newTRENDs

Circular buildings: Paving the way to a net-zero industry

POLICY BRIEF

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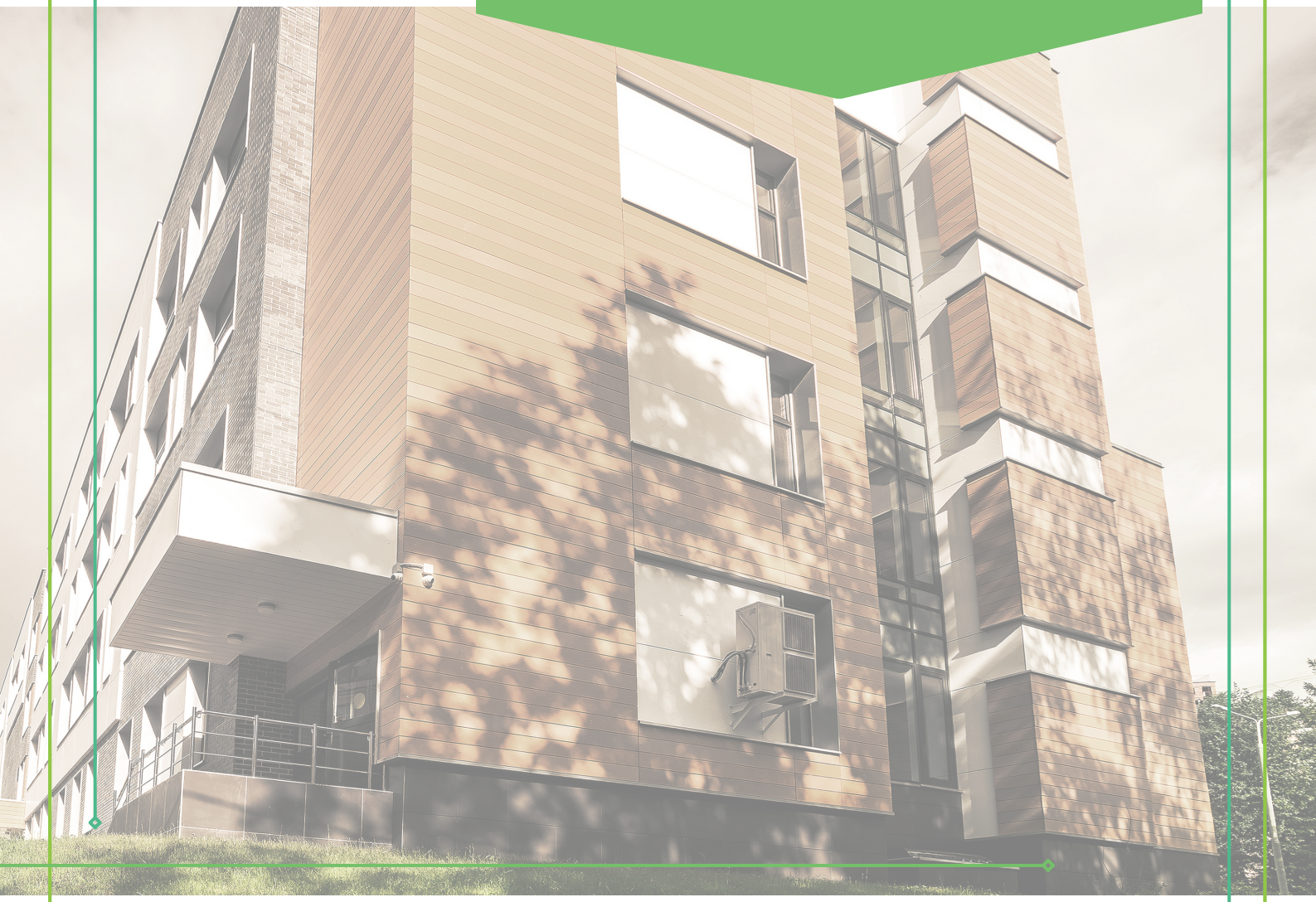

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Key messages:

- A circular economy can contribute significantly to reduce carbon emissions and achieve the climate targets in the hard-to-abate sectors.
- Buildings are a key value chain related to a high demand for energy-intensive materials and characterised by high circularity potentials.
- Within the EU-funded project newTRENDs, a modelling approach and data basis were developed and applied, that quantify the contribution of circular buildings to the industry decarbonisation.
- Besides the cycling of materials, actions addressing building design and use can reduce steel and cement demand for buildings by up to 38% respectively 26% in 2050.
- The current EU policy mix is not sufficient to exploit these material demand emissions reduction potentials.
- newTRENDs recommends to focus on 5 key points to improve the policy mix, highlighting the central role of green public procurement in the early stage of a circular economy:
    - **A life cycle perspective**: The policy mix should address all stages of a building's lifecycle well-balanced and without contradictions.
    - **Broaden the scope**: An understanding of the circular economy beyond the cycling of materials is necessary to fully exploit its potentials.
    - **Push and pull**: The instruments should support both - a market push and a market pull, to equip the EU market for a circular economy.
    - **From voluntary to obligatory**: Instruments such as green public procurement can be used to roll out obligatory requirements to all consumers.
    - **Stay focused**: Product-specific requirements are necessary to meet the special requirements for buildings (affordability, liveability and sustainability).

Why do we need the circular economy for a deep decarbonisation of the industry?

In 2021, the industry sector was responsible for about 22% of carbon emissions in the European Union (EEA, 2021). Available technologies are not sufficient for a deep decarbonisation of this sector (Fleiter et al., 2019). Thus, material-based strategies grouped under the umbrella of a **circular economy** gain momentum in the political debate (European Commission, 2019).

These strategies can contribute to reduce the material demand by using materials and products efficiently and repeatedly avoiding adverse impacts, while enabling further economic growth (see info box).

The circular economy and the 9Rs

While the initial idea of the transformation from a linear to a circular economy was based on the cycling of materials (Boulding 1966), more recent studies also consider strategies addressing consumption patterns. For instance, Kirchherr et al. define the circular economy "as an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/ distribution and consumption processes" (2017). A well-known framework to categorize and prioritize these strategies are the 9Rs:

Circular exonomy → **Linear economy** (Increasing circularity)

Strategies		
Smarter product use & manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	R1 Rethink	Make product use more intensive (e.g. by sharing product)
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources & materials
Extend lifespan of product & its parts	R3 Reuse	Reuse by another consumer of discarded product which is still in good condition & fulfills its original function
	R4 Repair	Repair and maintenance of defective product so it can be used with its original function
	R5 Refurbish	Restore an old product & bring it up to date
	R6 Remanufacture	Use parts of discarded product in a new product with a different function
	R7 Repurpose	Use discarded product or its parts in a new product with a different function
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low
	R9 Recover	Incineration of material with energy recovery

Figure 1 The 9R framework from Kirchherr et al. 2017

In the context of industry decarbonisation, circularity addresses material production in the hard-to-abate sectors (see info box: *The role of hard-to-abate sectors in transformation scenarios*), with the potential to reduce carbon emissions. Moreover, circularity can reduce the demand for secondary energy carriers required for the decarbonisation of these sectors and thus, the overall transformation costs (IEA, 2019).

The role of hard-to-abate sectors in transformation scenarios

The basic industries (steel, cement, and petrochemicals) are usually referred to as hard-to-abate sectors, as carbon emissions from the manufacturing processes in these sectors are difficult to avoid.
On one hand, these processes are highly energy intensive and would require vast amounts of renewable energies or carbon-neutral energy carries, e.g. hydrogen.
On the other, part of the emissions come from the production processes and are thus not avoidable by fuel switching. In the latter case, alternative manufacturing processes can be used and/or the remaining carbon emissions can be captured and stored or utilized. However, this requires a fundamental transformation of the value chains and is related to high system costs and further challenges, such as societal acceptance.

For this reason, these sectors are typically classified to be "hard to abate". Consequently, demand reduction is an essential part of achieving emission reduction targets (Fleiter et al. 2019).

The relevance of circular buildings for the industry decarbonisation

Buildings are one of the main demanders for energy-intensive materials such as steel and concrete (including the precursors cement and clinker), responsible for a large share of carbon emissions in the industry sector (Lotz et al. 2022a). Furthermore, several studies showed that a circular economy can contribute significantly to reduce the demand for building materials (Circle Economy 2022; Hertwich et al. 2020; Le Den et al. 2020; Material Economics 2018).

Using the modelling approach and the data basis developed within the newTRENDs project (see info box: *Modelling approach and data basis developed within the newTRENDs project*), a reference case for the steel and concrete demand in buildings until 2050 were modelled. If building use and construction method do not change, the material demand will increase and drive industry emissions (see figures). It is therefore crucial to reduce the prospective demand for building materials to achieve the European climate goals.

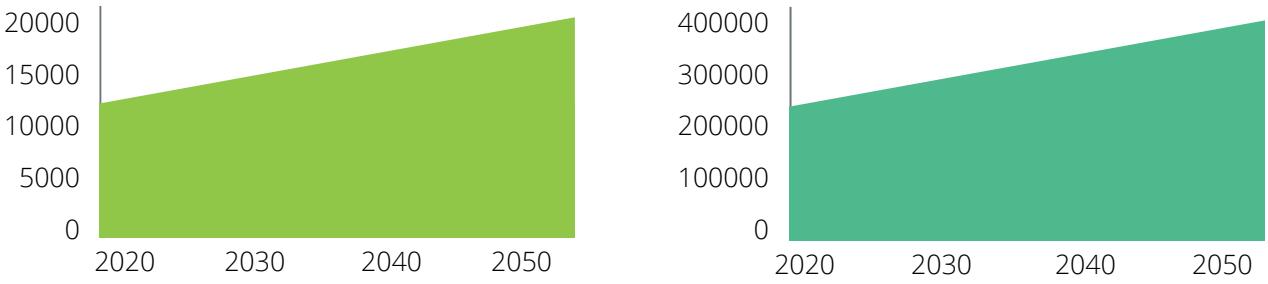

Figure 2: Steel and concrete demand for EU buildings in the reference (Lotz et al. 2022b)

Modelling approach and data basis developed within the newTRENDs project

In newTRENDs, partners improved the modelling of the contribution from circular buildings to industry decarbonisation. For this purpose, they developed a stock-driven material flow model of steel and concrete in EU buildings, that links two existing energy system models:

- **Invert/EE-Lab** is a bottom-up model for buildings, which allows to evaluate policy and technology-focus scenarios regarding GHG emissions, energy demand, energy carrier mix and costs. It provides disaggregated data for the building stock in the EU countries and the United Kingdom for the material flow model (Camarasa et al. 2022; Kranzl et al. 2013; Kranzl et al. 2022; Müller 2015; TU Wien et al. 2021).
- **FORECAST** aims to develop long-term scenarios for sectoral energy demand and emissions of individual European countries until 2050. It is based on a bottom-up modelling approach considering the dynamics of technologies and socio-economic drivers. The modelled material flows are an input for FORECAST-Industry (Fleiter et al. 2018).

Moreover, partners developed a database on material use for residential and commercial buildings in the EU, the data preparation for commercial buildings specifically closing a data gap [1].

[1] Detailed information on the model development and the data basis are available in the newTRENDs deliverable 6.1, available later in 2023.

Potentials of a circular economy along the building value chain

We analysed the reduction potential of 8 exemplary strategies for circular buildings representing the 9R framework excluding energy recovery (see info box: *The circular economy and the 9Rs*).
Besides the cycling of materials, the design and the use phase are of particular relevance for moving from a linear to a circular economy for buildings (see Figure 3).

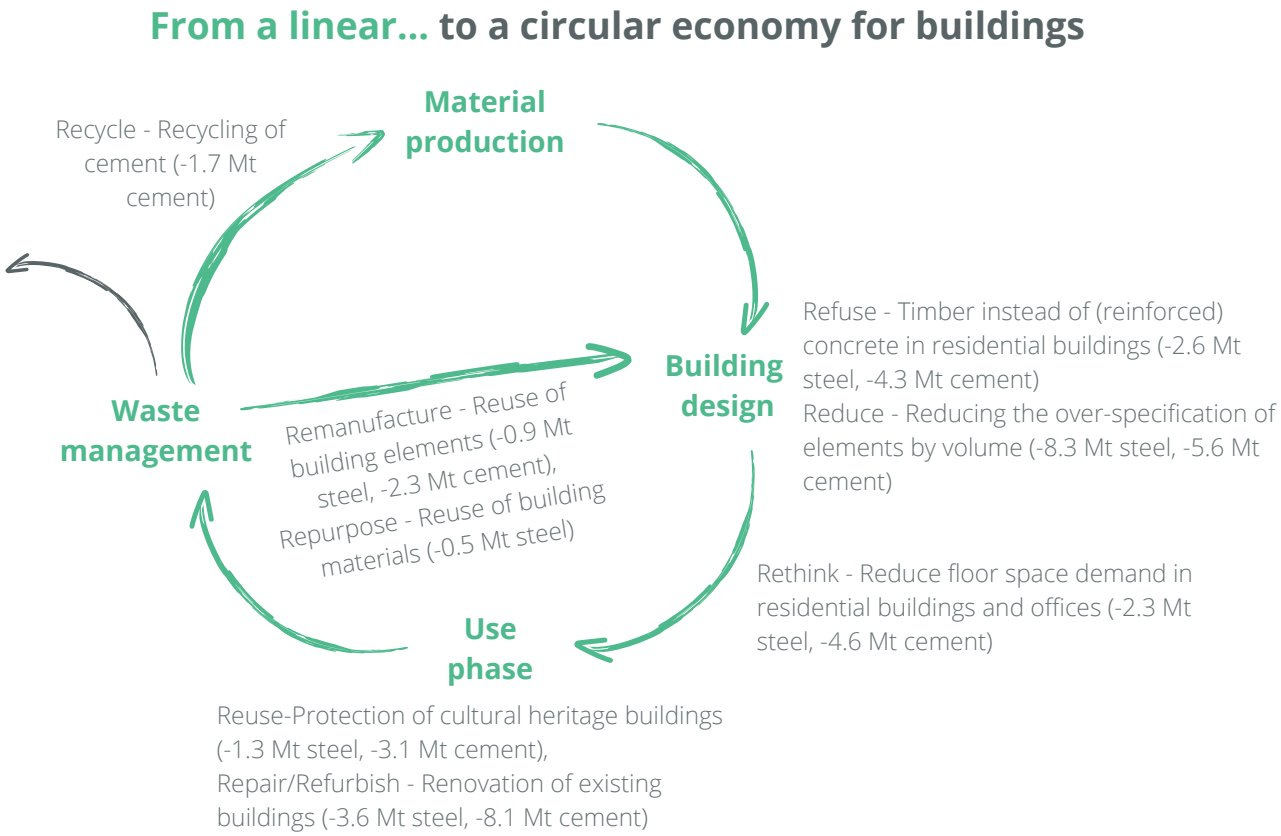

Figure 3: From a linear to a circular economy for buildings - Impact of individual actions on steel and cement [2] demand in EU buildings (Lotz et al. 2022b)

However, it also becomes clear that the shown potentials are not additive but influence each other. For instance, the preservation of the building stock through protection and renovation limits the availability of secondary materials for reuse and recycling. When the potentials are modelled combined, the steel and cement demand is reduced by 38% (7.5 Mt), respectively 26% (12.1 Mt) compared to the reference case in 2050 - and this even though it was assumed that only half of the maximum potential would be realized[3].

[2] Cement is a precursor of concrete, since some of the actions address cement demand but not concrete demand, only cement is shown here.
[3] Detailed information on the modelled impact and further scenarios are also available in the newTRENDs deliverable 6.1, available later in 2023.

The current policy mix is insufficient for a circular economy in buildings

A consistent policy mix is necessary to exploit these potentials. This is partly reflected in existing and emerging policy initiatives, such as the *Circular Economy Action Plan* or the *Sustainable Products Initiative* (European Commission 2020, 2022).

However, the current policy mix remains insufficient as it focuses on recycling and neglects the other R strategies shown before. While more ambitious policies such as *Green Public Procurement* or *Ecolabel criteria* are available, they remain voluntary and are not sufficiently aligned with the overall policy mix (Lotz et al. 2022a).

Symbol key
Building / constructions
Components

Color key
Minimum requirement
Informational requirement
Voluntary requirement

	Raw material	Processing/ Manufacturing	Use	Re-cycling	Recovery/ Disposal
Durability			GPP Ecolabel		
Re-usability/ Upgradability/ Reparability			GPP WFD Ecolabel		
Recycling/ Remanufacturing				GPP WFD Ecolabel	
Resource Efficiency		GPP			
Energy Efficiency			EPBD EPBD GPP		
(GHG) Emissions	GPP	GPP Ecolabel	GPP Ecolabel	GPP	GPP
Hazardous Chemicals/ Dangerous Substances	Ecolabel		GPP		Ecolabel GPP
Carbon/ Environmental Footprint	GPP	GPP	GPP	GPP	GPP
Critical Sourcing	GPP Ecolabel				

Figure 4: Circular economy policies for the buildings (Lotz et al. 2022a)

To improve, existing and emerging policies must be aligned along the building value chain, with product-specific instruments being highly relevant. In addition, the understanding of a circular economy should be expanded beyond the cycling of materials. Both market push and pull instruments must be designed well-balanced, considering short- and long-term objectives.
The development of a circular economy and the related business models must be supported, especially at the beginning (Lotz et al. 2022a).

The short-term role of green public procurement for circular buildings

Green public procurement is one option for the short-term support of a circular economy in buildings (Nilsson Lewis et al. 2023; Ntsondé et al. 2021). One of the major potentials of green public procurement lies in the various design options.
Partners took a closer look at these within newTRENDs.[4] Besides purchase quota for low-carbon or secondary materials affecting the material production, criteria can be defined for building design, use and waste management. On one hand, such criteria could cover thresholds for embedded emissions as already proposed by various EU member states (BPIE 2022). On the other, they could address the adaptability and deconstruction of buildings as presented by the JRC draft for procurement criteria (Donatello et al. 2022).

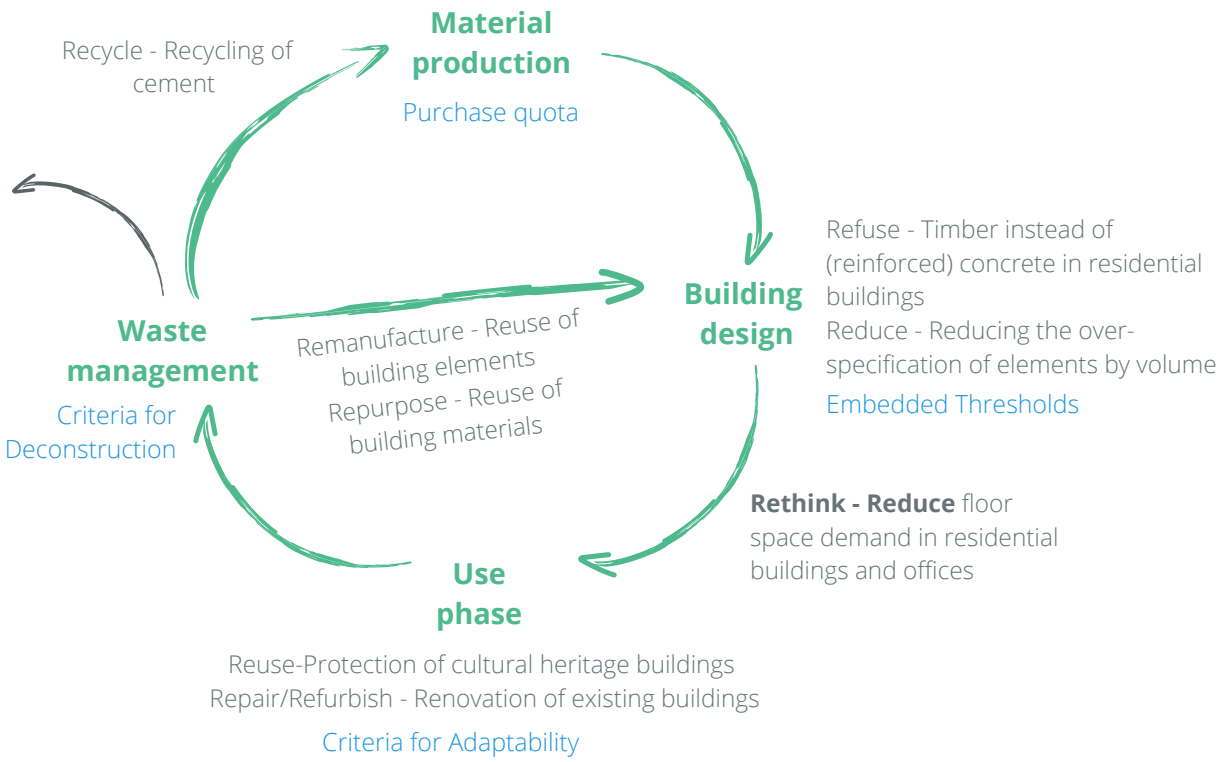

Figure 5: Impact areas of different design options for green public procurement

Consequently, green public procurement has the potential to cover various stages of the building value chain and address circular economy potentials comprehensively. In the short term, thresholds for embedded emissions are particularly relevant since they have an immediate impact and the target achievement is open for different impactful strategies, such as the reduced over-specification of elements or timber construction. While only a small share of building materials is demanded by the public sector, green public procurement can thus support the creation of lead markets and the gathering of experience for the roll-out of policies to the private sector.

[4] A detailed analysis of different policy cases can be found in the newTRENDs Deliverable 6.3.

5 points for improving the policy mix for circular buildings

A life cycle perspective: The policy mix should address all stages of a building's lifecycle well-balanced and without contradictions.

Broaden the scope: An understanding of the circular economy beyond the cycling of materials is necessary to fully exploit its potentials.

Push and pull: The instruments should support both - a market push and a market pull, to equip the EU market for a circular economy.

From voluntary to obligatory: Instruments such as green public procurement can be used to roll out obligatory requirements to all consumers.

Stay focused: Product-specific requirements are necessary to meet the special requirements for buildings (affordability, liveability and sustainability).

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