Agora Industry

EXECUTIVE SUMMARY

Circular Economy and Net-Zero Industry

Potentials for energy-intensive value chains in Germany

Preface

Dear reader,

The basic materials sectors are beginning their transformation to climate neutrality now that the reform of the European Emissions Trading System has set out an ambitious path for reducing greenhouse gas emissions. In just a few years, these energy-intensive sectors must make the necessary investments in climate-neutral energy supply and production processes. Speed and scale are required.

The bottlenecks that emerged during the coronavirus pandemic, the energy crisis and price shocks following the Russian invasion of Ukraine and a tense geopolitical situation have emphasised the importance of resilient supply chains and import dependencies. A new consensus has emerged that industry must not only decarbonise quickly, but also become more resilient in its transformation. Greater resource efficiency not only increases resilience and reduces import dependencies – it also entails significant potential for emissions reductions across the economy.

Our study shows that circularity is a key decarbonisation strategy: energy-intensive industries and value chains can effectively reduce their embodied emissions through recycling, material efficiency and substitution, as well as longer product use. With 3D printing, high-tech recycling and innovative product design, the circular economy offers potential for new business models and technological leadership. We propose a political framework to enable this transformation towards greener, more resilient energy-intensive value chains.

I wish you an enjoyable read!

Frank Peter
Director, Agora Industry

Key findings at a glance

1 **Resilience is increasingly discussed as a key success factor for the industry's transition.** Strengthening the circular economy offers significant potential for resilient, climate-neutral industrial sectors. Material efficiency and recycling enable new business models, reduce dependence on energy and raw material imports and preserve the value of domestic resources.

2 **A circular economy can achieve climate targets faster, at lower costs and with lower energy consumption.** A combination of decarbonised primary production and circular economy measures in the energy-intensive value chains of steel, cement and plastics can reduce cumulative GHG emissions in Germany by 25 percent, cut transformation costs by 45 percent and reduce energy consumption by 20 percent by 2045.

3 **With the right policy mix, the National Circular Economy Strategy in Germany can create a market for circular economy technologies and products.** Promoting technologies for resource efficiency and cooperation along key value chains and introducing standards for recyclable product design can incentivise investments in circular technologies and products. Standards for the embodied carbon in products, green public procurement and the removal of regulatory barriers are needed to create lead markets.

4 **In the transformation to climate neutrality, resource efficiency should be significantly improved alongside energy efficiency.** Besides supporting the achievement of climate targets, this will help conserve resources and boost competitiveness. The Federal Government should therefore set specific targets for reducing resource consumption and increasing resource productivity and the circularity rate in key value chains and material flows in Germany.

Executive summary

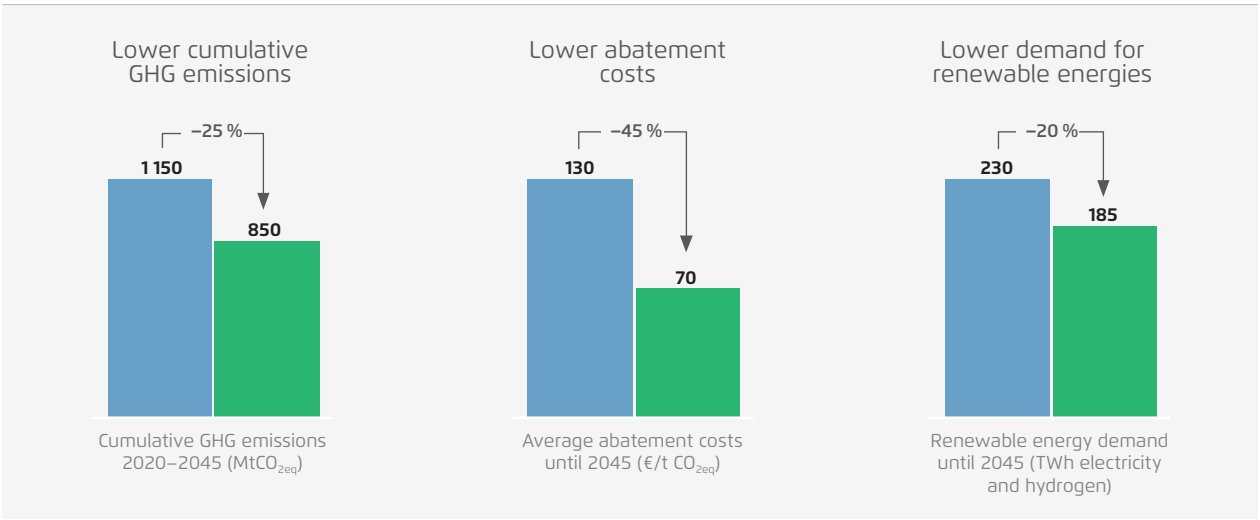
Circular economy strategies are indispensable if Germany's 2045 climate target is to be achieved: they can unlock significant cumulative emissions savings, improve resilience of supply chains and reduce costs and energy demand of the transition.

A quarter of all CO_2 emissions in Germany stem from the industrial sectors, 50 percent of which can be attributed to energy-intensive basic materials steel, concrete, cement and plastics alone. A large proportion of these materials (around 60 percent) is used in buildings, vehicles and packaging (Umweltbundesamt, 2022a). Climate-neutral production of primary steel, cement and virgin plastics requires low-carbon production technologies – for example by switching to green hydrogen, electrifying process heat or using carbon capture, utilisation and storage (CCUS). However, these technologies are dependent on extensive investment in infrastructure, must themselves be scalable and need cost-competitive renewable fuels, raw materials and electricity to be available.

In light of the ambitious decarbonisation pathway set by the EU ETS, all available decarbonisation strategies need to be considered in the industry's transition. A strategy that focuses exclusively on decarbonising primary production runs the risk of failing to meet climate targets while having a negative impact on other planetary boundaries such as biodiversity or water use. By combining the decarbonisation of primary production with circular economy measures in demand sectors, the value chains of steel, cement, concrete and plastics can be decarbonised faster, at lower cost and with greater economic resilience: while decarbonising primary production places heavy demands on scarce material, energy and capital resources, circular economy strategies can help reduce import dependencies on raw materials. Moreover, most circular economy technologies are market-ready and could be deployed at scale immediately, provided the right regulatory framework were in place.

Potentials from combining the decarbonisation of primary production with circular economy strategies in Germany

→ Fig. 1



Agora Industry and Systemiq (2023). * Modelled for steel, concrete, cement and plastics in the demand sectors buildings, vehicles and packaging.

This means that cumulative CO_2 emissions could be reduced significantly, at lower average abatement costs and reduced renewable energy consumption (Figure 1).

Circular economy measures offer CO_2 reduction potential along the entire industrial value chain, from production and use to the end of the life cycle.

The strategies covered in the study "Resilient climate action through a circular economy: perspectives and opportunities for energy-intensive materials" range from increased recycling to greater material efficiency (lightweight construction, substitution, loss minimisation) and the longer use of products (extension of service life and reuse of components). The potential modelled in this study for Germany only considers technologies that already have a maturity level of at least 7, i.e. those that are already being used in practice and are predominantly low-tech solutions.

Within the value chains of buildings, vehicles and packaging, these levers have the potential to reduce annual emissions from the production and use of steel, cement and plastics by the equivalent of 30 million tonnes of CO_2 by 2045 and by 18 million tonnes as early as 2030.

In the case of steel, emissions reductions can be achieved through various circular economy strategies: by 2045, emissions could be reduced by two percent compared to the business-as-usual (BAU) scenario by extending the service life of buildings and reusing steel components. A further 13 percent reduction could be achieved by increasing material efficiency (e.g. reducing production scrap), while improved recycling could bring about a 23 percent reduction in embodied emissions. The potential for increased recycling depends largely on the amount of scrap available in relation to the amount of raw steel required. Scrap currently accounts for 45 percent of steel production in Germany (Umweltbundesamt, 2020), which puts Germany below the EU average of 57 percent in 2020 (Bureau of International Recycling, 2021).

As far as cement is concerned, transitioning to a circular economy requires close cooperation and coordination along the entire value chain. The construction sector, which nowadays is often characterised by overspecification and a one-size-fits-all standardised approach, could cut 26 percent of its cement emissions by 2045 by increasing material efficiency, for example by optimising building design and construction techniques. Extending the service life of buildings and reusing concrete elements could potentially result in a four percent emissions reduction. If cement and concrete mixtures were optimised with regard to recycled cement, substitutes, fillers and additives, emissions could be reduced by 40 percent by 2045 compared to the BAU scenario.

Recycling is the most important lever when it comes to plastics, offering a 31 percent reduction potential by 2045. To achieve these emission reductions, considerable improvements in the collection and separation of homogeneous, mono-material plastics, an expansion of mechanical recycling and the development of new chemical recycling capacities are required. GHG emissions could also be reduced by using packaging for longer and more efficiently: reuse models, such as refilling containers in shops, have significant potential, as does reducing the amount of material used in packaging. Together, these measures could reduce greenhouse gas emissions by 18 percent by 2045.

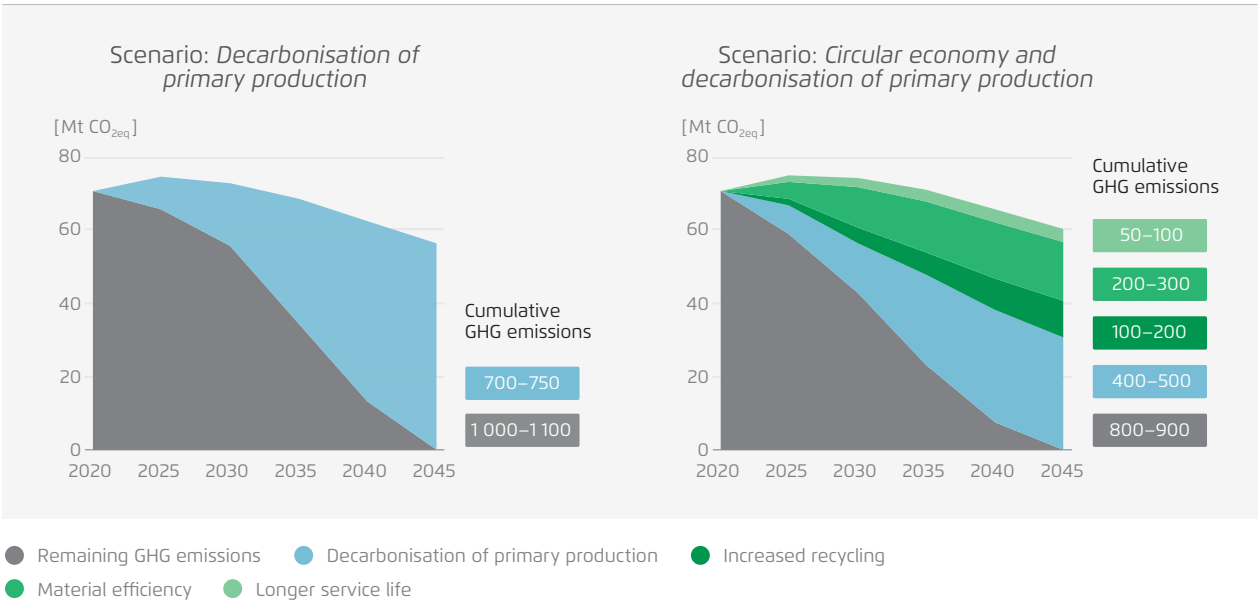
A circular economy promotes innovation, competitiveness and a resilient economy in Germany and Europe.

The vision of a circular economy represents a major paradigm shift from our traditional linear economy. For the first time, industrial activity and quality of life could be decoupled from the use of (new) resources. This would have several advantages for the economy. First, a circular economy would enable a shift in economic activity from low value-added raw materials to innovative business models and materials that increase efficiency by using technologies such as mathematical topology optimisation or artificial intelligence. Second, in an increasingly carbon-neutral world, recycling and efficient use of materials are crucial to maintaining competitiveness. Recycling can reduce the cost per tonne of climate-neutral material, while efficient use increases the value per tonne of material. The necessary technological, technical and logistical know-how could become a new competitive advantage in a world increasingly confronted with resource scarcity, rising material costs and planetary boundaries. Finally, a circular economy can improve the resilience of the economy as production inputs are sourced locally from waste products, reducing dependence on imports and volatile supply chains.

Europe and Germany are well positioned for this transition. With its technological leadership in mechanical recycling (especially of PET) and being home to some of the largest chemical companies, Germany could play a leading role in maximising mechanical recycling of plastics and innovating chemical recycling solutions. Similarly, the decarbonisation of primary steel production, which in Germany is based on direct iron reduction, can give rise to synergies with steel recycling by expanding the capacity of electric arc furnaces. Third, Germany has a world-leading and innovative cement industry that is well-positioned to improve efficiency along the entire value chain. In addition, Germany – and Europe – are renowned for their excellence in engineering and functional design, making efficient and circular design and technology solutions a key opportunity for Germany in a world that is moving towards climate neutrality with limited natural resources.

GHG reduction potential of circular economy measures for steel, cement and plastics in Germany

→ Fig. 2



Agora Industry and Systemiq (2023). The figure shows the circular economy potential of the material flows for steel, cement and plastics industries in the automotive, buildings and packaging demand sectors.

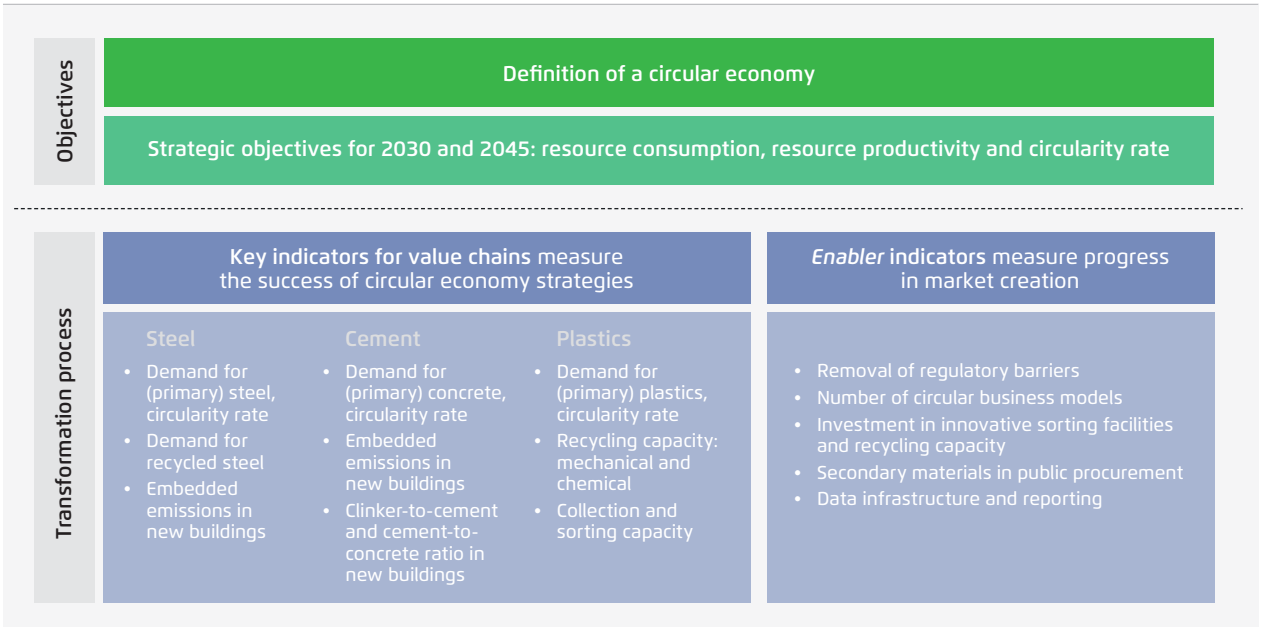
The transition to a circular economy requires clear targets, a comprehensive digital infrastructure and political framework.

The transition to a circular economy is complex: it requires changes in the way basic materials are produced, used in demand sectors and handled at the end of life. First and foremost, this transition requires a clear vision. Germany's National Circular Economy Strategy (NKWS) must define clear target metrics for a circular economy and quantify specific goals for the years 2030 and 2045: overarching targets for resource consumption, resource productivity and secondary raw materials are essential to put in place the necessary guard rails for the transformation. A successful transformation requires a monitoring framework that is based on clear principles and indicators to measure progress in the transition. In the full study, we outline the requirements and indicators for a monitoring system for the material flows of steel, cement, concrete and plastics. The indicator system should be differentiated and granular enough to map the potential, progress and failures of individual strategies within the respective material flows and thereby provide decision-makers with sufficient information for investment decisions and policy measures. Finally, an appropriate data basis is needed, which necessitates a digital infrastructure with extended reporting requirements and digital product passports.

The study further maps out the policy measures that will be required to create the necessary incentives in the energy-intensive industries. On the one hand, direct regulatory barriers will have to be identified and removed, and on the other, meaningful targets and incentives will need to be developed at national and European level to support both producers and consumers and increase demand for recyclable technologies and secondary materials.

Public financial support for key technologies, collaborations along the value chain and research and development are important drivers on the supply side. Investment in innovative circular economy technologies should be incentivised. As part of the amendment to the EU Ecodesign Regulation, product design for recycling and

Objectives and monitoring system for a circular economy for basic materials → Fig. 3



Agora Industry and Systemiq (2023)

material efficiency should be enhanced. At the national level, governments should improve the data collection and reporting infrastructure, especially for plastics, to obtain more reliable data on plastic waste and recycling rates and be better able to track plastic flows in the economy.

Measuring and setting limits for the CO_2 content of products (embodied carbon) plays a key role in generating demand for recyclable technologies and secondary materials in the relevant demand sectors. This technology-neutral instrument creates markets for recyclable and resource-efficient products and materials, while at the same time motivating manufacturers to use materials with a low carbon footprint. These limits can be set in appropriate regulations, such as those governing packaging or building efficiency at European or national level. Green public procurement can also be an impactful means of encouraging circular construction. The public sector should increasingly promote the use of circular building materials by using the CO_2 content of basic materials as a selection criterion and setting minimum quotas for recycled or reused building materials. Digital product passports (DPP) are an essential prerequisite for an efficient circular economy. They increase transparency, traceability and consistency for all players in the value chain and provide important information on the origin and composition of a product as well as its repair and dismantling options. Clear and practicable guidelines at European level are important for a successful implementation.

Circular economy strategies need to be defined for key value chains.

In the area of plastics, governments should improve deposit systems for single-use and reusable packaging by making systems compatible with different product formats and creating a comprehensive infrastructure. The planned integration of waste incineration into the EU Emissions Trading System is crucial for reducing CO_2 emissions in the plastics sector. This will prevent waste being relocated to countries with lower environmental standards and promote demand for high-quality recycling. At the same time, it will ensure a level playing field between EU member states.

In the construction sector, the removal of regulatory barriers is essential. This includes revising standards and building regulations to recognise low-carbon and recycled materials, reforming concrete standards, introducing experimentation clauses and creating new building standards and regulations to conserve resources. Standards for assessing circularity at various levels (building, component, construction product and material level) should also be laid down.

In the area of vehicle construction, the material efficiency potential of the circular economy strategies considered in the analysis has been largely realised. Specific quotas for the use of secondary materials in the automotive sector could boost demand for recycled plastics, however.

For an in-depth analysis of circular economy potentials for energy-intensive value chains in Germany and a comprehensive discussion of the policy mix, please refer to our study *Resilienter Klimaschutz durch eine zirkuläre Wirtschaft* (available in German) at www.agora-industrie.de.

Publication details

About Agora Industry
Agora Industry develops scientifically sound and politically feasible concepts for successful pathways to a climate-neutral industry – in Germany, Europe and internationally. The organization which is part of the Agora Think Tanks works independently of economic and partisan interests. Its only commitment is to climate action.

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