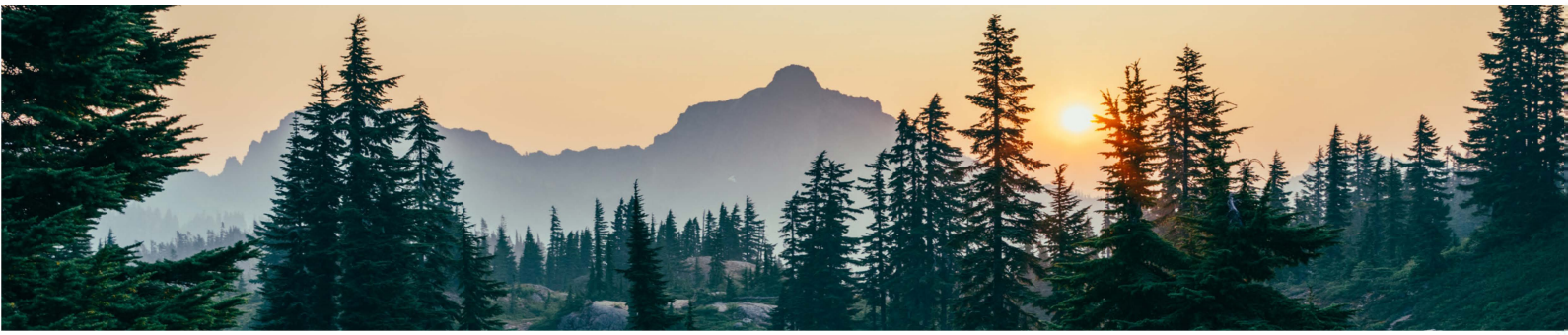
Circomod Policy Brief 5:

Circular Economy for Machinery and Equipment

CIRCOMOD summary brief for EU stakeholders

CIRCOMOD is an EU research project that develops integrated models, data and decision-support tools to assess how circular economy strategies can reduce greenhouse gas (GHG) emissions and material use at scale.



Executive summary

Circular economy strategies are increasingly recognised as essential to climate action because they can reduce demand for primary materials and associated GHG emissions in ways that decarbonisation alone cannot. Yet most climate modelling frameworks still do not represent circular economy strategies consistently. This makes it harder for policymakers and industry to assess system-wide effects, including trade-offs, synergies, and rebound effects.

CIRCOMOD addresses this gap by combining advanced modelling, data, and user-facing tools in a single framework. It provides a harmonised evidence base and makes results usable for policy design, impact assessment, strategy development, and stakeholder engagement.

This brief focuses on the underexplored potential of the machinery and equipment sector:
Carbon footprint evidence at the sectoral and technology levels are summarized, as well as **circular economy mitigation potential in industrial machinery**

Highlights

Circularity and material efficiency of machinery and equipment are central for achieving a circular economy in Europe

- **25-30% of metals use** to produce machinery and equipment
- Production causes **5% of global carbon footprint**
- **17% of Europe's export** by value

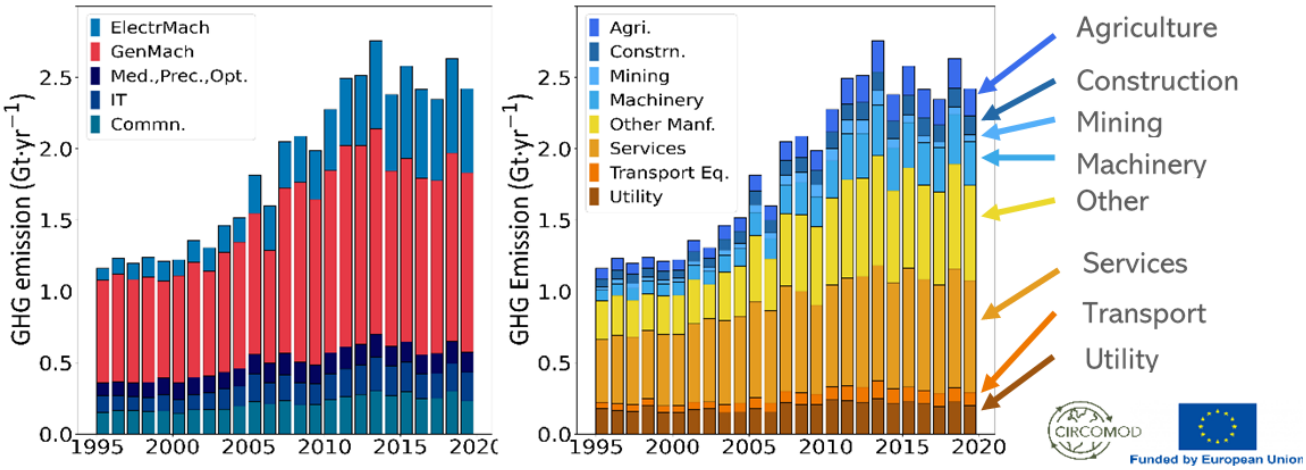
Context

- EU climate and industrial goals depend on cutting material-related emissions – including in iron & steel, copper, aluminium, and cement – through smarter use, reuse, and substitution beyond clean energy.
- The EU's 2026–2029 agenda, including the Circular Economy Act and Clean Industrial Deal, sets targets to double circularity and decarbonise industry while boosting resilience and competitiveness – requiring robust data and models to quantify the impact of circular economy strategies.
- Until now, machinery and equipment have received only selective attention. The value retention potentials are not well known.

Results – Carbon Footprint of materials

Production of machinery by type

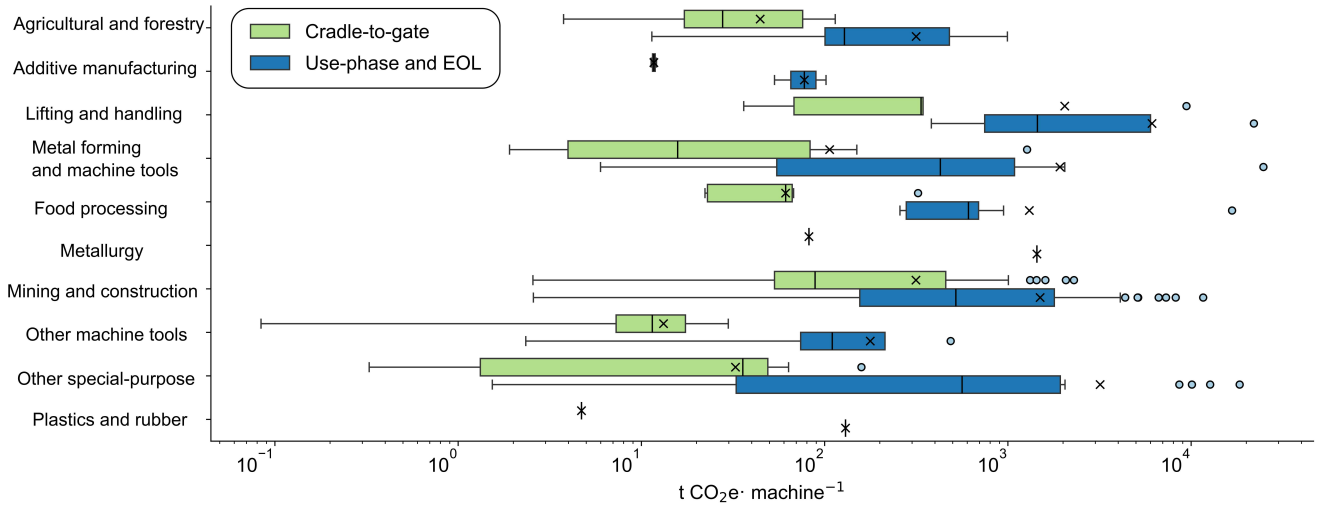
Use of machinery by using sectors



Materials are mostly used for general, i.e. mechanical machinery, from compressors through metal working tools to material handling equipment [1]

Most machinery is used in the service sector. Machinery production, utilities, agriculture and construction equipment are also important [1]

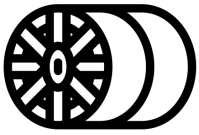
Results – Life cycle assessment (LCA) climate impact evidence of industrial machinery



LCA machinery studies (n=86) show evidence that although use-phase impacts dominate the life cycle climate impacts, manufacturing (i.e., cradle-to-gate) impacts are generally not negligible for multiple machinery types and are becoming more important under low utilization and under decarbonization pathways such as electrification in various technologies (e.g., lifting and handling, mining and construction) [2]

Evidence of circular economy mitigation potential in industrial machinery

Refurbishment – Tunnel boring machines (Herrenknecht AG)

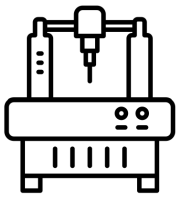


Refurbishing key components can reduce embodied CO_2 emissions by up to **71% per tonne of components** and achieve over **90% material savings**, primarily through lifetime extension, improved maintenance, and targeted repair of functional parts [3,4].

Remanufacturing – Water meters (Lorenz GmbH & Co. KG)

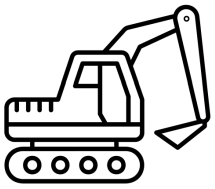
Systematic in-house remanufacturing consisting of comprehensive dismantling and reprocessing of components represents savings of around **90% in greenhouse gas emissions, energy consumption, and resource consumption** compared to producing new units [5,6].

Reuse – Metalworking equipment (Robert Bosch GmbH)



Internal reuse of 1,565 industrial machines avoided new production, saving thousands of tonnes of steel, aluminium, and plastics, demonstrating large-scale material demand reduction through equipment reuse [6].

Remanufacturing – Construction equipment components (Liebherr Components AG)



Remanufacturing of hydraulic pumps, gearboxes, and engines yields **75–78% primary material** savings and up to **53% reductions in embodied greenhouse gas emissions** [7].

Relevance for policy and industry

The machinery and equipment sector is central to the circular economy

- Machinery and equipment manufacturing is the largest user of metals after construction and depends on valuable resources largely imported to the EU. The sector generates high value added, accounts for a significant share of EU exports, and contributes to Europe's material resilience and industrial competitiveness.
- As energy systems decarbonise, manufacturing is expected to account for an increasing share of the life cycle climate impacts of machinery and equipment.

Substantial reductions in material demand and carbon emissions are possible

- Industrial cases from Bosch, Herrenknecht, and Liebherr demonstrate substantial material and cost savings and embodied carbon reductions, while research identifies opportunities to reduce material requirements and improve manufacturing yield, thereby lowering material demand.
- Evidence on sector-wide mitigation potential remains limited, highlighting the need for improved modelling and assessment of circular economy strategies to support policy and investment decisions.

The circular economy relies on machinery and equipment

- Scaling the circular economy depends on investments in machinery and infrastructure for reverse logistics, sorting, repair, remanufacturing and high-quality recycling.

EU policy can accelerate circularity in the machinery sector

- EU policy initiatives such as the Digital Product Passport can improve transparency, data sharing, and decisions that reduce material use and climate impacts.
- Policy measures addressing waste classification and warranties could support the expansion of reverse logistics and remanufacturing.
- Better alignment across product, waste, chemical and sustainability policies can strengthen circular business models and investment.

References:
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About CIRCOMOD

CIRCOMOD is an EU research initiative that develops integrated models to quantify how circular economy strategies – such as material efficiency, product lifetime extension, reuse, and high-quality recycling – can reduce greenhouse gas emissions and resource use at scale.

By combining detailed data on material flows, real-world technologies, and economic dynamics, the project enables a system-wide assessment of the impacts of circular strategies across sectors and regions. The project ran from 2022 to 2026.

Further information

CIRCOMOD
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