zero Pollution for Air, Water and Soil. These align with the overarching goal of enhancing circularity in a toxic-free environment.[68] To implement this goal, the European Commission developed a toxic-free hierarchy as part of its Chemicals Strategy, forming a key basis for the NCES. This prioritises the development and use of sustainable and safe chemical substances, following the Commission's recommendation to establish a European evaluation framework for "inherently safe and sustainable" chemicals and materials. This framework is currently being tested in collaboration with industry and will be further developed in the future. The next steps include the transparent monitoring of chemical substances in use and the elimination of substances of concern in appropriate sinks based on state-of-the-art technology. Such sinks for contaminated waste or pollutant fractions separated in recycling processes include municipal and hazardous waste incineration plants, underground landfills, surface landfills, and chemical and physical waste treatment

plants. These are essential for ensuring clean material cycles, which is why corresponding capacities must be maintained in the future.

Due to the registration requirement under the REACH Regulation and the classification and labeling requirements of the CLP Regulation (Regulation (EC) No. 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging (CLP) of substances and mixtures), economic operators must retain information on substances. Additionally, under Article 33 of the REACH Regulation, suppliers must pass on information regarding substances of very high concern (SVHCs) in articles along the supply chain and inform consumers. Furthermore, the Substances of Concern in Products (SCIP) database, established under Article 9(2) of the Waste Framework Directive, provides access to information on hazardous substances in products. However, availability of reliable data for secondary raw materials needs to be further improved to furnish the recycling industry and users of secondary raw materials with the necessary information.

3.6.3 Measures

Exclusion of pollutants in products

Efforts under the Ecodesign for Sustainable Products Regulation (ESPR) to further exclude substances of concern, which negatively impact the reuse and recycling of materials in a product.

Improving the flow of information along the product life cycle

The Federal Government will support the establishment of relevant standards, such as DIN/TS 51012:2020-04 Screening of substances of very high concern – General principles, with CD-ROM, at the European and international levels in relevant bodies including the European Committee for Standardization (CEN), the International Organization for Standardization (ISO) and the Organisation for Economic Co-operation and Development (OECD). This standard provides initial guidance for identifying contaminated products. Information needs can vary significantly depending on the material or waste stream. Information from digital product passports, for example, can facilitate more thorough material separation during waste collection, ensuring that contaminated products can be easily separated and these pollutants can be removed from circulation. This approach is also intended to ensure the continuous traceability of pollutants.

The recently adopted new pollutant criteria for the construction and real estate sectors under the EU Taxonomy Regulation [69] can support the initiation and establishment of corresponding technical standards. In this context, the Federal Government aims to expand[70] and validate DIN/TS 51012:2020-04.

3.7 Circular bioeconomy and biogenic raw materials

3.7.1 Current situation

The use of biogenic raw materials can contribute to climate change mitigation and the conservation, sustainable use and restoration of biodiversity. At the same time, biogenic resources can only be

produced to a limited extent, while there is a wide range of potential uses, partly due to the increasing substitution of fossil raw materials and fossil fuels with biomass. A large share of the biomass processed in Germany is already imported. Suitable economic, political and societal frameworks are therefore required to ensure that scarce agricultural land and raw material flows are put to the most efficient and productive use. At present, there is still insufficient recovery of essential nutrients such as phosphorus, leading to shortages in some regions and surpluses in others.

Within a sustainable circular bioeconomy that primarily employs biotechnological processes and products, the benefits of substituting fossil-based products with bio-based products, for instance in the chemical industry or construction, can be combined with optimising sustainable material flows, for example through cascading use and coupled uses, and with lowering raw material demand in general. This is particularly desirable when it contributes to reducing fossil greenhouse gas emissions and minimising land and water use.

Promoting an efficient, bio-based, resource-conserving circular economy is one of the goals of the National Bioeconomy Strategy (NBÖ Strategy), which lays the foundations for an innovative, sustainable bioeconomy in Germany and acknowledges the Federal Government's global responsibility within the internationally interconnected bioeconomy.
Despite the mandatory separate collection of biowaste in place since 2015, some biowaste is still not collected and moreover is often heavily contaminated with impurities. As part of the revision of the Bio-waste Ordinance (*Bioabfallverordnung*, BioAbfV), a review is being performed to determine whether specifications and criteria for the separate collection of biowaste can be defined, with the aim of increasing the quantity and quality of separately collected biowaste. Requirements for high-quality material use, ideally multiple times, with final energy recovery of separately collected biowaste are also being reviewed, with material flow management specifications taking into account the type and nature of the biowaste. The legislative process is planned for the next legislative period.
The upcoming revision of the Waste Wood Ordinance (*Altholzverordnung*, AltholzV), which is planned for the next legislative period, is intended to promote a circular economy by ensuring that untreated or lightly treated wood is primarily processed for material recovery. The regulations of the AltholzV will be aligned with the five-tier waste hierarchy outlined in the Circular Economy Act (KrWG).
For phosphorus recovery from sewage sludge, investment certainty and a legally sound financing option will be ensured by 2026 in coordination with the Länder, for example, via wastewater charges (see Section 3.11). In order to close the phosphorus cycle, all sewage sludge containing phosphorus must undergo phosphorus recovery from 2029 in accordance with the Sewage Sludge Ordinance (*Klärschlammverordnung*). To support the timely implementation of phosphorus recovery from sewage sludge and overcome obstacles, the Federal Government initiated a high-level industry dialogue involving the Länder and local government associations. In August 2024, a joint declaration was published on the expansion of phosphorus recovery from sewage sludge.

3.7.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Keep biogenic and biotechnologically usable raw materials in circulation for as long as possible and reuse them as much as possible through cascading.[71] Energy recovery only occurs at the end of a cascade. Biomass use will be focussed on areas where no other decarbonisation options are available. Processes for cascading use are continuously developed.
- Provide targeted support for products and processes in the industrial bioeconomy to make them competitive with conventional products and processes.
- Ensure in the product development stage that products can be easily repaired or recycled. Complex material composites and hazardous substances are avoided where technically feasible, so that individual materials can be effectively separated, reused and utilised in further cascades.
- Fully exploit the potential of biogenic residues from primary agricultural and forestry production through targeted management, bearing in mind their retention for humus formation, the maintenance of nutrient cycles and other ecosystem services.[72]

3.7.3 Measures

Managing and recovering vital nutrients in regional cycles

Achieving these goals requires the sustainable management of reactive nitrogen and the reduction of nitrogen emissions to a level that is safe for human health and the environment. Nitrogen recovery in wastewater treatment plants must be advanced and compared with established processes for the elimination of reactive nitrogen in terms of overall environmental impact.

Further support for and expansion of processes for phosphorus recovery from sewage sludge and sewage sludge ash is also necessary.

Using biogenic raw materials, waste and residues for the production of product and material alternatives

R&D activities, project funding and scaling initiatives will be utilised to promote the environmentally sound development and use of biogenic raw materials, waste and residues. Technological and biotechnological solutions will be developed to use these as raw materials for the production of basic materials, particularly for the chemical industry, as biogenic alternatives to fossil-based products and for new innovative products. The processing of biogenic waste materials will be designed to be adaptable to changing user requirements. Projects will assess the technical, economic and environmental potential of waste and residues to identify and minimise possible competing uses from the outset.

Developing indicators for a circular bioeconomy

Necessary measures include:

- Discussing the bioeconomy and the conflicts of use associated with its implementation in an international context.
- Strengthening networks among stakeholders.
- Exchanging knowledge on measures and strategies.
- Jointly advancing the goal of establishing a sustainable and circular bioeconomy with strategically important partners.

A crucial component is measuring the circularity of biogenic materials and products using relevant indicators. This will allow long-term monitoring of trends in circular bioeconomy and foster global interactions, regional initiatives and international cooperation.

Promoting industrial bioeconomy products and processes

Industrial bioeconomy projects related to waste and wastewater management, climate change mitigation and air quality control will be supported, including scaling products and processes that have been tested in laboratory settings.

Transitioning the raw material base of industry

A sustainable circular economy requires a sustainable raw material base. The use of biomass, recycled content and captured CO_2 as non-fossil carbon sources, particularly for durable industrial products, will be incentivised and strengthened in order to contribute to a sustainable transformation of the industrial raw material base. Green lead markets and public procurement must also be considered in this context.

3.8 Global material flows

3.8.1 Current situation

Global economic growth has led to a sharp increase in the use of materials in recent decades. With increasing global trade, global material flows have grown more than resource extraction itself. Resource extraction has risen by around 2.3 percent annually, from 30 billion tonnes in 1970 to 106.6 billion tonnes in 2024.[73] In addition to consumer goods, Germany imports raw materials and semi-finished goods, which are then further processed and largely re-exported. Germany is highly dependent on imports, with the degree of dependence varying by raw material. Due to its international interconnectedness, Germany also has a markedly large material, water and land footprint abroad, particularly in the Global South. For this reason, it is important to strengthen capacities for the development and expansion of a sustainable and fair circular economy in partner countries, particularly by involving the informal sector. At the same time, it is evident that there is also global demand for certain secondary raw materials (such as steel scrap), leading to raw material outflows. In light of current global challenges, further diversification of German and European supply chains through an ambitious, openness-based EU trade policy is urgently needed to promote competitiveness, diversification and resilience and contribute to multilateral sustainable development goals. Germany focusses on

cooperation with its partners based on multilateral standards and WTO law, and refrains from trade-distorting measures.

Global economic and security policy implications of a circular economy in Germany

Trade relations with countries that are currently important exporters of raw materials and semi-finished goods, such as China, Viet Nam, South Africa, Brazil, Peru, the United States and Canada, may well change in both depth and structure. Raw material flows may become partially localised or regionalised, new sustainable and fair recycling and technology partnerships (just circular economy partnerships) will emerge and create a diversified supply environment. The Federal Government seeks to promote local value creation in partner countries. A broader understanding of the circular economy will enable positive development effects in the Global South and thereby also ensure the long-term sustainability and resilience of supply chains.

At the same time, overall economic resilience and greater raw material sovereignty do not automatically make all supply chains more resilient as well. It is therefore crucial to promote responsible and sustainable raw material supply chains. In particular, supply chains that rely on critical raw materials, specific intermediate products or hard-to-recycle resources may continue to be vulnerable to disruptions. Increasing competition for valuable secondary raw material flows, such as scrap metal and other metal waste, must be anticipated and tackled. An ambitious and open EU trade agenda therefore remains indispensable for the raw materials sector in the long term. Alongside bilateral initiatives, the WTO also plays a key role, for example through its rules on export restrictions.

Global justice in a German circular economy

The transition to a circular economy in Germany may cause negative socioeconomic and environmental impacts in certain countries. Such impacts are conceivable for economic sectors such as raw materials, plastics and textiles. To mitigate potential negative consequences, it is important to involve countries in the Global South as equal partners from the outset and throughout the entire social and environmental transformation of the economy, while designing and communicating the stages of circular value creation across national borders. This includes creating new opportunties for workers – who in many countries in the Global South are currently employed primarily in informal circular economy sectors – through sustainable and dignified jobs in new production and raw material structures, while taking their backgrounds, concerns and challenges into account. A particular focus should be on enabling participation in the circular labour market for all people, regardless of gender, gender identity, sexual orientation, skin colour, disability or other characteristics.

In addition, efforts to promote fair trade conditions worldwide, close the technology gap, support resource-extracting countries in their transition from raw material suppliers to producers of semi-finished and finished goods, and strengthen their sustainable economic development and competitiveness should not be undermined but given renewed momentum through sustainable and just circular economy practices.

3.8.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Germany supports the goal of the CRMA to ensure that, by 2030, Germany is not dependent on a single third country for more than 65 percent of its annual consumption of any strategic raw material critical at any relevant processing stage.

- Strengthen capacities in partner countries for the sustainable extraction and use of secondary raw materials within a sustainable and just circular economy, including through the consistent development and expansion of circular economy and secondary raw material or recycling partnerships (just circular economy partnerships) for all strategic raw materials by 2030, as well as for the production of competitive semi-finished and finished goods based on secondary raw materials.

- Support partner countries in building economic and industrial policy capacities to develop a policy framework for an environmentally sustainable and socially just transformation of their economies that is compatible with a globally sustainable and just circular economy and sustainable value creation and supply chains.

- Close relevant data gaps regarding exports of products containing critical raw materials (such as vehicles and electronic products) as well as the import and origin of critical raw materials by 2030, including those embedded in semi-finished and finished goods.

3.8.3 Measures

Building capacities for the extraction and use of secondary raw materials

The Federal Government supports partner countries, particularly in the Global South, through bilateral cooperation to build capacities for the extraction and use of secondary raw materials. This commitment will be expanded. A key aspect of this is that Germany enters into circular economy and secondary raw material or recycling partnerships (just circular economy partnerships) with selected partner countries. Criteria must be established for their design. Particular attention should be given to material flows that are important in terms of certain critical and strategic raw materials. These partnerships present particular opportunities for selected material flows, provided that higher-quality circular processing is possible or can be enabled in partner countries. This applies, for example, in the field of textile recycling or the repair and refurbishment of electronic devices. Organisations and businesses can also be involved in these partnerships, in particular to expand recycling infrastructure. This can include knowledge exchange, the development of programmes and incentives for businesses. Initiatives to enhance expertise in the sustainable use of secondary raw materials in the local production of competitive semi-finished and finished goods that meet sustainability and quality standards will strengthen the circular economy and foster higher levels of sustainable local value creation in partner countries.

Promoting circular material flows with trade partners

Work at European level for an ambitious bilateral trade agenda and EU trade agreements with ambitious chapters on energy and raw materials, in order to promote sustainability, diversification, supply chain resilience and the circular economy. Particular attention is given to balancing volatile supply chains and existing strong dependencies.

Beyond trade agreements, in future second-hand flows will be structured within trade partnerships to maximise the reusability of second-hand goods and products. Together with trade partners, we will establish structures to support repair and recycling activities and the corresponding local infrastructure. This will enable the recovery and recycling of products at end-of-life, such as renewable energy systems, textiles and plastics.

Sectoral dialogues will facilitate private sector material flow cooperation between organisations or businesses on a supply chain-specific basis. This will allow participating businesses to gain competitive advantages, for example, by jointly utilising infrastructure and expertise.

Extended producer responsibility (EPR) with due diligence obligations

EPR systems will in future play a more active role in improving the functioning of secondary raw material markets. We must examine which instruments can be used to increase the return of products and raw materials exported from Germany. This includes the re-import of relevant end-of-life products or their raw materials, such as vehicles and electronic devices.

The following topics will be given greater consideration in future research funding:

- Assessing the impact of national and international circular economy measures in the international context through specific examples.
- Improving data on the economic, environmental and social effects of circular measures along value chains.
- Analysing individual material flows regarding their sustainability and resilience, including deriving measures to strengthen them.
- Analysing competing uses and supply risks in sustainable future technologies, particularly regarding critical and strategic raw materials.
- Defining requirements for global infrastructures for the extraction and use of secondary raw materials.
- Identifying the potential for expanding sustainable circular business models and their significance for Germany’s material consumption.

3.9 Research and development

Research and development (R&D) is an essential driver of innovation and progress in the transition to a circular economy, advancing innovations that, for both environmental and economic reasons, must then be rapidly placed on the market and scaled. Basic and applied R&D can test, pilot and scale new technologies and business models as solutions. It can also address questions around the societal acceptance and feasibility of such solutions while taking a holistic view of circular value creation. This applies both to global value chains and to cooperation across countries on product cycle integration. To achieve this, challenges in implementing the circular economy must be discussed with national and international stakeholders, research needs jointly identified and the necessary solutions explored in national and transnational projects.

The importance of circular economy research, particularly for Germany's innovation capability, is highlighted by the study *Innovation Indicator 2024*[74] by consulting firm Roland Berger and the Federation of German Industries (BDI). The authors attribute Germany's continued good performance in the ranking of the most innovative nations in part to its high R&D expenditure. They also emphasise Germany's leading position in circular economy technologies. The Federal Government aims to maintain these economic strengths and will continue to consistently promote research in the field of circular economy.

3.9.1 Goals and overarching measures

Advancing research and innovation across ministries

The suitability of research programmes within interministerial cooperation to be given greater consideration. In addition to further developing existing programmes, interministerial exchange and coordination are essential for optimising the existing funding landscape and sharing research findings.

The Federal Government will address R&D needs that have already been identified within existing programmes and initiatives and engage with all stakeholders to identify new needs. The specific research needs of the NCES will be addressed within its individual action areas. Where appropriate, ministries will invite stakeholders to expert discussions, taking into account the relevant groups of actors.

Transfer and rapid scaling of R&D results

The aim is to achieve rapid scaling of results from R&D projects. Publicly funded pilot and demonstration facilities can help to rapidly test promising findings from funded R&D projects in market-like environments, such as regulatory sandboxes, and, if necessary, enable their rapid scaling. Regulatory sandboxes can play an important role in testing circular economy innovations in practice. A reliable framework must be established for this purpose. Federal investment programmes can also support direct transfer to the market.

Promoting transfer to education and training programmes

The Federal Government is committed to working with stakeholders to establish cooperation formats in the education sector by involving the Standing Conference of the Ministers of Education and Cultural Affairs. Improved cooperation and communication between universities, non-university research institutions, chambers of industry and commerce, the Federal Institute for Vocational Education and Training (BIBB) and other actors can ensure the continuous integration of new R&D findings into relevant education and training programmes, thereby ensuring that they are up to date.

Supporting young researchers and taking the circular economy into greater account in Education for Sustainable Development and in science communication will ensure that current trends also find their way into civil society discussions.

3.9.2 Measures

The Future Strategy provides the overarching research policy framework. It is equipped with specific goals, missions and milestones. The circular economy is prominently addressed within its own mission: Resource-efficient and competitive industry based on a circular economy. The Future Strategy is implemented through interministerial cooperation and updated regularly.

Research into the circular economy is anchored as a cross-cutting theme in several third-party funding programmes at the **BMBF**. This means that collaborative research projects generally involve funding for both industry and the scientific community. The focus here ranges from high-risk technological developments to demonstration plants. Aspects such as standardisation, rebound effects, implementation barriers, necessary social innovations and new business models may also be considered.

Within the **Research for Sustainability Strategy (FONA Strategy)** the BMBF allocated approximately 150 million euros between 2018 and 2023 for digital technologies, new business models and eco-efficient product design aimed at extending and intensifying product use, as well as closing material cycles through the recycling of priority waste streams (construction materials, minerals, ash, metals, plastics and textiles). To enhance resource recovery from anthropogenic stock, the Urban Mining funding measure will be launched in 2025, focusing on the economically viable recovery of untapped secondary raw material potential from mining heaps, waste incineration ash, slag, buildings and infrastructure, alongside the development of planning and management tools for anthropogenic stock.

The **Resource-efficient Circular Economy research measure** will be further developed, with increased emphasis on critical raw materials, recycling technology advancements and design for circularity. European research collaboration will be supported through the future European Raw Materials Alliance (ERMA).

Under the Future of Value Creation programme, the BMBF takes a holistic look at circular value creation. In addition to technological innovations, this includes aspects of networking and cooperation, business models, value propositions, the role of people in value creation and dynamic change.

The National Bioeconomy Strategy (NBÖ Strategy) supports the bio-based renewable component of a sustainable circular economy by funding projects and initiatives on new bio-based materials, products and services under a unified framework. It always focusses on value creation, including through new production organisms, principles and processes, leveraging in particular the beneficial properties of many biogenic resources for integration into natural cycles (for example, carbon, nitrogen and phosphorus cycles).

Through its ongoing materials research programme From Materials to Innovation (2015-2024) and its upcoming successor programme currently being developed, the BMBF also supports measures to enhance resource efficiency and recyclable material design and to ensure circularity by considering entire process chains, from materials development to component manufacturing and application demonstration. The materials hub initiative MaterialNeutral – Resource Sovereignty through Material Innovations promotes material developments aimed at improving resource and material efficiency. Additionally, substitution concepts will be drawn up to develop alternatives for critical and scarce raw materials.

The contribution of individual material innovations to sustainability improvements will be facilitated through the development of indicators and agile, interdisciplinary and digitally supported R&D. The necessary digital transformation of experimental materials research into a standardised digital framework is being advanced through the BMBF's MaterialDigital initiative, which uses ontologies to semantically describe materials, associated processes, equipment and machines.

Depending on the material, circularity presents various logistical and technical challenges regarding the economically efficient collection, automated reusable material and process documentation, processing, recycling and use of recycled content. This requires seamless, standardised data collection and documentation of materials and processes in the cycle in order to improve transparency and traceability in the product life cycle. Established tools such as the national research data infrastructure (NFDI), the Platform MaterialDigital (PMD) and the initiatives Industry 4.0 and Manufacturing-X should be leveraged or integrated into future solutions.

Additional specialist programmes support the closure of existing value chains in line with a sustainable, economical and material- and energy-efficient circular economy. In battery technology, the BMBF applies this approach as a guiding principle in the Battery Research Framework (Dachkonzept Batterieforschung). Funding priorities include the processing and production of battery materials, components and cells, as well as research into scaling and digitalisation within resource-efficient battery cycles. R&D activities span the entire value chain to establish "use-optimised" value creation in batteries that are "Made in Europe", ensuring that raw materials, battery components and complete batteries are designed from the outset with future use and reuse in mind and are digitally traceable and manageable. In addition to material flows, energy flows and available data must also be optimised for this purpose.

Research in the field of circular economy is also conducted through institutional funding. For example, the Helmholtz Institute Freiberg for Resource Technology is exploring the concept of a potential FlexiPlant, enabling pilot-scale research into the recovery of technology metals using flexible, automated and digitalised processing technologies.

At the Fraunhofer Institute for Materials Recycling and Resource Strategies (IWKS), innovative processes are continuously being developed in areas such as magnetic materials, energy materials, bioeconomy and resource digitalisation.

Alongside overarching research programmes and institutional funding relating to circular economy overseen by the BMBF, other research initiatives fall under the remit of different ministries. A selection of key measures is presented here, with additional research activities of the ministries detailed in the specific sections.

BMUV Environmental Innovation Programme

The Environmental Innovation Programme (UIP), implemented on behalf of the BMUV, will be further developed in line with circular business practices and the promotion of innovative demonstration projects will be strengthened.

DigiRess funding programme

A focus of support will be on strategic metals as part of the Digital Applications for Improving Resource Efficiency in Circular Production Processes (DigiRess) funding programme, which is to be continued and expanded.

Consolidating and developing the special prize in Resource Conservation and Resource Efficiency – Young Researchers

The BMUV will further develop the special prize in Resource Conservation and Resource Efficiency into a special prize for circular economy and award it permanently at the regional, state and federal levels of the competitions Jugend forscht (Young Researchers) and Schüler experimentieren (school students experiment). The special prize is currently awarded in cooperation with the Education for Resource Conservation and Resource Efficiency (BilRess) network to projects that address the careful and efficient use of natural resources. By recognising projects that affect the lives of young researchers, the award aims to highlight the importance of this topic while also promoting education and skills around resource conservation.

BMUV AI lighthouse projects initiative

Circular economy research and innovation funding will be strengthened within the framework of the BMUV AI lighthouse projects initiative.

Improving funding

Government start-up funding will be provided for R&D, pilot systems and processes for the recovery of critical raw materials and technology metals.

Digitalisation for more circular production

It is essential to examine and promote further opportunities for the development of innovative digital technologies and business models in circular economy, especially for start-ups and their cooperation with established companies for more innovations.

Environmentally sound development and use of biogenic raw materials

To this end, biotechnological R&D approaches, for example, are being supported which will help to improve the recovery of waste and residues and return the resources they contain (nitrogen, carbon, phosphorus and others) to material cycles.

Optimising disposal of photovoltaic (PV) systems

Support should be provided to further research projects addressing the recovery of silicon, indium and gallium from PV modules in order to make economic processes market-ready. In addition, the development of processes for high-quality recycling should be supported for new PV technologies such as building-integrated modules, perovskite solar cells and PV films or modules.

Improvement and capacity building of metal recycling processes

A funding programme should be launched on the introduction of new technologies for the recovery of metals from slag and ash.

Technology Transfer Programme for Lightweighting

With the Technology Transfer Programme for Lightweighting (TTP LB), the BMWK is funding market-oriented R&D projects until 2027, taking into account closed material cycles in lightweight construction, which lead to significant CO_2 savings, particularly in the industrial and transport sectors. This is achieved through the development of new approaches for efficient resource use, the substitution of greenhouse gas-intensive resources and resource-efficient processes throughout the entire life cycle. To increase resource efficiency, the TTP LB integrates the principle of circular economy into production processes, enabling previously untapped savings potential to be utilised in the future.

International research collaborations

Within the Eureka Network, international cooperation will be intensified in order to develop solutions for the challenges of circular value creation along transnational and cross-continental value chains. This will be further enhanced, for example, under the German-Canadian EUREKA Presidency (1 July 2024 to 30 June 2025).

3.10 Qualifications and training

3.10.1 Current situation

Building competencies through the transfer of knowledge, skills and abilities by training stakeholders along the material cycle forms the foundation for a transition to a circular economy. This requires embedding technical, economic, environmental and social know-how, particularly in vocational training and education, and must begin in early childhood education, school education, vocational training and higher education.

It is also important to create an understanding of the need for circular economy practices and the value of resources and waste in all areas of society, both nationally and internationally. Therefore, vocational and adult education must place greater emphasis on the corresponding topics through training, continuing education and information, for example via consumer advice centres, supported by information campaigns.

3.10.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

The goal is to strengthen the necessary competencies in circular economy and resource efficiency. To achieve this, as many actors as possible, both within and outside the education system, must be involved to embed the principles of resource conservation and circular economy in the various educational areas (school education, vocational training, higher education and further education) and in politics, business, social partnerships and civil society. Since the Federal Government is not responsible, or not solely responsible, for many of these areas, we aim to engage in dialogue on the following topics with the relevant actors as part of the platform (see Section 7.2):

- **Adapting training structures and content** in vocational training to the new requirements of the circular economy, taking into account relevant qualifications along the entire cycle – particularly product development and design, skilled trades and industrial, technical and commercial competencies. A new standard occupational profile for environmental protection and sustainability should be created, along with an appropriate revision of vocational training programmes.

- A stronger network of **relevant actors in the education landscape** in order to create a nationwide dialogue about existing obstacles, potential incentives and successful approaches, for example, by utilising the existing Education for Resource Conservation and Resource Efficiency (BilRess) network, which also develops materials particularly for school education.

- The expansion and consolidation of **qualifications, supplementary training, further education and advisory services** by various educational providers for employees and managers to support the transformation of companies and administrations.

- The development and consolidation of **training and information offers in adult education** and all socially relevant sectors such as sport and voluntary work, in order to raise awareness of the efficient use of resources and requirements for the circular economy, for example as part of the BMUV Circular Euro 2024 project.

3.10.3 Measures

Strengthening skills profiles in curricula and study regulations and promoting new job profiles

Capacity building, particularly in the area of public procurement with the involvement of the Competence Center for Sustainable Public Procurement (KNB), including by embedding the topic of circular economy in the study regulations of the Federal University of Applied Administrative Sciences. Selected occupational profiles play a key role in the transition to a circular economy. Public awareness initiatives can enhance the attractiveness of training for skilled workers and encourage the trend towards green professions. With regard to training regulations and standard occupational profiles, the activities of the Vocational Education for Sustainable Development Project Agency (PA-BBNE), supported by the Federal Ministry of Education and Research (BMBF), can serve as a foundation.

Adapting framework curricula for the circular economy

Given the various responsibilities and measures of the Federal Government, Länder, the Federal Institute for Vocational Education and Training (BIBB), social partners and other stakeholders, it is appropriate to initiate a process to reach a common understanding of potential goals and options for action. In dialogue with all relevant stakeholders, the prerequisites and options for action can be explored with regard to incorporating content and modules related to the circular economy in training regulations, framework curricula, examination regulations and related teaching and learning arrangements and materials for vocational training programmes.

Supporting interdisciplinary exchange between institutions and stakeholders in the educational landscape

The Education for Resource Conservation and Resource Efficiency (BilRess) network will be continued and expanded to include content focussing on circular economy. Additionally, activities to raise awareness, strengthen networks and facilitate knowledge exchange will be intensified. Interdisciplinary exchange between educational institutions and pedagogical stakeholders (from primary through to adult and lifelong learning) will be reinforced.

Promoting and strengthening training and continuing education opportunities for company employees and consultants

The Federal Government supports the continuation of the work of the Competence Center for Resource Efficiency and its thematic expansion to include circular economy practices. Through training courses for employees in companies, the manufacturing sector and chambers of industry and commerce, and for consultants on resource efficiency and circular economy, the Competence Center imparts knowledge and key methods for analysing potential and implementing measures. This supports both the continuation of established training programmes and the practical implementation of measures.

Training and continuing education on the circular economy equip employees with the necessary knowledge and enable businesses to build essential expertise. A broad dialogue among all stakeholders is sought in order to mobilise all relevant education providers and programmes on training, additional vocational training, continuing education and consultancy for employees and managers. This is particularly true for trade unions, which, due to their presence in workplaces through works councils and employees, play a central role in the acceptance and implementation of continuing education measures.

3.11 Waste prevention and recovery

3.11.1 Current situation

Comprehensive circular economy legislation, including ordinances and acts that set specific requirements for certain waste streams, creates a framework in Germany for the consistent implementation of the goals pursued with the circular economy.

A key element, including for the implementation of the polluter pays principle, is producer responsibility, which has been established for the waste streams packaging, waste electrical and electronic equipment (WEEE), end-of-life vehicles, waste batteries and single-use plastic products.

We have succeeded in transforming waste management, which was initially focused solely on waste disposal, into a modern circular economy aimed at preventing waste and promoting its recovery. Its contribution to sustainable economic production in Germany is reflected not least in the exemplary shares of material recovery, saving raw materials and primary energy. The next step is to further develop the circular economy from a life cycle perspective.

To reduce demand for primary raw materials, it is essential to prevent waste from arising in the first place, increase resource efficiency throughout the entire life cycle, from raw material extraction, product design and production to the use phase and recycling, and to promote the use of secondary raw materials.

This can only be achieved by complying with the waste hierarchy outlined in the Circular Economy Act (KrWG) and the EU Waste Framework Directive. This waste hierarchy is structured in descending order as follows: 1. Prevention, 2. Preparing for re-use, 3. Recycling, 4. Other recovery, in particular recovery of energy and backfilling, 5. Disposal. The top priority is therefore the prevention of waste, both in terms of its quantity and its harmfulness. The Federal Government already focuses on this first tier of the waste hierarchy, prevention, and sets the goal in the NCES to reduce per capita municipal waste, which amounted to 613 kg in 2020,[75] by 10 percent by 2030 and by 20 percent by 2045.

This is an ambitious goal, but considering the waste prevention targets for specific material flows that are currently being discussed or have already been agreed upon at national and international levels, it appears achievable. In the area of food waste, the UN Sustainable Development Goal (SDG) 12.3,[76] to which Germany has committed alongside other EU member states, sets concrete reduction targets: By 2030, global food waste per capita at the retail and consumer levels is to be halved compared to the reference year 2015, and food losses along production and supply chains, including post-harvest losses,

are to be reduced. In trade, out-of-home catering, and private households, food waste is to be reduced by 50 percent. Further-reaching targets for reducing food waste are currently under discussion at EU level as part of the revision of the EU Waste Framework Directive. The forthcoming EU Packaging and Packaging Waste Regulation (procedure (2022/0396)[77] requires member states to reduce per capita packaging waste by five percent by 2030 compared to figures reported by the Commission for 2018. A 15 percent reduction is targeted for 2040.

For effective waste prevention, products should be designed to be durable and repairable. Additionally, waste can be avoided by extending the service life of products through reuse until the end of their service life and by preventing the destruction and disposal of consumer products that are still fit for use. Furthermore, systems should be established across the board to enable shared and multiple use of products, such as rental and leasing models.

Waste prevention also includes the deployment of reuse systems. By 2045, reuse systems in the packaging sector should be established nationwide. However, the overall environmental impacts, such as increasing freight traffic, must be considered. Reuse systems should therefore be regional and participate in pooling solutions to avoid long transport routes. The aim is to achieve the statutory target of 70 percent of beverages in reusable packaging by 2045 through the promotion of regional reuse systems participating in open or closed bottle pools. A good overview of measures for waste prevention, which address not only public authorities but also business, industry and consumers, is provided by the Waste Prevention Programme (AVP) of the Federal Government involving the Länder and its update.

To promote preparation for reuse as the second tier of the waste hierarchy for waste from private households, a comprehensive infrastructure is required, along with appropriately trained personnel to systematically assess waste for its suitability for preparation for reuse. Currently, this is only implemented sporadically in bulky waste collection and recycling centres. Producers and holders of commercial waste, in particular, should also be required to assess their waste for its potential to be prepared for reuse. The necessary framework must be created for this, including legal regulations (for example, for waste wood).

Recycling aims to provide high-quality secondary raw materials and, through the use of recycled content, directly contribute to the reduced use of primary raw materials while preserving non-renewable deposits of critical raw materials (such as phosphorus), especially given an increasingly tense geopolitical situation. For phosphorus recovery from sewage sludge, investment certainty and a legally secure financing option will be ensured by 2026 in coordination with the Länder, for example via wastewater charges.

The basis for high-quality recycling is the consistent separate collection of waste, both in the private and commercial sectors. Significant efforts are still required in both sectors regarding information and enforcement by the Länder and municipalities (see the obligations under section 46 of the Circular Economy Act, KrWG). Another essential aspect of recycling is the exchange of information between product manufacturers and recyclers regarding certain properties and substances of concern in products to ensure that these are specifically considered or removed during recycling, where technically feasible and compatible with the aim of conserving resources. Additionally, recycling infrastructure must be further expanded around the country to ensure high-quality recycling without long transport

routes. This is particularly relevant for material flows that are not expected to occur in larger volumes until further into the future, such as lithium batteries from electric mobility.

Other recovery, in particular recovery of energy – the penultimate tier of the five-tier waste hierarchy – may only apply to waste that cannot be considered for higher-quality material recovery. The same applies to the amount of waste to be disposed of.

Environmental protection and a circular economy must not end at the borders of Germany or the EU. Therefore, cooperation with the Global South must be further expanded to establish structures for waste collection and treatment there. The models established in Germany and the EU can serve as examples of good practice.

Further development of circular economy law

The instruments of circular economy law need to be further developed to better achieve the goals of the Circular Economy Act (KrWG). To this end, the Federal Government is already promoting many legislative projects at national and European level. Important projects include:

- More high-quality recycling of used electrical appliances to keep valuable resources in circulation: An amendment to the Electrical and Electronic Equipment Act (*Elektro- und Elektronikgerätegesetz*, ElektroG) will make it easier for consumers to return their used appliances to retailers. This includes significantly improved consumer communication. To reduce fire risks from lithium batteries in electrical waste, the amendment will also improve battery removal at collection points, ensuring more batteries are collected and treated separately in future. Other measures to reduce fire risks from lithium batteries, which present challenges to the waste management industry, are being reviewed. Following the amendment of product-related regulations on batteries and end-of-life vehicles at European level, the Commission has also announced the timely revision of the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU. In this context, quality requirements for the recycling of waste electrical equipment, such as material-specific recycling targets, will also be discussed.

- Better use of the recycling potential of commercial waste: An amendment to the Commercial Waste Ordinance (*Gewerbeabfallverordnung*, GewAbfV) will make the ordinance more stringent and enforceable, strengthen the official monitoring of the separate collection of commercial municipal waste and construction and demolition waste, and secure achievement of the recycling target in the pre-treatment stage. The goal is to make better use of the recycling potential of commercial waste.

- The forthcoming EU Packaging and Packaging Waste Regulation (procedure (2022/0396)) aims to significantly reduce packaging waste by 2040, establish uniform recycling criteria, achieve greater harmonisation of packaging within the internal market and set recycled content targets. The regulation is expected to be adopted by the European Parliament and Council by the end of 2024. It will enter into force 20 days after publication in the Official Journal, with the first provisions applying 18 months after its entry into force.

- The rules of the forthcoming EU Packaging and Packaging Waste Regulation will also provide a boost for more reuse solutions. Through sectoral dialogue with industry, we aim to create an alliance to further increase the share of reusable packaging and support industry in establishing, improving and expanding reuse systems that are as user-friendly as possible.

- To reduce uncertainties for business, industry and authorities, clear rules are needed on when materials and objects lose their waste status and regain non-waste status. For high-quality mineral substitute construction materials that can replace primary construction materials, a corresponding end-of-waste ordinance is planned to provide legal certainty on the determination of release from the waste regime. A second step will formulate the scientific foundations for requirements for the safe use of recycled construction materials in buildings and for their end-of-waste status.

- In accordance with the polluter pays principle, not only waste producers but also manufacturers of products should increasingly be held responsible. The existing provisions for extended producer responsibility (referred to as product responsibility under German law, see section 23 et seq. of the Circular Economy Act, KrWG) must be continuously reviewed and further developed, particularly with a view to promoting recycling-friendly design. Due to the EU internal market, this approach must primarily be pursued at European level (for example through product-specific provisions in waste legislation or, in future, the Ecodesign for Sustainable Products Regulation, ESPR). The goal must be to ensure products are durable, repairable and recyclable and, at the end of their life cycle, can be processed through high-quality recycling, thus making a life cycle approach the standard in European legislation. In the long term, producer responsibility should also be extended to other waste streams; the current proposal for a revision of the EU Waste Framework Directive already includes textiles. The focus should be on high-volume waste streams that offer potential for raw material recovery as well as those where proper recycling contributes to pollutant removal.

- Advocate taking circularity into consideration in the European Emissions Trading System (ETS), so that the incentives are created to use CO_2 where economically viable and conducive to achieving greenhouse gas neutrality.

Challenges and solutions

Strengthening the circular economy in the long term demands action at different levels. This includes harnessing previously untapped recycling potential. This can be achieved by considering and regulating additional waste streams and their separate collection (for example, tyres and floor coverings). Additionally, even where regulations already exist, further efforts are needed to improve the separate collection of waste for high-quality recovery. This applies, for example, to biowaste, waste wood, commercial waste, bulky waste, textiles and waste electrical and electronic equipment.

A central component of this effort is raising public awareness of waste prevention and the importance of proper waste disposal. Given the already overwhelming amount of information in daily life, Länder and municipalities need to develop, standardise and expand information services so that consumers can access clear and comprehensive guidance easily.

Another challenge for the proper and safe recovery of waste arises from insufficient information sharing regarding the presence and concentration of certain substances of concern in products, from manufacturers to waste processors. Improving this exchange of information is crucial, particularly through the further development of the SCIP database,[78] ensuring that waste processors can easily and efficiently access the information relevant to them.

For certain material flows, circular economy goals can only be partially achieved through waste legislation. This means that these objectives must also be given greater consideration in other, related legal areas. Harmonising waste law with legislation governing non-waste materials can help resolve conflicts of objectives and unlock further circular economy potential. For example, selective dismantling, embedded in building code regulations, can support the preparation for reuse and recycling of construction and demolition waste while also facilitating the targeted removal of pollutants such as asbestos.

Legal provisions are only effective if their enforcement is adequately ensured. To guarantee compliance with legal requirements both within Germany and across the EU, legal provisions will be reviewed where necessary, formulated in a way that ensures enforceability in future and backed by sufficient personnel capacity for enforcement. Additionally, it should be considered whether, in some cases, consolidating enforcement responsibilities under a single authority could enhance the efficiency of legal enforcement. Against this backdrop, discussions should take place with the Länder to explore ways of strengthening and harmonising the enforcement of both existing and new circular economy measures. This would also contribute to ensuring a level playing field in international trade.

4. Priority areas for the transformation

4.1 Action areas

The action areas outlined below do not cover all aspects relevant to the transition to a comprehensive circular economy. Instead, they focus on topics that should be prioritised because of significant material flows or strong circular economy potential. The measures presented here were discussed or introduced as part of an extensive participatory process involving participants from business, civil society, environmental and consumer protection associations, and the Länder.

4.2 Digitalisation and circular economy

Digitalisation plays a key role in the successful implementation of the circular economy.[79] Digital technologies enable and drive circularity in Germany and globally. The Federal Government closely cooperates with partner countries in the Global South to establish digital solutions and product passports worldwide (see Section 6). Transparency in the value chain is a key prerequisite for many circular economy measures and strategies. Physical material flows must be linked with digital data streams, allowing the life cycles of materials and products to be tracked across the stages of value

creation. This enables analysis and ultimately optimisation of material flows and resource use. Additional potential emerges for new circular economy business models, such as product-as-a-service offers and specific digital solutions and platforms. These can promote sustainable consumption and strengthen repair and reuse, help to influence the throwaway mentality and waste disposal behaviour and strengthen markets for secondary raw materials, keeping resources in circulation. Data and knowledge about real material flows and the impact of circular economy strategies and measures are also the basis for effectively monitoring progress, and evaluating and developing policies.

To establish Germany as a technological leader in digital circular economy, specific measures will leverage the potential of digitalisation for the circular economy in the following areas:

Laying the foundations for the digital circular economy: enhancing transparency for products, material flows and resource consumption with digital product passports and data spaces

The digital product passport (DPP) was initiated by the European Commission. It is mandated in the EU Batteries Regulation for introduction from 2027, defined in the Ecodesign for Sustainable Products Regulation (ESPR), and included in draft regulations for toys, detergents and construction products. Over the coming years, nearly every industry will equip products and materials with interoperable DPPs based on EU rules for specific product groups.

The DPP is intended as a central information carrier in a digitally supported circular economy. It integrates datasets on materials and products, including on composition, repairability and recyclability, which can be shared and processed digitally across value chain stakeholders. Throughout a product's life cycle, these datasets will be supplemented with further information on product use, such as records of completed repairs. The conceptual development of the DPP and enabling technologies is currently underway. In addition to regulatory requirements on the core elements – data carriers, unique identifiers and a central registry – publicly funded projects at federal and EU levels are developing concrete aspects of the DPP. An EU standardisation request, led by the German Institute for Standardization (DIN), will define the necessary standards by the end of 2025 (see Section 3.4).

Increasingly, data is being exchanged within industrial supply relationships between suppliers and buyers, forming circular economy data spaces. This applies to DPPs as well as specific segments of industrial supply chains and aggregated sector and industry analyses. The goal is therefore to create a decentralised, interconnected knowledge repository for circular economy through these data spaces, enabling data-driven collaboration and scaling effective systemic solutions.

The introduction of the DPP and development of data ecosystems offer new opportunities for the system-wide analysis of material and goods flows. The prerequisite is that data from different sources can be linked together and evaluated, for example with regard to specific materials, critical raw materials and the proportion of product groups or circular services. Business confidentiality and data protection must be ensured. It is important to note that in global value chains, international standardisation must be achieved through norm-setting efforts and the comparability of analysis and measurement data.

The German economy, building on Industry 4.0 technologies, has laid important groundwork for implementing the DPP. However, many businesses and sectors will require further support to adopt it.

The objective is to establish information and data systems for a fully developed digital and circular economy in Germany by 2030, making it easier for businesses to exchange relevant information.

Measures

To achieve these goals, the following measures, among others, are required at national or EU level.

A **Digital Product Passport Initiative** to link the introduction of DPPs with suitable data space concepts, such as those being developed in Manufacturing-X based on Industry 4.0. This initiative will prepare and implement funded pilot projects (DPP lighthouse projects) in key sectors (including plastics, textiles, electronics, packaging, batteries and vehicles, construction and buildings) to gather practical experience and build competencies. To enable diffusion and scaling of data space solutions, DPP-specific use cases will be designed and tested in the DPP lighthouse projects, with the involvement of SMEs. To avoid duplication of efforts, implementation should align with Manufacturing-X, where initial DPP use cases have been and are being tested. The lighthouse projects will collaborate in a joint body, similar to the Manufacturing-X Guidance Board, to coordinate consistent and cross-industry development. Coordination with the Manufacturing-X Guidance Board should take place.

To support the introduction of product passports, accessible offers and services should be developed as part of specific funding programmes, especially for SMEs. Information and funding opportunities for SMEs should also be strengthened at EU level.

Circular-friendly design of the DPP in cooperation with the European Commission and the European Parliament within ongoing EU regulation of product groups, ensuring effectiveness and proportionality at the sector level (in terms of costs and complexity).

Establishment of a **Coordination Office for Circular Economy Information Systems** as part of the platform supporting implementation of the NCES (see Section 7.2). This office will coordinate stakeholders to ensure consistency and compatibility of data flows and applications in the context of the future DPP, fostering transparency and transfer of experiences.

Digitalisation for climate change mitigation and resource conservation in design and production

The design and construction phase at the beginning of a product's life cycle is particularly important for circularity, determining material selection, material reduction, repairability and recyclability (see Section 3.2). Digital design and construction tools facilitate assessment of various supply chain and material options, for example, when supported by AI in conjunction with easily accessible and continuously improving material data. Digital solutions enable complex, multi-criteria design tasks and optimisation problems to be solved with the goal of maximising resource efficiency. They also enable virtual engineering to incorporate downstream R-strategies from the outset by modelling them as a digital twin (for example, repair, refurbish, remanufacture and repurpose). This enables the modelling of products and processes as digital twins, facilitating a holistic, forward-looking simulation of the economic and environmental performance of circular solutions throughout their entire life cycle.

In production, Industry 4.0 digital tools offer numerous opportunities for optimised control of machinery and systems, such as minimising downtime, improving temperature management and

preventing waste and rejects. Digital twins of facilities and processes also provide new possibilities for cross-cutting optimisations.

Measures

- Launch of a best practice initiative for circular economy design tools with developers and providers of design and construction tools, and development of standards with stakeholders for the effective use of digital tools for circular design (where appropriate, this could include open-source solutions for use by specific stakeholder groups, such as within the European market).
- Research funding for AI, including generative AI, to design and optimise circular products and processes (including opportunities to enhance resource efficiency through 3D printing and circular lightweight construction).
- The BMUV intends to initiate targeted research projects, including internationally oriented projects, conducted by the German Environment Agency (UBA) that will expand the environmental reference data basis (life cycle assessment data) and develop methods for the prospective use of future DPP data so that independent, quality-assured environmental data is available in the DPP.

Aligning value creation with circular economy: Facilitating data-based management of circular business models

In the target vision of a circular economy, a single, uniform and consistent data basis within a company is used for all processes related to corporate planning, management and reporting.

Measures

The BMWK will support pilot projects for a toolbox on Integrated Corporate and Production Planning for Circular Economy and its integration into business software through best practice initiatives by industry and software providers. The toolbox will be aligned with Industry 4.0 and Manufacturing X to ensure compatibility and interoperability with existing planning systems.

Initiatives to strengthen digital circular economy competencies in vocational and higher education, as well as concrete educational modules developed in cooperation with the Länder, will be further advanced (for example, learning content on computer-aided design and engineering as well as circular value creation and corporate management).

Additionally, research and innovation funding in this area will be strengthened, for example as part of the BMUV AI lighthouse projects initiative.

Making the circular economy easier in everyday life: Using digitalisation to promote sustainable consumption, extend product lifespans and strengthen repair and reuse

Digitalisation increasingly shapes household consumption and can therefore become an important lever for climate change mitigation, environmental protection and resource conservation in daily life. In digital consumption, platforms and online trade currently use advertising (often personalised), social media influencing and purchasing process design to repeatedly create new consumption incentives, some of

which have negative environmental impacts. A key approach is therefore to provide user-friendly access to information relevant to the circular economy, for example at the point of purchase, especially for online shopping (market transparency). Digital assistance systems such as apps can also help consumers search and evaluate consumption options or assist them with everyday needs, for example by providing care guidance or automatic maintenance reminders. Digital platforms can enable shared use of products in a sharing economy or their continued use as second-hand goods.

Measures

To achieve these goals, the following measures, among others, are required at national or EU level.

As part of the development of the DPP, linking products in online trade with information on circularity, particularly on repairability. This will provide the basis for corresponding comparison portals.

Further levelling the playing field between brick-and-mortar retailers and online businesses in terms of the distributor and information obligations under the Electrical and Electronic Equipment Act (ElektroG). Creating improved information and advisory services for consumers, including through consumer advice centres, to prepare them for the introduction of the DPP and enable them to use the data. This also includes highlighting repair options, continued use and recycling as part of environmental education.

Online platforms and fulfilment service providers will play their part in ensuring that only products meeting European requirements and for which manufacturers have accepted producer responsibility are placed on the German market.

Developing a concept for digital solutions and measures to comprehensively support sustainable consumption for the circular economy. This includes purchasing decisions as well as extending product lifespan during use. Existing developments, such as AI-based voice assistants, will be included. A key focus will be advancing platforms for resource-efficient products, services such as repair and sharing, and offer of second-hand products for use across regions. Measures will also be developed to improve access to quality-assured information, for instance through certificates and environmental labels.

Keeping resources in circulation: Using data to influence the throwaway mentality and waste disposal behaviour and strengthen markets for secondary raw materials

At the end of the use phase, digitalisation can support commercial and private users in preventing waste. A key focus is on the interface between private households or small businesses and the waste management sector, in order to reduce the loss of valuable raw materials in residual waste fractions. In business operations, digitalisation helps to optimise logistics and route planning and to identify and classify waste.

During the processing and recycling of collected residues, digital information facilitates the tracking and identification of material flows for the recycling industry, improves sorting technology efficiency and enhances recovery quality. Therefore, the establishment and further development of these processing systems must be promoted, alongside the advancement and establishment of digital trading platforms as key channels for marketing quality-assured, certified secondary materials and linking the recycling sector with downstream producers.

Support for pilot projects to improve digitalised waste separation, for example using AI applications through competition prizes for municipalities or as part of communication and mobilisation campaigns.

Together with the waste management sector, we aim to advance digital verification, process documentation and quality certification for recycled content. This will also serve as a foundation for digital trading systems in all major material flows (see Section 0).

Making the circular economy measurable: data for monitoring progress

The transition to a circular economy is a long-term process that must be regularly reviewed to allow adjustments to changing conditions.

To enhance market transparency, the introduction of the DPP will include enabling an anonymised cross-sectional analysis of data on the use of secondary raw materials in selected product groups, while ensuring that date and relevant property rights are protected. These data will be processed by the German Mineral Resources Agency (DERA).

DPP data should also be used to strengthen market surveillance and enforcement within Europe.

This will be supported by new research projects to quantify data on the progress of implementation and trends in areas such as repair and refurbishment, for monitoring purposes.

4.3 Circular and resource-efficient production

4.3.1 Current situation

Alongside product design, which sets the course for a circular and low-resource product life cycle and largely determines manufacturing technologies, further frameworks are necessary for production processes in order to optimise them in terms of resource efficiency and circularity. The Federal Government therefore introduced the German Resource Efficiency Programme (ProgRess) in 2012 and has since updated it. This includes measures to improve resource efficiency in production and already incorporates measures for circularity within and between companies.

Measures for resource efficiency and circularity in production address the following obstacles:

- Implementing resource efficiency and circular production measures in day-to-day business operations is often not considered due to short-term costs and a lack of time and personnel capacity. Where measures are implemented in businesses, there is often no established methodology to measure their effectiveness.

- There is a lack of product- and process-specific information for the development and implementation of effective design-for-circularity solutions enabling high-quality circularity that is on an equal footing with the linear use of primary raw materials.

- For businesses, secondary materials in sufficient quantities and quality are often either not yet available in economically viable quantities or their availability is too volatile and uncertain to be

incorporated into design specifications and material procurement routines for high-volume quality production. This situation prevents the creation of corresponding market demand.

- The absence or volatility of key secondary material markets creates high business risks and uncertainties, discouraging the necessary investment in more sophisticated sorting, processing and recycling technologies.

4.3.2 Ongoing national and European initiatives

Various regulations and current initiatives form an important basis for measures to implement the above objectives:

- The existing EU Ecodesign Directive and its development into the Ecodesign for Sustainable Products Regulation (ESPR), including requirements for circularity, recycled content and information obligations such as the digital product passport.
- EU-wide product responsibility systems enshrined in waste legislation, their national implementation under the Circular Economy Act (KrWG), and their further development.
- Standardisation of recycled materials at the EU level through norms and within the Standardisation Roadmap Circular Economy developed by the German Institute for Standardization (DIN), German Commission for Electrical, Electronic & Information Technologies (DKE) and the Association of German Engineers (VDI).
- The revision of EU regulations on Best Available Techniques (BAT) reference documents (BREFs) and the Industrial Emissions Directive (IED), particularly BAT conclusions and their implementation in German law, embedding circular economy practices in operator obligations in plant permitting.

4.3.3 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following objectives are defined for the NCES implementation period up to 2030:

- Promoting targeted measures to improve resource efficiency and circular production, particularly through digitalisation in small and medium-sized enterprises.
- Providing targeted information and necessary training on technological options for resource efficiency and circularity through the Circular Economy Competence Centre.
- Supporting the development and application of a sound methodology for simple, unbureaucratic measurement of circularity within and between companies.

- Developing comprehensive quality standards that also draw on the standardisation needs identified in the Standardisation Roadmap Circular Economy for all secondary raw materials and overarching input specifications for all high-volume recycling routes by 2030, with parallel transfer to the European level.

4.3.4 Measures

To achieve these goals, the following measures, among others, are required at national or EU level.

The proposed measures involve adjustments to frameworks in order to enable circular production processes and the management of materials in circular production. All measures and instruments are closely interconnected:

Supporting investment in recycling and resource efficiency

In keeping with circular economy principles, the BMUV Environmental Innovation Programme (UIP) will increasingly support innovative demonstration projects, including UIP lighthouse circular economy projects.

Suitable federal funding programmes will be reviewed to determine whether they can be further developed or, where appropriate, prioritised in terms of the circular economy.

The introduction of a new fund that ensures equal access for businesses of different sizes and structures will be considered for finance pilot and demonstration plants.

Supporting the transition of industry to a circular economy through digital technologies

Continuation, consolidation and expansion of the successful funding programme Digital Applications for Improving Resource Efficiency in Circular Production Processes (DigiRess) beyond 2025. This will support industrial companies, particularly SMEs, in leveraging digital solutions for the circular economy and facilitating a successful transition to circular, resource-efficient production and value creation processes. Additional funding options will be reviewed to develop innovative digital technologies and circular economy business models, particularly for start-ups and their collaboration with established businesses to drive innovation.

Accelerating investment in circular economy

Decisions to accelerate planning and approval procedures (including through the Pact for Germany between the Federal Government and the Länder) will also speed up investment in the circular economy. Through the Circular Economy Platform, dialogue with businesses and experts will identify additional barriers and explore targeted ways of removing them in order to accelerate the transition to a circular economy. We also want to initiate an investment and innovation campaign in collaboration with industry. A clear legal and economic framework will provide planning certainty. As a complementary measure, the draft Regulatory Sandboxes Act (*Gesetz zur Verbesserung der Rahmenbedingungen für die Erprobung von Innovationen in Reallaboren und zur Förderung des regulatorischen Lernens*, ReallaboreG), which aims to improve the framework for testing innovations in living laboratories and promotes regulatory learning, will also be used for investments in the circular

economy, leveraging the potential of regulatory sandboxes to accelerate the testing and market introduction of key innovative technologies.

Creating market transparency on resource efficiency in different primary and secondary material production routes

To highlight resource efficiency across different primary and secondary production routes and enable informed market choices, relevant metrics are required. Metrics that are still missing will be developed in a research project. These will quantify the resource input needed to produce, for example, one tonne of a given material.

Support for competition law-compliant coordination among manufacturers to ensure standardised methodologies for the transparent identification and data transparency of resource efficiency metrics for defined materials, creating a level playing field across different material routes.

With the ProBas database at the German Environment Agency (UBA), such data will be made available free of charge, regularly updated and expanded. This will include data that enable the calculation of greenhouse gas emissions reductions, which is relevant for some federal and Länder funding programmes.

Targeted further development of product responsibility schemes

The quality of secondary raw materials depends on applicable standards. At European level, discussions must explore whether, in addition to volume-based targets, quality requirements for sorting fractions should also be embedded in the manufacturer's product responsibility.

Mandatory requirements should be established in collaboration with plant operators, secondary raw material suppliers and potential buyers to define input specifications for recycling processes as part of product responsibility obligations.

In addition, discussions at the EU level must explore whether product groups not currently subject to product responsibility should be covered under specific regulations, such as implementing acts under the Ecodesign for Sustainable Products Regulation (ESPR).

Embedding circularity in corporate strategies: integrating circular and resource-efficient production into environmental and sustainability management systems

Circularity must be taken into account in corporate strategies. Environmental and sustainability management systems, such as the Eco-Management and Audit Scheme (EMAS) and DIN EN ISO 14001, enable businesses and organisations to systematically identify circularity potential and opportunities to reduce resource consumption, while raising employee awareness.

Further development and campaigns to encourage more businesses to introduce environmental and sustainability management systems and integrate existing standards into their operations.

Further development of advisory and training services, especially for SMEs

Further development and continuation of existing advisory services, such as those provided by the VDI Center for Resource Efficiency (VDI ZRE), as SMEs in particular require targeted support in developing and implementing circular and resource-efficient products and production processes.

Similar to resource efficiency, industry-specific checklists, training and advisory services will be developed for circular products and production processes. Better coordination and further development of existing Länder programmes with federal initiatives to enhance effectiveness.

Launch of a training campaign for circular technologies and business models in collaboration with industry. This initiative is also to be developed, implemented and expanded in dialogue with the Länder.

Establishing a European Circular Economy Knowledge Center for advising SMEs

Work at EU level to leverage existing structures and networks (such as the European Circular Economy Stakeholder Platform and the Circular Cities and Regions Initiative (CCRI). The aim is to strengthen networking, knowledge transfer and visibility of institutions, initiatives and activities at national and regional levels in Europe, with the goal of establishing a European Circular Economy Knowledge Center. This will focus on technical expertise and supporting tools and activities for business model innovation, drawing on experiences gained from the European Resource Efficiency Knowledge Centre (EREK).

Efficiency standards for harnessing the potential of materials, including circular materials

Development of suitable material efficiency requirements in the IED/BREF implementation process, particularly through best available techniques (BAT) conclusions, and their incorporation into plant operator obligations for plant permitting.

Support for ongoing information exchange, including on best practices on improving the efficient use of materials and raw materials and the direct and indirect recovery of by-products and processing residues. A dialogue on this will also be established with the Länder. If the results of best practices are incorporated into BAT conclusions, the general operator obligations under section 5 of the Federal Immission Control Act (*Bundes-Immissionsschutzgesetz*, BImSchG) can be specified in more detail in the plant permitting procedures and the implementation of corresponding measures prescribed.

4.4 Vehicles and batteries, mobility

4.4.1 Current situation

The vehicle stock in Germany in 2023 consisted of 48.8 million passenger cars and 3.6 million lorries. On average, there are around 1.1 passenger cars per household.[80] Two trends can be observed that run counter to the principles of resource conservation and circular economy. Firstly, the share of large, heavy passenger cars and sport utility vehicles in new registrations continues to rise steadily.[81] Secondly, the number of electronic devices and equipment installed in passenger cars is also increasing. The German Association of the Automotive Industry (VDA) puts the share of secondary materials in new cars

at around 30 percent.[82] Alternative business models to private car ownership currently play only a minor role. At the beginning of 2024, the Bundesverband Carsharing e.V. (German carsharing association, bcs) recorded just over 5.5 million participants in carsharing schemes in Germany.

In the medium to long term, battery electric vehicles are expected to account for the majority of passenger cars and light commercial vehicles as a result of the EU fleet limit adjustment, which mandates that only zero-emission vehicles may be registered from 2035. The design, durability and circularity of batteries will be key to the sustainability of electric mobility in road vehicles. This includes electric vehicle and starter batteries (lithium-ion and future battery systems) as well as batteries in devices and light vehicles (LV batteries) and the raw materials they contain, including critical and strategic raw materials.

The following barriers hinder a circular economy in vehicles and batteries:

- The repair network for electromobility-specific components in battery electric vehicles is currently inadequate. In addition, there is a lack of economically and environmentally sustainable guidance on repair and/or partial replacement of damaged batteries, particularly for independent workshops.
- Forecasts on the development of waste battery return volumes (both collected waste batteries and battery production waste) vary widely, increasing the risk for circular business models. At the same time, the investment costs for building and equipping plants are very high (up to 100 million euros), and secondary materials face strong competition from primary raw materials, which are, on average, available at lower prices and enjoy greater market acceptance.
- Construction often involves non-recyclable materials and inseparable material compounds or composites.
- The location of a significant share of permanently decommissioned vehicles remains unclear. For more than ten years, approximately 150,000 end-of-life vehicles per year have likely been dismantled by unauthorised companies or illegally exported. Systematic enforcement must be strengthened in order to stop illegal vehicle exports, so that decommissioning end-of-life vehicles is only possible with a certificate of destruction and collection points must be authorised recycling facilities.

4.4.2 Ongoing initiatives at national and European level

The following regulations and initiatives are currently in preparation and provide important frameworks for the objectives of the NCES in the area of vehicles and batteries. These conditions will be taken into account when implementing the NCES:

- At European level, the new Batteries Regulation (EU) 2023/1542 was published at the end of July 2023. For the first time, the EU Batteries Regulation takes into account the entire life cycle of batteries; the sustainability of the manufacturing and waste phases will be considered together in future. Among other things, the regulation sets minimum recycling targets and minimum recycled content targets for certain metals and introduces a digital battery passport. To ensure smooth

alignment between the EU Batteries Regulation and Germany's complex legal framework, the existing German battery legislation needs to be adapted. The Federal Government has therefore approved a proposal for an act to align national battery law with EU regulations. This is intended to replace the previous Batteries Act (*Batteriegesetz*, BattG) with a Battery Implementation Act (*Batterierecht-Durchführungsgesetz*, BattDG). In particular, responsibilities, procedural regulations and additional requirements for the management of waste batteries are clarified.

- In July 2023, the European Commission proposed a comprehensive revision of the EU End-of-Life Vehicles Directive with the new End-of-Life Vehicles Regulation (ELVR), formally titled the Regulation on circularity requirements for vehicle design and on management of end-of-life vehicles.[83] This proposal includes provisions to improve circular vehicle design and facilitate better dismantling of components, introduces mandatory recycled content targets for plastics and plans recycled content targets for metals (once further studies have been completed). The regulation also aims to enhance the recovery of end-of-life vehicles through more stringent requirements for the separation and recovery of vehicle components. A digital vehicle passport is planned to record repair and dismantling information. Incentives, including economic incentives, will be introduced to promote reuse, remanufacturing and refurbishment. It is hoped that the collection of end-of-life vehicles will be improved through: the introduction of a digital certificate of destruction, which must be sent to the registration authority when an end-of-life vehicle is deregistered; the definition of clear criteria for differentiating between used and end-of-life vehicles; and requirements for the export of used vehicles. The Commission proposal for a regulation to improve the circularity of the automotive industry will also be extended to other vehicle classes.

4.4.3 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- **Significantly increasing the recyclability of passenger cars:** in EU negotiations under the ELVR, Germany supports requirements for vehicle longevity, repairability and high-quality recycling of individual materials.

- Expanding the well-functioning legal **market for used spare parts**, continued use of the market, including by insurance companies, and effective adjustment of the market to the **transition in drive systems**.

4.4.4 Measures

Design for circularity of vehicles (durability, repairability and recycling)

The Federal Government supports the requirement in Article 9 of the European Commission's proposed ELVR for manufacturers to develop circularity strategies. It will work to ensure these strategies include

take-back concepts, specific provisions on the longevity and repairability of vehicles and all key components, the use of secondary raw materials (for both plastics and metals) and regular consultations with representatives from dismantlers, waste disposal operators and recyclers.

Establishing a platform for circular battery design

Establishing a platform for circular battery design in collaboration with industry, trade unions and the scientific community. The aim is to use battery design as a key lever to improve both secondary use and recyclability. A broad, participatory approach will be taken to define specific steps for improving circular battery design (for example, for electric vehicle batteries, which represent the largest market segment). To ensure the platform is established as quickly as possible and as recommended by the Alliance for Transformation the first implementation project will build on existing preliminary work such as the Circular Economy Initiative Deutschland (CEID), the Battery Pass and the platforms of the VDMA (the German association for mechanical and plant engineering) and the German Electro and Digital Industry Association (ZVEI). The platform's activities will be coordinated and harmonised with those of the Länder.

Strategic planning for recycling electric vehicle batteries

Under reporting obligations for producers and waste management operators set out in the EU Batteries Regulation, data will also be recorded on waste electric vehicle batteries regarding quantities that have been collected, prepared for reuse or repurposing and recycled. Data access and evaluation should enable forecasts of future capacity needs for recovery. Information on battery lifetime is particularly important here. This strategic knowledge helps ensure planning certainty for the necessary recycling and collection infrastructure. This also allows comparison between theoretical and actual waste battery take-back rates. Data on collection scheme efficiency can be used to assess suitability and improve incentive schemes. This can also help prevent new batteries that have not yet been used in a vehicle from being recycled, for example because the storage time has been exceeded or new battery systems have been introduced). Concepts and business models for second-life applications (such as remanufacturing, reuse, repurposing, or preparation for reuse or repurposing) of electric vehicle batteries should be further developed. Recycling processes must also ensure that the black mass obtained remains within the European market.

Improving information on the location of vehicles, including end-of-life vehicles / preventing illegal recovery and exports

Improving transparency regarding the location of vehicles, including end-of-life vehicles. Appropriate and proportionate measures will be developed to prevent a situation where the location of large numbers of permanently decommissioned vehicles cannot be determined, as is currently the case. These vehicles are consequently not being processed in accordance with the EU End-of-Life Vehicles Directive and the German End-of-Life Vehicles Ordinance (*Altfahrzeugverordnung*). New measures will also help secure the business operations of numerous accredited small and medium-sized dismantling businesses.

Further development of end-of-life vehicle recovery through separation requirements and metal removal obligations

Germany has consistently met the weight-based recycling targets for end-of-life vehicles for many years. However, higher-quality material fractions must be produced from vehicle recovery (as pure as possible and suitable for long-term circular use). It is therefore necessary to assess whether further requirements should be introduced for removing components (such as printed circuit board fragments and magnets) in dismantling facilities and whether obligations to remove metals from shredder residues should be implemented and enshrined in law.

4.5 Information and communication technology (ICT) and electrical and electronic equipment

4.5.1 Current situation

The use and lifespan of electrical and electronic equipment have declined in recent years, while repair rates remain consistently low. As a result, the quantity of electrical and electronic equipment placed on the market has steadily increased. In 2022, it reached 3.26 million tonnes, double the amount of a decade earlier (2013: 1.6 million tonnes). The annual collection rate for waste electrical and electronic equipment (WEEE) has remained well below the current statutory collection target of 65 percent in recent years. In 2021, the collection rate was only 38.6 percent. High collection losses mean that the total yield of secondary raw materials is much lower than potentially possible.[84]

Among the obstacles to implementing the circular economy for electrical and electronic equipment, the prevailing market conditions and cost structures play a key role. Equipment prone to failure, software obsolescence, new technology trends and consumer demand for new products drive increasing consumption of electrical and electronic equipment. Repairs are often not carried out due to factors including design features that prevent repair, poor product quality and poor conditions for independent repair businesses. High repair costs compared to the purchase price of new, often cheaper products and the low residual value of the product to be repaired discourage consumers from choosing repair. Additionally, a lack of care during collection and take-back, as well as incomplete pre-treatment, separation and sorting of waste devices and their fractions, result in inadequate removal of pollutants and separation of recyclable materials. This limits the optimal recovery of materials and leads to sorting errors. The recovery of raw materials (some of which are critical and strategic) is not economically viable under current recycling methods, especially when these materials are present in low concentrations.

4.5.2 Ongoing national and European initiatives

The following regulations and initiatives are currently in preparation and provide important frameworks for the objectives of the NCES.

EU Ecodesign for Sustainable Products Regulation (ESPR): This regulation replaces the Ecodesign Directive and expands its scope to cover most products, introducing requirements for material efficiency, durability, reusability, repairability, recycled content and information obligations, including a digital product passport (DPP). Negotiations on individual measures for product groups are expected to begin by late 2025. The ESPR also makes it possible to prohibit the destruction of unsold products (overstock and returns) and introduce a reporting obligation on these products.

Electrical and Electronic Equipment Act (ElektroG): In line with the coalition agreement, a revision of ElektroG is planned for the current legislative period. The Federal Government presented a draft revision on 16 October 2024. The revision aims to increase collection rates for waste equipment, minimise fire risks associated with improper handling of battery-containing devices, improve the recovery of resource-relevant metals and plastics during the treatment of waste equipment and promote preparation for reuse.

4.5.3 Goals

Extending the lifespan and use of electrical and electronic equipment is the most important lever in reducing environmental impact and raw material demand.

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Design for circularity is the key principle for electrical and electronic equipment. Equipment is fundamentally designed to maximise technical longevity and lifespan, support reuse, enable repairs, and facilitate remanufacturing, repurposing and recycling in order to ensure materials remain in circulation for as long as possible.
- Cycles should be as closed as possible while reducing negative social impacts across the supply chain.
- Software and security updates are available for an adequate period of time, and software and hardware are upgradeable.
- Electrical and electronic equipment is used and reused by consumers for a long time.

4.5.4 Measures

To achieve these goals, the following measures, among others, are required at national or EU level.

Promoting design for circularity

Design to enable a stronger focus on circular economy principles, including repairability, durability, easy access to repair information, avoidance of hazardous substances, easy access to and replacement of components, spare parts, batteries and parts containing pollutants, use of recyclable materials and recycled content, use of material combinations and forms of assembly which, where technically feasible, allow for easy disassembly and separation of individual parts. As part of the ESPR, support for overarching measures that facilitate the cross-manufacturer use and interchangeability of parts in ICT products, such as batteries, standardised ports and power adapters. This extends product lifespan, reduces the overall number of components that have to be offered, and facilitates the repairability and availability of spare parts .

Strengthening the reuse of ICT and electrical equipment

Public procurement has significant market influence and a role model function in many submarkets. In reviewing a potential revision of the federal procurement guidelines (AVV Klima und Umwelt – the General Administrative Regulation on the Procurement of Climate- and Environmentally Friendly

Services), taking into account outcomes from the public procurement reform package, prioritising the procurement of used and remanufactured ICT and electronic products will also be considered (see Section 4.11).

It should also be examined whether public sector organisations could reintegrate their waste devices into circulation, (such as by participating in refurbishment platforms or donating devices to schools and non-profit organisations).

The market for refurbished electrical equipment is growing, but its share of the total market remains low. To strengthen this market and provide consumers interested in second-life devices with clear product identification, reliable quality seals are needed.

Support for the introduction of a quality seal by suppliers of refurbished electrical equipment, helping consumers identify suitable reuse options. To ensure that these seals can also be used in public tenders, procurement regulations should also be taken into consideration.

Societal awareness of the importance of extending product lifespan and use of electrical and electronic equipment is increasing, contributing to higher collection and recovery rates. Numerous, mostly private initiatives play a key role in this shift and will be supported, for example mobile phone collection schemes (for example, at ALBA Berlin or in schools).

Consideration should be given to how existing quantity monitoring systems can be further developed as a basis for future regulatory measures.

Strengthening circularity at end-of-life

Separate collection, sorting and recovery must be improved in order to ensure that valuable materials from ICT and electrical and electronic equipment are properly reintegrated into material cycles at the end of their technical lifespan or when no longer used due to consumer preferences.

Collecting more waste equipment separately, in a way that avoids as much damage and destruction as possible, first requires strengthening enforcement, which also falls under the responsibility of the Länder, of the ElektroG and the Commercial Waste Ordinance (GewAbfV). In addition to ensuring easily accessible collection infrastructure and raising consumer awareness, this includes reducing illegal exports of waste electrical and electronic equipment (WEEE) and facilitating intra-European shipments in preparation for reuse and recycling. This will help keep reusable or recyclable devices, components and materials in circulation in the internal market (see analogous measures in Sections 4.4 and 4.6).

Improving recovery of waste electrical and electronic equipment

In connection with the upcoming revision of the WEEE Directive, Germany should support the option of more extensive requirements for the treatment of WEEE, particularly to promote high-quality recycling, are considered. This includes, for example, material-specific recycling targets and minimum recycled content targets. In this context, discussions should also explore whether and how eco-modulation within extended producer responsibility (EPR) could be introduced at European level to create incentives for circular ICT and electrical and electronic equipment.

A key supporting measure is the promotion of R&D, particularly for open innovation models. Open-source hardware increases transparency and accessibility, making it easier to maintain, repair, remanufacture and recycle ICT and electrical and electronic equipment. For its part, open-source software can enhance hardware longevity by supporting long-term compatibility with software. Consideration should be given to whether existing funding programmes could support the development and scaling of open innovations, or whether new funding measures should be introduced specifically for this purpose.

4.6 Renewable energy systems

4.6.1 Current situation

To meet the established climate targets in Germany, a massive expansion of renewable energy generation is required, with at least 80 percent of gross electricity consumption to be covered by renewables by 2030. In particular, a tripling in the expansion rate of wind turbines and photovoltaic (PV) systems is planned, which will also result in a significant increase in demand for raw materials. This includes concrete, steel and composite materials for wind turbines, as well as glass, aluminium and metals such as silicon for PV modules. In order to integrate fluctuating energy generation, electricity grids and storage options must also be massively expanded, further increasing demand for raw materials.

Given supply risks and the strategic importance for the European economy, some raw materials, including technology metals, are classified as critical under the Critical Raw Materials Act (CRMA) or as strategic due to their relevance for environmental, digital and defence technologies.[85] As a result, high-quality recovery of these raw materials is becoming increasingly important. The revised Buildings Energy Act (*Gebäudeenergiegesetzes*, GEG) includes the provision that from mid-2028 at the latest, all newly installed heating systems must operate with at least 65 percent renewable energy. In new-build areas and larger cities, this requirement will apply even earlier. As a result, heating systems such as heat pumps will increasingly replace oil and gas heating, helping to decarbonise heat supply. This will reduce demand for raw materials such as copper, steel and aluminium for fossil-based heating systems while initially increasing demand for heat pumps.

The status quo of circularity in renewable energy systems varies significantly depending on the raw materials used: for copper and, in some cases, aluminium there are well-established, high-quality recycling cycles; glass, on other hand, is often downcycled; and, at the other end of the spectrum, for materials such as indium from PV modules and fibre-reinforced composites in wind turbine rotor blades, recovery is still linear and low value – high-quality recycling has so far not progressed beyond pilot projects due to a lack of economic viability. While technical solutions have been extensively researched, they have yet to reach market maturity or commercial viability.

With a technical lifespan of around 20 to 30 years for installations such as wind turbines and PV modules, and the beginning of a significant expansion of these technologies driven, in particular, by the 2000 Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz*, EEG), a very sharp increase in the volume of waste is expected in the coming years, both for PV modules[86] and wind turbines. Infrastructure must

now be established or expanded to ensure the proper take-back and environmentally sound and high-quality recovery of these installations. The existing legal frameworks differ significantly between the various technologies: PV modules fall under ElektroG and are therefore subject to product responsibility, including shared responsibility, whereas operators of wind turbines are required to set aside appropriate reserves for dismantling.

Recycling requirements for different wind turbine components fall under various general and specific regulations, including the waste hierarchy under section 6 of the Circular Economy Act (KrWG), the GewAbfV, the Waste Oil Ordinance (*Altöl-Verordnung*) the Battery Act (BattG) and the Secondary Construction Materials Ordinance (*Ersatzbaustoffverordnung*, ErsatzbaustoffVO). Heat pumps may fall under the scope of the Waste Electrical and Electronic Equipment Directive[87] or the national ElektroG.

Manufacturers are fundamentally responsible for disposal, treatment and recovery. However, as large-scale, fixed installations (or devices) heat pumps may be exempt from ElektroG and instead their disposal is subject to Circular Economy Act (KrWG) regulations. Fluorinated greenhouse gases (F-gases), such as hydrofluorocarbons (HFCs), used as refrigerants must be recovered by system operators under the F-gas Regulation[88] so that they can be recycled, reprocessed or destroyed. The Chemicals Climate Protection Ordinance (*Chemikalien-Klimaschutzverordnung*, ChemKlimaschutzV) requires manufacturers and distributors of F-gases to take them back or ensure they are taken back.

Barriers to the circularity of raw materials in renewable energy systems are complex and, as shown, vary greatly between the individual raw material groups and applications. For instance, high recycling rates are already achieved for mineral construction materials such as concrete in wind turbines, but the challenge lies in incentivising the highest possible recycling quality and preventing downcycling (see Section 4.8). Wind turbines pose particular challenges in relation to rotor blades, The potential for lightweight construction in this regard is an important factor in the rapid ramp-up of wind energy production. At the same time, the high-quality recycling of glass-fibre-reinforced plastics (GFRP) is generally not yet economically viable, meaning that glass fibres are, for example, often used as raw materials in cement clinker production in cement plants.[89] Carbon fibres from carbon-fibre-reinforced plastics (CFRP) can be recovered using pyrolysis, but plant capacity must be scaled to match projected waste volumes.[90] There is also considerable uncertainty regarding the materials used in rotor blades.[91] Additionally, there is generally still a lack of economic incentives for the separate collection of permanent magnets used in direct-drive wind turbines, so they are often processed together with steel scrap and and therefore not reused.

The careful dismantling, transport and proper collection of PV systems and modules are key requirements for (preparation for) reuse or high-quality recycling and recovery of raw materials such as glass or technology metals, including critical and strategic metals, like silicon, indium and gallium. In addition, there is a lack of practical requirements, criteria and application guidelines to support decisions on whether a module or end-of-life module can still be used as a functional second-hand device, can be prepared for reuse as a waste management measure, or should be recycled. Particularly with regard to the disposal of end-of-life PV modules in private use, both the general public and the trades companies contracted to dismantle them often still lack awareness of the correct way to dispose of them or incentives to return them to designated collection and take-back points. There is also often

a lack of suitable infrastructure at the waste collection points run by the public waste disposal authorities. The limited quantity of end-of-life modules is also a barrier to the large-scale and economically viable implementation of recycling processes, particularly for thin-film modules. There is also evidence of illegal shipments abroad of modules that are, in fact, end-of-life modules.[92] Moreover, product design is not yet optimised for dismantling and material separation. Multi-layer composite structures must be designed in a way that does not prevent repair, high-quality recycling and recovery of critical raw materials. Promoting safe and sustainable design, including in terms of application, is therefore of the highest priority.

Heat pumps and switchgear in PV systems and wind turbines pose particular challenges due to the use of high-climate-impact F-gases, which must be recovered under the F-gas Regulation and subsequently recycled, reprocessed or destroyed. While EU-wide regulations and obligations govern the take-back, disposal and treatment of heat pumps falling under ElektroG, there are currently no specific disposal regulations (for example take-back structures) for heat pumps that do not fall within its scope.

4.6.2 Ongoing national and European initiatives

Renewable energy systems are being addressed in various European and national initiatives. The European WEEE Directive, which has been transposed into national law through ElektroG, establishes binding recycling targets for PV modules and heat pumps and is currently in the consultation phase for revision. At national level, the Ordinance on the Treatment of Waste Electrical and Electronic Equipment (*Elektro- und Elektronik-Altgeräte-Behandlungsverordnung*, EAG-BehandV) [93] sets out initial requirements to enhance circularity in the initial treatment and recycling of PV modules, as well as for electrical equipment and components of electronic equipment in general (for example, components of heat pumps that fall within the scope of ElektroG). The European Commission is also developing regulatory proposals for PV modules, inverters and complete PV systems.

A working group on heat pump circularity is currently being established at the International Energy Agency (IEA) to explore approaches for optimising the circularity of these installations at the international level. The industry has also taken up the issue, and in some cases has made or announced voluntary commitments towards zero waste by 2040.

4.6.3 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

In the field of renewable energy systems, there are various targets that need to be balanced appropriately. Given the goal of achieving greenhouse gas neutrality by 2045, a significant increase in the expansion of renewable energy is necessary. In this context, particular emphasis should be placed on ensuring high-quality material cycles, especially for critical and strategic technology metals. This will directly contribute to resource conservation and climate action while also strengthening the resilience of supply chains in the renewable energy sector.

National and European objectives:

- Recovery of critical raw materials from wind turbines and PV modules, in line with the targets of the Critical Raw Materials Act (CRMA).
- Development of technological standards for scaling uptake-back infrastructures.
- High-quality recovery or reuse of decommissioned rotor blades by 2040.
- Development and implementation of concrete indicators for assessing the recyclability of products and their components by 2030.

4.6.4 Measures

The following measures and instruments at national and EU level are necessary to achieve these objectives for wind turbines, PV modules and heat pumps. Other technologies, such as energy storage systems and biogas plants, which also play a substantial role in expanding renewable energy, will be examined in greater detail as part of the continued implementation of the NCES.

To improve transparency regarding the materials contained in wind turbines (particularly rotor blades), PV modules and heat pumps, as well as their processing, at European level Germany will support the introduction of a digital product passport for these renewable energy systems. This would ensure the availability of relevant information.

A European regulation is needed to establish uniform recovery concepts for installations and components that are predominantly manufactured in Europe or internationally. Manufacturers shouldtake into account the eventual decommissioning or refurbishment of their products from the planning and construction phase of new installations. This should include plans and documentation specifying aspects such as which materials and components are used and where, which external suppliers were selected, the extent to which problematic substances and parts were avoided, how the installation, its components and materials should ultimately be dismantled, disassembled and disposed of, and what costs are to be expected for subsequent dismantling and disposal.

4.6.5 Measures: Wind energy installations

Promoting circular installation design

To strengthen circularity in individual components of wind turbines that are not yet (or cannot be) recycled to a high standard, steps should be taken to promote product design that is more aligned with circular principles. To this end, at European level (and ideally internationally) in dialogue with installation manufacturers, Germany will support the development of standards for rotor blade design, such as dismantling capability and the clean separation of fibre-containing components. This will build on DIN SPEC 4866, in which relevant concepts are already being developed in collaboration with industry. This DIN SPEC should be incorporated into international standardisation processes in the near future. The BMWK supports relevant technological developments as part of the energy research programme.

Optimising recycling

While incentives for circular product design will only apply to newly installed wind turbines, optimised dismantling and recycling processes are needed for the rapidly increasing number of decommissioned installations in the coming years.

To this end, secondary legislation will be adopted stipulating that carbon fibre-reinforced plastic (CFRP) waste may not be disposed in waste incineration plants and may not be used for energy recovery in cement kilns, or only if certain requirements are met. In parallel, the introduction of quality requirements for recycling facilities handling rotor blades and for specialist waste management companies handling fibre-containing waste is being considered. The Länder should be consulted in order to coordinate new and further measures. One of the aims of this is to ensure that regional regulations are further developed in line with the NCES. However, this must not result in such waste being consigned exclusively to landfill.

At the same time, therefore, targeted research funding is required for innovative recycling processes for glass fibre-reinforced plastic (GFRP) and CFRP waste, as well as other relevant waste streams (such as balsa wood). The BMWK provides funding for such research as part of the energy research programme.

To promote the recycling of permanent magnets, the implementation of specific measures under the Critical Raw Materials Act (CRMA) will be examined. These could include comprehensive monitoring of product flows, including imports and exports of scrap, the establishment of a collection and logistics system for permanent magnets from relevant sources, the introduction of collection and recycling targets for permanent magnets, or support for facilities for the reuse and recycling of permanent magnets.

Beyond recycling, innovative applications for reuse or repurposing of individual components will also be promoted, for example through demonstration projects. Rotor blades, for instance, could be reused as structural components in noise barriers, production halls, stages, observation towers or floating offshore platforms. This reuse approach could cut carbon emissions and costs,[94] while giving the rotor blades a second life of 10 to 20 years, during which time innovative recycling methods could be further developed.

4.6.6 Measures: Photovoltaic modules

Extending the lifespan of photovoltaic modules and promoting circular installation design

PV modules have a long technical lifespan, but have often not reached the end of their functional life when support is discontinued and modules or entire PV systems are dismantled. The aim must therefore be to extend the service life of modules through second-life measures, in other words, the repair and reuse, or preparation for reuse, of used or end-of-life PV modules. This will lower consumption of primary raw materials and resources and reduce environmental impacts. To support this, a digital documentation guide will be developed to identify and present procedures for handling disused modules to be dismantled and to establish clear and verifiable criteria for this. In future, this will be based on data from digital product passports to be developed for PV modules. As a central element of

the guide, practical checklists, verifiable criteria and instructions for action will simplify the distinction between waste and non-waste, which will also help reduce and prevent illegal (waste) treatment and shipments.

Strengthening producer responsibility will be reviewed, including the possibility that in future, the mandatory registration of a PV installation with the Bundesnetzagentur (federal network agency, BNetzA), will include a legally binding registration number[95]. This measure should not increase administrative burden (it could be implemented in an automated manner) but will ensure that only legally compliant and safe modules are put into operation and that manufacturers do not evade their organisational and financial responsibility for end-of-life disposal.

The NCES will also create incentives for circular product design. Current PV modules are highly complex, optimised for electricity generation and minimising efficiency losses, but this complexity often significantly hinders recycling. Individual material fractions and components must be designed to be as easy to dismantle and repair as possible, without compromising durability, performance or economic viability of the modules. Germany will work to promote this type of design for circularity at European level.

Optimising disposal

The disposal chain for installed PV modules and existing PV systems, more and more of which will reach the end of their service life in the coming years, will be strengthened, from collection and take-back to initial and further treatment and the recovery of raw materials. To this end, when a PV system is decommissioned, BNetzA will in future automatically send households guidance on the proper and environmentally sound disposal of end-of-life PV modules. Operators of large-scale PV systems and solar parks will also receive guidance on correct disposal procedures. In addition, it will be examined whether specific documentation requirements for the proper disposal of large volumes of waste are necessary, without increasing administrative burden (for instance, through digital and automated processes).

As part of the upcoming revision of the WEEE Directive, consideration will be given to how the requirements for high-quality recycling of PV modules can be further developed. One potential option is the introduction of material-specific recycling targets, which should also align with the objectives of longevity, repairability and reusability of PV modules, as well as uniform EU treatment standards.

Special investment programmes will be promoted to develop and expand recycling capacity (see Section 3.5), particularly for CIGS (copper indium gallium selenide) thin-film modules and crystalline silicon modules.

Further research projects addressing the recovery of silicon, indium and gallium from PV modules will be supported in order to make relevant economic processes market-ready. The development of high-quality recycling processes will be supported for new PV technologies such as building-integrated modules, perovskite solar cells or PV films or modules.

To support the proper disposal of PV modules that are no longer in use, the opportunities and risks of different models will be examined. Additionally, guidance on disposal will be developed and more widely communicated to skilled trades companies and associations, as well as end users.

4.6.7 Measures: Heat pumps

The potential for resource efficiency in heat pumps varies significantly. A distinction must be made between small household systems and large heat pumps used in industry and district heating networks. Small household systems exist in greater numbers and represent a larger market. The following measures focus on small heat pumps.

Promoting circular installation design

Heat pumps are already generally recovered separately due to the value of their materials. However, given the scaling needed for the energy transition, incentives should also be introduced for circular design, focusing on system upgradeability and the repairability of individual components. This is also crucial for enabling consumers to use their heat pumps for as long as possible. Germany will work at European level to support this.

At the same time, targeted support will be provided to research projects that build on findings such as those from IEA SHC Task 71[96] on life cycle assessments of heat pumps and IEA (Heat Pumping Technologies) HPT[97] on circular economy approaches.

Supporting circular business models

The transition to circularity in heat pumps will depend on supporting appropriate business models that ensure the most efficient use and high-quality circularity of systems (for instance, in the context of Heating as a Service).[98]

Potential regulatory barriers, such as those affecting contracting models compared with traditional distribution structures, will be examined and addressed, particularly with regard to necessary take-back systems (reverse logistics).

To further support the scaling of heat pumps, a monitoring system will be established to determine whether adjustments to product responsibility are needed.

Developing an optimised disposal system

In practice, heat pumps are often not disposed of in accordance with the requirements of ElektroG. This is often due to a lack of awareness, market structures or to the fact that (large) heat pumps (and fixed installations) may fall outside the scope of ElektroG, meaning disposal follows a different route (which may not always be appropriate or environmentally sound). To ensure proper disposal of heat pumps, guidance will be developed and more widely communicated to skilled trades businesses and associations, as well as end users. Additionally, it will be examined whether mandatory take-back schemes could help improve circularity for products, individual components or raw materials.

4.7 Clothing and textiles

4.7.1 Current situation

Each year, nearly 19 kg of textiles per person are consumed in Germany, amounting to a total of 1.56 million tonnes. Around 1 million tonnes are collected as waste textiles.[99] Consumer spending on clothing and footwear in Germany reached approximately 77.7 billion euros in 2022 and, with few exceptions, has risen continuously over the past 30 years [100] – mainly due to fast fashion. This exacerbates the problems associated with textile production and waste, leading to increased greenhouse gas emissions, higher consumption of chemicals and their environmental impact, increased use of fertilisers and growing water extraction.[101] This environmental issue particularly affects countries in the Global South that produce textiles and import used textiles. Additionally, social challenges associated with this industry persist in production countries, including child labour and low-wage workers.[102]

The obstacles to implementing circularity in the textile sector are highly diverse. Market conditions and cost structures play a key role. Fast fashion textile products are primarily imported by large buyers from countries with low labour costs and weak labour and environmental standards and are sold at low prices. Moreover, an increasing number of textiles are supplied directly to consumers via online platforms from third countries. Circular business models often cannot compete with this global supply market. Low prices for new goods, fast fashion designs and limited willingness or ability to repair textiles and use second-hand items lead to the low appreciation of textiles in society. Furthermore, there are insufficient incentives for technical innovations and investments at the end of a textile's life cycle. Most manufacturers still rarely incorporate circularity into their designs. To establish functioning circularity, it is important to focus on longevity, durability, reusability and repairability in textile production, integrate circularity into textile design and ensure the flow of information among textile suppliers, brands and textile recyclers along the supply chain regarding these and other relevant aspects, such as material composition. At present, this flow of information is often inadequate. Improvements are needed.

German manufacturers and research institutions are leaders in Europe in the field of technical textiles. The circular economy is increasingly gaining importance in this area as well, with opportunities to be leveraged, for instance, through cross-cycling (processing textiles for high-quality applications in other sectors).

4.7.2 Ongoing national and European initiatives

A number of key measures are currently being discussed and developed in legislative initiatives, many at EU level. The most relevant include:

- The EU Strategy for Sustainable and Circular Textiles (2022) sets out a framework and vision for a sustainable and circular textile sector by 2030. This is currently being implemented through various horizontal legislative acts.

- The EU Ecodesign Regulation includes textiles as one of the first product groups for specific regulations (see Section 4.5.2).
- The EU Waste Framework Directive (2008/98/EC) requires EU Member States to prevent waste generation. A proposal for a targeted revision of the Waste Framework Directive, presented by the European Commission in July 2023, includes extended producer responsibility for textiles, textile products and footwear from households, with environmentally graded fees.
- From 2025, the Circular Economy Act (KrWG) will require the separate collection of textile waste and textiles for reuse.
- A proposal for a new EU Textile Labelling Regulation, announced for 2025, aims to improve fibre labelling for textiles, set specific requirements for the digital product passport and simplify the transfer of future information requirements along the value chain.
- The revised EU Waste Shipments Regulation introduces stricter rules on the export of textile waste.

4.7.3 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Increase the number of businesses engaged in selling or renting clothing and textiles primarily for reuse, as well as the number of employees and revenue in these businesses. Define a quantifiable target by the end of 2025.
- Increase revenue from durable clothing and circular business models.
- Increase the use of recycled fibres in textile production.

4.7.4 Measures

The action area includes not only clothing, footwear and leather goods but also home textiles. Due to the large and growing volumes of clothing, the following measures primarily focus on this area. As a general point, it should be noted that there are currently no sector-specific regulations for textiles. This is now changing with the initiatives outlined in Section 4.7.2, which will play a key role in achieving the objectives set out in Section 4.7.3. It is advisable to closely monitor the introduction and implementation of these regulations and their impact on the internal market. If they do not produce the desired results in the coming years, it must be reviewed whether additional measures at EU and/or national level are necessary and appropriate.

Industry dialogue on circular business models

A dialogue between the Federal Government and businesses on a sector-specific approach to tracking and increasing revenue from durable clothing and circular business models. The use of recycled fibres will also be increased. Technologies for the automated sorting of fibre materials and for removing additives and dyes, for example using enzymes, will be further developed to the point where they are ready for application.

Minimum durability requirements

Advocate EU product regulations for textiles in order to lay down ambitious minimum longevity requirements within the framework of the ESPR and to create conditions for increasing the use of recycled fibres.

Changing awareness and providing information

A cultural shift and change in awareness among consumers is a key factor in transforming the textile sector. To make the sector circular, textiles should be durable and used for a long time. Purchases in the fast fashion segment, which is characterised by low quality and short lifespans, should be reduced. Awareness-raising and information campaigns to promote appreciation for durable clothing, greater visibility and availability of circular services and appropriate corporate communication strategies play a significant role in permanently changing consumption patterns. Such efforts can drive a shift in awareness, ultimately supporting sustainability in the textile sector.

Targeted information and awareness campaigns are required, potentially in coordination with manufacturer and retail associations. Possible opportunities for such initiatives include Repair Day, the European umbrella campaign European Week for Waste Reduction and updates to the Waste Prevention Programme (AVP) of the Federation and the Länder.

Awareness raising among businesses through relevant committees and/or events must also be advanced. Providing information at the point of sale is important for reaching consumers. Additionally, businesses will be encouraged to test and establish new business models, such as product-as-a-service models, which do not depend on increasing new purchases for their economic viability.

Another component of this measure is engagement with municipal institutions, such as the Association of German Cities and local administrations. Joint discussions will be held on ways to increase the visibility and accessibility of circular textile providers in city centres.

Improving textile waste collection and promoting high-quality recycling

A separate collection target for textile waste should be examined going forward. To this end, R&D in logistics, sorting systems, recycling and verification technologies and the further processing of recycled fibres must be supported to increase recycling capacity in Germany. This is a prerequisite for introducing mandatory recycled content targets. Support should also be provided for sorting post-consumer textile waste. Another focus is on start-up funding for pilot plants and demonstration projects in collaboration with EU and non-European partners in order to account for international material flows.

Research support

The following topics are to be considered in future ministerial research by the BMUV:

- Basic and market research on quality and sustainable alternative fibres in textile flows, including end-of-life flows, and their impact on fibre-to-fibre recycling, as well as the compatibility of design for recycling and longevity.

- Incorporating textiles as a product case study in transdisciplinary collaborative research projects, where the practical experiences of stakeholders are integrated into research.

4.8 Construction and buildings

4.8.1 Current situation

In 2020, 584.6 million tonnes of aggregates were produced for the construction industry in Germany, 485 million tonnes of which were derived from primary mineral raw materials.[103] This figure is rising and has significant environmental impacts. Although this demand is offset somewhat by around 220 million tonnes of construction waste, which are generated annually and which could serve as a potential source of raw materials, only 13 percent (77 million tonnes) of the aggregates used each year currently come from recycled construction materials. In terms of total construction waste, 35 percent is used as recycled construction materials. Excavated soil accounts for the largest share of construction waste, exceeding 129 million tonnes per year, with 75 percent being backfilled without prior processing or used in landfills as substitute construction material. A further 14 percent is disposed of in landfills.[104] Compliant and quality-controlled materials for road surface construction make up only a small proportion of commercially available recycled construction materials. The potential to reintegrate secondary raw materials into the economic cycle is not being fully exploited, while landfill capacities are decreasing, disposal costs are rising and the need for action is increasing.

Key barriers to circularity and resource efficiency in the construction and buildings sector include:

- A general lack of information on the materials and substances used in construction.

- Since awareness of reuse, ease of dismantling and recycling was very low at time of construction, it is often not possible or very costly to recover unmixed material flows from secondary raw materials.

- Reviews do not prioritise the preservation of buildings or the potential for continued use of buildings and infrastructure.

- The construction or maintenance of structures and buildings was partly carried out using materials that are now classified as pollutants. These must be reliably removed from the material cycle in accordance with current technical standards.

- Despite the fact that resource-efficient and low-waste products are to be given preference under the EU Construction Products Regulation and the Circular Economy Act (KrWG), tenders by private and public clients do not place sufficient emphasis on the use of secondary raw materials, due to

uncertainties regarding the quality of secondary materials and concerns about the legal certainty of procurement decisions.

4.8.2 Ongoing national and European initiatives

- **EU Construction Products Regulation – revision:** The revision of this regulation includes requirements for standardisation processes to harmonise construction products. For the first time, the European Commission is to be authorised to set binding environmental requirements for construction products at EU level. Additionally, manufacturers will be required to include sustainability indicators from EN 15804 +A2 regarding environmental and climate impacts in the declarations of performance for their construction products. The regulation also provides for future harmonisation of used construction products.

- **Standard specification manual:** The Federal Ministry for Housing, Urban Development and Building (BMWSB), together with the Deutscher Vergabe- und Vertragsausschuss für Bauleistungen (German procurement and contract committee for construction services), will further develop the standard specification manual (Standardleistungsbuch) to ensure greater consideration of reused building components and recycled construction materials in public-sector construction projects.

- **End-of-waste ordinance:** A new end-of-waste ordinance is intended to increase the use of secondary raw materials by defining the conditions under which as many mineral substitute construction materials as possible cease to be classified as waste. Reclassifying these materials as products in this way will improve marketability and support broader use of substitute construction materials, for example in building construction. The protection of human health and the environment must be ensured in this process.

- **Integration of funding components in federal funding programmes:** The BMWK Federal Funding for Efficient Buildings (BEG) programme supports the circular economy through additional funding for buildings that meet the sustainability standard. The BMWSB's new construction funding already incorporates QNG Sustainable Building Certification. Further additions are planned to integrate circular construction methods into the QNG.

- **Timber construction initiative:** The timber construction initiative, adopted by the Federal Cabinet under the lead responsibility of the BMWSB and the Federal Ministry of Food and Agriculture (BMEL), aims to promote construction with timber and other renewable raw materials as an important contribution to climate-friendly and resource-efficient construction.

- **Lightweighting Strategy:** Adopted on 26 July 2023, the Federal Government's Lightweighting Strategy highlights the importance of lightweight construction as a transformative technology. Developed under the lead responsibility of the BMWK, the strategy emphasises the significant potential of lightweight construction in reducing raw material use and greenhouse gas emissions, including in the construction sector.

- **Monitoring of the Secondary Building Materials Ordinance:** The Federal Government is required under the *Mantelverordnung* (a legislative package on secondary construction materials and related areas) to review the impact of regulations on the recovery of mineral waste by 1 August 2025 and to make any necessary amendments. The German Environment Agency (UBA) has therefore launched a research project to conduct scientific monitoring of the use and location of mineral secondary construction materials.

- **Urban mining strategy:** Through the German Resource Efficiency Programme (ProgRess III), the Federal Government has committed to developing an urban mining strategy on how to explore, access and extract materials stored in anthropogenic deposits and prepare recovered secondary raw materials for reuse. The strategy will outline future resource availability and the necessary frameworks, instruments and measures for ensuring the supply of quality-assured secondary raw materials. Twelve action areas have been identified as priorities, including mineral construction materials for buildings, roads and bridges.

- **Round table on future-oriented construction:** In 2023, the BMWSB merged various existing dialogue formats into a round table on Future-Oriented Construction, comprising stakeholders from the construction and real estate sectors, the scientific community, public bodies at the federal, Länder and municipal levels, and environmental and social organisations. This forum facilitates experience sharing on resource-efficient construction, promotes technical innovation and advances circular economy practices. The goal is to lower raw material consumption and maximise resource conservation in order to reduce greenhouse gas emissions.

- **Alliance for Affordable Housing:** In October 2022, the Affordable Housing Alliance, consisting of representatives from the Federal Government, the Länder, local government associations, the housing and construction sectors, and civil society, presented a comprehensive package of measures for a construction investment and innovation campaign to create more affordable housing. The package contains a large number of measures to support the reuse of existing buildings, increase recycling rates in residential construction and expand the use of recycled or reusable building products. Specific initiatives include: the development of a guideline with an evaluation framework for decisions on demolition or replacement new build in order to assess greenhouse gas savings, energy efficiency and resource efficiency over the life cycle; the planned funding programmes Jung kauft Alt (Young Buys Old) and Gewerbe zu Wohnen (Commercial to Residential); and the vacant property activation strategy. All of these measures aim to reuse underutilised buildings and parts of buildings.

- The **Dialogue Platform on Recycled Raw Materials**: The German Mineral Resources Agency (DERA) has developed options for increasing the share of recycled raw materials, including construction materials, gypsum and industrial residues and by-products. Some proposals from the final report have been incorporated into the measures in Section 4.8.4.

- **EU Energy Performance of Buildings Directive (EPBD):** The 2024 revision of the EU EPBD introduces, for the first time, requirements for calculating and reporting the cumulative life cycle emissions (life-cycle global warming potential or GWP) of all new buildings from 2028 (>1,000m²) and from 2030 (<1,000m²). By 2027, national roadmaps must be developed detailing the introduction (from 2030) of maximum limit values and targets for greenhouse gas emissions, with a progressive downward trend. The aim is to significantly reduce both embodied and operational emissions over a building's life cycle.

- **The German Federal Government's Guidelines for Baukultur**: The Federal Government's Guidelines for Baukultur, based on the Davos Declaration Towards a high-quality Baukultur for Europe, aim to promote a high-quality Baukultur in its own areas of planning and construction responsibility and to reinforce its role as an independent participant, promoter and the largest public-sector client in Baukultur. The guidelines set out objectives, action areas and measures for well-designed, climate-neutral and climate-adaptive built environments, with a particular focus on preserving and repurposing existing buildings and protecting resources through the circular use of construction materials.

4.8.3 Goals

Priority is given to the conversion, expansion and continued use of buildings and structures. Where necessary, this is supplemented by new builds designed and constructed in line with circular economy principles and climate-friendly standards. From 2030 onwards, the building stock is constructed in a climate-friendly, circular and resource-efficient manner and digitally documented. Embodied emissions arising from the production and maintenance phases are reduced as far as possible. The flexible conversion and continued use of buildings enables housing options suited to different life stages as well as optimal adaptation to changing requirements for office and commercial spaces. The trend of a steady increase in soil sealing has been reversed. Resource-efficient construction methods are standard in building construction and civil engineering, including the use of renewable raw materials.

Once a building reaches the end of its service life and dismantling is necessary, structures are repurposed in line with a dismantling plan. The range extends from the reuse of buildings or dismantled components, to mechanical or raw material recovery and thermal recovery. The goal is to keep resources in technical cycles for as long as possible. The anthropogenic stock is an important source of raw materials for the construction industry. Whenever possible, building components and materials are reused or processed into recycled materials for construction projects. To this end, they are removed unmixed from buildings and structures during selective dismantling or renovation, and prepared for reuse as functional components and materials for the construction materials industry.

The overarching vision of slowing resource flows and reducing resource consumption in the construction sector can be broken down into the following targets for 2045:

- Conserving primary raw materials by increasing the use of secondary raw materials, in other words, materials generated as by-products of other industrial processes (section 4 of the Circular Economy

Act, KrWG), such as slag, or other mineral substitute construction materials obtained from dismantled buildings and used as recycled construction materials.

- **Prioritising the conversion and continued use of buildings:** The continued use and conversion of existing buildings generally require fewer resources than new construction, which must always be carefully considered. The potential for creating residential and commercial spaces within the existing building stock is maximised through densification, vertical extensions, renovation, conversion and flexible use concepts, supplemented by urban development measures. The regulatory requirements for energy-efficient building renovations have not been further tightened to support the preservation of the existing stock. At federal level, the life cycle approach is consistently implemented in legislation.

- **Circular and low-waste planning of buildings, as well as reuse of building components:** Buildings are designed to facilitate later changes in use and conversions in a way that is as straightforward, climate-compatible and low-waste as possible. A fundamental planning principle is construction that prioritises flexibility and the life cycle while focusing on durability and sustainability in design and material selection. The adaptability of building services (heating, cooling, electrical and data infrastructure) to future challenges over a building's life cycle is factored in. Information related to buildings, including dismantling and reuse, is recorded in the digital resource passport for buildings (*Gebäuderessourcenpass*, GRP). Liability and warranty issues concerning the reuse of building components are clarified.

- **Utilising the material properties of resources through recycling measures:** Recycling takes precedence over backfilling. The targeted inclusion of construction materials with recycled content in tenders for construction services and corresponding requirements for planning services, along with progressively lower maximum life cycle emissions for new buildings, help increase the acceptance, demand for and availability of resource-efficient construction materials. Urban planning also considers the need for sites where materials can be processed close to where waste is generated.

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- The guiding principle set out in Section 2 to reduce primary raw material consumption will be supported by pursuing the indicative target of a significant reduction in the material footprint (raw material consumption, RMC) for the major material flows of mineral construction raw materials by 2045, compared with 2020.

- The use of secondary raw materials in in public construction projects will be increased. A roadmap for implementation will be developed by a specialised body involving relevant stakeholders. To support this, the Federal Government will further develop the Assessment System for Sustainable Building (BNB) and make it available to public authorities. The BNB will define technology-open and

material-neutral requirements regarding environmental impacts and resource consumption based on a life cycle perspective, thereby encouraging the preferential use of secondary raw materials.

- Review the further development of minimum targets for the use of secondary raw materials under the QNG Sustainable Building Certification for non-residential buildings, as well as developing a roadmap for the QNG.

- All proposed measures are subject to the condition that their implementation must not lead to increased construction costs.

4.8.4 Measures

The Alliance for Transformation, led by the Federal Chancellor, has assigned particular importance to the priority area "Circularity in construction, building materials and buildings".

To achieve these goals of the NCES, the following measures, among others, are required at the national or EU level.

Prioritising the preservation of existing buildings over new construction

Establishing the following frameworks:

- Amendment of the statutory fee schedule for architects and engineers (*Honorarordnung für Architekten und Ingenieure*, HOAI): The scope of services will be further developed and fees reviewed. This includes optimising fee regulations for services related to existing buildings to enable appropriate and more practical agreements.

- More data is needed to make better use of the building stock. Currently, there is no standardised national building stock database. However, given its importance for the circular economy and a future urban mining strategy, options for its development must be examined.[105]

Continuing discussions with the Länder on building stock preservation and coordinating possible additional measures and instruments through the relevant Länder ministerial conferences, namely the Conference of Environment Ministers (*Umweltministerkonferenz*, UMK) and the Conference of Building Ministers (*Bauministerkonferenz*, BMK). The aim is to build on the measures already agreed in the Affordable Housing Alliance and identify further measures to achieve the following:

- Assess preservation of existing buildings before replacement new build: develop a guideline with an evaluation framework for decisions on demolition or replacement new build. This will factor in greenhouse gas savings, energy and resource efficiency over the life cycle, and economic proportionality.

- Facilitation of building expansions: Refurbishment projects require adapted regulations. Rules for new buildings must not automatically apply equally to extensions (for example, regarding spacing requirements, fire protection and soundproofing). Existing proposals in this area will be further

developed into a catalogue of recognised standardised compensatory measures to reduce the need for individual case approvals, such as in fire protection.

Promoting buildings that can be dismantled

Establishing the following frameworks:

- **Mandatory introduction of a digital building resource passport (DGRP) to systematically document the materials and products used, their components and installation methods:** This is intended to support resource management and circularity. It will be based on the available environmental information on the building and the materials and products used in its construction. The aim of the DGRP is to aggregate all relevant life cycle data, assess the consumption of primary and secondary raw materials, estimate urban mining potential, and enable the targeted management and analysis of building material flows. The Federal Government has already carried out extensive preparatory work. An initial version of the DGRP is set to be introduced in 2025 as part of the QNG Sustainable Building Certification, with mandatory implementation for new building projects planned thereafter.

- To ensure the unmixed collection of construction materials, building designs that **facilitate selective dismantling** must be chosen. This includes modular construction methods, detachable connections, and avoiding non-circular material composites and pollutants. This will first be addressed through existing funding instruments and certification systems (QNG and BNB).

- **Further developing raw material indicators to improve measurability:** The Zukunft Bau (Construction of the Future) research project has explored the development of specific indicators for better quantification of resource conservation in construction. At the level of building structures, the indicators RMI (raw material input) and TMR (total material requirement)[106] may be incorporated as material footprint metrics into life cycle assessments in the future.

Optimising the separate collection of construction waste

- For public buildings, the **introduction of a requirement to provide a dismantling feasability assessment and a pollutant management plan** for new builds, refurbishments and extensions is being examined. Dismanling (or partial dismantling) should already be factored in and the project's circularity ensured in the planning stages of a new build, a conversion or an expansion of an existing structure. The dismantling feasibility assessment and pollutant management plan should form the basis for implementing construction projects.

In engagements with the Länder, the Federal Government will advocate the following measures to optimise the separate collection of construction waste via the relevant ministerial conferences (UMK and BMK):

- **Introduction of a requirement** for on-site **inspection of building components** prior to demolition.

- **Compilation of an inventory** of reusable or recoverable building components and materials.

- Optimisation of building component reuse and recycling.

- **Improvement of conditions for the reuse of building components:** Rules governing the safe use of repurposed components and construction products will be progressively expanded. The development of regional marketplaces for building components will be supported.

- **Expansion of recycling infrastructure:** To enable comprehensive construction waste recycling and reduce transport distances, regional secondary raw material centres, including at landfill sites, need to be established.

Creating favourable conditions for regional marketplaces for construction materials and building components.

Promoting the use of secondary raw materials

The following measures will be taken in Federal Government procurement:

- Reviewing the introduction of binding guidelines and criteria for circularity and, **in addition, outlining circularity** and resource conservation **criteria** for the procurement of construction services by public authorities under the Assessment System for Sustainable Building (BNB): methods for assessing circularity and resource conservation in public procurement will also be made available to Länder and municipalities. Publicly procured construction services will, in accordance with budgetary principles of cost-effectiveness and efficiency, consider resource conservation, longevity and repurposing/conversion from the outset in needs assessments and incorporate these into planning. This may include binding requirements for selective dismantling capability, repairability, reusability and recyclability of buildings, building components and construction materials. To this end, the Federal Government will update the BNB. The BNB will define technology-open and material-neutral requirements regarding environmental impacts and resource consumption based on a life cycle perspective, thereby encouraging the use of secondary raw materials. Through a circularity assessment, the BNB will incentivise the construction of circular buildings.

- The German Environment Agency (UBA) will develop a practical implementation plan for considering a shadow price for CO_2, which goes beyond the provision in section 13(1), third sentence, of the Federal Climate Action Act (KSG), as well as potentially other environmental impacts in procurement decisions. The shadow price will be used to calculate external costs hypothetically, making them transparent for bid evaluations. It may also facilitate the practical implementation of the requirement to take into account section 13(2) of the Federal Climate Action Act (KSG). Retrofitting and resource-efficient construction methods and materials could result in a lower shadow price. The methodology to be developed by the German Environment Agency (UBA) will also be discussed within the planned working group on public procurement, which will include representatives from the Länder and local government associations, and promoted for widespread adoption.

- Federal Government engagement with companies in the construction materials sector to advance the following measures:

- In collaboration with businesses and industry associations, developing the necessary conditions for a sector-wide solution to **increase** the **substitution rate of clinker with secondary raw materials** and industrial by-products **in cement production**.

- In further discussions with businesses and associations, exploring how to increase the supply of recycled aggregates through higher-quality recovery of construction and excavation waste, while avoiding the risk of replacing mineral secondary construction materials with primary raw materials.

- **Supporting digital platforms for the registration and assessment of used building components**; a corresponding implementation concept will be developed jointly with the construction industry.

Reducing landfilled mineral waste

- **Reviewing a landfill ban on recoverable waste:** The German Environment Agency (UBA) will commission a research project to support the implementation of the Landfill Ordinance (*Deponieverordnung*) before 2030 in relation to a ban on landfilling recoverable waste and to assess its practical feasibility. An evaluation will also be conducted to determine whether implementation would lead to a reduction in landfilled recoverable waste in the construction sector in line with NCES objectives.

- If this is not the case, the **introduction of a landfill levy for recoverable mineral construction materials** will be considered.

Research

Circularity and the reuse and conservation of resources are a key focus of the ministerial research component under the BMWSB Zukunft Bau programme. Focal areas of the respective programmes include:

1. **Zukunft Bau ministerial research**

- Transformation of the construction industry.
- Decarbonisation of the building sector.

2. **Zukunft Bau model projects**

- Reducing greenhouse gas emissions and curbing resource consumption and land take.

3. **Planned federal research centre/LAB – Living Art of Building**

- Climate-neutral and climate-adapted building stock.
- Future-proof materials and renewable raw materials over the life cycle.
- Resource-efficient and circular construction.

4.9 Metals

4.9.1 Current situation

Germany relies heavily on imports to meet its demand for many metals.[107] At the same time, the transition to a climate-neutral economy requires large quantities of metals. A functioning circular economy can make a significant contribution to securing the supply of raw materials with regard to metals, as high-quality recycling enables metals to be kept in circulation almost indefinitely.

In addition, metal recycling has the potential to reduce environmental impacts compared to primary production; the extent of this potential depends on the specific metal, its application, and the waste stream in question. For instance, recycling copper from cables has a significantly lower carbon footprint than primary production. However, producing secondary copper from construction waste, for example, generates roughly three times as much CO_2 as production from cables, meaning it is not always environmentally advantageous compared to primary production.

In this context, ship recycling may become increasingly important. The German merchant fleet comprises 2,500 vessels, 800 of which will be 25 years or older within the next 5 years, including 150 state-owned ships. The German inland shipping fleet consists of 2,400 vessels, with the average age in many segments exceeding 50 years. Establishing recycling capacity is a crucial step toward a maritime circular economy and is necessary to ensure the efficient use of scarce raw materials. The vast majority of a ship's mass consists of steel, and its recyclability and CO_2 reduction potential in relation to steel recycling and green steel is currently being widely discussed. However, due to the high weight of ships, other materials, although present in much smaller proportions, are also relevant. Strengthening shipbuilding based on the cradle-to-cradle principle, including ship recycling, is stipulated in the coalition agreement but remains in its early stages.

Barriers to a circular metals economy:

- Design for recycling and R-strategies such as reuse currently play only a minor role in the action area of metals.
- Many metals, particularly critical or strategic metals, are used in low concentrations, making recovery difficult.
- In most cases, there is no available information on which alloys are used in which components or products.
- While well-functioning material cycles have long been established for some metals, the end-of-life recycling rate for others, particularly technology metals, is often below one percent.
- The high number of different steel and aluminium alloys that mix during scrap collection complicates the reuse of recovered secondary raw materials in the production of high-quality wrought steel and aluminium alloys.

- Although multi-stage analysis and sorting processes exist, they are not used across the board because more complex recycling processes are often not economically viable.
- Greater separation, pre-disassembly and manual processing would improve scrap quality but also lead to higher costs.
- Circularity considerations have so far played little role in shipbuilding, starting from the design phase. Current regulations, such as the EU Ship Recycling Regulation (EU) 1257/2013,[108] are not designed to promote or prescribe future recycling processes or recyclable and material-efficient ship designs. Instead, these regulations and standards aim to minimise risks and negative impacts associated with ship recycling, for example on the environment and working conditions.
- Ship recycling in Germany is still in its early stages. The necessary regulatory frameworks and approval procedures for ship recycling facilities must still be established. Ship recycling is generally capital-intensive, and its profitability is difficult to predict, depending on several factors (for example, demand for recovered components and materials, contaminated waste disposal costs, labour costs, investment costs in recycling technologies, and the level of automation).

4.9.2 Ongoing national and European initiatives

Various regulations and initiatives are already in preparation and provide important frameworks for the objectives of the NCES. These conditions will be taken into account when implementing the NCES:

- Dialogue Platform on Recycled Raw Materials: The German Mineral Resources Agency (DERA) has developed options for increasing the share of recycled raw materials, including metals.
- In mid-August 2023, the new Batteries Regulation (EU) 2023/1542 came into force.[109] Among other provisions, it sets minimum recycling targets and mandatory recycled content targets for certain metals in batteries.
- In November 2013, the EU Ship Recycling Regulation (EU) 1257/2013 was adopted. It establishes rules for the safe and environmentally sound recycling of ships and aims to make the associated activities safer and more environmentally friendly. The regulation stipulates that since 2018, merchant ships flying the flag of an EU Member State (with a gross tonnage over 500 GT) may only be recycled at certified shipyards (EU list).
- The definition of climate-friendly steel from the BMWK concept Lead markets for climate-friendly basic materials.

4.9.3 Goals

For the action area metals, the focus is primarily on a recycling-based strategy. The upstream elements of the R-strategies, which have a closer link to specific products, are assigned to the product-related action areas (such as vehicles, ICT and circular production).

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

To achieve these goals, the following measures, among others, are required at national or EU level.

- Reducing the material footprint (raw material consumption, RMC) for metals.
- Further developing and supporting recycled content targets at EU level in the medium to long term, in cooperation with industry. A potential example for metals would be EU-wide, material-specific targets for the use of recycled content in components containing technology metals.
- In line with the European Critical Raw Materials Act (CRMA), which aims to cover at least 25 percent of annual demand for strategic raw materials through recycling and to significantly increase the recycling volumes of individual strategic raw materials in waste, the Federal Government aims to:
  - Reduce import dependency for aluminium processing, particularly by increasing recycling
  - Reduce import dependency for copper, particularly by increasing recycling
  - Meet part of the demand for lithium through recycling from lithium-ion batteries
- Supporting the creation of appropriate frameworks for establishing a sufficient number of ship recycling facilities in Germany, with a particular focus on increasing the share of clean steel scrap used as green steel.

4.9.4 Measures

Establishing recycling processes and capacities, particularly for strategic metals

To achieve the goal of enabling functional recycling processes for critical and strategic metals, the following measures, among others, are required at the federal or EU level:

- Supporting the EU-wide introduction of digital product passports (DPPs) for metal-containing products such as vehicles, ships, and electronic goods.
- Expanding and further developing suitable funding programmes; integrating a funding focus on strategic metals within the DigiRess programme, which is to be consolidated and expanded.
- Establishing a funding programme on the introduction of new technologies for the recovery of metals from slag and ash.
- Supporting standardisation processes to improve recycled content quality for metals.
- Reviewing the introduction of separation requirements for strategic metals (such as rare earth metals) from commercial waste.

Creating a dynamic materials register

A dynamic materials register will be developed, based on work such as the mapping of the anthropogenic stock by the German Environment Agency (UBA). This register will provide information on material flows, alloy types and their chemical composition, including the presence of critical and technology metals in products and waste streams.

Increasing the transport of steel scrap and recycled steel by rail and inland waterways

As transport modes particularly suited to bulk materials, rail and inland waterways play a key role in transporting waste and residues, which helps to minimise energy consumption and emissions. However, increasing their role in transport requires suitable facilities and terminals for transferring materials to rail and waterways. Steel scrap, for example, is becoming increasingly important in the steel industry, which aims to make German steel carbon neutral by 2045. Given this development, it is crucial to reduce greenhouse gas emissions in transport by switching to rail and waterways, and to increase transport capacities. To support the shift specifically to rail, the track access charge assistance could be extended. The expansion of infrastructure and the development of innovative freight transport concepts for recycled steel could be supported through state investments or funding programmes. Regarding inland waterways, businesses operating in a circular economy at ports face several barriers that make the approval processes for handling and storing recycling materials significantly more difficult. This is particularly an issue when handling or transporting not only steel scrap but also other recyclable materials such as construction materials for reprocessing. To address these challenges, measures from the National Ports Strategy, adopted by the Federal Cabinet on 20 March 2024, will be implemented. Key measures include:

Measure 1.22: *Strengthening existing port infrastructure and expansion potential, ensuring long-term sustainability against competing land uses. Priority should be given to future-oriented uses, where necessary with deep-sea access, such as for the energy transition, energy supply and circular economy.*

Measure 1.7: *Reviewing immission control and water regulations for goods handling in ports to reduce barriers for handling port-relevant goods without lowering environmental standards. In particular, this includes the classification of substances hazardous to water into water hazard classes (section 3 and appendix 1 of the Facilities for Handling Substances that are Hazardous to Water (Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen, AwSV).*

Supporting innovative ship recycling technologies and fostering collaboration among relevant stakeholders

To advance innovations and technologies for sustainable ship recycling, the Federal Government has been supporting the ShipRec innovation network since 2023.[110] The 13 project partners currently involved, including the Maritime Cluster Northern Germany (MCN), aim to identify innovative approaches and technological advancements in ship recycling. At the same time, the initiative seeks to foster dialogue between key stakeholders across the entire value chain and drive forward concrete projects for a more sustainable ship recycling industry. This includes both solutions to regulatory approval challenges and innovative technological concepts. The goal is to develop scalable and transferable processes for dismantling ships and large maritime structures, thereby promoting

sustainable dismantling, supporting optimal use of existing resources and keeping valuable raw materials within the local economy. To achieve this, the approval regime for ship recycling companies must first be streamlined.

4.10 Plastics

4.10.1 Current situation

Plastics are ubiquitous and are used across all economic sectors, in the majority of production processes and an innumerable variety of products, such as vehicles, buildings, infrastructure for electricity, water and wastewater, electronic devices and modern medicine. There is an urgent need to transition to a circular economy in the plastics sector due to its low circularity and the increasing global consumption of plastics. In 2021, plastic production in Germany amounted to approximately 21.1 million tonnes,[111] of which only 1.65 million tonnes were from recycled content.[112] The vast majority of plastics placed on the market are petroleum-based. Biobased plastics account for around one percent of the German market.[113]

Of the total annual plastic waste generated in Germany, which amounts to 5.7 million tonnes, 64 percent is still incinerated, while only 35 percent is recycled. In the case of post-consumer waste, 33 percent undergoes material recovery.[114] This primarily involves mechanical recycling processes, while chemical recycling processes currently account for a marginal share of 26,000 tonnes.[115] Given that chemical recycling is more energy-intensive than mechanical recycling, it should only be used as a complementary process where mechanical recycling is not feasible or, for example, where particularly high standards are required for the end product (such as single-use nappies and food packaging).

Plastics are primarily consumed, in descending order, in the construction, packaging, automotive and electronics sectors.[116] Without a reduction in plastic production and a fundamental shift towards circularity, approximately 56 gigatonnes of CO_2 would be emitted globally by 2050 from plastic production and incineration alone. This is equivalent to 10–13 percent of the remaining carbon budget needed to stay within the 1.5°C target.[117] The chemical industry thus faces the major challenge of transitioning to a fossil-free raw material base. Three approaches are being discussed: the most significant is the use of plastic waste as recycled material. Additionally, biomass can be used, though it is only available to a limited extent and must come from sustainable sources. Another option, provided it contributes to climate change mitigation, is CO_2 from point sources and the atmosphere (carbon capture and utilisation – CCU, see Section 1.4). Increasing plastic circularity can reduce the demand for primary raw materials. However, the potential of recycling processes remains limited by current technological capabilities, depending on the application. This presents challenges, but it also creates opportunities for innovation and competition, particularly for the chemical industry if the raw material base undergoes a fundamental transformation and Germany establishes itself as a technology leader.

Another challenge is the presence and formation of microplastic particles and their uncontrolled release into the environment. The significant negative impact of plastics and plastic pollution on ecosystems is recognised and is being mitigated by initial EU-wide regulatory approaches.[118] However, the effects on human health remain largely undocumented and have not yet been systematically researched.[119]

Plastics play an important role in many other action areas of the NCES, particularly at the product level. This section focusses primarily on the material level.

4.10.2 Ongoing national and European initiatives

The following regulations and initiatives are already in preparation and provide important frameworks for the objectives of the NCES in the action area plastics.

EU Packaging and Packaging Waste (PPWR): Under the forthcoming EU Packaging and Packaging Waste Regulation, Member States will be required, as is already the case under the existing Packaging and Packaging Waste Directive (Directive 94/62/EC), to recycle at least 55 percent of plastic packaging by 2030. Additionally, all packaging must be recyclable, with large-scale recyclability becoming mandatory from 2035 onwards. Specific targets are laid down for 2030 and 2040 for recycled content in plastic packaging. The EU Packaging and Packaging Waste Regulation is expected to be adopted by the European Parliament and Council by the end of 2024. The Regulation will enter into force 20 days after publication in the Official Journal and will apply directly in Member States 18 months after its entry into force, except for provisions with different deadlines. Germany's Packaging Act (*Verpackungsgesetz*, VerpackG) must therefore be brought into line with the EU regulation by mid-2026. This process must also use the flexibility provided by the PPWR to national legislators.

The Federal Government is developing a **Carbon Management Strategy (CMS)**, which will identify potential applications for carbon capture and utilisation (CCU) as well as the legal and economic frameworks necessary for its successful expansion, including the establishment of the required infrastructure (see Section 1.4). The existing pilot plants and processes are energy-intensive due to their substantial hydrogen demand. However, they will play a key role in the transformation of the chemical industry as the availability of green energy increases. Where necessary, they can complement recycled plastic and biomass as sources of raw materials.

At international level, the Federal Government supports the **development of a treaty to end plastic pollution**, which is being negotiated under the United Nations. The aim is to establish the foundations for the globally sustainable use of plastics. The Federal Government is advocating globally binding prevention targets, harmonised requirements and the mobilisation of necessary financial resources, particularly from the private sector, to ensure adequate funding.

4.10.3 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Gradual increase in recycled content derived from post-consumer waste, combined with an expansion of sorting and recycling capacity.
- Increased use of recycled content in plastic production, broken down by polymer type, for example, polyethylene terephthalate (PET), polypropylene (PP), polyvinyl chloride (PVC) and polystyrene (PS).

4.10.4 Measures

To achieve these goals, the following measures, among others, are required at national or EU level.

Dialogue on material diversity in plastics

Increasing product requirements have made the development of ever more plastic types necessary. At the same time, placing new plastic variants on the market complicates the collection of unmixed material streams, the establishment of economically viable recycling infrastructure and circularity in plastics. To address this, the Federal Government will initiate a dialogue with industry to encourage the voluntary reduction of material diversity, particularly in the use of thermoplastics.

Strengthening the share of recycled content in plastics

In the medium to long term, minimum recycled content targets at EU level will be further developed and supported with the involvement of industry. Minimum recycled content targets must be market-oriented, reliable and not overly bureaucratic, they must send clear market signals and ensure investment certainty. The prerequisites for this are sufficient availability of recycled materials, their quality and consumer acceptance, as well as an accompanying market analysis that also evaluates the possible impacts on competitiveness of minimum recycled content targets. Examples include:

Product-specific minimum shares of recycled content from post-consumer waste to advance circularity in plastics. This would incentivise the development of collection structures, take-back systems and recycling technologies. The selection of product groups and the level of targets is to be determined in dialogue with industry representatives and the scientific community. A prerequisite is that existing quality standards continue to be met, which requires stringent quality controls on imported plastic recycled content.

Introduction of mandatory shares of recycled materials containing minimal pollutants in plastic production (so-called polymer-specific targets).[120] These targets apply directly to the plastic or polymer itself, regardless of the product. For certain plastic types (for example, PET and PP), these targets specify what percent by weight of production must come from recycled plastic waste in order for it to be permitted on the market in Europe. The market will then determine how recycled content is used in different product applications. The mechanism of such polymer-specific substitution targets can be outlined as follows: they would apply to plastics produced in Germany and Europe as well as to imported plastic products and would be gradually increased. Their introduction must take place across the EU (for example, through an EU Directive) and ensure a level playing field, including for imported products. Trade policy and trade law considerations (WTO law, free trade agreements) must also be taken into account. Mandating a polymer-specific share of recycled content in plastic production will reduce the environmental footprint of plastic products. At the same time, such regulation aims to increase long-term demand for recycled content (pull effect), creating planning certainty and incentives for innovation. The goal is to ensure that downstream value chains are supplied with sufficient quantities of plastics containing recycled content that meet demand (push effect). This approach is also intended to reduce the price-related competitive disadvantages of recycled content. This instrument has an impact across the entire value chain, as distributors and manufacturers of plastic products will be able to plan based on a reliable supply of recycled content and adjust their production accordingly. The target

thus stimulates investment in the recycling sector within the chemical and plastics industries, as well as among waste disposal operators and recyclers. In order to keep the regulatory burden as low as possible, particularly at EU level, this concept can apply only to the polymers with the highest sales volumes and the market players with the largest shares.[121] Realistic targets should be clarified through a stakeholder process involving relevant industries and integrating different stakeholder requirements.

Assessing the **introduction of a feed-in tariff** and developing a model concept for the plastics sector. The level of remuneration could be linked, based on the Carbon Contracts for Difference model, to the reduction of greenhouse gas emissions achieved by using recycled content compared to new plastic production. This would provide lasting support for the competitiveness of recycled plastics.[122] The market would then determine how recycled content is used in different product applications.[123]

Removing barriers to the use of recycled content through standardisation

Efforts should be made to engage in relevant committees in order to initiate **standardisation mandates** at both national and European level (see Section 3.4). The standardisation roadmap coordinated by the German Institute for Standardization (DIN) has highlighted a significant need for both revised and new standards, particularly for plastics. Existing standards primarily relate to mechanical recycling processes and do not adequately reflect all dimensions of the recycling process. According to the Standardization Roadmap Circular Economy developed by DIN, these gaps in standardisation particularly concern pollutants, additives in compounding processes, and chemical analysis related to odour and emissions. Additional standards should focus particularly on developing a standardised approach to life cycle cost assessments, standards for assessing the reusability of plastics and plastic waste, and industry-specific standards for the reusability of plastic packaging.

Optimised recycling of plastics

The thermal recovery of plastics must be significantly reduced, not only to lower CO_2 emissions but also because recycled carbon is essential for transitioning to a fossil-free chemical industry. To achieve this, mechanical recycling processes will be further developed and used more extensively, while chemical recycling will be established for waste streams that are currently only processed through thermal recovery.

Design for Recycling will ensure that, wherever possible, materials are used that can be mechanically recycled. For material flows where mechanical recycling is not an option, chemical recycling processes will be supported as a complementary solution. From an industry perspective, the mass balance fuel-use exempt method is considered a prerequisite for investments in chemical recycling. The Federal Government supports this mass balance method and has advocated it in EU-level coordination processes.

Research

Strengthening the ministerial research of the BMUV, with a particular focus on the rapidly scaling of successful research and pilot projects:

- Developments in plastic recycling technologies related to: the quantities and qualities of plastics in various applications, especially for product categories where data on circularity is lacking; metrics

and indicators for determining the circularity of plastics; the technological, economic and environmental characteristics of different plastic recycling technologies, including mechanical recycling, enzyme-based processes and chemical decomposition methods; and the handling of composite materials where the use of non-composite materials is not feasible.

- Use and management of flame retardants in waste from technical plastics, particularly from electrical and electronic equipment, the automotive sector and the construction industry.

- Data, methods and indicators for the environmental assessment of sorting and recycling technologies.

4.11 Public procurement

4.11.1 Current situation

Public procurement is an important lever. However, to incorporate sustainability criteria, questions related to procurement and funding regulations and the financing of additional costs must be addressed. The public procurement action area covers contracts for the supply of goods and services at all levels of public procurement bodies: Federal Government, Länder and municipalities.[124] The NCES focusses primarily on measures at federal level, while also considering potential cooperation with the Länder and municipalities and at EU level. Public procurement holds significant market power, which can also be leveraged to reduce environmental impact. However, there are still considerable deficits in the implementation of general sustainability criteria.[125] The majority of procurement processes continue to follow a linear approach. As a goal of sustainable public procurement, the concept of circular procurement,[126] meaning procurement that aligns with energy and material cycles within supply chains, requires a fundamental rethinking of procurement processes, strategic procurement management and the reorganisation of procurement procedures.

This shift cannot be initiated by individual organisations alone but also requires governance through economic, procurement and waste management regulations. Public sector demand is a key driver for transitioning from a linear to a circular economy, yet it depends on a functioning overall system, particularly logistical infrastructure for take-back and preparation for reuse, as well as a sufficiently large and qualified supply market that can provide the required functionalities.

The following barriers hinder circular procurement in Germany:

- Procurement offices primarily acquire goods and services on behalf of their internal clients in a largely linear manner and often base decisions on the initial purchase price as the most important criterion, without considering long-term costs and benefits over the entire life cycle. Although there are legal provisions for circular procurement, particularly in section 45 of the Circular Economy Act (KrWG), which applies to federal authorities, legal entities under public law, special funds and other institutions under federal supervision, these requirements are not always known to procurement officers and internal clients, are not correctly applied or are insufficiently operationalised. Additionally, there is a lack of suitable guidance to help implement these requirements.

- It is not legally defined, particularly in terms of budgetary law, whether and to what extent procurement offices and internal clients are permitted to incur potential additional costs for circular procurement. The conflict of objectives between short-term budgetary frugality, which focusses on minimising direct acquisition costs, and genuine economic efficiency, which considers the total life cycle costs of products (including external costs), is often unresolved in procurement practice.
- Procurement offices lack a central contact point that could supplement existing resources by providing legal guidance on circular procurement and support in preparing tender documents.
- Shared structures and strategies that bring together all circular economy actors with the public sector have not yet been widely established.
- Indicators and tools for labelling and quality assurance of circular products, as well as for monitoring procurement behaviour, are largely lacking.

4.11.2 Ongoing national and European initiatives

The following ongoing legislative processes, regulations and measures at the national level are relevant to this action area and will be considered in the implementation of the NCES:

- **Reform of national procurement law (public procurement reform package) by the BMWK:** This reform aims to strengthen sustainability in public procurement and make it more binding.
- **Preparation of the further development of the Federal Government's General Administrative Regulation on the Procurement of Climate-Friendly Services (AVV Klima) to also cover environmentally friendly services (AVV Klima und Umwelt).** This revision will incorporate the results of the public procurement reform package and strengthen and clarify the requirements for circular procurement. The new AVV is expected to be evaluated after an appropriate period.
- **The Federal Government's Maßnahmenprogramm Nachhaltigkeit 2021 (2021 Sustainability Action Programme),** which includes various restructuring and process optimisation measures for federal public procurement. According to section IV of the action programme on procurement, federal authorities and institutions are required to procure standardisable products and services electronically through framework agreements from the Federal Purchasing Portal (*Kaufhaus des Bundes*, KdB), provided such agreements with sustainability criteria exist. The central procurement bodies that use the KdB as a platform for the provision of framework contracts, as well as all other procurement bodies within the federal administration, must align their procurement increasingly with the guiding principle of sustainability.[127] According to the action programme, the KdB is to be further developed as a central body for the sustainable procurement of standardisable products and services, where available on the market. The planned inclusion of circular procurement criteria in future framework contracts of the KdB will be implemented swiftly, in line with available resources.

- **Key principles** for a **recycling label** for sustainable public procurement will be developed. This includes assessing the feasibility of providing information on recyclability and recycled content, as well as determining which product groups would be particularly suitable for such a label. The label will be designed to comply with relevant regulations, including procurement regulations.

- Circularity criteria will also be integrated into additional **quality labels** used in procurement.

- The BMWK will advocate linking **definitions of climate-friendly basic materials** with national and European procurement law in order to strengthen markets for green products. This applies to definitions for climate-friendly steel and cement, as well as potentially climate-friendly ethylene as outlined in the BMWK concept Lead markets for climate-friendly basic materials.

- At **EU level**, public procurement is also being addressed as a key driver, for example in the Ecodesign Regulation, the Construction Products Regulation and the EU Monitoring Framework by Eurostat, which will include an indicator for sustainable public procurement in 2024.

4.11.3 Goals

The overarching vision of a circular economy in the action area of public procurement is that procurement bodies at the federal, Länder and municipal levels consistently align procurement, particularly of goods and services, with the principles of circularity, while adhering to the budgetary principles of efficiency and cost-effectiveness.

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goals apply to this action area:

- Unless obviously excluded by the nature of the case, an assessment is carried out for every need to determine how it can be met in line with circular procurement. All possible ways of meeting the need are considered, including purchasing, leasing, product-as-a-service systems and extending product lifespans.

- New working methods, use patterns, longer durability, service models, and maintenance, repair and upgrade measures are used as much as possible to limit new acquisitions to the necessary level.

- Needs assessment and performance specifications prioritise long life cycles, products with recycled context and the circularity of procured items.

- Linear products or those designed for short life cycles are only selected in justified exceptional cases.

- Indicators for circular procurement are developed and consistently applied.

- Close cooperation and specific procurement partnerships between public sector institutions enable joint purchasing, exchanging or leasing wherever possible.

- When defining award criteria for evaluating tenders, sustainability criteria, including circular procurement criteria, are considered in all suitable cases and where appropriate included alongside price in the performance specification.

- Once products are no longer needed, they are primarily passed on to third parties for refurbishment or reuse rather than being disposed of. The necessary adjustments to the legal framework to allow public bodies to resell and repurpose products are in force. If reuse is not possible, decommissioned products are recycled in a way that prioritises the highest possible level of the waste hierarchy.

- Resources for training staff on implementation are expanded accordingly.

To achieve this, the following timeframes are set for medium-term objectives:

- By 2030, the Federal Government will define qualitative and quantitative target values, including measurable indicators, for its own circular procurement, based on an evaluation of existing programmes and targets and in line with developed guidelines. Clear timelines for achieving the objectives by 2045 will be established.
- Early discussions will be held with the Länder with the aim that the Länder and municipalities set qualitative and quantitative targets for circular procurement by 2035. Efforts will be made, in coordination with the Länder and municipalities, to introduce a shared digital monitoring system.

4.11.4 Measures

Embedding circularity in public procurement through regulations

The **existing regulations** on a circular economy (particularly in section 45, paragraph 2 of the Circular Economy Act, KrWG) are not sufficient to effectively implement circularity in public procurement. They are therefore to be **supplemented** and **clarified** through appropriate regulations. The regulations to be developed for implementing these provisions must continue to allow the special interests of the Federal Ministry of Defence to be taken into consideration. The Russian war of aggression against Ukraine has demonstrated the fragility of the European peace framework. This necessitates ensuring accelerated public procurement to maintain the material readiness of the armed forces, without compromising the quality of the procured goods.

Taking into account the results of the procurement transformation package, work is underway to introduce a General Administrative Regulation on the Procurement of Climate- and Environmentally Friendly Services (AVV Klima und Umwelt): It is intended to replace the General Administrative Regulation on the Procurement of Climate-Friendly Services (AVV Klima) and the Timber Procurement Policy and, if necessary, consolidate provisions that have not yet been laid down or have been regulated elsewhere. This will involve a review of how the requirement to take account of life cycle costs as an award criterion when determining the most cost-effective tender, which is already included in the AVV Klima, can be better reflected in procurement practice.

Prioritising the procurement of used and refurbished products: There will be a review to determine how the existing special legal provision for the Federal Government in section 45(2) no. 2 of the Circular Economy Act (KrWG) can be more effectively applied in practice, for example through an administrative regulation.

Assessment to determine whether the principles of efficiency and cost-effectiveness should be expanded to include environmental considerations in secondary legislation for cost-effectiveness assessments: In the cost-effectiveness assessments conducted before procurement, environmental costs (life cycle costs, external costs) must be evaluated in a standardised way, factored into decision-making and documented. The BMUV will submit concrete proposals to the relevant committee.

Enabling the continued use of long-lived products at the end of their life cycle by:

Internal clients within the direct federal administration will be required to prioritise making decommissioned items **available for refurbishment** or **recycling** them in accordance with best practice, if reuse, resale or donation is not possible.

Preferential transfer or donation of Federal Government products that are no longer needed to non-profit organisations and public interest enterprises, particularly those whose main aim is the social and professional integration of disabled or disadvantaged persons (as defined in section 118 of the Competition Act (*Gesetz gegen Wettbewerbsbeschränkungen*, GWB). This will be implemented by the Federal Government in cooperation with the German Supreme Audit Institution Bundesrechnungshof (BRH) through amendments to the existing BRH directive on the disposal of decommissioned assets and the current directive on service life, decommissioning and disposal of IT equipment and software (IT Council Decision 2013/7).

Legal provisions will be created to enable the **sale** of decommissioned items through **public procedures**.

The Federal Government will promote the adoption of similar regulations by the **Länder and municipalities** within their respective areas of responsibility.

Statistical recording of circular procurement will be **improved**. An indicator[128] for circular procurement will be developed, and an assessment will be conducted to determine to what extent the Public Procurement Statistics Ordinance (*Vergabestatistikverordnung*, VergStatVO) can be amended accordingly.

Digitalising procurement and providing digital support for monitoring

Circular procurement as part of public procurement will be supported by the digitalisation of needs assessment, procurement processes and monitoring. The development of **digital tools**[129] for circular procurement will be initiated, and these tools made available for use at all administrative levels. Interfaces with established award management systems (VMSs) used by procurement offices will be leveraged. Mandatory use at the federal level is planned.

The federal administration is particularly aiming to implement the following measures:

- Reviewing, developing, establishing and introducing **digital pooling and sharing platforms**. These platforms will facilitate joint inventorying and procurement of infrequently used items (pooling solutions) and serve as digital exchange and redistribution platforms at the federal level. Products at the end of their service life can be transferred to third parties, such as social institutions, via these platforms.

- Developing and, following successful pilot implementation, mandating the introduction of (digital) **evaluation tools for circular procurement** at the federal level. These tools will provide procurement bodies with additional support and information on implementing circular procurement.

- Developing and introducing a digital **contract and supplier management tool** with an interface to the planned federal award management system (VMS), which identifies circular economy-relevant information. This will enable automated monitoring of warranty periods, maintenance intervals, repair services and guarantees, as well as the storage of standardised information such as type of delivery, packaging and reuse options.

- Developing and introducing a digital **monitoring tool** to record data on circular procurement. Existing data collection structures for public procurement (such as eForms) will be expanded in future, including indicators for circular procurement. Procurement bodies will be able to record data on the quantity and type of procured goods and services and the circular procurement criteria applied. This will help identify untapped potential in circular procurement.

Pooling expertise and organisational measures

The pooling of expertise and the strengthening of central procurement bodies within federal authorities and institutions, as set out in the Interministerial Working Group on Sustainable Public Procurement (*Interministerieller Ausschuss Nachhaltige Öffentliche Beschaffung*, IMA nöB), will be expanded. The organisational integration of Länder and municipalities into the work of the IMA nöB will be assessed and considered for future implementation.

Taking into account personnel and financial resources, a central advisory body for circular procurement will be established at the federal level, housed within the Competence Center for Sustainable Procurement (KNB) as the main advisory and information centre for sustainable procurement. The existence of multiple advisory bodies for public procurement makes it difficult for procurement bodies to obtain the necessary guidance on complex circularity issues from a single source. Further centralisation will consolidate the strengths of the various advisory bodies and ensure targeted provision of information. This will enable procurement to better meet requirements related to climate action, environmental protection, innovation and circular economy. The following services will be provided:

- Centralised **advice** on the legally compliant formulation of circular procurement processes, including individual consultations, wherever structurally feasible and legally permissible. This will be reviewed in coordination with the Länder.

- Provision of information, **practical guides and best practices** for circular procurement. This also includes aggregating the findings of market research efforts.

- **Training programmes** on circular procurement for federal authorities, focusing on raising awareness of challenges and presenting possible solutions, while also being open to Länder and municipalities as part of the Sustainable Procurement Training Initiative (Fortbildungsinitiative nachhaltige Beschaffung, FoBi). These measures will include suitable information services for internal clients and management alongside procurement bodies.

- Avoided procurement, for example through **reuse, continued use or repair**, will be promoted as a resource conservation strategy and showcased through practical examples.

A working group will be established, involving representatives of the Länder and local government associations, with the aim of contributing to the harmonisation of procurement regulations and requirements for circular and sustainable procurement and promoting their application. This working group will be integrated into the structures of the IMA nöB and the KNB.[130]

Expansion of cooperation

To improve cooperation and strengthen synergies in procurement, the following instruments will be introduced:

- **Implementation** of **model projects** for procurement cooperation and support in establishing sharing models[131] between procurement bodies. To enable internal clients and procurement bodies to gain practical experience with circular procurement, they will work together on collective procurements and temporary procurement collaborations within the limits of competition law. Procurement bodies will receive support in establishing procurement cooperations and sharing models.

- **Establishing cooperation** between the **public sector** and **companies** or **organisations** with circular business models. Refurbishment, remanufacturing and reuse of procured items will be promoted through cooperation and network-building between internal clients, procurement bodies and companies or organisations with circular business models (such as reuse organisations), while ensuring compliance with procurement law. The exchange of information on respective needs will also be facilitated.

- **Establishing exchange opportunities** and networks among different stakeholders. Successful circular procurement requires collaboration with various stakeholders, including the Länder, municipalities, businesses, chambers of industry and commerce, chambers of skilled trades and civil society organisations. The Federal Government will support the establishment and operation of networks while ensuring compliance with competition law.

Research funding

- To further strengthen circular procurement in the long term and support the measures outlined above, the following research and innovation needs should be funded by the Federal Government:

- Development of **product group-specific minimum requirements** for circular procurement.
- Modelling and **assessing environmental impacts**, especially regarding circular product alternatives of particular relevance to public procurement.
- Development of criteria and indicators enabling reliable **labelling** of circular products or aspects (such as durability, functional reliability, longevity, repairability, recyclability and recycled content). These should be designed to serve as verification mechanisms within the procurement process.

5. The NCES in the European context

5.1 Current situation

The production, use and disposal of raw materials, products and waste streams in the EU are already governed by an extensive regulatory framework, owing to both the EU internal market and shared environmental and climate policy objectives. Key overarching strategies and regulations on the path to circular economy at EU level include the EU Circular Economy Package and the EU Circular Economy Action Plan (CEAP).

With the Circular Economy Package adopted in 2018, the EU aims to assume a global leadership role in circular economy practices. It includes a strategy as well as new legally binding targets for waste recycling, with specific targets for certain materials and landfill reduction. The CEAP adopted by the European Commission in March 2020 is a central pillar of the European Green Deal. The CEAP aims to decouple economic growth in the EU from resource consumption while ensuring the competitiveness of the EU in the long term. It includes 35 legislative and non-legislative measures intended to keep resource consumption within planetary boundaries and make a decisive contribution to climate neutrality by 2050. By the end of 2023, nearly all individual dossiers related to these measures had been presented.

The most important existing EU regulations and initiatives include the Ecodesign for Sustainable Products Regulation (ESPR), the Waste Framework Directive (WFD; 2008/98/EC), the EU Critical Raw Materials Act (CRMA), the Waste Electrical and Electronic Equipment Directive (WEEE Directive), and the Batteries Regulation.

To align the regulatory framework with the objectives of the European Green Deal and implement the CEAP, numerous EU regulatory initiatives have been or are currently being revised or newly introduced. In addition to the aforementioned measures, these include the Packaging and Packaging Waste Regulation (PPWR), the EU-wide Right to Repair Directive, delegated acts under the EU taxonomy (including the sale of used goods, reuse of products and product parts for textiles and footwear in circular economy), the revision of the EU Construction Products Regulation (CPR), the proposal for a comprehensive revision of the European End-of-Life Vehicles Directive, and the Directive on substantiation and communication of explicit environmental claims (Green Claims Directive).

Germany's share of secondary raw materials in total raw material use stands at 13 percent, slightly above the EU average of 11.8 percent. However, in France and the Netherlands, the share is nearly double and triple that figure, respectively.

5.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goal applies to this action area:

The transition to a climate-neutral, sustainable and circular economic model by 2045 can only succeed in cooperation with European neighbours. In shaping and implementing EU measures in the field of circular economy, the Federal Government closely collaborates with other Member States (including within the framework of the Expert Group on Circular Economy and Sustainable Production and Consumption). The NCES aims to make the Federal Government a pioneer in circular economy and set new benchmarks for the further development of the EU-wide framework. As an industrial and technology hub with a leading position in circular economy technologies (such as mechanical recycling and the chemical industry), Germany is ideally positioned. The objective is to maintain this technological leadership and further expand it in collaboration with European partners.

The initiatives and measures at EU level outlined in Sections 3 and 4 must continue to be advanced and supported. Advocating an ambitious design of the new legislative act announced in the Political Guidelines of the President of the European Commission for the 2024-2029 term contributes to the objectives of the NCES.

6. International cooperation

6.1 Current situation

Germany's economy operates as a throughput economy, importing many raw materials and semi-finished goods while often exporting finished, industrially manufactured products. As such, it relies on a well-functioning network of international partnerships (see Section 0). In an increasingly circular world, value creation must be organised in a way that brings mutual benefits, is socially just and inclusive, and supports climate action and environmental protection.

Germany is likely to become an even more significant producer of secondary raw materials which can also be sold on global markets. At the same time, for cost or energy reasons, due to differing technical specialisations and to ensure the appropriate integration of the Global South into this evolving market, it will be reasonable and necessary to source certain shares of secondary raw materials from abroad. The Federal Government should play a key role in establishing and promoting the necessary network of international partnerships in close coordination with European and international partners. The opportunities and risks of circular economy must be distributed fairly, both globally and across different population groups. For instance, it is essential to ensure that the concerns of all social groups, including

those in the informal sector, are considered and that equitable access, as well as sustainable and decent jobs, are created for all population groups.

The Federal Government is guided by the 2030 Agenda for Sustainable Development and the Paris Agreement. Circular economy and resource efficiency play an increasingly important role in implementing these and other global framework agreements. For many years, the Federal Government has therefore successfully advocated that circular economy and resource efficiency be recognised internationally as key instruments for addressing the global environmental and climate crises. The global agreements are implemented, for example, through cooperation with partner country governments as part of development cooperation, including in the form of multilateral and bilateral instruments, financing solutions and projects. Such cooperation strengthens country ownership, thereby enhancing the sustainability of implementation.

In addition, the G7 Alliance on Resource Efficiency (ARE)[132] was formed in 2015 under the German G7 Presidency. Germany used its G7 Presidency in 2022 to introduce the Berlin Roadmap,[133] an ambitious plan for the G7 to leverage resource efficiency and circular economy for climate action and environmental protection. At G20 level, the G20 Resource Efficiency Dialogue (RED)[134] was established under the German Presidency in 2017 as the main G20 forum for discussions on resource efficiency and the circular economy. The Federal Government has also long advocated for an ambitious international agreement to end plastic pollution[135] and co-founded the High Ambition Coalition to End Plastic Pollution.[136]

In international climate negotiations, Germany is committed to ensuring that greater consideration is given to the significant, but as yet largely untapped, climate change mitigation potential of the circular economy and resource efficiency (see Section 1.4). A breakthrough was achieved at the 28th UN Climate Change Conference (COP28) when, for the first time, the closing Decision of the signatory states recognised the importance of circular economy practices for climate change mitigation. The Federal Government also supports plurilateral trade and environment initiatives within the WTO framework, including the Trade and Environmental Sustainability Structured Discussions (TESSD). In an informal working group, TESSD addresses trade aspects of the circular economy, such as transparency, standards and regulation, trade facilitation, waste management, capacity building and technical assistance.

Many countries lack the capacities and resources to step up implementation of circular economy measures, particularly financing solutions to initiate and implement broader circular economy initiatives (see R-strategies in Section 3.1). Low and middle income countries face major challenges in providing the necessary funds and mobilising private investment in sustainable circular business areas. International financial institutions, such as multilateral and regional development banks and international funds, can play a decisive role in this regard. This could take the form of advisory services, financing, risk mitigation for private investments and standardisation of evaluation criteria for circular economy investments.

To achieve this, it is essential for international financial institutions and governments to increasingly prioritise a sustainable and equitable circular economy as a cross-cutting issue in attaining other strategic goals, including the 2030 Agenda for Sustainable Development and the Paris Agreement. This

includes promoting impactful and transferable circular projects and sharing relevant practical knowledge.

6.2 Goals

Based on the vision of a comprehensive circular economy for 2045 presented in Section 1.3, and complementing the guiding principle and overarching goals formulated in Section 2, the following additional goal applies to this action area:

Actively drive forward the transition to a sustainable, largely resource-efficient and circular global economy as a strong voice in Europe and internationally. This includes a fundamental realignment towards a circular economic model and ensuring that the environmental and economic transformation is inclusive and socially just. To this end, Germany will continue to establish strong and effective bilateral and multilateral networks and will engage proactively and constructively in United Nations processes as well as in other international forums and dialogues (such as the G7 and G20).

6.3 Measures and instruments

The following measures are required to achieve the objectives outlined above. In many cases, their success will depend on close cooperation with stakeholders from business, civil society and the scientific community.

- Firmly establishing a circular economy as a **lever for international climate action**: The inclusion of the circular economy as a climate change mitigation tool in the first global stocktake under the Paris Agreement (COP28 Decision) was an important success, but it must be seen as only the first step. It is crucial to further establish the topic in climate negotiations while simultaneously driving forward the global implementation of necessary measures. The next important milestone is the 2025 update of the **nationally determined contributions (NDCs)**. The global stocktake should serve as a mandate for all signatory states to give greater consideration to the circular economy in their NDCs.

- Implementing a circular economy as a key entry point for international biodiversity conservation: Pollution prevention and sustainable consumption are goals of the **Global Biodiversity Framework**, which will be supported by integrating the circular economy into **national biodiversity strategies and action plans (NBSAPs)**.

- Further implementation of the **G7 Berlin Roadmap**: In the 2022 G7 Berlin Roadmap, G7 members affirmed that achieving the United Nations Sustainable Development Goals, as well as global climate and biodiversity goals, is unattainable without greater resource efficiency and circularity. The roadmap therefore includes a list of concrete measures to be implemented by the G7 within its timeframe (2022-2025). Germany will continue to advocate for concrete implementation steps to follow these commitments.

- Advancing the circular economy **at G20 level**: The **G20 Resource Efficiency Dialogue (RED)** remains the key forum for discussions on this topic. Germany will actively and constructively advance the update process of the RED work plan, initiated under India's 2022 G20 Presidency. Resource efficiency and the circular economy must remain high on the G20 agenda in the coming years.

- Strengthening **dialogue with key stakeholders**: Germany has extensive expertise in circular economy practices from which both other countries and German businesses can benefit. Examples include the *bilateral circular economy dialogues* initiated in 2023 with the People's Republic of China and Brazil. Germany also maintains close dialogue with other key strategic partners, such as Japan, Indonesia and India.

- **Enhancing capacities in partner countries:** The Federal Government works closely with its partner countries to support their transition to a sustainable and fair circular economy, with a particular focus on disadvantaged groups. This commitment must be expanded to ensure that countries of the Global South are not excluded from circular economy value chains or burdened with environmental and social impacts shifted from elsewhere. In this context, the Federal Government launched the PREVENT Waste Alliance[137] in 2019. This cooperation platform brings together stakeholders from different countries to scale innovative circular economy solutions in the Global South. Other key instruments include the new funding priority of the International Climate Initiative (IKI) **Closing the loop – circular and resource-efficient management as a driver of climate action and environmental protection, especially in G20 emerging economies**,[138] as well as projects under the Team Europe Initiative (TEI).

- It is also important to strengthen **digital capacities in partner countries** for a sustainable and fair circular economy and to bridge digital divides to ensure the successful global implementation of initiatives such as the digital product passport. Additionally, the Federal Government supports partner countries in their participation in the development and harmonisation of internationally recognised standards, measurement methods and testing procedures, which are essential, for example, for ensuring product safety and facilitating international trade.

- Strengthening **cooperation at multilateral level and within the framework of the United Nations**: Germany will use its leadership role in multilateral processes to highlight the importance of circular economy in addressing the planetary crises. A key process in this regard is the **United Nations Environment Assembly (UNEA)**, which regularly adopts important resolutions on this topic. A central basis for guidance will be the research of the **International Resource Panel (IRP)**, particularly the newly published Global Resources Outlook 2024. In addition to advocating for circular economy in international forums, the Federal Government will also support projects in cooperation with multilateral partners, such as the United Nations Industrial Development Organization (UNIDO).

- Improving **financing options for circular economy at international level**: Low and middle income countries in particular are faced with the challenge of mobilising capital for the transition to circular economy. A circular economy can provide a complementary approach to sustainable development

by linking industrialisation, innovation, environmental protection and resilience. For example, the Global Environment Facility (GEF) funds projects aimed at expanding circular economy initiatives. A key priority is strengthening established financing mechanisms, such as extended producer responsibility (EPR), on a global scale and promoting innovative financing models. Furthermore, the role of international financial institutions, including **multilateral development banks (MDBs), regional development banks and the private sector** (see Section **Fehler! Verweisquelle konnte nicht gefunden werden.**), in **financing investments in the circular economy** must be reinforced.

- Establishing **recycling and technology partnerships (just circular economy partnerships)** with international partners: In close coordination with the EU, recycling and technology partnerships (just circular economy partnerships) are to be established with selected partners to promote mutual knowledge exchange and the supply of high-quality secondary raw materials. Particular attention will be given to evaluating the strategic role of initiatives such as the **Export Initiative Environmental Protection (EXI)**,[139] the **RETech Partnership**[140] and the **PREVENT Waste Alliance**. The goal of EXI is to support GreenTech companies (especially SMEs) and research institutions in the key area of circular economy to utilise instruments and measures such as extended producer responsibility as a lever for the international deployment of German resource efficiency and environmental protection technologies. In doing so, sustainable value chains can be established through environmentally focussed foreign trade promotion. In addition to knowledge and technology exchange, international cooperation will also be leveraged to encourage start-ups and entrepreneurs in the field of circular economy to set up in Germany, thereby strengthening the long-term positioning of "Circular Economy Made in Germany" as a global brand.

- Setting a framework for the circular economy in plastics through the **UN Plastics Treaty**: Germany will continue to advocate for an ambitious outcome in the negotiations on the UN Plastics Agreement. The objective must be to address the entire life cycle of plastics, from primary polymer production to waste management, in order to establish a global level playing field for plastics circularity and combat plastic pollution worldwide.

7. Implementation and further development of the strategy

7.1 Steps towards implementing the NCES

To achieve the ambitious goals of the NCES by 2045, the measures and instruments set out in the strategy must be implemented swiftly and consistently. In addition to the overarching targets for 2045, initial interim targets for 2030 have also been defined for individual action areas.

An implementation roadmap based on these targets is already set out in the NCES. Following cabinet approval of the NCES, the following steps will be initiated for its implementation:

- Establishment of a platform for circular economy to prepare and support the concrete implementation of the NCES together with stakeholders from business, civil society and the public sector, as well as experts from the scientific community (see Section 7.2).
- Development of a Roadmap 2030 to specify in detail the projects and timetables outlined in the NCES.
- Establishment of an appropriate and efficient monitoring and evaluation system that reports on the implementation status of the goals and measures (see Section 7.4).
- Review of whether and how central NCES objectives and the monitoring thereof could or must be established on a new legal foundation.
- Decisions on financing as a basis for the adopted measures (see Section 7.5).

The Roadmap 2030 and the underlying priorities will be reviewed regularly and adjusted or expanded as necessary.

In addition, there are other existing strategies, programmes and initiatives of the Federal Government. The NCES is intended to integrate and consolidate these efforts (see Section 1.7).

7.2 Platform for circular economy

The implementation of the NCES will only succeed through close cooperation between policymakers, business, civil society, culture and the scientific community. This requires joint, regular dialogue on progress towards goals and measures, as well as discussions on necessary further steps and adjustments to specific instruments. A platform for circular economy, as called for by the Alliance for Transformation and numerous stakeholders involved in the NCES consultation process, is a prerequisite for the fundamental transformation envisaged by the NCES. This platform will encompass new technologies, structures and business models.

The Länder and municipalities have a special role to play in implementing the goals and measures of the NCES. Within Germany's federal system, they hold legislative and administrative powers in key areas of circular economy. For topics that are particularly relevant to the Federal Government, Länder and municipalities including procurement and circular construction, other established bodies will be drawn on, such as the Federal-Länder Working Group on Waste (*Bund-Länder-Arbeitsgruppe Abfall*, LAGA) and the Länder-wide Working Group on Resource Efficiency (*länderoffene Arbeitsgruppe Ressourceneffizienz*, LAGRE) of the Conference of Environment Ministers (UMK). Relevant bodies from other ministerial conferences will also be involved where necessary.

Furthermore, cooperation at EU and international level is essential for making the circular economy a global success model.

To successfully implement the NCES, a reliable and clearly structured platform is required to ensure the involvement of business, civil society and the scientific community beyond the cabinet decision and legislative period. Potential elements and tasks of a circular economy platform could therefore include:

- Advancing the strategic direction and continuous development of the transition to a circular economy in Germany in collaboration with all relevant stakeholders.
- Contributing to the practical, low-bureaucracy development of measures and instruments in the individual action areas by facilitating networking among all stakeholders relevant to policymaking and public administration.
- Initiating the practical development, advancement, testing, piloting and implementation of measures and instruments. This includes measures by economic and societal actors (for example, demonstration projects and voluntary industry agreements) as well as political actors (including creating better frameworks for regulatory sandboxes).
- Unlocking the potential of digitalisation for the circular economy and supporting the development of the necessary data infrastructure by the Federal Government.
- Mobilising private capital for the implementation of lighthouse projects (for example by linking them to public funding).
- Increasing the national and international visibility of Germany's transition to a circular economy, establishing Germany as a hub for innovations and technologies in this field, and promoting broad-based communication on the transferability of solutions.
- Providing information on funding initiatives, incubators and measures by third parties for businesses, start-ups and research institutions, as well as general information on the circular economy for interested citizens, for example through platform conferences, social media and the NCES website.

The organisational details of the platform structure, which will be designed to be streamlined and effective, as well as its mandate, will be developed and defined following the adoption of the NCES. In doing so, the Federal Government will draw on its experience with similar platforms to inform its design and avoid duplication.

7.3 Initiatives from the business sector and civil society

The circular economy relies on initiatives from the business sector and civil society to ensure swift implementation of measures, enable mutual learning and drive scaling efforts. The aim is to disseminate environmentally, technologically and socially sound innovations as quickly as possible.

These initiatives cover a wide range of areas, including cross-sector business initiatives, topic-specific expert groups, start-up initiatives, and regional and municipal initiatives.

Examples of initiatives from the business sector and civil society include: The Circular Economy Initiative of the Federation of German Industries (BDI), the CIRCONOMY® Hub of the Fraunhofer-Gesellschaft, CIRCULAR REPUBLIC, the Circular Futures network, Circular Valley, Cradle to Cradle NGO, CIRCULAZE, the CirculAid funding initiative for circular economy in healthcare, and previously completed initiatives such as the Circular Economy Initiative Deutschland by acatech – the National Academy of Science and Engineering, the Circular Economy Model Germany of the World Wide Fund for Nature (WWF), and DIN's Standardization Roadmap Circular Economy.

The diverse range of initiatives from the business sector and civil society demonstrates that many market participants are willing to engage in circular business and practices, and produce, conduct research and consume in a resource-efficient manner. As part of the NCES implementation, these initiatives at national, European and international level should be even more actively integrated in order to enhance networking and strengthen their impact, ensuring that the circular economy becomes a collective effort driven forward by broad support. To this end, joint formats and initiatives will be developed.

7.4 Monitoring and evaluation

Regular evaluation of the strategy, considering its objectives, indicators, measures and instruments, will assess progress towards its goals and allow for adjustments where necessary. The scientific evaluation will be commissioned by the lead ministry, BMUV, or the German Environment Agency (UBA).

A key basis for the evaluation is continuous monitoring of all indicators relevant to goal achievement, as well as the implementation status of measures and instruments. Monitoring will be developed as part of a research project. Existing official statistics should be reviewed for their suitability for use in monitoring. Responsibility for implementation lies with the ministries in charge of the respective measures.

Monitoring and evaluation should encompass all ministerial programmes of measures that make a substantial contribution to achieving the NCES objectives.

7.5 Financing

There are already numerous Federal Government support programmes that fully or partially address the objectives of the circular economy and resource efficiency (see Annex). These existing programmes will be further developed in line with the objectives, measures and instruments of the NCES. An Action Plan on Circular Economy Practices will serve to implement the NCES going forward. Through a broad mix of instruments, the Action Plan will initiate the national and global transformation towards reduced primary raw material consumption and closed material cycles, contribute to achieving climate targets and further improve opportunities for circular economy practices.

The financial requirements associated with implementing the NCES are in line with the Federal Government's budgetary and fiscal policy guidelines. All measures under the NCES, including Action Plan on Circular Economy Practices, are subject to funding availability and the Federal Government's financial and constitutional competencies/responsibilities. They do not constitute a commitment or

pre-commitment in terms of budget allocations, nor do they prejudice decisions of the budget legislator. Any additional personnel or material costs arising for the Federal Government as a result of the Strategy must be fully financed for the long term within the applicable budget and financial planning in the respective departmental budget.

8. Annex

List of abbreviations

Acatech	National Academy of Science and Engineering
AI	Artificial intelligence
AltholzV	Waste Wood Ordinance (*Altholzverordnung*)
ARE	G7 Alliance on Resource Efficiency
AVP	Waste Prevention Programme
AVV Klima	General Administrative Regulation on the Procurement of Climate-Friendly Services (*Allgemeine Verwaltungsvorschrift zur Beschaffung klimafreundlicher Leistungen*)
AVV Klima und Umwelt	General Administrative Regulation on the Procurement of Climate- and Environmentally Friendly Services (*Allgemeine Verwaltungsvorschrift zur Beschaffung klima- und umweltschonender Leistungen*)
AwSV	Ordinance on facilities for Handling Substances that are Hazardous to Water *(Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen)*
BAT	Best Available Techniques
BattDG	Batteries legislation Implementing Act (*Batterierecht-Durchführungsgesetz*)
BattG	Batteries Act (*Batteriegesetz*)
BDI	Federation of German Industries
BEG	Federal Funding for Efficient Buildings
BGR	Federal Institute for Geosciences and Natural Resources
BIBB	Federal Institute for Vocational Education and Training
BioAbfV	Ordinance on Biowastes (*Bioabfallverordnung*)
BImSchG	Federal Immission Control Act (*Bundes-Immissionsschutzgesetz)*
BMEL	Federal Ministry of Food and Agriculture
BMBF	Federal Ministry of Education and Research
BMF	Federal Ministry of Finance
BMK	Conference of Building Ministers (*Bauministerkonferenz*)

BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
BMVg:	Federal Ministry of Defence
BMWK	Federal Ministry for Economic Affairs and Climate Action
BMWSB	Federal Ministry for Housing, Urban Development and Building
BÖL	Federal Scheme for Organic Farming (*Bundesprogramm Ökologischer Landbau*)
BREF	Best Available Techniques reference documents
BRH	Bundesrechnungshof (German SAI – Supreme Audit Institution)
CCRI	Circular Cities and Regions Initiative
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CEAP	Circular Economy Action Plan
CEID	Circular Economy Initiative Deutschland
CEN	European Committee for Standardization
CFK	Carbon-fibre-reinforced plastic
CIGS	Copper indium gallium selenide
CLP	Classification, labelling and packaging
CMS	Carbon Management Strategy
CMUR	Circular material use rate
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
COP28	28th meeting of the Conference of the Parties to the UN Framework Convention on Climate Change
COREPER	Committee of Permanent Representatives
CRMA	EU Critical Raw Materials Act
DERA	German Mineral Resources Agency
DIERec	Direct and indirect effects of recycling
DIN	German Institute for Standardization
DKE	German Commission for Electrical, Electronic & Information Technologies

DNS	German Sustainable Development Strategy
DPP	Digital product passport
EAG-BehandV	Ordinance on the Treatment of Waste Electrical and Electronic Equipment (*Elektro- und Elektronik-Altgeräte-Behandlungsverordnung*)
EC	European Community
EEG	Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz*)
EFSI	European Fund for Strategic Investments
EIB	European Investment Bank
ElektroG	Electrical and Electronic Equipment Act (*Elektro- und Elektronikgerätegesetz)*
ELVR	End-of-Life Vehicles Regulation
EMAS	Eco-Management and Audit Scheme
EN	European Standard
EPBD	EU Energy Performance of Buildings Directive
EPR	Extended producer responsibility
EREK	European Resource Efficiency Knowledge Centre
ERMA	European Raw Materials Alliance
ESPR	EU Ecodesign for Sustainable Products Regulation
ETS	Emissions Trading System
EU	European Union
EXI	Export Initiative Environmental Protection
F-gases	Fluorinated greenhouse gases
FONA	Research for Sustainability
GEF	Global Environment Facility
GEG	Buildings Energy Act (*Gebäudeenergiegesetz*)
GewAbfV	Commercial Wastes Ordinance (*Gewerbeabfallverordnung*)
GFRP	Glass fibre-reinforced plastic
GHG	Greenhouse gas
GRP	Resource passport for buildings (*Gebäuderessourcenpass*)

GRW	Joint Task for the Improvement of Regional Economic Structures
GT	Gross tonnage
GWB	Competition Act (*Gesetz gegen Wettbewerbsbeschränkunge*n)
GWP	Global warming potential
HaaS	Heating as a Service
HFC	Hydroflurocarbon
HOAI	Statutory fee schedule for architects and engineers (*Honorarordnung für Architekten und Ingenieure*)
HSEG	High Seas Dumping Act (*Hohe-See-Einbringungsgesetz)*
ICT	Information and Communications Technology
IED	Industrial Emissions Directive
IKI	International Climate Initiative
ITC	International Trade Centre
IMA nöB	Interministerial Committee for Sustainable Public Procurement (*Interministerieller Ausschuss Nachhaltige Öffentliche Beschaffung*)
IRP	International Resource Panel
ISO	International Organization for Standardization
JICE	Joint Initiative on Circular Economy
JRC	Joint Research Centre
KdB	federal government electronic procurement platform (*Kaufhaus des Bundes*)
KNB	Competence Center for Sustainable Public Procurement
KrWG	Circular Economy Act (*Kreislaufwirtschaftsgesetz*)
KSG	Federal Climate Action Act (*Bundes-Klimaschutzgesetz*)
KSpG	Carbon Storage Act (*Kohlendioxid-Speichergesetz)*
LAB	Living Art of Building (federal research centre)
LAGA	Federal-Länder Working Group on Waste (*Bund-Länder-Arbeitsgruppe Abfall*)
LAGRE	Länder-wide Working Group on Resource Efficiency (*länderoffene Arbeitsgruppe Ressourceneffizienz*)
LCA	Life cycle assessment

LV batteries	Light vehicle batteries
MCN	Maritime Cluster Northern Germany
MDB	Multilateral development banks
MiD	Mobility in Germany (*Mobilität in Deutschland*)
Mt	Million tonnes
NBÖS	National Bioeconomy Strategy
NCES	National Circular Economy Strategy
NDC	Nationally determined contributions
NFDI	National Research Data Infrastructure
NGO	Non-governmental organisation
NKI	National Climate Initiative
OECD	Organisation for Economic Co-operation and Development
PA-BBNE	Vocational Education for Sustainable Development Project Agency
PCR	Post-consumer recycled material
PET	Polyethylene terephthalate
PM	Particulate Matter
PMD	Plattform MaterialDigital
PP	Polypropylene
PPWR	EU Packaging and Packaging Waste Regulation
ProgRess	German Resource Efficiency Programme
PS	Polystyrene
PV	Photovoltaic
PVC	Polyvinyl chloride
QNG	QNG Sustainable Building Certification
R&D	Research and development
REACH	Registration, evaluation, authorisation and restriction of chemicals
RED	G20 Resource Efficiency Dialogue
RMC	Raw material consumption

RMI	Raw material input
SDG	Sustainable Development Goal
SCIP	Substances of Concern In Products
SMEs	Small and medium-sized enterprises
SVHC	Substances of very high concern
t	tonne
TEI	Team Europe Initiative
TESSD	Trade and Environmental Sustainability Structured Discussions
TMR	Total material requirement
TTP LB	Technology Transfer Programme for Lightweighting
TWh	Terawatt hour
UBA	German Environment Agency
UIP	Environmental Innovation Programme
UMK	Conference of Environment Ministers (*Umweltministerkonferenz*)
UN	United Nations
UNCTAD	UN Trade and Development
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VergStatVO	Procurement Statistics Ordinance (*Vergabestatistikverordnung*)
VDA	German Association of the Automotive Industry
VDI	Association of German Engineers
VDI ZRE	VDI Center for Resource Efficiency
VerpackG	Packaging Act (*Verpackungsgesetz)*
VMS	Award management system
WEEE	Waste electrical and electronic equipment
WTO	World Trade Organization

WWF	World Wide Fund for Nature
ZVEI	German Electro and Digital Industry Association

Current and pending Federal Government funding programmes for the circular economy

Title	**Responsible ministry**
Battery Research Framework (in German)	BMBF
Federal Organic Farming Scheme (BÖL) (in German)	BMEL
CO_2 as a sustainable source of carbon – ways to industrial use (CO_2-WIN)	BMBF
Deutsche Bundesstiftung Umwelt	BMUV
DigiRess (in German)	BMUV
Digitalisation in Agriculture (in German)	BMEL
Energy Research Programme	BMWK
Resource Efficiency and the Circular Economy	BMWK
ERA-Min – The ERA-NET on raw material efficiency and the circular economy (in German)	BMBF
Regional Phosphorus Recycling (RePhoR) funding measure (in German)	BMBF
Funding measure on Resource-efficient Circular Economy – Urban Mining: Harnessing Anthropogenic Stock as a Source of Raw Materials (in German)	BMBF
Funding measure on Resource-efficient Circular Economy – Circular and Sustainable Textiles (in German)	BMBF
Funding programme on Energy and Resource efficiency in Industry (EEW) (in German)	BMWK
Industrial Bioeconomy funding programme (in German)	BMWK
Energy and Resource Efficiency funding competition (in German)	BMWK
Research and Development of Battery Technologies for Technologically Autonomous, Competitive and Sustainable Battery Value Chains (in German)	BMBF
Research and Development on Electric Mobility	BMWK/BMUV
Joint Task for the Improvement of Regional Economic Structures (GRW) (in German)	BMWK
Green AI Hub	BMUV
KfW Funding for Energy and the Environment	KfW
KfW Environment Programme (in German)	KfW
AI Application Hub for Plastic Packaging – Sustainable Circular Economy through Artificial Intelligence (in German)	BMBF

AI Lighthouse projects for the Environment, Climate, Nature and Resources (in German)	BMUV
Climate Action Campaign for Businesses, KfW (in German)	KfW
Innovative SMEs (in German)	BMBF
Innovative SMEs: Resources and Circular Economy (in German)	BMBF
Sustainable Renewable Resources (in German)	BMEL
National Climate Initiative (NKI) – Model municipal climate projects (in German)	BMWK
Programme to Promote Innovation (in German)	BMEL
Regional Science Service Centres for Work and Employment Research – Circular Economy (in German)	BMBF
Resource-efficient Circular Economy – Building and Mineral Cycles (ReMin) (in German)	BMBF
Resource-efficient Circular Economy – Plastic Recycling Technologies (KuRT) (in German)	BMBF
Technology Transfer Programme for Lightweighting (TTP LB) (in German)	BMWK
Environmental Innovation Programme (UIP)	BMUV
Continuation of Call for Proposals on Resource Efficiency and Circular Economy from the 7th Energy Research Programme (in German)	BMWK
From Materials to Innovation – Clusters Go Industry, KfW	BMBF
Central Innovation Programme for SMEs (ZIM)	BMWK

1 The term “circular economy” is used in the NCES as defined in the EU Circular Economy Action Plan and covers all phases of value creation – from product design and production to consumption, repair, waste management and secondary raw materials returned to the economy. In Germany, the Circular Economy Act provides a legal definition: “Circular economy within the meaning of the present Act shall constitute the prevention and recovery of waste”, Circular Economy Act (KrWG) section 3(19). This more narrowly defined term is included in the concept of the NCES, but is only one part of the comprehensive approach.

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4 According to calculations of Agora Industrie and Systemiq (2023) in the study “Resilienter Klimaschutz durch eine zirkuläre Wirtschaft” https://www.systemiq.earth/wp-content/uploads/2023/11/A-EW_309_Kreislaufwirtschaft_WEB.pdf, Figure p.15

5 The negotiations on the EU Packaging Regulation have been concluded. The EP and COREPER approved the trilogue agreement of 4 March 2024. The regulation is expected to be officially adopted by the European Parliament and the Council of of the European Union in autumn 2024.

6 Post-consumer recycled content (PCR) must be distinguished from post-industrial recycled content (PIR).

7 Particulate matter (PM) health impacts.

8 Biodiversity loss due to both land use and freshwater eutrophication.

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12 International Resource Panel (2019): Global Resources Outlook 2019 https://www.resourcepanel.org/global-resources-outlook-2019

13 Eurostat (2024): Circular material use rate. Data code: cei_srm030 https://ec.europa.eu/eurostat/databrowser/view/cei_srm030/default/table

14 Figure 1 shows Germany’s direct material flows in 2022. On the left, domestic extraction and imports are shown, which together make up the material flows processed within an economy. On the right, use and location of the utilised materials are shown: as exports, losses dispersed into the environment, landfill or emissions. The flows of materials that are physically utilised (material use, recycling, backfilling) are heavily dominated by non-metallic minerals. In contrast, non-metallic

minerals play a smaller role in imports and exports. In terms of total material flows, imports are dominated by fossil raw materials.

15 German Environment Agency (UBA) (2026): The Use of Natural Resources. Resources Report for Germany 2026, forthcoming.

16 The raw material consumption (RMC) indicator, also referred to as the material footprint of a country, is composed of domestic raw material extraction and direct and indirect imports converted into raw material equivalents, minus the raw material equivalents used for the manfacture of exported goods https://www.umweltbundesamt.de/en/data/environmental-indicators/ndicator-raw-material-consumption#at-a-glance

17 This also takes into account raw materials that were required both domestically and abroad for the production of goods that were used or in demand in Germany. The weight of raw materials used in their manufacture is taken into account in the calculation of the raw material equivalents https://www.umweltbundesamt.de/bild/primaerrohstoffeinsatz-rmi (in German)

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19 According to calculations by the International Resource Panel, the global average in 2021 was around 12.6 tonnes per capita, https://www.resourcepanel.org/global-material-flows-database

20 Given economic growth of 40 percent between 2010 and 2021 (with 2020 being an exceptional year due to the COVID-19 pandemic) and a slight increase in RMC, a relative decoupling can be observed. Germany's consumption-based environmental impacts increased by around eight percent up to 2019, which tends to indicate a relative decoupling from economic growth. Preliminary data for 2021, on the other hand, shows a slight decrease in consumption-based environmental impacts compared to 2010.

21 The consumption footprint covers five areas of consumption: food, mobility, housing, household goods, and appliances. Consumption intensities are calculated on the basis of consumption statistics. Environmental impacts are based on life cycle assessments (LCAs). A total of 16 environmental impacts, such as climate change, particulate matter pollution, land use etc. are taken into account. The indicator is part of the EU Circular Economy Monitoring Framework and the 8th Environment Action Programme.

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72 These include crop residues, residues from livestock farming or forestry and biogenic by-products and waste materials that arise during the further processing of agricultural and forestry products, distribution and trade, as well as during or after use. In addition, there is biomass that is produced during the maintenance of green spaces such as gardens and parks, roadside vegetation, areas for habitat and species protection, or in the context of preserving cultural landscapes. This biomass is used as raw material.

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108 Under the EU regulation, each Member State designates a contact point responsible for providing information and advisory services on ship recycling. In Germany, the designated contact point is the Federal Maritime and Hydrographic Agency (BSH).

109 European Council (2023): Regulation 2023/1542 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R1542

110 ShipRec innovation network https://www.shiprec.eu/ (in German)

111 The figure includes the use of fossil and biobased raw materials, secondary raw materials and by-products, and also accounts for 8 million tonnes of plastics used in coatings, paints, adhesives and fibres. Conversio (2022): Material flow analysis plastics for plastics in Germany 2021: Facts and figures on the life cycle of plastics https://www.bkv-gmbh.de/files/bkv/brochures-en/Conversio_Material%20Flow%20Analysis%20Plastics%20in%20Germany%202021_brief%20version_November%202022.pdf

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113 Behr, A. & Seidensticker, T. (2018). Kunststoffe aus der Natur: Biopolymere. Einführung in die Chemie nachwachsender Rohstoffe: Vorkommen, Konversion, Verwendung, pp. 317-335

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115 Ibid.

116 Ibid.

117 Systemiq (2023): Breaking the Plastic Wave https://www.systemiq.earth/breakingtheplasticwave/

118 For example, the REACH microplastic restriction for intentionally added particles, requirements for tyre abrasion limits in EURO 7 and the European Commission proposal to reduce microplastic pollution from plastic pellets

119 For example, the REACH microplastic restriction for intentionally added particles, requirements for tyre abrasion resistance in EURO 7 and the European Commission proposal for a microplastic pellet regulation

120 See The Association of German Engineers (VDI) (2022): Rethinking the circular economy for plastics. How the transformation to circular value creation can succeed https://www.vdi.de/fileadmin/pages/mein_vdi/redakteure/publikationen/VDI-Green-Paper-Rethinking-the-circular-economy-for-plastics-english-version.pdf

121 in 2021 these were polyethylene (PE), PP, PET, PVC and PS (see Lindner, C., Schmitt, J., Fischer, E., and Hein, J. (2022), Conversio (2022), Conversio (2022): Material flow analysis plastics for plastics

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123 In 2021 these were PE, PP, PET, PVC and PS (see Lindner, C., Schmitt, J., Fischer, E., and Hein, J. (2022), Conversio (2022), Conversio (2022): Material flow analysis plastics for plastics in Germany 2021: Facts and figures on the life cycle of plastics https://www.bkv-gmbh.de/files/bkv/brochures-en/Conversio_Material%20Flow%20Analysis%20Plastics%20in%20Germany%202021_brief%20version_November%202022.pdf

124 The specific procurement requirements for construction contracts areaddressed in action area of construction and buildings.

125 Federal Ministry for Economic Affairs and Climate Action (BMWK) (ed.) (2023): Vergabestatistik, Bericht für das zweite Halbjahr 2021, Kapitel 6 „Berücksichtigung von Nachhaltigkeitskriterien in der öffentlichen Auftragsvergabe“, https://www.bmwk.de/Redaktion/DE/Publikationen/Wirtschaft/bmwk-vergabestatistik-zweites-halbjahr-2021.pdf?__blob=publicationFile&v=6 (in German)

126 See the European Commission approach to the definition (2017): Public Procurement for a Circular Economy. Good practice and guidance https://circulareconomy.europa.eu/platform/sites/default/files/knowledge_-_public_procurement_circular_economy_brochure.pdf, p. 5

127 Specific legal provisions must be mandatorily taken into account, including section 13 of the Federal Climate Change Act (KSG), section 45 of the Circular Economy Act (KrWG), the AVV Klima and the Timber Procurement Policy (*Holzerlass*).

128 The indicator is being developed under the lead responsibility of the BMUV.

129 The Federal Government is developing implementation concepts, taking existing tools into account, selecting suitable options, developing prototypes, evaluating them, rolling them out for use and making them available to the authorities.

130 The lead responsibility for this working group lies with the BMUV.

131 The BMUV is expected to lead on implementation.

132 G7 Alliance on Resource Efficiency: https://www.g7are.com

133 G7 Alliance on Resource Efficiency (2022): Berlin Roadmap on Resource Efficiency and Circular Economy, https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Europa___International/g7_berlin_roadmap_bf.pdf

134 G20 Resource Efficiency Dialogue: https://g20re.org

135 United Nations Environment Programme (UNEP) Intergovernmental Negotiating Committee on Plastic Pollution, https://www.unep.org/inc-plastic-pollution

136 High Ambition Coalition to End Plastic Pollution: End Plastic Pollution by 2040, https://hactoendplasticpollution.org/

137 International Climate Initiative (IKI) (2023): IKI Thematic Call 2023. Thematic Priorities, https://www.international-climate-initiative.com/fileadmin/iki/Dokumente/Calls/Themencall/2023/05b_TSP_Papiere_TC_23_EN.pdf

138 International Climate Initiative (IKI) (2023): IKI Thematic Call 2023. Themenschwerpunkte, https://www.international-climate-initiative.com/fileadmin/iki/Dokumente/Calls/Themencall/2023/05a_TSP_Papiere_TC_23_DE.pdf

139 Zukunft – Umwelt – Gesellschaft (ZUG): Export Initiative Environmental Protection, https://www.exportinitiative-umweltschutz.de/en/

140 German Recycling Technologies and Waste Management Partnership e.V., https://www.retech-germany.net/en/