

Cutting greenhouse gas emissions through circular economy actions in the buildings sector

## Cutting greenhouse gas emissions through circular economy actions in the buildings sector



Together, European countries have reduced their greenhouse gas emissions significantly since 1990. Achieving climate neutrality by 2050, however, will demand additional and long-lasting climate mitigation strategies. With materials management accounting for up to two thirds of global greenhouse gas emissions, one promising area for further reductions is the circular economy. A new methodological approach helps to identify circular efforts that can contribute to reducing emissions in any sector and has highlighted key ways to cut emissions in the buildings sector.

### Key messages

Greater circularity and more efficient use of materials present new opportunities for further reducing greenhouse gas emissions.

A new methodology can help to identify which circular economy actions in each sector can make the most promising contributions to meeting targets to reduce emissions and to achieving climate neutrality in Europe.

In the buildings sector, selected circular economy actions can lead to reductions of up to 61 % in the materials-related greenhouse gases emitted across buildings' life cycles.

## The circular economy can contribute substantially to reducing emissions

Materials management, including the production, consumption and disposal of materials, products and infrastructure, contributes a major share of global greenhouse gas emissions — up to two thirds by some accounts (UNDP, 2017).

Greenhouse gas emissions can be reduced by making material flows more efficient and maintaining the utility and value of materials and products for as long as possible. The European Green Deal highlights the importance of transforming Europe's economy into a more circular one. This strategy is a key element in the European Commission's vision for a climate-neutral economy by 2050 (EC, 2018a).

## Climate change mitigation

Improving circularity and increasing the efficiency of materials management can take many forms:

- extending product lifetimes
- reducing material losses
- recirculating materials and products
- preventing downcycling
- substituting greenhouse gas-intensive materials with those with lower emissions.

However, when deciding which circular economy actions to prioritise and integrate into climate-oriented policies and measures, countries and companies need to be able to compare the relative benefits — and emission reductions — of the individual circular economy actions.

# A new method to compare the benefits of sectoral circular economy actions

Research into the climate mitigation potential of circular economy actions is increasing. However, comparing the results of studies is difficult, as each draws on a unique methodology, scope of actions modelled and background data. In dialogue with European countries and companies, the EEA has sought a more straightforward way to identify and compare which circular economy actions, individually or in combination, can deliver the greatest climate benefits. Such assessments can be of value when new climate mitigation policies and measures are being considered and their relative impacts estimated.

Therefore, the EEA, together with a consortium of European experts, has developed a new methodology. It combines the benefits of various approaches to quantifying the potential impacts of circular economy actions while requiring only limited investment in modelling.

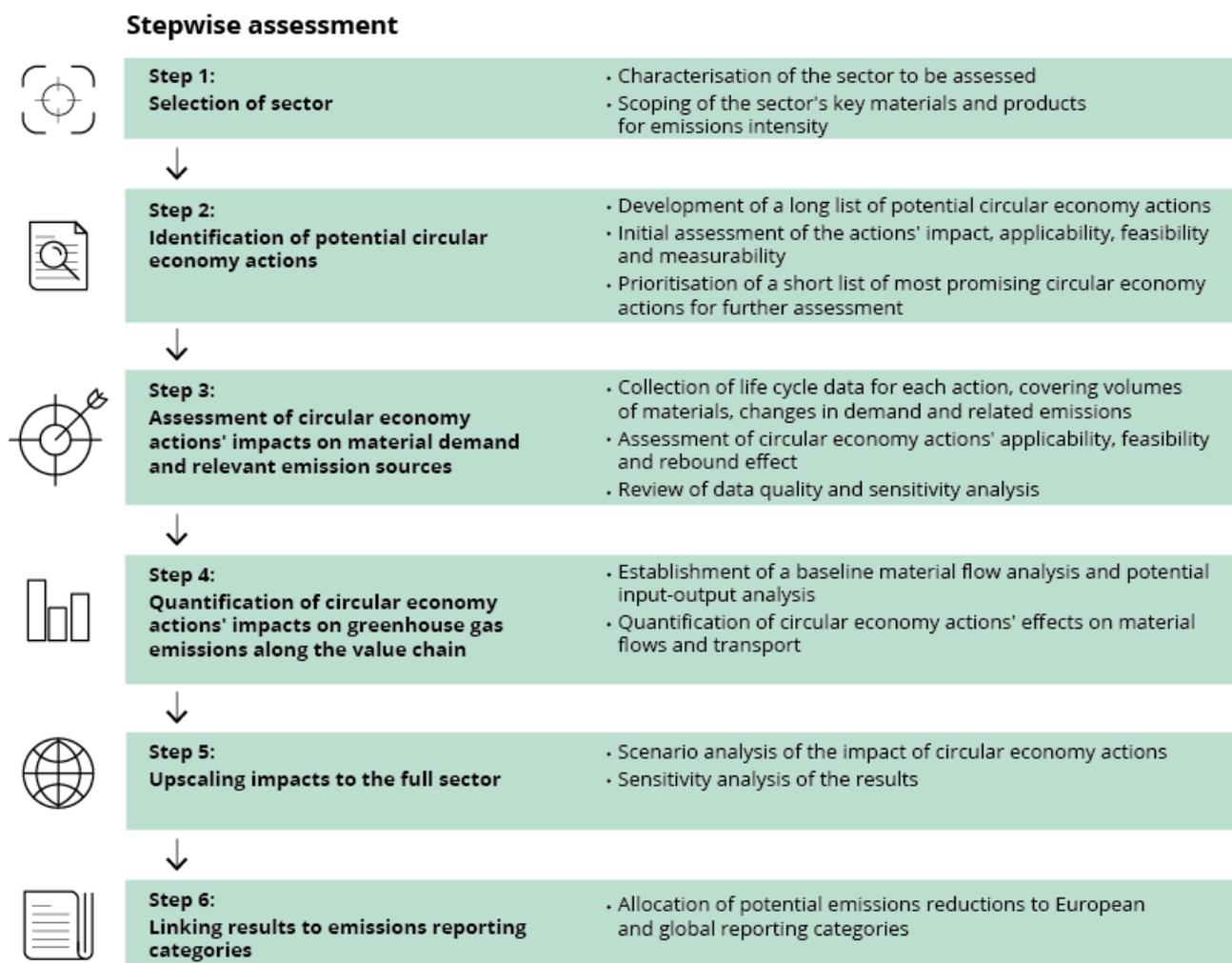
## Climate change mitigation

This methodology takes a stepwise approach to identifying, prioritising and assessing the relative benefits of changes that can increase circularity and reduce greenhouse gas emissions in any given sector. The approach also links to the European and international climate reporting frameworks and helps to identify how emission reductions from circular economy actions can be accounted for in reporting on climate mitigation targets.

Figure 1 shows the steps in the methodology, which are described in full in a background report (Ramboll et al., 2020). The methodology's first application — to the buildings sector specifically (excluding infrastructure) — is described below. Further details can be found in the background report.

# Climate change mitigation

**Figure 1. Methodology for assessing the potential of circular economy actions to help reduce emissions in a given sector**



Source: Ramboll et al. (2020).

# Together, key actions can deliver emission reductions of up to 61 % across buildings' life cycles

To demonstrate the utility and value of the new methodology, and to shed further light on a key policy area, the approach described above was applied to the buildings sector. The EEA intends also to apply the methodology to the agrifoods sector in 2020.

The buildings sector was chosen because of its important role in achieving climate neutrality in the long term, as the emissions embodied in buildings have a lasting impact. The EU circular economy action plan under the European Green Deal confirmed the importance of greater circularity in buildings and construction as a means to reduce waste, improve material use and further reduce greenhouse gas emissions in the EU (EC, 2020).

The new approach made it clear that each of a building's life cycle stages — from design, production and consumption to demolition and waste management — offers rich opportunity for greater circularity and emission reductions. A long list of potential circular economy actions was drawn up, ranging from 3D printing of building elements to improved maintenance to extend a building's lifetime.

An initial assessment shortened this list to promising and specific actions for further analysis. Most of these selected actions target concrete, cement and steel, which have a high impact in terms of greenhouse gas emissions and are used in large quantities in Europe's buildings sector. For each of the shortlisted actions, background life cycle data were collected and assessed for their potential to help reduce demands for the most emission-intensive materials <sup>[1]</sup>.

## Climate change mitigation

A 2015 baseline of material flows and emissions related to the shortlisted steps was set, accompanied by three scenarios for the assessment:

1. a base case with no changes from the 2015 baseline
2. a medium-ambition scenario with 50 % implementation of the shortlisted actions
3. a high-ambition scenario with 100 % implementation of the shortlisted actions across the EU by 2050.

By scaling up the shortlisted circular actions to the three scenarios, it became clear that they can have a major cumulative impact. By 2050, in a high-ambition scenario, they could reduce greenhouse gas emissions by as much as 61 % (130 million tonnes carbon dioxide equivalent, MtCO<sub>2e</sub>) in the EU-27 and the United Kingdom across the life cycle of the buildings (compared with the 2015 baseline and under the assumptions made in the study).

The full reduction potential could be achieved for new buildings, starting from the design stage, but partial benefits could also be achieved for existing buildings by implementing circular actions in the later life cycle stages. These emission reductions would be in addition to the large reductions that can be achieved through energy efficiency measures during the use phase of buildings. The actions assessed and their contributions to reducing emissions are illustrated in Figure 2.

# Climate change mitigation

**Figure 2. Overview of key circular economy actions in the buildings sector and their emission savings**



**Note:** The shortlisted actions are presented by life cycle stage, and their contributions to reducing greenhouse gas emissions are charted in MtCO<sub>2</sub>e (compared with the 2015 baseline). All the shortlisted actions are described in detail in the full report.

**Source:** Ramboll et al. (2020).

# Reducing concrete, cement and steel use in buildings offers the greatest potential

The study's results, illustrated in Figure 2, demonstrate that all four phases of a building's life cycle offer opportunities for substantially reducing emissions. The greatest potential is in the design, production and demolition and waste management phases, which also reflects these phases' heavy influence on material flows [2].

Most of the shortlisted circular economy actions are promising as pathways towards reducing emissions in the next 30 years. However, three offer the greatest reductions compared with the baseline:

- in the design phase, 12 % emission reductions through reducing overspecification of concrete in building plans
- in the production phase, 16 % emission reductions through using innovative and alternative cement types
- in the demolition and waste management phase, 15 % emission reductions through reusing structural steel.

These three actions focus directly on making the flows of steel, cement and concrete more efficient, as these constitute some of the most emission-intensive materials used in the buildings sector. This emission intensity applies to the design phase, where overspecification drives up the use of greenhouse gas-intensive materials without a concomitant increase in quality. It also applies to the construction and waste management and demolition phases, where choices in the handling and possible reuse of these materials can have a critical impact on the resulting emissions.

## Climate change mitigation

Circular economy actions that reduce the demand for such emission-intensive materials can therefore deliver some of the most promising emission reductions in the material flows of the buildings sector, especially within the 2050 time-frame of this study. This makes these types of actions ideal for inclusion in roadmaps towards major emission reductions by 2030 and climate neutrality by 2050 [3].

# The time horizon affects which actions appear most promising

Other circular economy actions may reduce emissions over a longer time-frame. This makes them appear less promising in this study but no less important for achieving a sustainable, low-carbon economy in the future. For example, renovations that improve the efficiency of buildings' use and extend their lifetimes can reduce the need for new buildings and lead to real and lasting emission reductions.

The study demonstrates that increasing the average occupancy of buildings during their lifetime can offer an 11 % reduction in emissions compared with the baseline. However, the shortlisted action related to design for buildings' lifetime extension and disassembly had only a minor effect (1 % reduction compared with the baseline).

In a study with a longer timescale, these actions can be expected to deliver much more promising results. Assuming an 80-year lifetime for buildings, the investment made today in design for disassembly will not be realised until much later than 2050. In addition, the current availability of such disassembly-ready elements is limited. Therefore, while the effect of these actions appears small, it would be larger with a longer time-frame.

# A sector-wide approach facilitates effective policy design

The methodology shows how different policy domains — in this case circular economy policies and climate change mitigation policies — can work together to create multiple benefits, e.g. reducing material use, waste and greenhouse gas emissions.

While the background study emphasises the potential benefits of individual circular economy actions, it also reveals how these actions can interact. The interplay between actions renders their combined impact lower than the sum of the individual actions. The study's finding of a potential to reduce greenhouse gas emissions by up to 61 % in a 100 % implementation scenario takes these interactions into account <sup>[4]</sup>.

This illustrates the importance of taking a comprehensive, sector-wide approach when identifying potential circular economy actions to pursue or support in new or expanded climate mitigation policies and measures, e.g. when revising building regulations. Interaction between efforts is also an important aspect to consider and strongly depends on the specific combination of actions. The EEA's new methodology ensures that these can be taken into account.

### Footnotes

1. The life cycles of private houses and commercial buildings in Europe were considered but reductions in their energy consumption during the use phase were not included, as this is not directly related to material flows. Energy consumption in buildings is, however, another key area to be addressed by climate mitigation policies and measures.
2. While not included in this study, the consumption phase also includes energy consumption for electricity and heating/cooling and is another important area for achieving greater efficiency and emission reductions (see also EC, 2018b).
3. While this study focuses specifically on the climate mitigation effects of circular economy actions, these can interact with other environmental factors, such as land use, that are also important to consider. Attention should also be given to the bioeconomy when considering material substitution with timber, for example, in a broader policy impact assessment.
4. In specific situations, there can also be further interactions between circular economy actions that affect the total emission reduction potential. For example, increasing a building's multi-functionality can lead to conscious overspecifying materials use to increase future flexibility, or energy-efficiency measures may require more materials. Such choices and trade-offs should be assessed on a case-by-case basis.

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