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Climate mitigation contributions from circular economy actions

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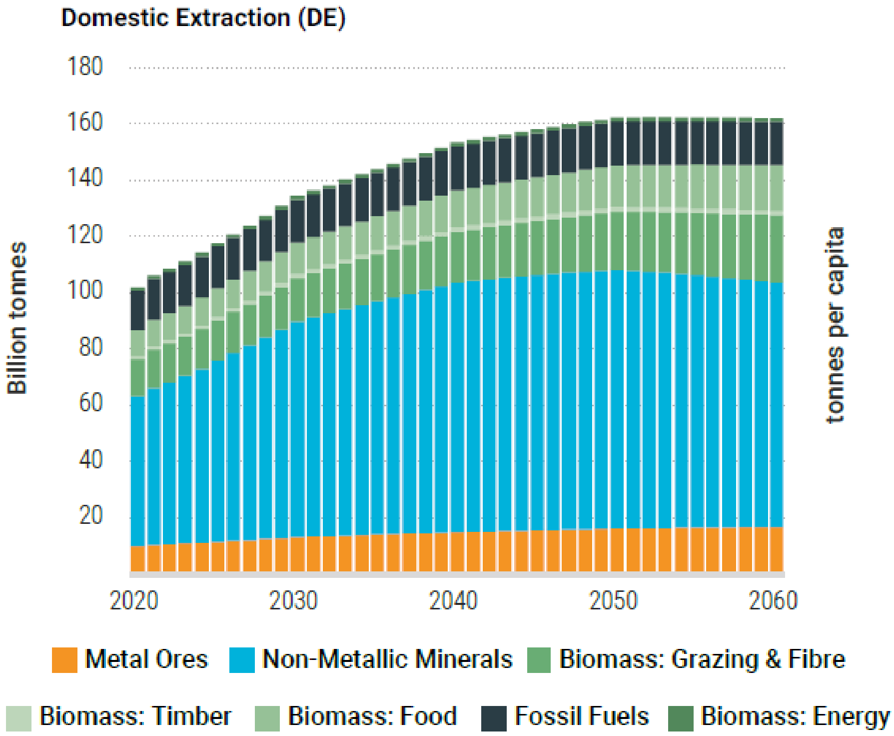
Summary / Description

There is growing awareness of the key role that the circular economy can play in reducing greenhouse gas (GHG) emissions based been a notable increase in publications exploring the intersection of CE and climate mitigation and adaptation. This recent surge in research and political attention makes it a timely moment to take stock of existing findings and assess the climate mitigation potential of circular economy actions. Based on a review of over 130 publications published between 2020 and March 2025 on this topic, this report provides a consolidated overview of the climate mitigation potential and identifying hot spots and potential “low hanging fruits”. A key finding is that estimates of mitigation potential vary widely across studies. Therefore, the report evaluates possible reasons for the differing results. The report concludes with key lessons learned based on the literature to support future policy developments and climate modelling efforts.

1 Introduction

A recent report, by Potsdam Institute for Climate Impact Research, stated that seven out of nine planetary boundaries have already been crossed, and that this is mainly due to human activities in production and consumption systems (Sakschewski et al., 2025). Various studies show that global demand for energy and raw materials based on traditional linear production and consumption patterns will continue to rise significantly in the coming decades—as will the associated serious consequences for the environment (UNEP IRP, 2024; OECD, 2019) (see Figure 1.1).

Figure 1.1: The outlook for global raw materials extraction under historical trends according to the UNEP IRP GRO 2024



Source: (UNEP IRP, 2024)

The extraction and processing of raw materials often require extensive energy, materials, and chemicals, resulting in high greenhouse-gas emissions and air, soil, and water pollution (de Haes and Lucas, 2024; UNEP IRP, 2024). Furthermore, the cultivation and harvesting of biomass has a significant impact on greenhouse gas emissions and biodiversity loss due to land use changes and unsustainable land management and harvesting practices (IPBES, 2019; IPCC, 2022; UNEP IRP, 2024). Simultaneously, there is an urgent need to transition from fossil fuels to renewable sources to mitigate the climate crisis, primarily caused by fossil fuel combustion. This shift increases the demand for materials related to low-carbon energy technologies (IEA, 2024; Mathieux et al., 2017).

In contrast, circular economy strategies aim to reduce society's demand for energy and primary raw materials while maintaining the level of services, thereby reducing environmental impacts. Policies and measures to close material cycles, as well as closed-loop business models, can improve resource and energy efficiency, reduce emissions, and support climate goals at the national, regional, and global levels (Johannsdottir, 2014; Korhonen et al., 2018; Trinomics et al., 2018; Trinomics, 2023; Ramboll/Fraunhofer ISI/Ecologic, 2020). Circularity of critical energy transition minerals will be essential to reducing the growing demand and declining the need for primary mining (Mathieux et al., 2017).

Therefore, the circular economy (CE) plays an increasingly important role in climate change mitigation. The UN Environment Assembly’s Resolution 5/11, adopted in 2022, also recognized the importance of CE to tackling climate change and meeting other environmental goals:

> *“Acknowledges that pursuing circular economy approaches as a pathway to achieving sustainable consumption and production patterns can contribute to addressing climate change, biodiversity loss, land degradation and the impact of water stress, pollution and the impact thereof on human health, thus contributing to the achievement of related goals under the 2030 Agenda for Sustainable Development and other internationally agreed environmental goals”* (UNEA, 2022)

During the past years there has been a notable increase in publications exploring the intersection of CE and climate mitigation and adaptation (Cantzler et al., 2020; Gallego-Schmid et al., 2020). Although, due to different methodologies and underlying assumptions the exact mitigation potential of CE is currently difficult to estimate, most reports and publications point to a substantial contribution to lowering emissions (Cantzler et al., 2020; Wiedenhofer et al., 2025; EEA, 2024c). This surge in research makes it a timely moment to take stock of existing findings and assess the climate mitigation potential of circular economy actions.

The **aim of this report** is to provide an initial assessment by synthesizing the existing literature to provide a consolidated overview of the climate mitigation potential and identifying hot spots and potential “low hanging fruits”. In addition, possible reasons for the differing results will be identified. Another important goal is to identify key lessons learned based on the literature to support future policy developments and climate modeling efforts.

2 Circular Economy as a relevant lever for climate mitigation

A review of the scientific literature forms the basis for evaluating the current state of knowledge on the mitigation potential of CE policies and measures and deriving indications and recommendations for future policy measures in climate and resource protection. For this purpose, the relevant sectors and hotspots are identified, the mitigation potentials of various CE measures described in the literature are evaluated, and the most important influencing factors are identified.

2.1 Methodological approach

The underlying literature review focuses on peer-reviewed scientific articles, including meta-studies and review articles. The set of publications to review was selected using a keyword-based search in the literature database "Web of Science[1]", limited to the publication period of 2020 to 2025 (February) and English language documents.

In a first step, keywords were selected to cover the topics of CE and climate change (see Annex 1; Table A-1). CE keywords covered a broad understanding the circular economy, including keywords on closing, slowing, and narrowing resource loops, circular business models, r-strategies, and circular design, as well as related terms such as the biobased economy, the sharing economy, and industrial symbiosis (amongst others). Climate change mitigation keywords covered both general terms (e.g., global warming) and terms related to greenhouse gases (e.g., methane). The circular economy terms were required to appear in the publication title, whereas the climate change keywords were required to occur in the title and either the abstract or the publication keywords. As a result, **463 publications** were identified.

To further scope the search results to publications that focus on quantifying the contribution of the circular economy to climate change mitigation, a third set of keywords was added that focused on methods previously identified as being commonly used for assessments of the climate change mitigation contribution of the circular economy (see EEA, 2024c). These keywords were required to occur either in the title, abstract, or publication keywords. This reduced the number of publications to 222.

Finally, a minimal threshold on publication impact was set, requiring that articles published before 2024 had at least been cited once per year on average. This excluded 21 additional publications, resulting in a set of 201 publications subjected to further analysis. A schematic overview of the steps of the literature search are provided in Figure 2.1 the different Web of Science queries are presented in Annex 2.

In the second step, an artificial intelligence (AI)-supported screening of the publication abstracts was carried out with the help of the ChatGPT 4o model with the goal of objectively extracting, structuring, and summarizing key information of the selected set of publications. A procedure was set up in which the AI-model first returned the abstract to be analysed, and then extracted the information regarding a structured set of aspects, including a brief thematic summary of the publication, the sector, the method and geographical region, the relation to the circular economy, and the quantified GHG mitigation potential.

The information provided was exported to Excel and used to roughly cluster the publications for the full-text analysis and to sort out those publications that did not contain a quantification of the greenhouse gas reduction potential or did not have an explicit relation to the CE. A total of 165 publications were subsequently subjected to further evaluation, in which the information provided by the AI model was reviewed by a first screening of the full texts with regard to their relevance, in particular with regard to the actual investigation of the greenhouse gas mitigation potential of CE measures and the quantitative presentation of the mitigation potential. This led to the exclusion of a further 32 publications, so that a total of **131 publications** were used for full-text analysis.

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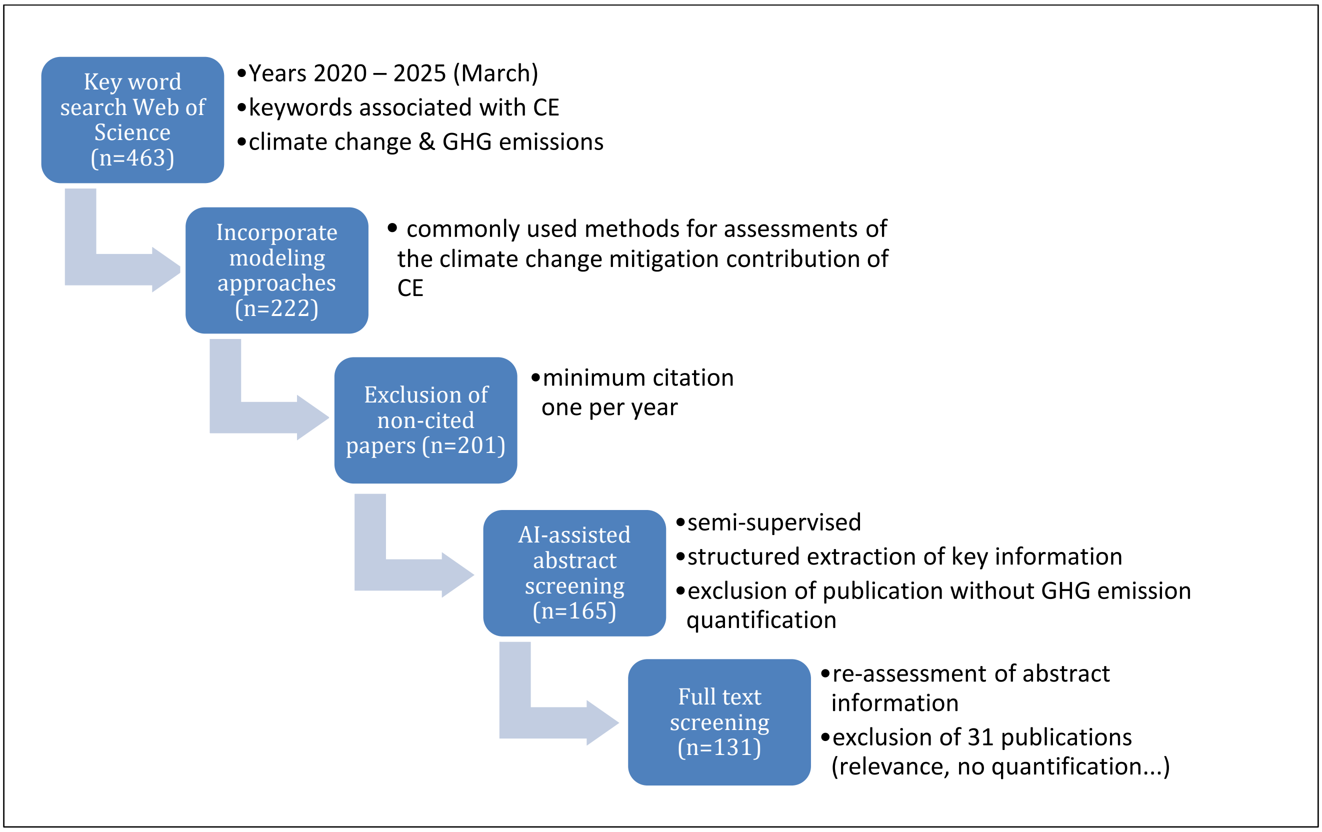
[1] www.webofscience.com

Figure 2.1: Selection process for literature review



Source: ETC CE

In addition to the peer-reviewed publications identified in the systematic literature review, some relevant publications from key international institutions working on the topic including the UNEP International Resource Panel, the OECD, Circle Economy Foundation, and the Ellen MacArthur Foundation were also considered.

As not all screened publications provided information on the total amounts of avoided GHG emissions and in order to make the greenhouse gas mitigation potentials described in the evaluated literature comparable in a first overview, these were transformed into percentage savings. For this purpose, a baseline was first identified in each evaluated study. This can be an explicitly mentioned baseline scenario, a business-as-usual scenario, but also - depending on the study - the historical development or current emissions situation. This baseline was then compared with the described reduction potentials and the percentage savings were calculated.

2.2 General overview

A total of 131 publications with publication dates between 2020 and 2024 were identified in the systematic literature search, which quantify the GHG mitigation potential CE measures. Of these publications 14 were published in 2020, while 34 were published in 2024 (Figure 2.2). This suggests that the intersection between CE and climate change mitigation and adaptation is seen increasingly important.

2.2.1 Geographic coverage

An analysis of the geographical resolution shows that the majority of publications focus on the leading developed countries (Europe 30 studies, North America 5 studies, Japan[2] 4 studies, G7 1 study), followed by 24 studies on the so-called BRICS countries (e.g. Brazil, Russia, India, China and South Africa) - with a

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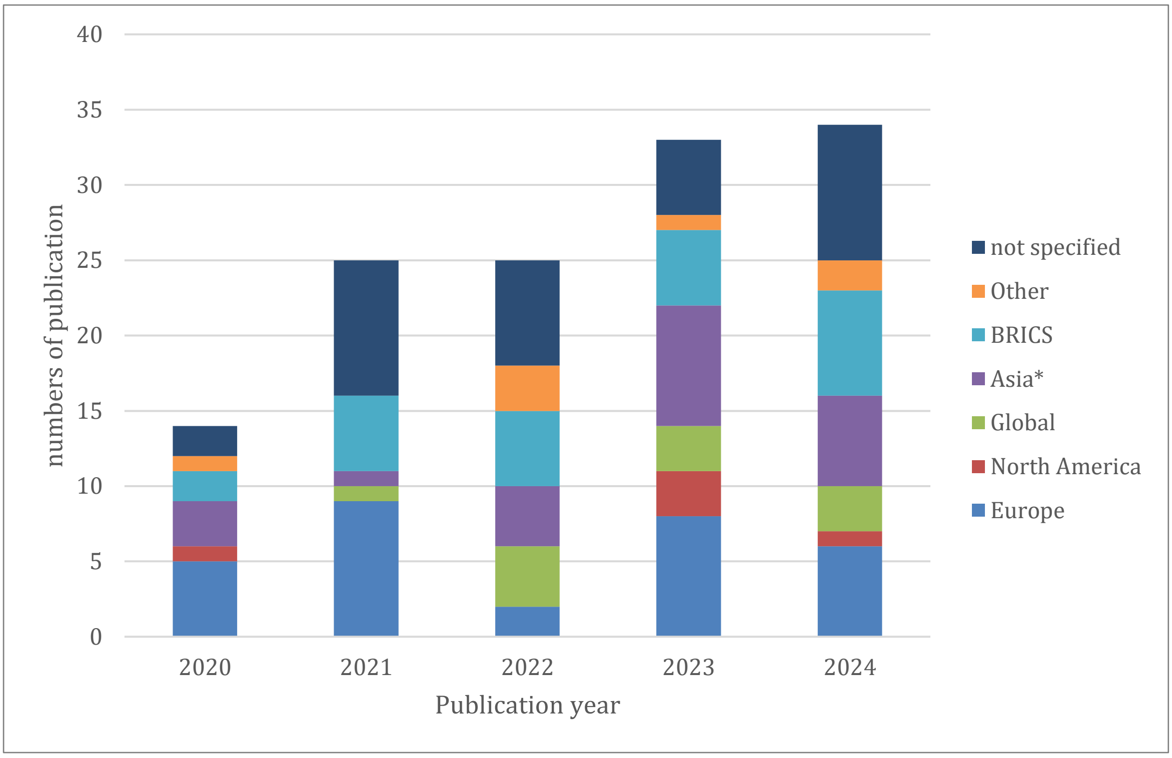
[2] as further G7 state, but included here in the category “Asia”

high concentration on China. A comparison of the five years of publication shows that publications relating to the BRICS countries and Asian countries (without China and India) have steadily increased, but without showing a clear trend (Figure 2.2). It turns out, that the geographical scope of the studies is often linked to the geographical location of the author. A global analysis is carried out in 11 evaluated studies. 7 studies consider other countries like Australia or Uganda or analyzed different countries as case studies. In 32 studies, mainly product-specific, no geographical reference is discernible.

Figure 2.2 Number of publications per year and geographical coverage



Source: ETC CE; * without China and India

The year 2025 is not included, as only publications until March 2025 were reviewed.

2.2.2 Methods used to assess mitigation potentials

The screened literature covers various analytical methods, however most papers employed LCA (Life Cycle Assessments) and hybrid modelling (**Error! Reference source not found.**). However, it should be noted that the hybrid modelling category is a collective category in which different methodological approaches are included. For example, in 16 of 49 studies, LCA approaches are combined with other methods. Many studies evaluate and quantify various concrete CE measures with regard to their effect on the reduction of GHG emissions. For this purpose, scenarios[3] are usually developed to estimate the individual effects of the measures using various assumptions or target values and the impact of the implementation of the measures is converted into a potential GHG emissions saving. Various approaches are available for this purpose, such as LCA, material flow analysis, optimization models or, for example, using just coefficients for GHG emissions.

The different methodological approaches naturally have different strengths and weaknesses and are therefore more or less suitable for assessing the mitigation potential of the CE, depending on the research question and scope (EEA, 2024c). In any case, however, it is hardly possible to compare publications that use different methodological approaches, particularly due to the different levels of detail and system

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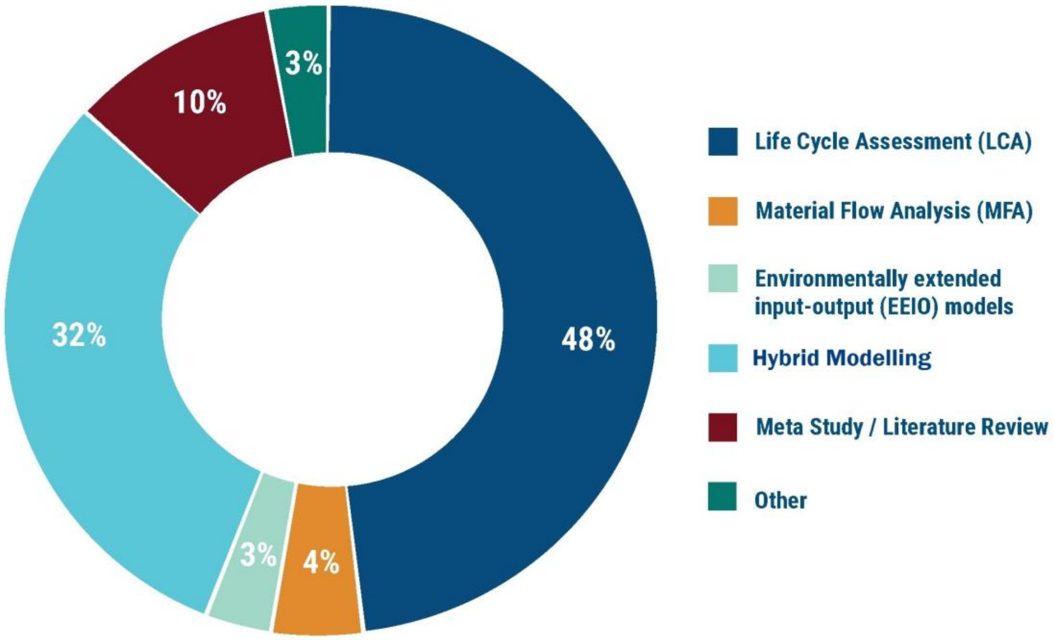
[3] The Shared socioeconomic pathways are often used a base for this purpose (see https://globaldatalab.org/gvi/ssps/)

boundaries. The strengths and weaknesses of the three clearly identifiable methodological approaches are briefly outlined below on the basis of EEA (2024c).

Figure 2.3 Percentage of methods used in screened literature[4]



Source: ETC CE designed in collaboration with CSCP

Life cycle assessment (LCA) is a standardized method (ISO, 2006b, 2006a) designed to systematically quantify the environmental impacts of a product, process, or service throughout its entire life cycle. The strength of life cycle assessment is its level of detail, comprehensiveness, quantitative nature, and suitability as a comparative tool. Because LCA considers the entire life cycle, it provides a holistic view of the environmental impacts associated with a product, process, or service and as such prevents impact displacement across life cycle stages, which allows for the modelling of very specific CE measures. In terms of climate change mitigation, 'global warming potential' is one of the impact categories typically assessed in a life cycle assessment. This shows the greenhouse gas emission intensity of the product, process, or service under investigation throughout its entire life cycle. The disadvantage of such assessments at process-level is that they does not model how the product, process, or service under investigation relates to other sectors or the economy as a whole. Also, LCA requires extensive data collection with a high level of detail, which can be time-consuming and costly to collect. Moreover, there is a degree of uncertainty in the collected data and when specific data cannot be found, the analyst will have to resort to assumptions. Especially this data-intensive nature and the need for assumptions makes that performing an LCA can be challenging for non-experts

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[4] The percentages shown here include double counts, as hybrid modeling in particular combines several methodological approaches. Since this model coupling is increasingly being used, it is presented here as a separate methodological approach. At the same time, however, the significance of the individual methodological approaches should also be highlighted.

Material flow analysis (MFA) provides a detailed understanding of how materials flow through or accumulate in a system, based on measurable data, for systems ranging from a single factory process to material flows at the level of world regions. Therefore it is a useful tool for modelling CE measures, as it can directly model measures for material efficiency, service life extension and reuse (Graedel, 2019).
A limitation of MFA is its dependence on the chosen system boundary: interactions outside the boundary are not modelled in detail and only captured as inflows and outflows, unless the study is linked to broader frameworks (e.g., economy-wide MFA or IO models). Like LCA, MFA is a detailed method that requires extensive data collection, which can be time consuming and costly. However, unlike LCA, MFA focuses specifically on material flows, without considering the associated emissions. MFA therefore does not allow a broad assessment of the environmental impacts of the studied system, unless it is complemented with data from other methods such as LCA or linked to e.g. environmental extended input output (EEIO) analysis in order to assess the environmental impacts associated with the system's processes.

As a tool for analysing CE measures, **environmentally extended input–output analysis (EEIO)** is well-suited because it captures economy-wide, cross-sector supply-chain linkages and can quantify environmental and economic impacts consistently at sector and multi-region scales, helping to avoid burden-shifting across sectors or borders. However, EEIO is built on monetary supply-use or IO tables and therefore represents environmental pressures via environmental extensions; it does not track physical flows by default, and sectoral aggregation plus price homogeneity assumptions limit detail. Moreover, standard EEIO is static and linear (fixed coefficients), so it cannot endogenously represent price/behavioural change, rebound, or other dynamic interactions without coupling to additional models. For climate-mitigation questions, EEIO enables consumption-based attribution by linking emissions embodied in global supply chains to the final demand of specific end-user groups and regions, and conversely tracing the emissions of producing industries back to the consumption that drives them. Building on this foundation, Donati et al. (2020) provided a practical methodology (and software) to implement CE interventions by editing IO coefficients, final demand and extensions within EEIO, with case studies and a web tool; the Circularity Gap Reports[5] apply EEIO to assess circular strategies and model counterfactual scenarios in national and global assessments using similar scenario adjustments. The ETC CE is also using this method to develop EU CE scenarios and highlighting mitigation potentials regarding GHGs, air pollution, and biodiversity loss (EEA, 2025) .

In order to combine the strengths of individual methods and to minimize the influence of the weaknesses, a combination of different methodological approaches is often used in the sense of **hybrid modelling**, especially in recent publications (Wiedenhofer et al., 2025). A common method is to combine models with high level of detail and technological granularity (such as LCA and MFA) with macro models with less technological detail (such as EEIOA). The macro-scale models can then be used to analyze the macroeconomic impact of the alternatives compared in the LCA/MFA studies, while benefiting from the increased level of detail to achieve more specific and precise results. Another approach would be to link models with high technological granularity (such as LCA) to complex systems models (such as system dynamics or agent-based models) to account for dynamic or behavioural effects over time (Walzberg et al., 2021).

Some of the studies identified do not provide their own calculations of greenhouse gas reduction potentials, but instead evaluate relevant publications in the form of a **meta-study or literature review** and make the reduction potentials calculated therein available (e.g. Gallego-Schmid et al., 2020). The reductions identified in this way may therefore have been calculated using a wide variety of methodological approaches, including those mentioned above.

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[5] https://www.circularity-gap.world/methodology

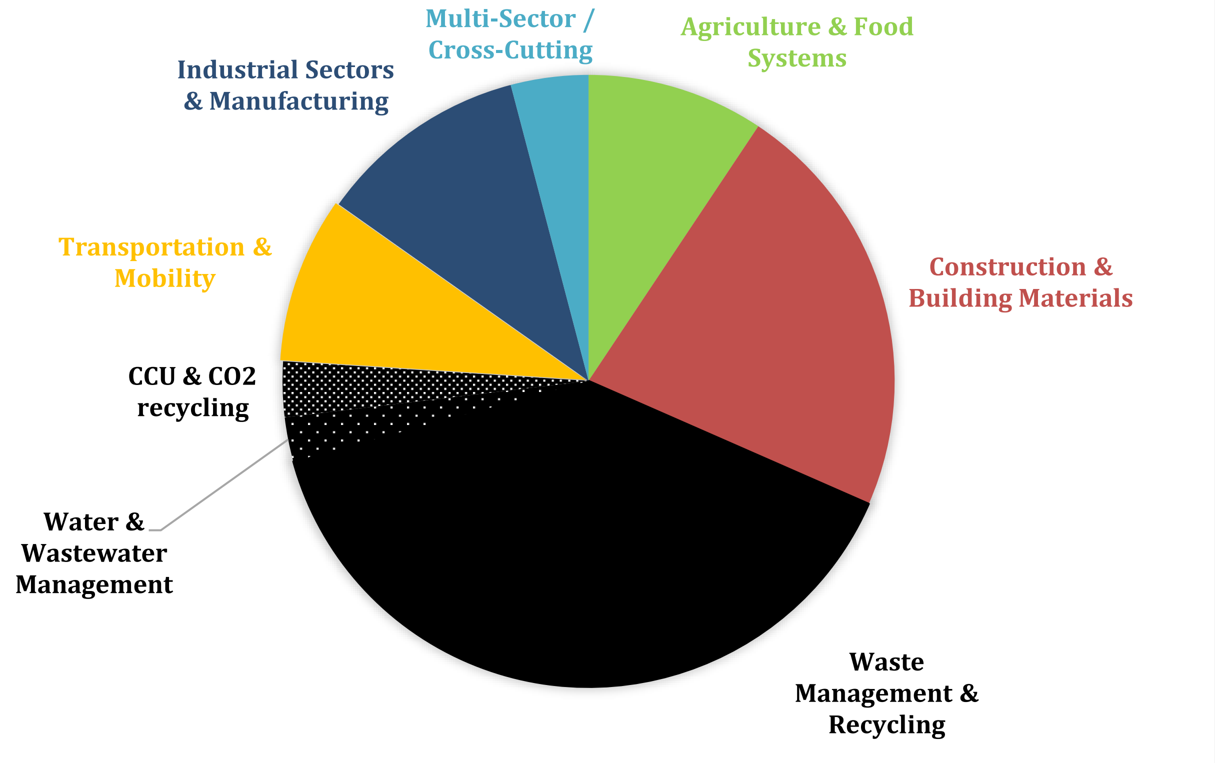
2.3 Identified key areas

Based on the evaluated literature, it is possible to identify the sectors and topic clusters considered as well as to describe the examined and modelled circular economy measures. The following sections, evaluate the sectors and CE measures most frequently examined in the publications reviewed.

2.3.1 Frequently investigated sectors

The AI-based literature analysis led to a clustering of the screened literature in a total of 6 sectors (Figure 2.4). Overall, it appears that waste management and recycling incl. wastewater and CO_2-recycling, as well as construction and building materials, are the sectors most frequently considered, consisting of 44 % and 22 % of the literature reviewed.

Figure 2.4 Relevant Sectors identified by AI-based screening (multiple entries possible)



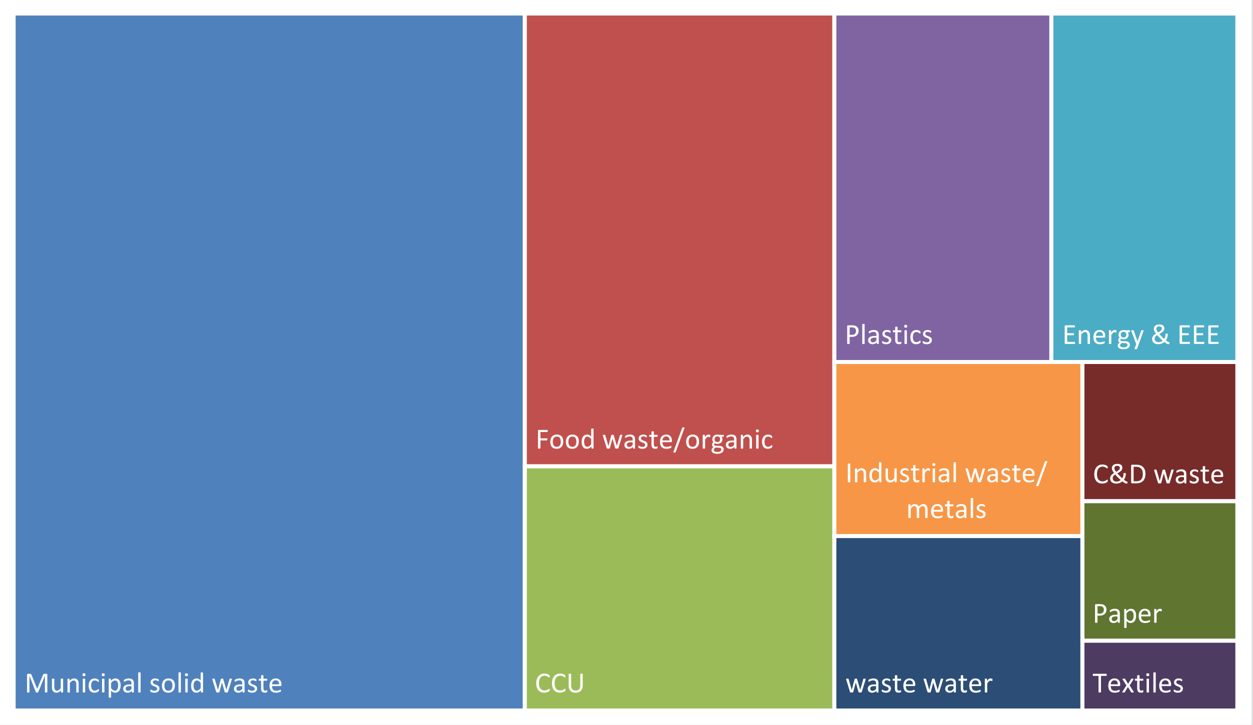
Source: ETC CE

This illustrates how waste management and recycling are often considered as a core part of CE. The construction and housing sector is also the sector to which a great potential in terms of both climate protection and the saving of raw materials was attributed at an early stage in various studies (EEA, 2020). The industrial and manufacturing sector, is investigated to a much lower degree (11%), indicating room for future studies to explore (Figure 2.4). However, publications evaluating the recycling of industrial waste have been assigned to the waste management sector in our analysis (see Figure 2.5). The agriculture and food systems sector, is another area with relatively few publications (9 %). Again, there is an overlap with waste management as studies that examine food waste, food waste prevention, and recycling of agriculture and food waste have been categorized in the Waste Management and Recycling sector. Another issue is the scope of CE, some publications that investigate CE-related actions e.g. dietary change or regenerative agriculture, may not refer to CE in their keywords nor in the abstract, and may therefore not have been included in our analysis.

Waste Management and Recycling deep dive

Since Waste Management and Recycling is by far the largest sector identified in our analysis, we have taken a deeper dive to explore some of the various thematic focuses covered. From this, we see that there is a clear dominance of the waste treatment of municipal solid waste (MSW) (Figure 2.5). Here, reduction of emissions from lower levels of landfill is often calculated due to separate collection of individual waste fractions, especially biogenic waste (e.g. Gómez-Sanabria et al., 2022; Bian et al., 2022; Zhang et al., 2023). Energy recovery of solid and/or biogenic waste is also often assessed as a circular economy action with a potential mitigation effect (although it can be questioned whether incineration should be considered as CE given that it breaks the material loop) (e.g. Pudcha et al., 2023; Temireyeva et al., 2022; Zhao et al., 2022; Zhang et al., 2023). Publications with a focus on food waste often go beyond anaerobic digesters with biogas recovery and focus more on converting organic waste (e.g. Song et al., 2021; Zhang et al., 2024; Jain and Gualandris, 2023), for example as biochar used for carbon storage (e.g. Jia et al., 2024; Yuan et al., 2022c), or for the production of growing substrates and nutrient-rich soils (e.g. Thomson et al., 2022; Pradhan and Meena, 2023). Similarly, publications in the context of carbon capture and utilization (CCU) address the use of waste for carbon storage in products (e.g. Yuan et al., 2022b, 2022a; Kocak et al., 2024) or the recycling of CO2 for the production of fuels or gases (e.g. Turnau et al., 2020; Yang et al., 2022), for example. Publications focusing on “Energy & EEE” (Figure 2.5) examine the recycling of electric vehicle batteries (e.g. Abdelbaky et al., 2023; Xu et al., 2023) or the prevention of electronic waste (e.g. Sigüenza et al., 2021; Mangmeechai, 2022). Zooming in on plastics, a large part of the publications reviewed focus on emissions reduction potential from plastic recycling in general (e.g. Bora et al., 2020; Samitthiwetcharong et al., 2024; Stegmann et al., 2023; Gabisa et al., 2023), with several studies assessing the GHG emissions reduction potential of chemical recycling - in particular (e.g. van der Hulst et al., 2022; Zhang and Nakatani, 2024).

Figure 2.5 Thematic focus of studies in the waste management sector

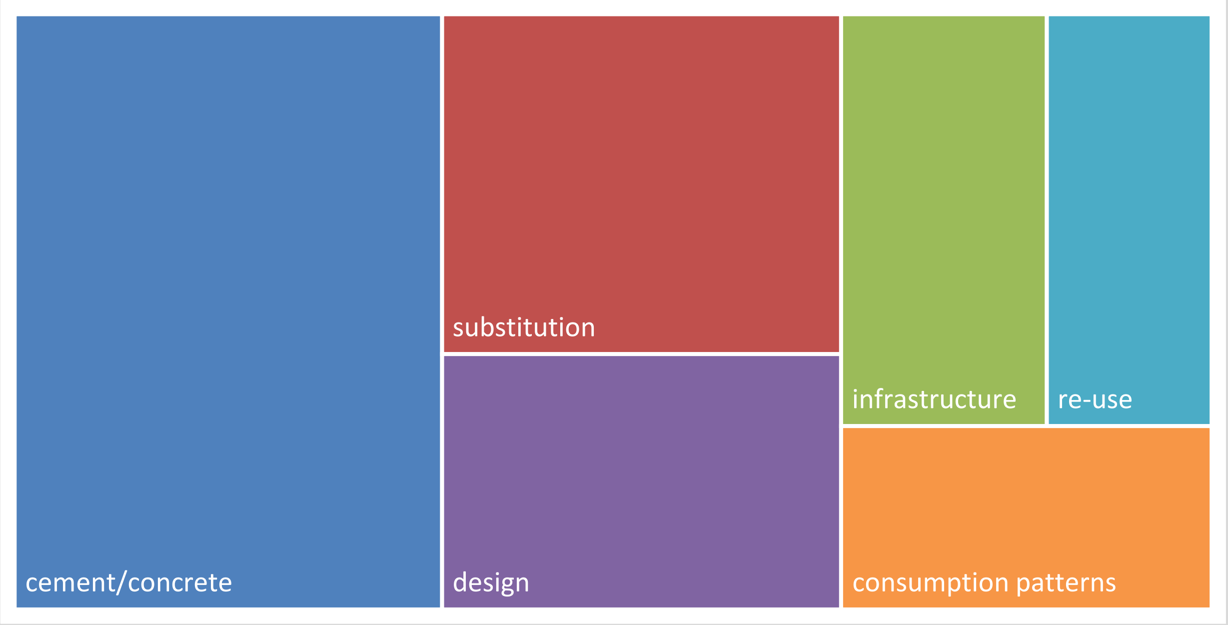


Source: ETC CE

Construction and buildings materials deep dive

A deeper analysis of the publications in the construction and building materials sector shows that, technical measures such as the recycling of concrete (e.g. Xing et al., 2022; Gallego-Schmid et al., 2020; UNEP IRP, 2024), material substitution (e.g. Wiprächtiger et al., 2023; Pauliuk and Heeren, 2021; Circle Economy, 2021), and changes to cement production (e.g. Sousa et al., 2022; Shah et al., 2022; Bennett et al., 2022) are most often assessed for their climate change mitigation potential. In addition, the climate change mitigation potential from a consumption perspective is increasingly being investigated (Figure 2.6). This concerns both the reuse of components and materials (e.g. Gallego-Schmid et al., 2020; Pauliuk et al., 2024; Wiprächtiger et al., 2023), as well as demand side measures e.g. reduction of per capita living space and shared housing (e.g. UNEP IRP, 2020; Pauliuk et al., 2024; Creutzig et al., 2022). Another focus of the publications is on the substitution to less energy- and emission-intensive building materials and circular design (e.g. design for disassembly (Roberts et al., 2023) or light weight construction design (UNEP IRP, 2020; Pauliuk et al., 2024; UNEP IRP, 2024)).

Figure 2.6 Thematic focus of studies in the construction & building materials sector



Source: ETC CE

The evaluation shows that CE is becoming relevant in various sectors, but that it is often difficult to clearly delineate the sectors. This brief overview of the scope of the publications evaluated already allows initial conclusions to be drawn regarding the assessment of the mitigation potential presented later. In particular, it is not possible to assign the thematic clusters or measures to individual sectors without overlap or ambiguity. For example, the increased use of recycled concrete can be assigned to both the construction sector and the waste sector. Furthermore, the exemplary analysis of the waste management and construction and building materials sectors shows that there is also a certain range of different thematic priorities and modeled circular economy aspects within the sectors. Taken together, this illustrates is the challenges when comparing the reduction potentials of CE described in the literature.

2.3.2 Most common interventions

Following the transition framework for a circular economy provided by the EEA, the implementation of circular interventions can be grouped into before use, during use and after use based on the life cycle of a product (EEA, 2024a). Before use includes policies and measures taken before the creation or use of a product for example circular design that minimizes the need for primary raw materials or substituting to lower impact-materials.

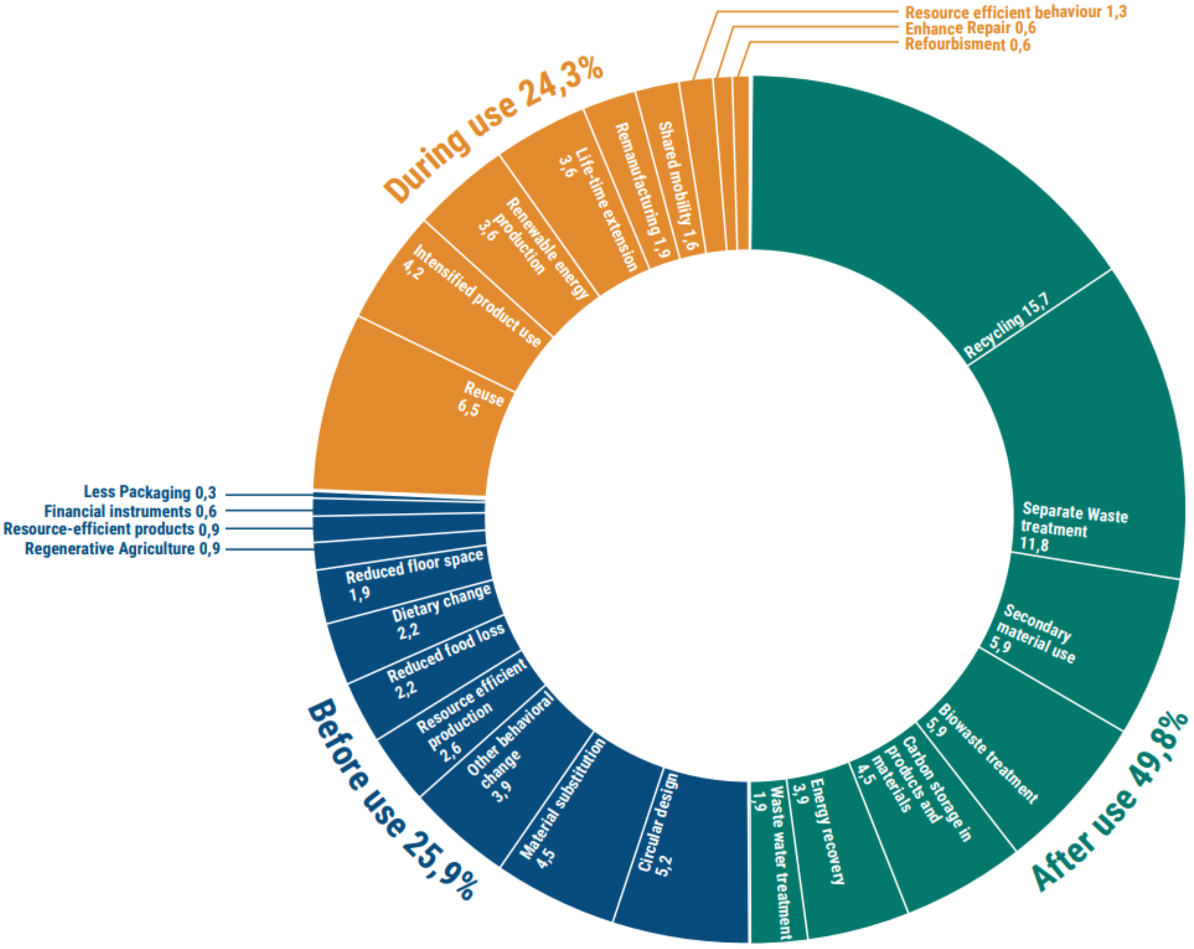
During use groups measures that increase the circularity of products and services during their use stage, for example increasing product lifespans and the intensity of use.

After use includes measures at the end of a product's life cycle to return these and the raw materials they contain to the economic cycle for productive use.

The measures identified in the examined publications can be summarized in 27 types of measures and assigned to the three life cycle categories before, during and after use (see Figure 2.7). With around 50 %, the majority of the interventions considered in the evaluated publications concern the end of life of products (after use). Slightly more than 24% of publications deal with the use phase and around 26% examine measures that occur at the before use phase.

Measures to improve recycling (16%) and separate collection and treatment of waste (12%) are both the most frequently studied intervention overall and, in the category, “after use”. During the use phase, the most frequently considered measures are focusing on reuse (6.5%), measures to intensify the product use (4%), such as sharing business models, as well as to extend the product lifespan (4%). In the “before use” phase, several demand-side interventions (2-4%), the design of products (5%) and material substitution (5%) are the most frequently considered measures (Figure 2.7).

Figure 2.7 Circular Economy measures modelled in evaluated publications [percentage share of publications per measure][6]



Source: ETC CE designed in collaboration with CSCP

In summary, the evaluation shows that although the entire life cycle of products, including demand reduction measures, is addressed in the publications reviewed, recycling remains the most extensively studied CE strategy, while reuse and reduction actions have received comparatively less attention. The thematic focus on the end of the life cycle, which is already apparent when looking at the sectors, is also reflected in the evaluation of the measures. This means that there is potentially an imbalance in our understanding of the CE mitigation potential of measures that occur before or during the use stage, compared to after the use stage, and further studies could be dedicated to those stages. It may also be that there are more information and data on CE measures during the after-use stage. Finally, we see that behavioral and demand-side measure are also much less studied than more ‘technical’ measures although several studies have found that demand-side measures have high reduction potentials (OECD, 2024; IPCC, 2022; Creutzig et al., 2022). This is also a research gap that could be addressed.

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[6] Some studies cover the full life cycle, but the majority focus on specific CE measures

2.4 GHG Mitigation potential

The number and identified key areas of the reviewed publications per topic cluster can, for example, provide information about which areas are associated with the circular economy and are therefore being increasingly studied scientifically. However, these are not necessarily the sectors or measures with high reduction potential.

Relative Reduction:	*Emissions reduction of a measure or sector compared to a baseline, expressed as a percentage reduction. The baseline may be described as baseline scenario, a business-as-usual scenario, but also - depending on the study - the historical development or current emissions situation.*
Absolute Reduction:	*Emission reduction of a measure or sector compared to a baseline, expressed in Gt CO2e. The baseline is either the current emissions situation or a business-as-usual scenario.*

The following chapters therefore provide an overview of the relative and absolute greenhouse gas reduction potentials identified in the evaluated publications for each sector and for individual measures (clusters). This allows conclusions to be drawn about potential key sectors and relevant CE measures with high climate protection potential.

2.4.1 Relevant sectors

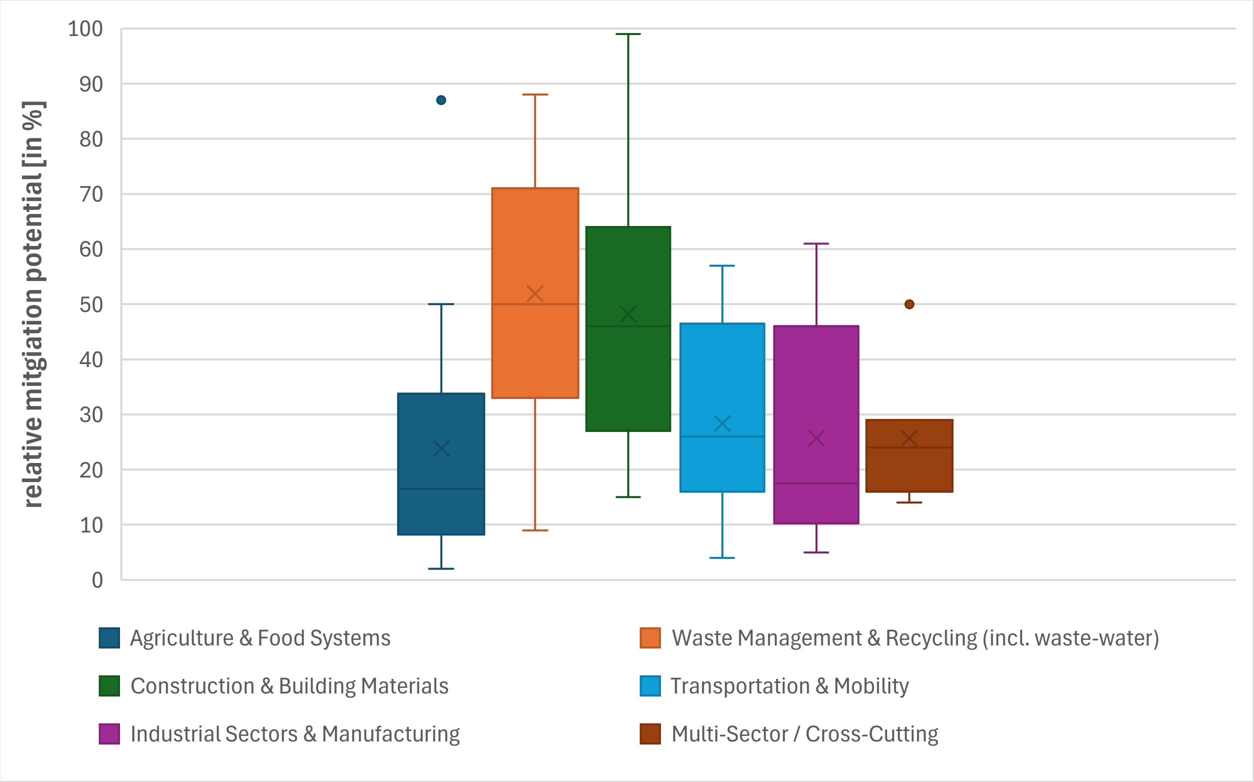
In order to evaluate the mitigation potential of the sectors and measures identified in reviewed publications the relative reduction potential against a baseline is first determined.

The analysis shows a large range of possible greenhouse gas reductions (2 % to 99 %) (Figure 2.8) with a theoretical reduction potential of around 33% in average achieved across all sectors. Thus, particularly with regard to the wide range, the analysis shows similar results to other literature reviews (e.g. Cantzler et al., 2020; Wiedenhofer et al., 2025; Gallego-Schmid et al., 2020). However, it should be noted that studies with different geographical references, at different levels of consideration from the product perspective to the economy-wide view and a wide range of measures are included and compared. For example, greenhouse gas reduction potentials determined in a product life cycle assessment can only be transferred or scaled to a limited extent. Similarly, reduction potentials of different geographical resolutions are only comparable to a limited extent. Therefore, the values given here should only be used for an initial assessment of sectors with greenhouse gas reduction potential by CE.

With an average of 52 %, waste management & recycling is the sector with the highest relative reduction potential in average of the modelled measures, showing a spread between 9 % and 88 % GHG reduction. This is followed by the construction and building materials cluster with an average relative reduction potential of 48% (range 15 % - 99 %). On average, agriculture & food systems (2-87 %), the transport & mobility sector (4-57 %), the industry and manufacturing sector (5- 61 %) as well as the cross-cutting evaluations (14 -50 %) show a reduction potential of around a quarter of GHG emissions (Figure 2.8).

In order to be able to assess the identified relative mitigation potentials also with regard to their actual possible contribution to climate mitigation, it is necessary to provide an estimate of the absolute savings of greenhouse gases. However, this is associated with various challenges and uncertainties, as the evaluated publications vary greatly in terms of methodological approaches, their scope and the level of detail. In order to meet at least some of the challenges, Figure 2.9 shows the absolute mitigation potential per sector of those publications in Gt CO2eq. with geographical coverage at the global level. However, it should be noted that this evaluation is based on only 13 publications and therefore a certain degree of bias cannot be ruled out.

Figure 2.8 Range of relative mitigation potential per sector (% GHG saving)[7]



Source: ETC CE

High mitigation potential, with up to 7,3 Gt CO2eq., is described in the context of agriculture & food systems where measures on dietary change and food waste reduction are described to have the largest impact (Creutzig et al., 2022) (Figure 2.11). However, depending on the level of ambition of the dietary change, the reduction potential can also vary greatly, e.g., between 0.91 Gt CO2eq. and 5.96 Gt CO2eq., depending on how much meat consumption is reduced (Steinitz et al., 2024).

With potential savings of up to 6.8 Gt CO2eq. in 2050 compared to a BAU scenario, the building sector has the second highest potential for savings similar to the consideration of relative reduction potentials, mainly through reduced floor space[8] and material substitution (UNEP IRP, 2024; Pauliuk et al., 2024; Circle Economy, 2021) (Figure 2.11). Changes in cement production, e.g. increase use of secondary cementitious materials, may reduce GHG emissions globally by 1.3 Gt CO2eq. compared to traditional cement production (Shah et al., 2022).

Interestingly, the high relative reduction potentials in the waste management and recycling sector are not reflected in the same way when looking at absolute greenhouse gas reductions. This could be due, among other things, to the fact that a large number of publications in this sector have either a very specific or purely local or regional perspective. Both the maximum and minimum values in this sector refer to varying levels of ambition in metal recycling, up to the current technical potential for the use of secondary raw materials in metal production (Gorman et al., 2022).

The mitigation potential within the transport and mobility sector shows high potential through changed mobility behavior like shared mobility or less traveling (Figure 2.11) (Creutzig et al., 2022; Circle Economy,

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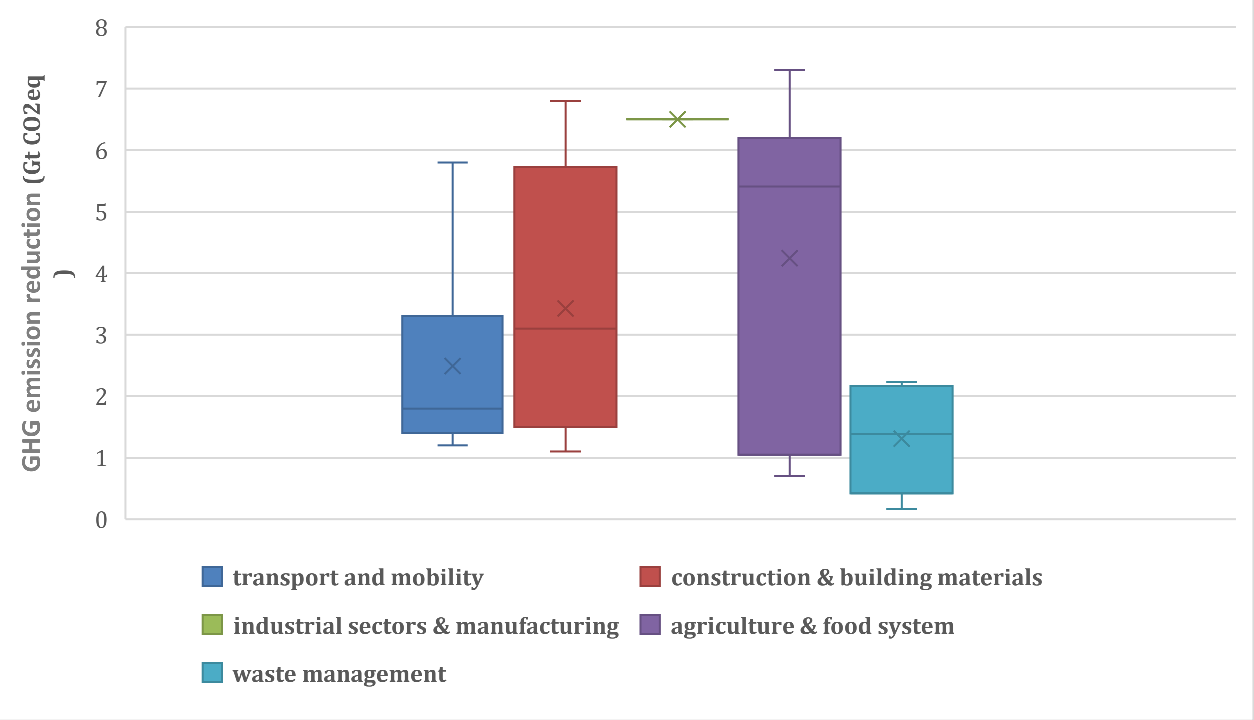
[7] X represents the average value within a sector, lower and upper line or dot represent the lowest and highest value calculated; figures should be interpreted with caution and are subject to the constraints and assumptions set out in the underlying studies.

8 There is a wide range of mitigation potential described in the literature mainly due to differences in assumptions (see also Table 3.1 section “reduced floor space”).

2021), partly in combination with technical measures such as lightweight construction and material substitution (UNEP IRP, 2024). Technical solutions such as circular design, lightweight construction, or secondary material use appear to have less potential for reduction, between 1.2 and 1.8 Gt CO2eq. (Circle Economy, 2021)

It should be noted that the current evaluation only lists one total value from one publication in the industrial sector (Creutzig et al., 2022). This is partly due to the fact that individual aspects have been assigned to other sectors. For example, the aforementioned increased use of secondary materials in the cement industry (Shah et al., 2022) or in metal production (Gorman et al., 2022) could also be assigned to the industrial sector, but has been assigned to the construction respectively waste sectors here.

Figure 2.9 Global GHG emissions reduction potential of CE by key sectors (Gt CO2eq reduction by 2050)[9]



Source: ETC CE

2.4.2 Circular Economy measures and interventions

In addition to the relevant sectors with high relative and absolute greenhouse gas mitigation potential, the contribution of the interventions examined is also of interest. For this purpose, the emissions reduction potential (in percentage) of the most frequently considered measures in the life cycle categories before, during and after use is evaluated (Figure 2.10). Similar to the sectoral perspective, there is a high relative reduction potential in waste management and recycling (after use) with an average reduction of 60%. Interventions that start before the use phase of products also have a greenhouse gas reduction potential, on average 39%. Measures in the use phase also have a comparable average reduction potential of 40%, with measures for reuse being most frequently referred to.

With regard to individual measures, recycling (63%) (e.g. Ciacci et al., 2020; Gorman et al., 2022; van der Hulst et al., 2022) and separate waste treatment (78%) (e.g. Yamada et al., 2023; Zhao et al., 2022; Gómez-Sanabria et al., 2022), material substitution (48%) (e.g. UNEP IRP, 2020; Wiprächtiger et al., 2023; Circle Economy, 2021), measures for circular design (42%) (e.g. Pauliuk et al., 2024; Pauliuk and Heeren, 2021;

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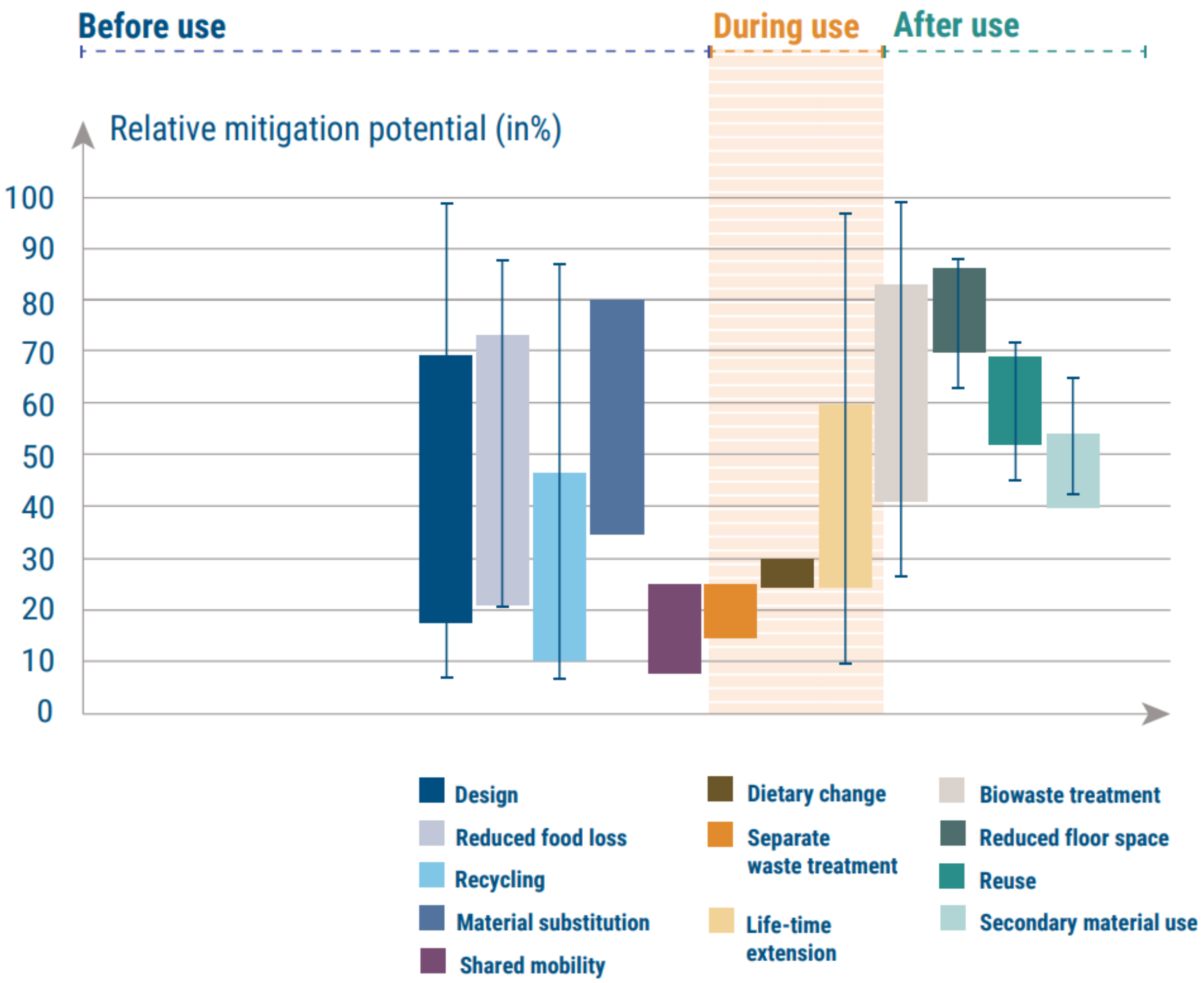
[9] X represents the average value within a sector, lower and upper line or dot represent the lowest and highest value calculated; figures should be interpreted with caution and are subject to the constraints and assumptions set out in the underlying studies.

UNEP IRP, 2020), and reduced floor space (57%) (e.g. Circle Economy, 2021; Pauliuk et al., 2024; UNEP IRP, 2024, 2020) have high potential for reduction. There is also a high bandwidth of the relative mitigation potential. Interestingly, when looking at the percentage reduction potentials, there is no strong indication that either technically oriented measures or demand-side measures have higher mitigation potential. Rather, it is becoming clear that a combination of both actions can complement each other and thus increase the mitigation potential. However, it can also go in the opposite direction, with strong mitigation efforts in one – leading to lower mitigation potential in the other. For example, reducing food waste would significantly reduce the climate mitigation potential of biowaste treatment (since there would be less of it).

Figure 2.10 Relative mitigation potentials of selected interventions (% GHG savings)[10]



Source: ETC CE designed in collaboration with CSCP

Figure 2.11 shows the absolute mitigation potential of measures identified in publications with a global perspective. As already mentioned in the sectoral analysis, interventions aimed at reducing floor space (Circle Economy, 2021; Pauliuk et al., 2024; UNEP IRP, 2024) and changing diets (Steinitz et al., 2024; Creutzig et al., 2022) in particular offer high reduction potential.

Shared mobility and other behavioural change measures like reduced traveling or sustainable consumption (Circle Economy, 2021; Creutzig et al., 2022; UNEP IRP, 2024) show higher mitigation

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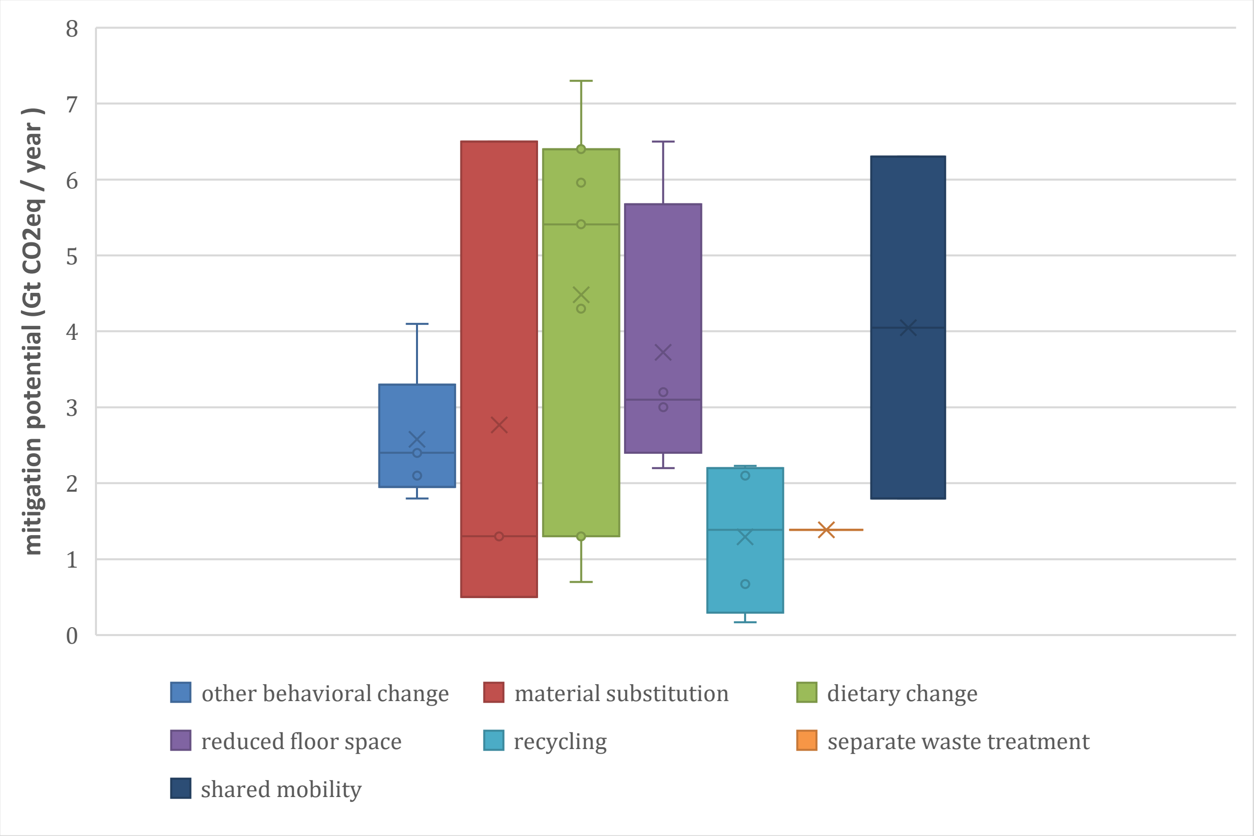
[10] The figures should be interpreted with caution and are subject to the constraints and assumptions set out in the underlying studies.

potential than after use measures like recycling (Gorman et al., 2022) or separate waste treatment (Gómez-Sanabria et al., 2022). On the other hand, more technical measures, like material substitution especially using wood for construction (Circle Economy, 2021; Pauliuk et al., 2024), also show high reduction potential. Nevertheless, this shows that demand-side measures in particular have possibly a high reduction potential. However, it should be noted that due to the rather small number of publications (n=13) with a global perspective, a bias towards certain measures cannot be ruled out. It also follows from this that the selection of measures for the relative and absolute consideration of the greenhouse gas reduction potential cannot be completely congruent.

Another striking feature is the high dispersion of the values, all but two categories have a factor of 3 between the lowest and highest climate mitigation potential. This illustrates once again the difficult comparability of studies with different methodological approaches and depth of detail.

Figure 2.11 Mitigation potential of selected interventions on the global scale in 2050[11]



Source: ETC CE

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[11] X represents the average value within a sector, lower and upper line or dot represent the lowest and highest value calculated; figures should be interpreted with caution and are subject to the constraints and assumptions set out in the underlying studies.

3 Influential factors

The preceding analysis has shown that the implementation of circular economy measures can have significant greenhouse gas reduction potentials. However, it is also clear that the reduction potential can vary greatly both within a sector or subject area and when considering similar measures. Therefore, some possible explanatory factors are discussed below.

There are several factors that influence the results on CE mitigation potential:

- Choice of methodological approach (see chapter 2.2.2). Each method has certain advantages and disadvantages, they capture different elements and thus yield different results. Choosing the most appropriate model highly depends on the specific question being analysed, the scope of the analysis e.g., individual products or economy-wide view, the required level of detail e.g., individual concrete measures or overarching policies, and the desired temporal and spatial resolution (EEA, 2024d).
- Choice of scope including the level of granularity, what measures are included as part of CE (and which are not), and different geographical resolutions (EEA, 2020; Wiedenhofer et al., 2025).
- Base years/scenario: what the CE emissions reductions are measured against is also important. For example, when assessing emission savings compared to a base year, important underlying assumptions including what type of technological progress is considered, population development, changes in the energy system, etc.). Similarly, when modelling greenhouse gas reductions compared to a baseline scenario, questions arise, for example, what projections are considered.
- Underlying assumptions: even similar CE measures can have very different underlying assumptions when it comes to actual implementation of measures yielding in very different results for potential emissions reductions. For example, publications modelling the reduction potential of the measure “Reduction of per capita living space” show that the implementation of this measure differs significantly, for example by specifying a specific number of square meters per capita (UNEP IRP, 2020) or reducing the number of buildings due to restrictions on new construction (Circle Economy, 2021) (see Table 3-1, section “reduced floor space).
- Interactions with other measures, the interactions between the measures must also be included in the interpretation and analysis as individual measures can strengthen or weaken each other (see also Circle Economy, 2021, p. 40). For example, the less cars or buildings are in demand due to measures/assumptions on changes in consumption, the lower the mitigation potential of lightweight construction measures.
- Rebound effect, the same applies if economic links or rebound effects are not taken into account. For example, the mitigation potential of timber construction could be overestimated if the demand for wood in other sectors is not considered. Reduced meat consumption could also have a lower reduction potential if milk consumption is not reduced at the same time.

Table 3-1 Different assumptions regarding the implementation of selected CE measures relevant to the results in the reviewed publications

CE measure	**Sector**	**Emission reduction (in 2050)**	**Geographical scope**	**Assumption/ implementation**	**Publication**
Dietary change	Agriculture & Food system	1,3 Gt CO2e	Global	Nearly vegan diet unprocessed food is favoured Prevention of high-sugar and high-salt products	(Circle Economy, 2021)
		5.96 Gt CO2e	Global	almost vegetarian diet (following the Indian and South Asian diet)	(Steinitz et al., 2024)
		0,91 Gt CO2e	Global	meatless Monday	(Steinitz et al., 2024)
Sustainable agriculture	Agriculture & Food system	3,4 Gt CO2e	Global	50 % local, Seasonal and organic food choices; 100% reduction of fertilizer use	(Circle Economy, 2021)
		0.19 Gt CO2e	EU	reduction of at least 20% mineral fertilisers application, 50% less pesticides use 25% organic farming on EU's agriculture land, 10% area of high-diversity landscape features 50% reduction in nutrient surplus from organic and synthetic sources	(EC, 2024)
		2,5 Gt CO2e	Global	Regenerative cropland approaches like use of cover crops, intercropping, and the use of organic fertilisers	(Ellen MacArthur Foundation, 2021)
Reduced floor space	Construction & building materials	3.2 Gt CO2e	Global	Stop building with virgin materials and only use available C&DW only half of all C&DW is fit for purpose; Cap number of new residential buildings (housing demand) to	(Circle Economy, 2021)

				the amount of available C&DW	
		up to 8.8 Gt CO2e	G7 plus China & India	Average floor area in 2060 is 34, 55, and 70 m2/cap depending of scenario	(UNEP IRP, 2020)
		2.2 Gt CO2e	Global	Global average of per capita floorspace 23.7 m2/cap Global average commercial floorspace 8.1 m2/cap increase in lifetime for new buildings from 30% increase on houses with long lifetimes to 90% mean lifetime increase on houses with short lifetimes and commercial buildings for Commercial buildings 40% penetration of lightweight construction and 20% penetration rate of substitution (wood-construction) 20% wood-construction of all new residential buildings Recycling rate for concrete 37%	(UNEP IRP, 2024)

- Framework conditions, the framework conditions on which the modelling is based and the possibility of varying this over time can also be relevant to the results. For example, considering the energy transition or changing population trends is relevant for the general demand for materials and products and therefore also for estimating the reduction potential of product-specific measures. On the other hand, the concrete contribution of CE measures can also be evaluated in contrast to the effects of changing framework conditions such as the trend towards decarbonization.

- In or out of scope is, in particular, with regard to the importance of waste management or the waste sector for greenhouse gas reduction through circular economy, this has been shown in our analysis, another aspect of relevance. Many publications investigating the treatment of solid household waste have a relatively high reduction potential due to the substitution of fossil energy production by waste incineration (e.g. Gómez-Sanabria et al., 2022; Temireyeva et al., 2022; Zhang et al., 2023; Zhao et al., 2022). Although the energy recovery of waste is included in both the waste hierarchy and the concept of circular economy R strategies (Potting et al., 2017), it is at least debatable whether or not waste incineration contributes to the circular economy, as material cycles are broken. On the other hand, incineration can also provide important support functions for the circular economy, such as the removal of pollutants from the recycling process or the recovery of metals from non-separable waste fractions (Brunner and Morf, 2025).

- In the same context of understanding and defining the circular economy, measures relating to behavioural changes or changes in consumption are also included. These often result in significant greenhouse gas reductions (see Table 3 1), but it is often difficult to distinguish whether the reduction contribution results, for example, from improved energy efficiency, increased use of renewable energies, or material-related reduction options (see also Wiedenhofer et al., 2025). For example, measures such as changing one's diet or switching to electric mobility can be seen as concrete implementations of the refuse strategy, but their concrete contribution to the circular economy is at least controversial.

4 Lessons learned and conclusions

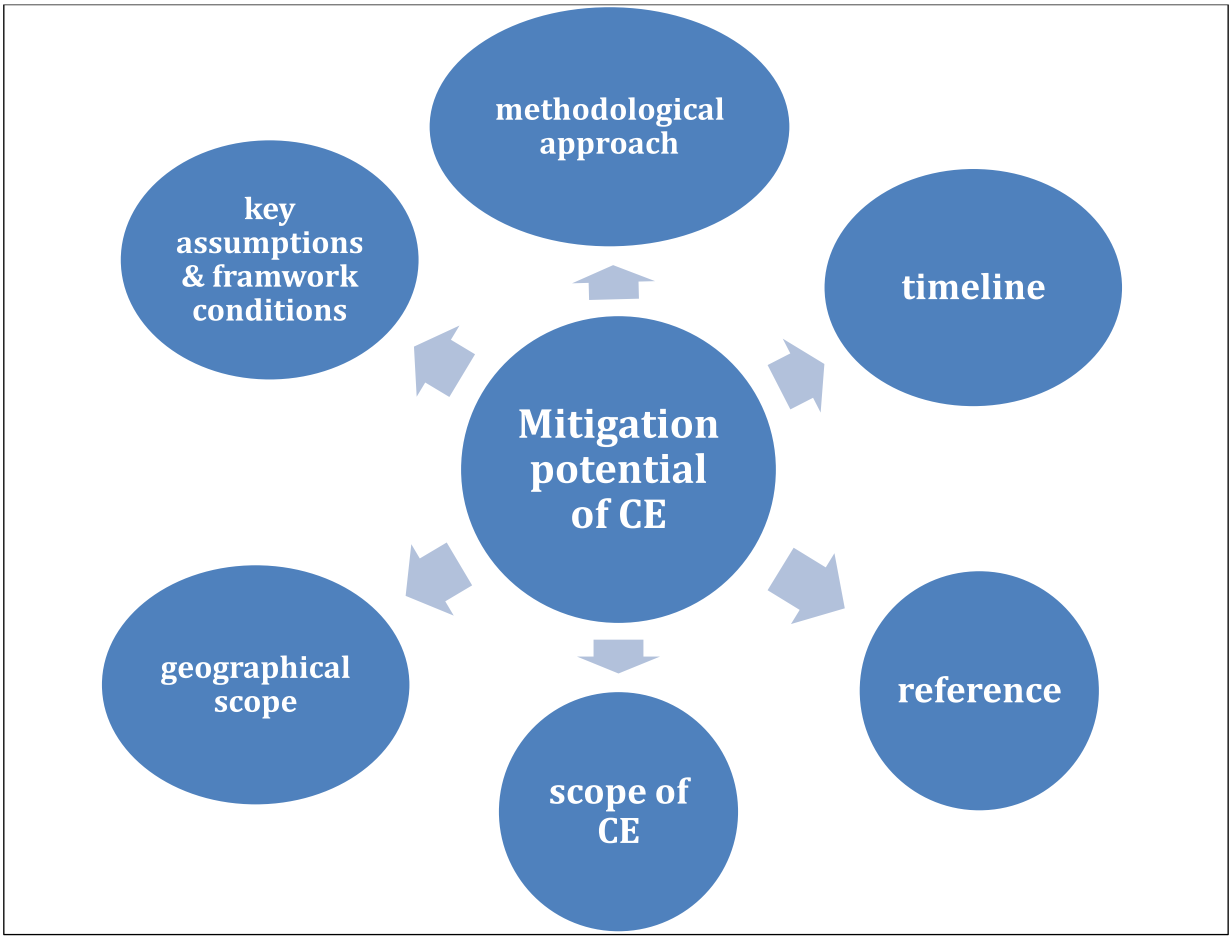
The scientific literature over the past five years has shown that there is a solid scientific basis for the climate mitigation potential of CE. There are also clear synergies between circular economy, energy efficiency and defossilisation of the economy. However, while the positive contribution of CE to climate mitigation has been clearly demonstrated in the literature, the wide variation in results across studies makes it difficult to define a single, concrete mitigation potential.

Below are some key considerations one should consider when assessing the literature on the mitigation potential of CE.

Interpreting the mitigation potential of the circular economy requires knowledge of key aspects

As the previous chapters have shown, there is a wide range of identified GHG reductions when looking at a single sector or even specific CE measures (see also Cantzler et al., 2020; Wiedenhofer et al., 2025). This means that when interpreting the mitigation potentials described in the literature, one has to consider the core aspects that influenced the results (see Figure 4.1).

Figure 4.1 Core aspects for interpretation of CE mitigation potentials



Source: ETC CE

As stated in chapter 3, the different **methodological approaches,** the **scope of circular economy** and the distinction between measures for the circular economy and measures in other areas of action and the level of detail of the **modelled measures and the underlying assumptions**, are highly relevant for identifying relevant sectors and important circular economy measures for climate protection. Just as relevant as the level of detail of the measures and assumptions is the consideration of economic interactions in the modelling and rebound effects as well as the interactions between the measures, which must be included in the interpretation (see chapter **Error! Reference source not found.**). A detailed overview of these core aspects is provided, for example, by Wiedenhofer et al. (2025) or EEA (2024c). Understandably, the **timeline** under consideration is important for the assessment and comparison of different studies. In addition to the actual time horizon, the extent to which the calculation extends into the future is also relevant, as longer modelling periods usually result in greater uncertainty regarding the assumptions made. The corresponding **reference** framework for greenhouse gas savings is also important. Using a reference year presents different challenges and aspects to consider than using a baseline scenario or a time period in the past as a reference. Of course, the **(geographical) scope** also plays an important role in assessing greenhouse gas reduction potential. There are uncertainties involved in extrapolating reduction potentials determined at regional or national level to the global level, just as it is only possible to a limited extent to break down reduction potentials determined globally to the national level. It becomes even more difficult when product-specific potentials are to be transferred to the national level.

Despite these variations in the results there are some recurring results that can help determine what CE measures have significant mitigation potential.

Improved waste management seems to be a "low hanging fruit"

As the first important measure to exploit the reduction potential of the circular economy, comprehensive waste management geared towards climate protection should be implemented. Avoiding emissions from open burning of municipal solid waste and landfills through implementing improved waste management systems with separate collection and subsequent high-quality recycling offers great potential to reduce greenhouse gas emissions (Cantzler et al., 2020; Gómez-Sanabria et al., 2022). In particular, the separate collection of biotic waste fractions and their recycling by anaerobic digestion with subsequent energetic use of the biogas are the first steps with a high reduction potential (Zhang et al., 2023; Yamada et al., 2023; Gómez-Sanabria et al., 2022).

Focus on climate-intensive materials

Reducing demand, in particular for primary raw materials and materials whose extraction and production are climate-intensive, through recycling and the use of secondary raw materials builds on the ambitious waste management measure and identifies further relevant reduction potentials. Whereas cement, sand and gravel have the highest potential to increase the circularity rate, however introducing circularity measures for metals would generate a much higher climate mitigation effect (EEA, 2025).

Combining upstream and downstream measures provide the largest mitigation potential

As demonstrated in chapter 2.4, downstream measures like waste management have significant mitigation potentials, but are 'over-represented' in the literature. While upstream measures including eco-design, reuse models, and product repair are often overlooked. The same goes for demand-side measures addressing consumption patterns and consider behavioral changes, like reduced floor space per capita or car sharing, offer great potential to lower GHG emissions. While all of these measures can have significant mitigation potentials on their own - a combination of upstream and downstream measures as well as technological innovations and behavioral changes can foster the largest reduction in global material demand and GHG emissions (IPCC, 2022; Circle Economy, 2021; EEA, 2025).

Building and housing offer key opportunities for climate protection and the circular economy

Worldwide, an estimated two billion tons of construction and demolition waste (CDW) are generated annually in the construction sector, which corresponds to about one-third of all global waste. In addition, the extraction and production of building materials such as steel and cement accounts for 18 percent of global CO_2 emissions related to buildings (UNEP, 2025). Thus, CE measures in this sector offer significant reduction potential for raw material demand and GHG emissions (EEA, 2020, 2024b). Options here include both production and consumption side. Relevant measures here include the substitution of energy- and emission-intensive materials such as steel with wood (Wiprächtiger et al., 2023; Circle Economy, 2021), but also the increased use of concrete recycling or the use of secondary raw materials in cement production (Shah et al., 2022). However, reducing the need for new buildings through measures such as modular design or reducing the amount of living space per capita are also circular economy measures with great reduction potential (e.g. Pauliuk et al., 2024; UNEP IRP, 2020).

Identifying the most effective policy measures

Measures contribute to varying degrees to advancing the circular economy, reducing material consumption, or lowering CO_2 emissions (EEA, 2025). In addition, measures have different effects along the value chain. It is therefore crucial to understand which measures at which point in the value chain will have the greatest impact on the desired outcome. Potential synergies and conflicts of interest between measures must also be taken into account. Therefore, selecting the most effective measures along the value chain and combining them into a consistent policy mix is an important aspect of enabling the best possible mitigation effects of CE measures.

Disentangling CE impacts from other policy domains

Distinguishing CE measures from measures in other policy areas is often difficult due to the inconsistent understanding of CE. In order to be able to present the mitigation contribution of CE more clearly, it is therefore important to describe and model measures as specifically as possible. In particular, the distinction from measures relating to energy efficiency, the energy transition and decarbonisation, or agriculture should be examined closely (Wiedenhofer et al., 2025).

Harmonization of models and methods for the assessment of the climate change mitigation potential is needed

Based on our analysis, that the wide range of greenhouse gas mitigation potentials of individual sectors or measures can largely be attributed to methodological issues and the setting of key assumptions, there is also a need for harmonisation with regard to the model approaches, key assumptions (e.g., impact factors in LCA studies or socio-economic conditions in economy-wide modeling) and questions of data availability and data quality that could not be addressed in the analysis and thus require further research (see also EEA, 2024c; Wiedenhofer et al., 2025). The first step is to describe the methodological approaches transparently, including their strengths and weaknesses, and ideally to examine and discuss the influence of the assumptions made on the results. In addition, significant potential to improve comparability lies in adopting consistent analytical frameworks. Comparing results from using the same methodological frameworks e.g. EEA's project on measuring the environmental benefits of the circular economy (EEA, 2025) and the Joint Research Centre's (JRC) work on assessing the mitigation potential of heavy industry (JRC, 2025), but also efforts towards streamlining impact factors and reducing data gaps could help. Several Horizon Europe projects, including CircEUlar, CIRCOMOD, and CO2NSTRUCT- are developing comprehensive modelling frameworks designed to better quantify the climate mitigation potential of circular economy measures.

Strengthening the ex-ante perspective

The vast majority of studies on the contribution of CE to greenhouse gas reduction describe potential effects using modelling approaches and ex ante investigations. This means that there is an almost complete lack of assessment of actual greenhouse gas savings achieved through CE measures in the form of ex post analysis or impact assessment. There is a great need for research in this area in order to expand the evidence base and confirm the modelling results.

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[12] A complete list of the literature evaluated is available as supporting information.

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6 Annex

6.1 Annex 1 Key words Web of Science search

Table A-1 Key word list for the Web of Science literature search

Collective term	**Keywords**
circular economy	resource-efficient economy biobased economy regenerative economy sharing economy industrial symbiosis Industrial ecology sustainable consumption
closing resource loops	circularity zero waste closed-loop cradle-to-cradle recycling upcycling material/resource/waste recovery secondary (raw) materials waste management
slowing resource loops	resource loops slowing resource loops narrowing resource loops product life(time) extension durability
narrowing resource loops	resource/material efficiency - efficient resource/material (use) reduced/-ing resource/material/waste
circular business (models/practices/processes)	Circular business product-as-a-service (PaaS) sharing platforms

	extended producer responsibility take-back programs
R-strategies	r-strategy refused/-ing consumption rethinking consumption reduced/-ing consumption reuse repair refurbish remanufacture repurpose
circular design	design for longevity regenerative design ecodesign / eco-design
Climate change (mitigation)	Climate change Climate mitigation Global warming Climate crisis
Greenhouse gas(es)	CO2 / carbon dioxide CH4 / methane N2O / nitrous oxide HFC / hydrofluorocarbones PFC / perfluorocarbones SF6 / sulfur hexafluoride NF3 / nitrogen trifluoride
Method-related terms	Life-cycle LCA Material flow MFA Stock flow Input-output

	MRIO EEIO EEMRIO Exiobase Exiomod Figaro Equilibrium GEM-E3 IAM System dynamics Agent-based IMAGE messageIX integrated assessment discrete event simulation

6.2 Annex 2 Web of Science query

Query 1:

(TI=("circular economy" OR "resource-efficient economy" OR "biobased economy" OR "regenerative economy" OR "sharing economy" OR "industrial symbiosis" OR “industrial ecology” OR "sustainable consumption" OR "clos* resource loop$" OR circularity OR "zero waste" OR "closed loop" OR "cradle-to-cradle" OR recycl* OR upcycl* OR "material recovery" OR "resource recovery" OR "waste recovery") OR TI =(recover* NEAR/2 material) OR TI=(recover* NEAR/2 resource) OR TI=(recover* NEAR/2 waste) OR TI=(secondary NEAR/2 material) OR TI=(secondary NEAR/2 resource) OR TI=("waste management" OR "slow* resource loop$" OR "product life* extension" OR durability OR "narrow* resource loop$" OR "resource efficiency" OR "material efficiency") OR TI=(efficient NEAR/3 resource) OR TI=(efficient NEAR/3 material) OR TI=(reduc* NEAR/2 resource) OR TI=(reduc* NEAR/2 material) OR TI=(reduc* NEAR/2 waste) OR TI=("circular business*" OR "product-as-a-service" OR "sharing platform$" OR "extended producer responsibilit*" OR "take-back" OR "r-strateg*") OR TI=(refus* NEAR/2 consum*) OR TI=("rethink* consumption") OR TI=(reduc* NEAR/2 consum*) OR TI=(reuse OR repair OR refurbish OR remanufacture OR repurpose OR "design for circularity" OR "circular design" OR "design for longevity" OR "regenerative design" OR ecodesign OR "eco-design"))

AND

TI=("climate change" OR "climate mitigation" OR "global warming" OR "climate crisis" OR "greenhouse gas*" OR "carbon dioxide" OR methane OR "nitrous oxide" OR hydrofluorocarbon* OR perfluorocarbon* OR "sulfur hexafluoride" OR "nitrogen trifluoride" OR "GHG" OR "CO2" OR "CH4" OR "N2O" OR "HFC" OR "PFC" OR "SF6" OR "NF3")

Query 2:

Previous query
AND
TS=("climate change" OR "climate mitigation" OR "global warming" OR "climate crisis" OR "greenhouse gas*")

Query 3:

Previous query
AND
TS=("life cycle" OR "$LCA" OR "LCA$" OR "material flow" OR "MFA" OR "MFA$" OR "stock flow" OR "input-output" OR "EEMRIO$" OR "EEIO$" OR "exiobase" OR "exiomod" OR "figaro" OR "fidelio" OR equilibrium OR "GEM-E3" OR "E3ME" OR "GTAP" OR "ICES" OR "GAMS" OR "GEMPACK" OR "integrated assessment" OR "IAM$" OR "messageIx" OR "IMAGE" OR "complex system$" OR "system dynamic$" OR "agent-based" OR "ABM" OR "discrete event simulation$" OR "DES" OR "operational research" OR "cost-benefit" OR "CBA" OR "life cycle cost*" OR "LCC" OR multicriteria OR "multi-criteria" OR "MCDM" OR regression OR optimization OR "atmosphere-ocean general circulation" OR "AOGCM$" OR "earth system" OR "ESM$" OR "EMIC$" OR scenario OR quantification)

European Topic Centre on
Circular economy and resource use
https://www.eionet.europa.eu/etcs/etc-ce

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