COP31 GLOBAL CLIMATE ACTION AGENDA

Our Zero Waste Future

From the 2035 targets to a fairer, lower-carbon, circular materials economy by 2050



November 2026

COP31 TÜRKİYE ANTALYA | Climate High-Level Champion

ZERO WASTE FOUNDATION

Credits and citation

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FOREWORD

Zero Waste: From Climate Ambition to Real-Economy Transformation

Zero waste is a thread that connects climate action with wider environmental outcomes, the circular economy and more sustainable ways of living. It creates an opportunity to bring climate action closer to communities, households and individuals, enabling people to participate directly in building a more resilient world. For climate action to succeed, its benefits must be inclusive and tangible. People must be able to see the difference it makes in their daily lives, recognise their role in driving change and become part of the collective effort.

COP31 represents an important milestone in advancing this agenda. It is the first Zero Waste COP, bringing materials, resource use and waste prevention more firmly into the global climate conversation. It also places zero waste among the cross-cutting themes through which we can accelerate climate action and advance our collective ambitions. Building on Türkiye's leadership in the global zero waste movement, the COP31 Presidency has set ambitious goals for 2035: halving the projected increase in global waste generation and achieving at least 15% circular material use in production and manufacturing.

While the energy transition remains essential, we must also transform how materials are extracted, products are designed, food is produced and consumed, and resources are managed throughout their life cycles. The extraction of resources, production of goods, construction of infrastructure and eventual disposal of products all carry significant environmental and climate costs.

This is where zero waste offers an important economic and social opportunity. We must move beyond an approach centred primarily on waste collection and disposal towards more circular approaches that prioritise prevention, reuse, repair, sharing and the responsible use of resources. These approaches can reduce emissions and pressure on natural resources while creating local jobs, supporting livelihoods, improving affordability and strengthening communities.

But the transition cannot succeed unless it is fair and inclusive. Lower- and middle-income countries, informal waste workers, local enterprises and communities already sustain many of the reuse, repair and recovery systems on which a circular economy depends. We must ensure that the transition builds on existing practices, creates opportunities for those who are already driving change and distributes its benefits more equitably.

This report provides a foundation for translating the Presidency's ambitions into action. By establishing a global baseline, identifying sectoral pathways and highlighting priority policies, investments and initiatives, it sets out a practical direction towards the 2035 goals and the longer-term transformation needed by 2050.The challenge now is to move from ambition to implementation at scale. Through the Istanbul Zero Waste Action Platform and other collaborative initiatives, COP31 offers an opportunity to connect stakeholders, mobilise investment, accelerate solutions and track measurable progress.

The legacy of COP31 should be defined not only by the ambitions we establish, but by our collective ability to turn zero waste into a driver of climate action, economic transformation and sustainable development.



Samed Ağırbaş
COP31 Climate High-Level Champion

FOREWORD

Zero waste thinking makes climate action more effective, cheaper and fairer

Over more than three decades spent working towards a more resource efficient world, I have felt that part of the climate conversation was missing.

In that time, enormous progress has been made in the transition to renewables, industrial decarbonisation and energy efficiency. Yet alongside those advances, global demand for materials has continued to grow. We have become increasingly good at making things cleaner, while paying much less attention to whether we need to make quite so much in the first place.

The COP31 Presidency's focus on Zero Waste feels like a pivotal moment. Not because the concepts or evidence are new, but because the moment is. Antalya signals an important shift. It reflects a growing recognition that climate action is not only about changing how we produce and consume energy, but also about how we produce and use materials and products.

Every home, every product, vehicle and piece of infrastructure begins with materials. Any material we avoid using reduces the amount we need to decarbonise, or the extent we will have to remove greenhouse gasses from the atmosphere. This report aims to quality what can be achieved in reducing and avoiding greenhouse gas emissions by implementing zero waste thinking, and to set out the priority actions to focus on.

On a personal level, this is the kind of report I have always wanted to help to create. I am grateful to the colleagues and collaborators who brought their expertise and insight to this work. Together we have tried to capture an idea whose time has come: that climate action is not only about producing more cleanly, but also about using the world's resources more wisely.

What encourages me most is that this is not a story of sacrifice or constraint. It is a story of innovation, opportunity and plenty. Around the world, businesses, cities and communities are already showing that reuse, repair, sharing and longer-lasting products can reduce emissions while creating economic and social value. More utility from less material means more economic output for less natural resource input. The challenge is no longer to prove that these approaches work. It is to make them the norm.

My hope is that this report helps broaden the conversation about what climate action can be. Cleaner production remains essential. But so too does making better use of what we produce. Both will be needed, and each makes the other easier and more impactful.

The opportunity is in front of us. The task now is to seize it.

Joe Papineschi
Chairperson, Eunomia Research & Consulting
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EXECUTIVE SUMMARY

Applying a zero waste approach to the whole materials economy could save 149 $GtCO_2e$ by 2050

COP31 is the first COP to make zero waste a priority, bringing materials, a fastest-growing climate challenge, into climate action.

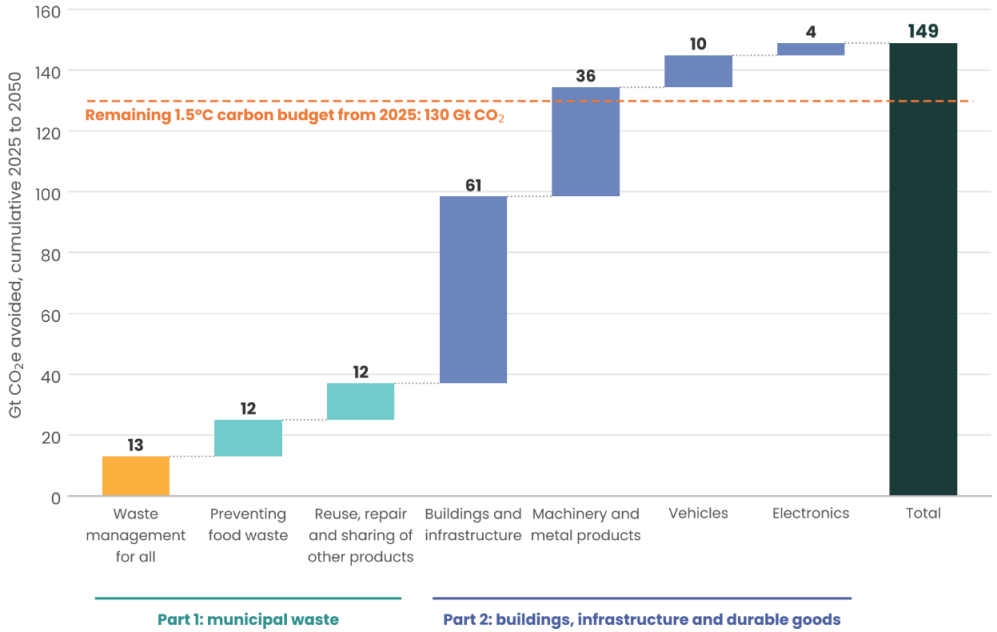
Why now. GHG emissions are still rising, and at current rates, the remaining 1.5°C carbon budget will be spent by 2028. Overshoot is now all but certain; what matters is how far, and for how long.[1]

Energy alone is not enough. Renewables, electrification and energy efficiency have made crucial progress and remain the top priority. But materials are where the problem keeps growing: cleaner production has been outpaced by growth in volume, and demand is still rising. Even if production were to be fully decarbonised tomorrow, steel, cement, aluminium and plastics alone would emit more than the remaining budget by 2050.

Zero waste approaches close much of the gap. Meeting the COP31 Presidency's 2035 targets (halving the projected growth in municipal waste and more than doubling circular material use to at least 15%), followed by ambitious waste reduction and more efficient use of materials in buildings, vehicles and infrastructure, could avoid 149 $GtCO_2e$ by 2050. By then, annual savings reach 9.6 $GtCO_2e$, more than total global transport emissions today.[2]

What this means

Decarbonising production is essential but cannot do the job alone. Using less, using better products for longer, and preventing and managing waste well makes the task smaller, cheaper and faster.



GHG emissions avoided by a zero waste approach, cumulative 2025 to 2050, by lever ($GtCO_2e$)

Source: Eunomia analysis. Part 1: global municipal waste model. Part 2: upper material efficiency savings rate applied to all durable goods (see the scale of the opportunity). Other waste streams, such as construction and industrial waste, are not modelled and could add further savings. The carbon budget is for CO_2 only (Forster et al. 2025).

[1] IPCC, "Summary for Policymakers," in Climate Change 2021: The Physical Science Basis (Cambridge: Cambridge University Press, 2021), 29; Piers M. Forster et al., "Indicators of Global Climate Change 2024," Earth System Science Data 17 (2025): 2641.

[2] United Nations Environment Programme, Emissions Gap Report 2025: Off Target – Continued Collective Inaction Puts Global Temperature Goal at Risk (Nairobi: UNEP, 2025), executive summary and chapter 2. Global GHG emissions in 2024 were 57.7 $GtCO_2e$, of which transport was 8.4 $GtCO_2e$.

The COP31 Presidency's 2035 targets are the first stepping stone on a longer path

Each step widens the opportunity, from waste to products to buildings and infrastructure, benefiting people and climate.

1. The 2035 targets. Slowing the growth in municipal waste and doubling circular material use bring zero waste into climate action. The COP31 Presidency cites IEA analysis that related measures could cut energy-sector GHG emissions by over 1.5 Gt CO_2e a year by 2035.[3]

2. Less waste, better managed. Sound waste management for all, far less food wasted, composting and anaerobic digestion to cut methane emissions, and increasing longevity of everyday products save around 37 $GtCO_2e$ to 2050.

3. Upstream across the economy. Three quarters of material GHG emissions go into buildings, infrastructure, vehicles and machinery.[4] Making them last longer, using them more intensively and remanufacturing their parts saves a further 112 $GtCO_2e$. More secondary raw materials in production and behaviour change towards reuse, repair and sharing would add to this.

Who benefits

Most growth in waste and material use is now in low- and middle-income countries, which can learn from the take-make-waste mistakes of industrialised economies. Reuse, repair and sharing can deliver better products, lower costs and skilled local jobs.



The opportunity grows with each step

1	2	3	4	5	6
Count what reuse, repair and sharing save	**Build on the 2035 targets**	**Scale what works**	**Share responsibility fairly**	**Value existing practice**	**Design for longevity**
Agreed methods so the GHG emissions they avoid count in national climate plans.	Sound waste management for all, separate food waste collection and a published baseline.	Coordinate globally to scale proven models and remove the barriers they face.	Higher-income countries cut material use most; concessional finance enables the rest.	Fund and empower the reuse, repair and sharing already common in the Global South.	Durability and repair standards, whole-life carbon and procurement that rewards long life.

[3]COP31 Presidency, "COP31 Presidency's 3rd Letter to the Parties: The Challenges before Us Are Considerable, but So Are the Opportunities" (Ankara: COP31 Presidency, 2026), 3–5, https://unfccc.int/sites/default/files/resource/cop31_3rd_presidency_letter.pdf.
[4]Edgar G. Hertwich, "Increased Carbon Footprint of Materials Production Driven by Rise in Investments," Nature Geoscience 14 (2021): 151–53, table 1, https://doi.org/10.1038/s41561-021-00690-8.

CONTENTS

What's in this Report

FOREWORD **3**
EXECUTIVE SUMMARY **5**
Background **8**
Why materials matter 9
The Zero Waste COP 10
Upstream practice 11
How to read this report 12
Part 1: Municipal waste **13**
Municipal waste 14
Sound waste management for all 15
Reuse, repair and share in municipal waste 16
Where the emissions arise 17
Common but differentiated responsibilities 18
From waste to materials 19
Part 2: The global materials picture **20**
Material emissions over time 21
The carbon budget 22
Where material emissions go 23
Using less 24
Biological cycles 25
The economic opportunity 26
Part 3: Sector perspectives **27**
Food 28
Packaging 29
Textiles 30
Electronics 31
Transport 32
Construction 33
Part 4: Discussion and recommendations **34**
The scale of the opportunity 35
The shift 36
Conclusions 37
Recommendations 38
Appendix **39**

Background

Why materials matter at COP31 and beyond



Producing materials such as steel, cement and plastics causes 20% of global GHG emissions, up to 70% once their whole life is counted

Our analysis uses the 20% figure, counting only GHG emissions (GHGEs) directly from making materials, including the energy used.

When we imagine materials use, we often think waste alone – but when it comes to GHGEs, waste is just the tip of the iceberg. Long before becoming waste, electricity and fuel are consumed to extract materials and transport them, and emissions are generated during processing. By attributing this impact to different sectors, the emissions potential of tackling material systems head-on is often rendered invisible.

There are different ways to make it visible. The narrowest boundary counts only the emissions from producing materials such as steel, cement and plastics, including the energy used to make them: about a fifth of the total.[5] Adding food and agriculture takes the share to around 45%.[6] Counting the extraction and processing of every resource, including fossil fuels and biomass, takes it above 55%.[7] Allocating supply chains, freight and use-phase energy to what we consume takes it to around 70%.[8]

WHY THIS REPORT USES THE NARROWEST MEASURE

Following the IPCC, it uses a full, peer-reviewed inventory split by material and the sectors that use each material. Every figure in this report can be traced without double counting. The data year is 2018; with steel and cement's rising output, today's total is likely to be higher.

What this means

Whichever boundary is used, what we make and consume shapes most of the world's emissions. Even the narrowest scope, 11.8 Gt a year, is over 10x the direct GHGEs of commercial aviation.[9]

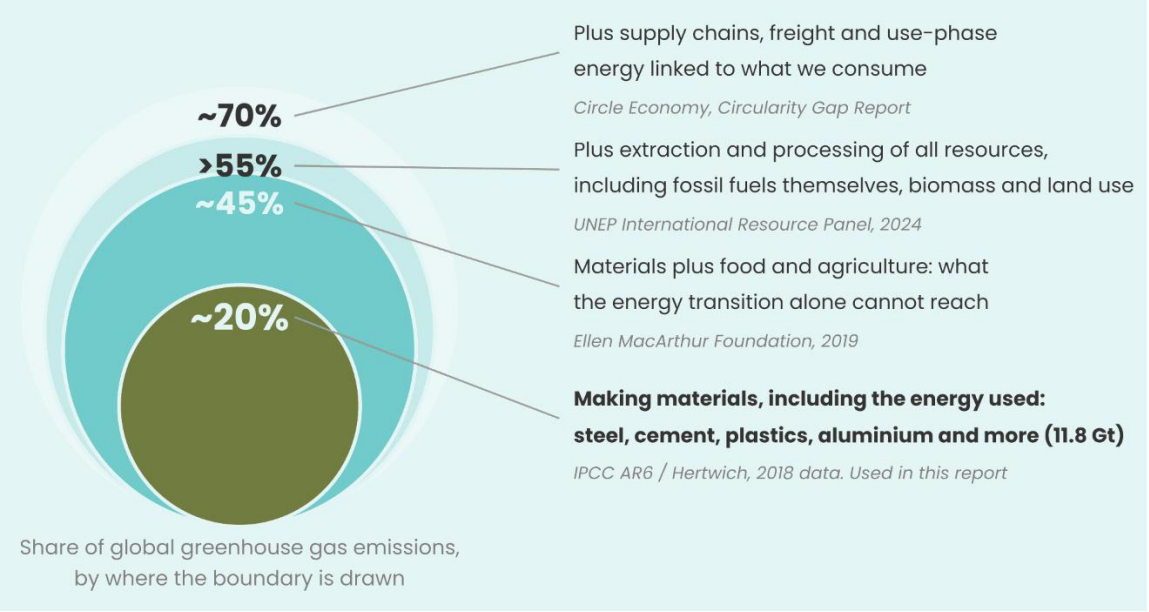


Figure 1: Share of global greenhouse gas emissions linked to materials, by where the boundary is drawn

Sources: IPCC AR6 WGIII (Hertwich update, 2018 data); Ellen MacArthur Foundation (2019); UNEP International Resource Panel (2024); Circle Economy (2021). Each ring includes the one inside it, so the shares are not additive. Circle areas are proportional to share.

Note: Shares depend on the global total used as the denominator, which is not fixed. The ~20% shown here divides material production emissions of 11.8 $GtCO_2e$ (2018) by total global greenhouse gas emissions of about 59 $GtCO_2e$, including land use, land-use change and forestry (IPCC AR6, 2019). Excluding land use, or using a different year, metric or dataset, gives a higher share of about 22–25%. The other rings are each sources' own estimates, calculated on their own boundaries and denominators, so they are indicative rather than strictly comparable.

[5]Bashmakov, Nilsson, et al., "Industry," 1172–73, n. 20.
[6]Ellen MacArthur Foundation, Completing the Picture: How the Circular Economy Tackles Climate Change (Cowes: Ellen MacArthur Foundation, 2019).
[7]UNEP International Resource Panel, Global Resources Outlook 2024: Bend the Trend – Pathways to a Liveable Planet as Resource Use Spikes (Nairobi: United Nations Environment Programme, 2024).
[8]Circle Economy, The Circularity Gap Report 2021 (Amsterdam: Circle Economy, 2021).
[9]Paulina Jaramillo, Suzana Kahn Ribeiro, et al., "Transport," in Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge: Cambridge University Press, 2022), chap. 10.

COP31 breaks new ground by putting zero waste at the heart of climate action

New 2035 targets formalise growing calls to tackle climate change through the scale of materials in the world economy.

For years, the IPCC has called for *"circular material flows" and "reduc[ed] material consumption,"* suggesting that this could be achieved by "intensive use of longer-lived repairable products."[10] This is a direction of travel echoed by the World Resources Institute, who state that industry decarbonisation "requires a multipronged approach [including] reducing demand for materials."[11] The IEA highlight that *"policy makers need to look beyond recycling to [...] repair, refurbishing, reuse and repurposing."*[12] The necessary direction of travel is clear, and Zero Waste is the goal on the horizon.

Until now, these calls have stayed at the perimeter of climate negotiations. This year marks a major change: the Turkish Presidency has made zero waste one of the priorities of COP31 and has introduced targets to guide the UNFCCC Action Agenda.[13] Citing IEA analysis, the Presidency notes that material efficiency, recycling, better waste management and biogas could cut energy-sector GHG emissions by more than 1.5 Gt CO_2e a year by 2035.[14]

HOW THIS REPORT FITS

This report looks beyond the 2035 targets to explore the impact of the deeper transformation required to achieve a Zero Waste world.

Zero Waste and Methane Reduction	Green Industrialisation
TARGET Cut the projected increase in global municipal solid waste generation by at least 50% by 2035.	**TARGET** Raise the global circular material use rate from 6.9% to at least 15% by 2035.
WHAT IT DELIVERS Less waste, less methane from landfill and dumpsites, and a cleaner local environment.	**WHAT IT DELIVERS** More secondary material in the economy.
THE NEXT STEP Sound waste management for all, and scaled reuse and product durability across every sector.	**THE NEXT STEP** Weight the metric by carbon, so that recycled steel and aluminium count for what they save.

Table 1: The COP31 Presidency targets setting a direction of travel towards zero waste

Note: these targets were announced by the Turkish Presidency for COP31 as part of a wider package of non-negotiated Action Agenda initiatives and targets.

What this means

The 2035 targets are key stepping stones. This report looks at how zero waste thinking – when applied upstream and with broader global equity goals in mind – can build on these targets out to 2050.

[10] Katherine Calvin et al., *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, First, ed. Paola Arias et al., with Hoesung Lee (IPCC, 2023), 29, https://doi.org/10.59327/IPCC/AR6-9789291691647; P. R. Shukla et al., eds, *Climate Change 2022: Mitigation of Climate Change* (IPCC, 2022), 34.
[11] World Resources Institute, State of Climate Action 2025 (Washington, DC: World Resources Institute, 2025), 31.
[12] International Energy Agency, Recycling of Critical Minerals (Paris: IEA, 2024), 14.
[13] UN Climate Change, "COP31 Presidency Announces New Targets on Global Electrification, Cutting Waste, Resilient Cities," press conference transcript, 9 June 2026, https://unfccc.int/news/cop31-presidency-announces-new-targets-on-global-electrification-cutting-waste-resilient-cities.
[14] COP31 Presidency, "COP31 Presidency's 3rd Letter to the Parties: The Challenges before Us Are Considerable, but So Are the Opportunities" (Ankara: COP31 Presidency, 2026), 3–5, https://unfccc.int/sites/default/files/resource/cop31_3rd_presidency_letter.pdf.

UPSTREAM PRACTICE

Reuse, repair and share models are up and running but their climate benefits go uncounted

Many parts of the world run on refill, repair and second-hand markets. Higher-income countries are now rebuilding systems they once dismantled. In both cases, they are making it work without credit for their climate contributions.

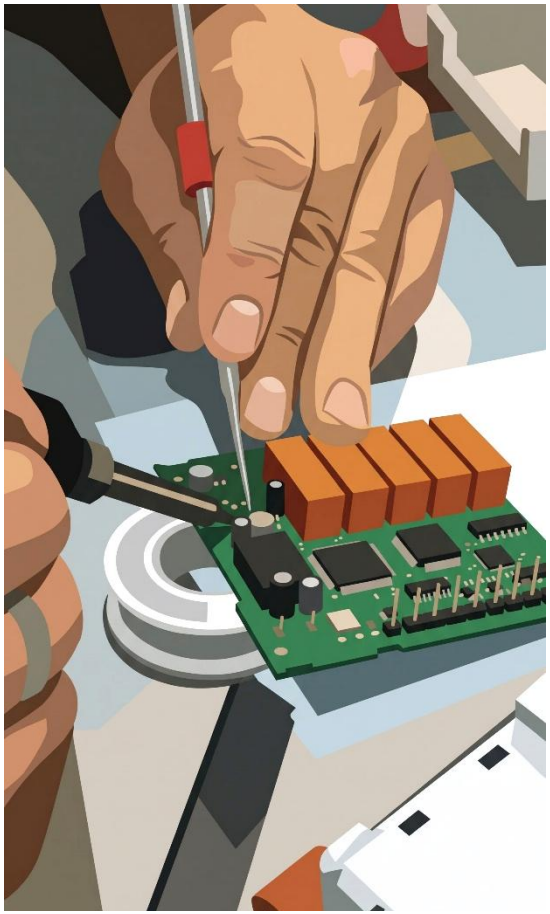
Repair of durable goods and packaging refill and container return models are ordinary commerce across much of South Asia, Africa and Latin America. Kantamanto market in Accra handles an estimated 15 million used garments a week. In Germany, pooled glass bottles average 42 refills, and CHEP circulates 348 million pooled pallets and crates globally.[15]

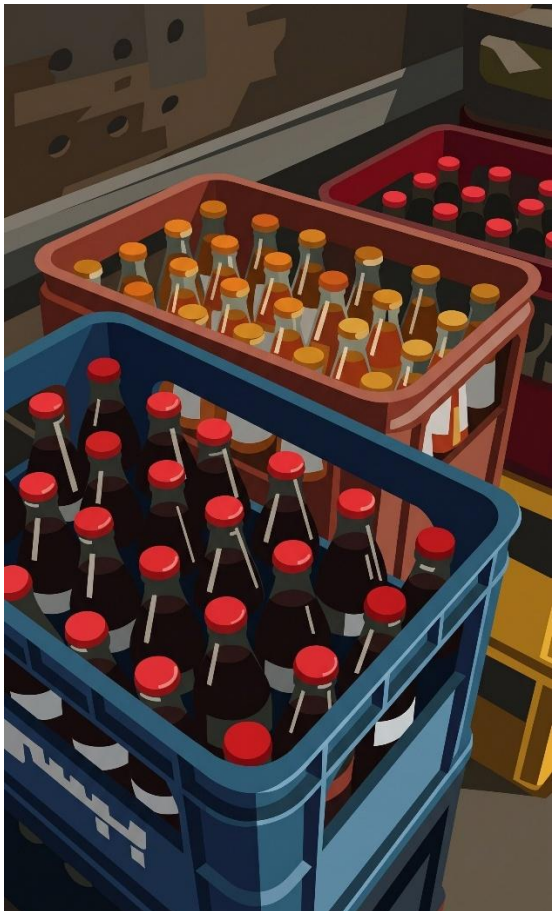
Caring for things so that they last is also a consistent foundation of indigenous economies the world over; one that predates any conceptions of a circular economy.[16]

Whatever the context, these practices give people more use from less material. Yet because their climate benefits are not counted, they rarely feature in national climate mitigation or finance plans. This means that they are left at the margins, unsupported, despite offering huge untapped potential. Were they to be recognised as climate solutions, they could be supported to grow, building a material system that works for people and planet.

What this means

The starting point is not only to invent new systems but to recognise, adapt, protect and grow those that already work.





[15] The Or Foundation, 'Stop Waste Colonialism', *Stop Waste Colonialism*, 2024, https://stopwastecolonialism.org/stop-waste-colonialism/; Deutsche Umwelthilfe (DUH), *Informationen Zum Umweltfreundlichen Deutschen Mehrwegsystem* (Mehrweg, 2014); Brambles, *Leading a Future of Connection and Illumination* (Brambles, 2025), www.brambles.com/Content/cms/FY25-Results/pdf/Brambles-FY25-Annual-Report.pdf.
[16] Ambisisi Ambituuni, 'Decolonising the Circular Economy', *Journal of Circular Economy* 4, no. 2 (2026), https://doi.org/10.55845/bg318951.

HOW TO READ THIS REPORT

Zero waste is about using less material across the economy, making climate mitigation easier, cheaper and fairer

It is not primarily about waste management. Waste is where material use becomes visible; most of the opportunity lies upstream.

HOW THE REPORT IS BUILT

Part 1 starts with municipal waste: the part of the materials economy we all deal with daily, and where the 2035 waste growth reduction target applies. Part 2 follows materials upstream to energy-intensive materials in buildings, infrastructure, vehicles and machinery, where most material GHG emissions sit, and the 2035 circular materials target applies. Part 3 looks sector by sector, with case studies focused on reuse, repair and sharing models. Part 4 adds up savings and sets out recommendations.

WHY WE COUNT MATERIAL EMISSIONS ONLY

Savings are measured against direct emissions from materials production, amounting to around a fifth of total GHG emissions. Downstream impacts of product manufacturing, transportation and use are excluded but do offer further savings if we do more with less. Industry pathways already map decarbonised production, so it is not modelled here. Keeping the two apart shows what using less adds, at today's emissions rates per tonne.

TWO LEVERS, ONE STRATEGY

Using less and decarbonising production strengthen one another. Reducing production shrinks the clean power, hydrogen and carbon capture that must be built. Cleaner materials have a higher value, which incentivises keeping them in use. The emissions savings overlap and cannot simply be added, but together form the strategy the world needs.

What this means

Interpret the numbers as what using less adds to decarbonising production, not an alternative to it. Countries that consume most can cut most while others build once and build well, so the transition is fairer as well as cheaper.

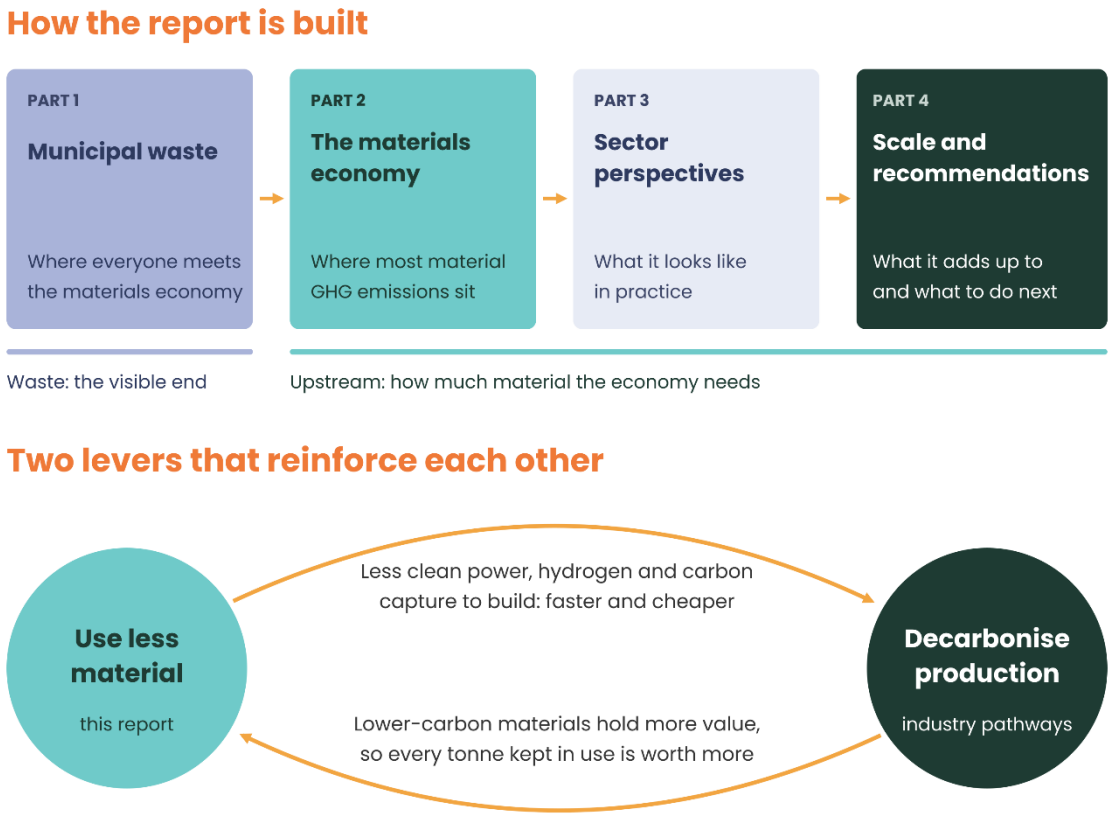


Figure 2: How the report is built, and how using less material and decarbonising production reinforce each other

Part 1: Municipal waste

Where everyone interacts with the material economy



Municipal waste is where everyone interacts with the material economy every day, and it is still growing

Nearly every product we buy ends up here. Municipal waste is the visible end of a chain that starts with extraction and manufacturing.

4.1 billion tonnes

of municipal waste generated in 2050 on current trends

Municipal waste is the part of the material system that every household, shop and office deals with every day. What we throw away reflects what we buy, and what we buy drives the extraction and manufacturing upstream. It is the essential starting point from which to build zero waste thinking.

Eunomia's global municipal waste model estimates that 2.8 billion tonnes were generated in 2025. On current trends, this rises to about 4.1 billion tonnes by 2050, an increase of almost half.[17] Many cities in Africa and South Asia could see their waste double every 15 to 20 years.[18] This result is mirrored by other studies, including the World Bank's What a Waste 3.0.[19] UNEP's Global Waste Management Outlook 2024 projects a comparable increase of 56%, from 2.1 billion tonnes in 2020 to 3.8 billion tonnes by 2050.[20]

What this means

Because municipal waste mirrors consumption, it is also where the benefits of reuse, repair and sharing become visible to everyone.

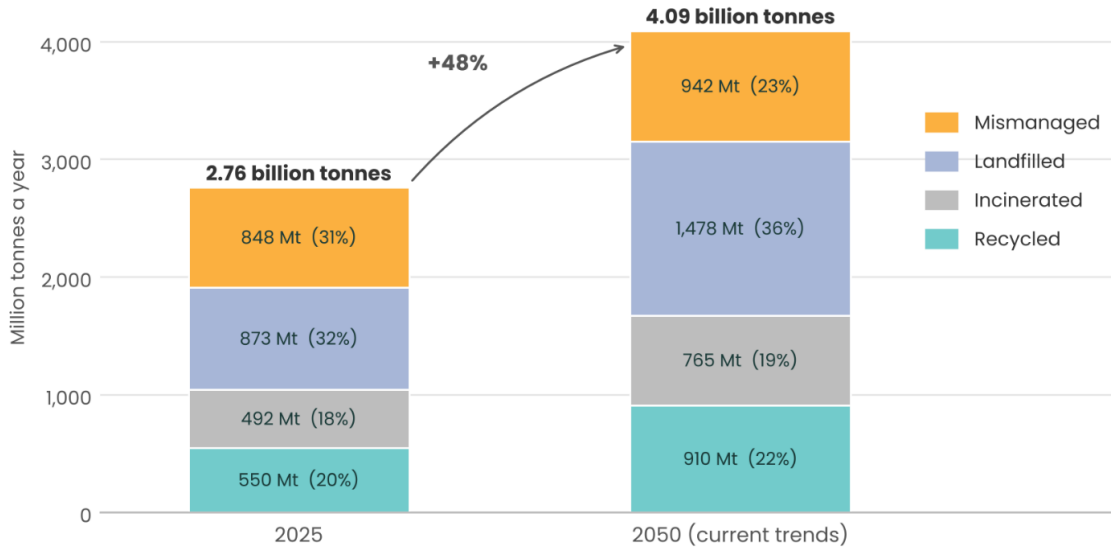


Figure 3: Municipal waste generated by destination, 2025 and 2050 on current trends (million tonnes)
Source: Eunomia global municipal waste model, SSP2 baseline, final destinations. Mismanaged covers waste that is uncollected, dumped at uncontrol sites, burned in the open or released to water. Landfilled covers sanitary and controlled landfill. Recycled includes reuse, composting and anaerobic digestion. For comparison, see UNEP Global Waste Management Outlook 2024 and World Bank What a Waste 3.0.

[17] Eunomia Research & Consulting, global municipal solid waste material flow model (SSP2), preliminary outputs, October 2026.
[18] Wilson et al., "Unlocking the Significant Worldwide Potential," 7.
[19] Ed Cook et al., *What a Waste 3.0: Global Snapshot of Solid Waste Management Toward Circularity until 2050* (World Bank, 2026), https://doi.org/10.1596/978-1-4648-2309-1.
[20] United Nations Environment Programme and International Solid Waste Association, *Global Waste Management Outlook 2024: Beyond an Age of Waste – Turning Rubbish into a Resource* (Nairobi: UNEP, 2024), 18, https://doi.org/10.59117/20.500.11822/44939.

Sound waste management is a fast win for climate and health

Nearly a third of the world's municipal waste ends up dumped or openly burned. Bringing it under control quickly cuts methane, black carbon and other emissions, and gives people a cleaner, healthier place to live.

31%

of municipal waste is dumped, openly burned or lost to water[21]

In 2025, 845 million tonnes of municipal waste were dumped, openly burned or lost to water, and 2.7 billion people had no regular waste collection.[22] Sound waste management for all means finding safer ways to manage waste, allowing people to live a more dignified life with less exposure to toxic chemicals.[23]

Change can be fast. Organic waste in landfills, dumps and wastewater produces about a fifth of human-caused methane, but UK landfill fell from 9.3% of national emissions in 1995 to 3.2% in 2021. [24,25]

From a climate perspective, separate collection of food waste, working in tandem with informal recyclers, is crucial or else methane from new landfills will rise. The UN Secretary-General's Call to Action on Methane makes the same case, calling for open dumping and uncontrolled landfills to be phased out and for circular, low-methane urban waste systems by 2030.[26]

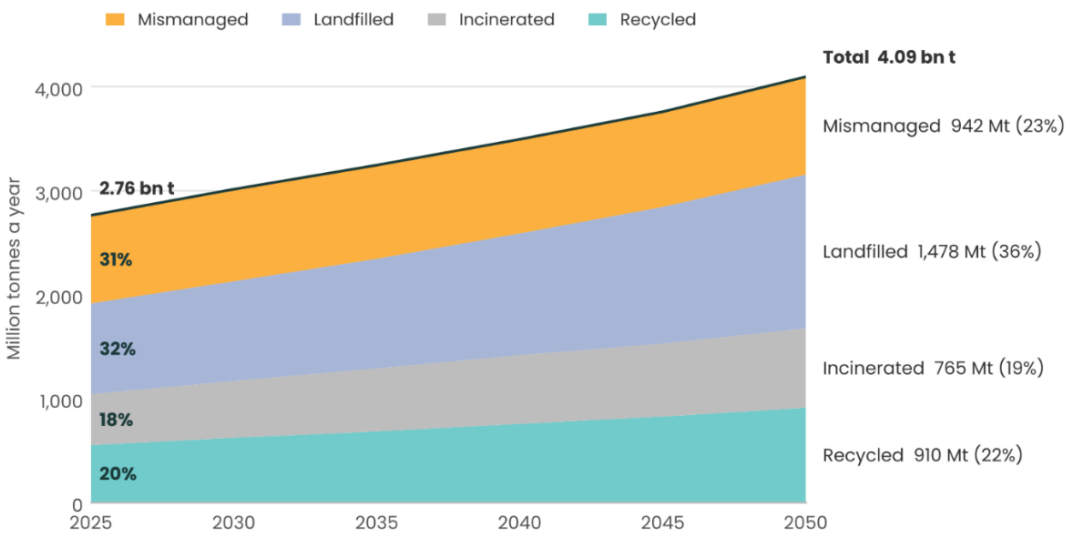


Figure 4: Municipal waste by destination on current trends, 2025–2050 (million tonnes a year)
Source: Eunomia global municipal waste model. Recycled includes reuse, composting and anaerobic digestion. The dashed line shows waste generated on current trends. For comparison, UNEP and ISWA estimate that 38% of municipal solid waste was uncontrolled (dumped or openly burned) in 2020.

What this means

Everyone has a right to a clean, healthy and sustainable environment, recognised by the UN General Assembly in 2022.[27] Sound waste management for all helps deliver that, along with some of the quickest climate gains available.

[21] Eunomia global municipal waste model, 2025. For comparison, UNEP and ISWA estimate that 38% of municipal solid waste was uncontrolled in 2020: UNEP and ISWA, *Global Waste Management Outlook 2024*, 21.
[22] Wilson et al., "Unlocking the Significant Worldwide Potential," 7. UNEP and ISWA, *Global Waste Management Outlook 2024*, 23.
[23] Institute of Development Studies et al., *No Time to Waste: Tackling the Plastic Pollution Crisis before It's Too Late* (Tearfund, 2019), 5, https://www.ids.ac.uk/publications/no-time-to-waste-tackling-the-plastic-pollution-crisis-before-its-too-late/.
[24] UNEP and ISWA, Global Waste Management Outlook 2024, 44.
[25] Wilson et al., "Unlocking the Significant Worldwide Potential," 2, 5, table 1.
[26] United Nations, *The Secretary-General's Call to Action on Methane: Three Sectors, Nine Actions by 2030* (New York: United Nations, 2026), https://www.un.org/en/climatechange/methane.
[27] United Nations General Assembly, *The Human Right to a Clean, Healthy and Sustainable Environment*, A/RES/76/300 (28 July 2022), https://undocs.org/A/RES/76/300.

Reduction and reuse could cut emissions linked to municipal waste by 44% by 2050

The model tests better waste management, and products kept in use for longer, reused and shared rather than thrown away.

THE SCENARIOS

A baseline on current trends (SSP2) and three scenarios: better waste management; reduction and reuse across food and organic waste, packaging, textiles, electronics, furniture and other products, based on the evidence for each; and the two combined.[28]

WHAT THE MODEL SHOWS

On current trends, net emissions linked to municipal waste rise from 4.9 $GtCO_2e$ in 2025 to 7.2 Gt in 2050. In the combined scenario, they peak around 2030 and fall to 4 Gt by 2050, 44% below the baseline and below today's level.[29]

Better waste management contributes about 1.1 Gt a year by 2050, and reduction and reuse deliver most of the saving, a further 2.1 Gt. Over 2025 to 2050 this **cumulatively adds up to more than 37 $GtCO_2e$ avoided in total.**

What this means

Better waste management lays the foundation. The larger climate gain comes from needing fewer new products in the first place through waste prevention, design for durability, reuse, repair and sharing.

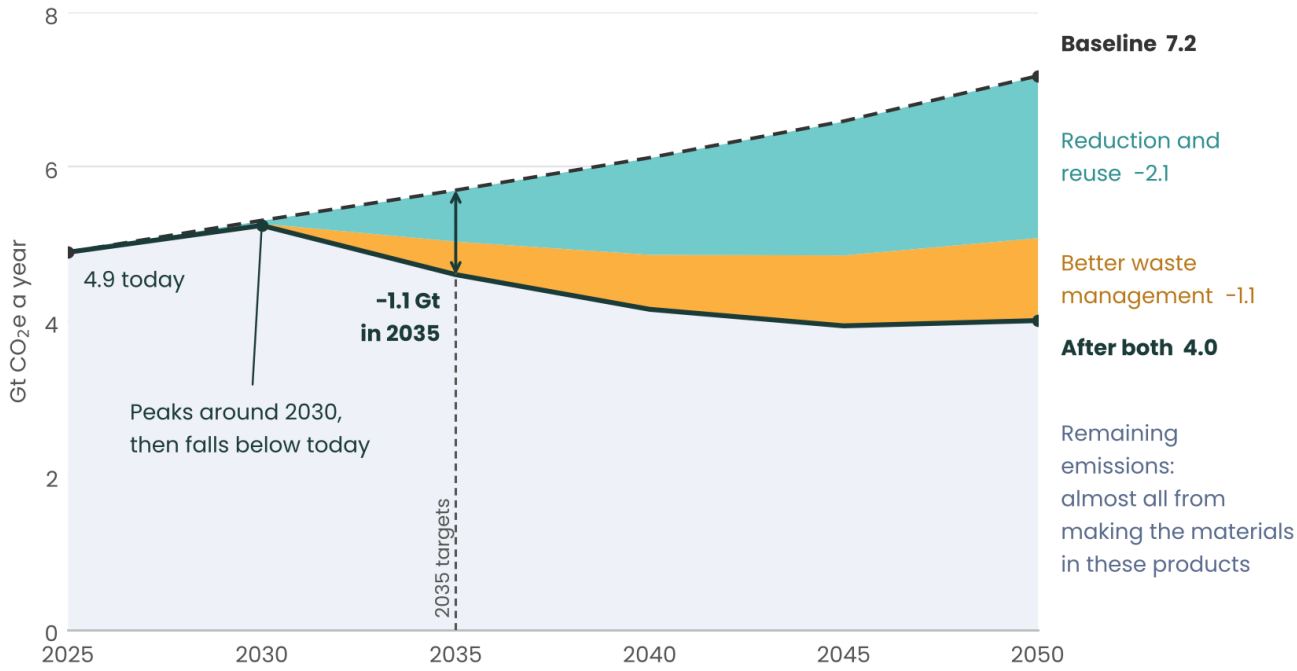


Figure 5: Net emissions linked to municipal waste, 2025–2050 ($GtCO_2e$ a year)

Source: Eunomia global municipal waste model using 2025 as baseline year. Covers making the products that become waste and managing them, net of avoided emissions. Wedges show better waste management, then reduction and reuse on top of it.

[28] Eunomia, reuse and reduction matrix for the COP31 material flow model, internal working document, October 2026.
[29] Eunomia Research & Consulting, global municipal solid waste material flow model (SSP2), preliminary emissions outputs, November 2026.

WHERE THE EMISSIONS ARISE

Most emissions linked to municipal waste come from making products, and almost half of that is food

About 70% arises before anything is thrown away. Better waste management cannot reach this share; wasting less food and keeping products in use can.

70%

of gross emissions linked to municipal waste come from making the products, before they are thrown away

In 2025, making the products that become municipal waste emitted about 4.0 $GtCO_2e$, compared to 1.7 $GtCO_2e$ emitted from collection, treatment, and disposal (with 0.8 $GtCO_2e$ of that offset by recycling, composting and energy recovery replacing new materials and energy).[30]

Better waste management works mainly on the smaller share. By 2050, it raises the offset from recovered materials to 1.2 $GtCO_2e$ but leaves production emissions unchanged. These can be tackled by reduction and reuse, which could cut production emissions from 5.9 to 3.5 $GtCO_2e$ a year by 2050.

Extending collection also moves waste from dumps into landfill, where methane rises unless food waste is collected separately and landfill gas is captured.

What this means

The largest climate gain opportunities from municipal waste come before anything is thrown away, from wasting less in the first place.

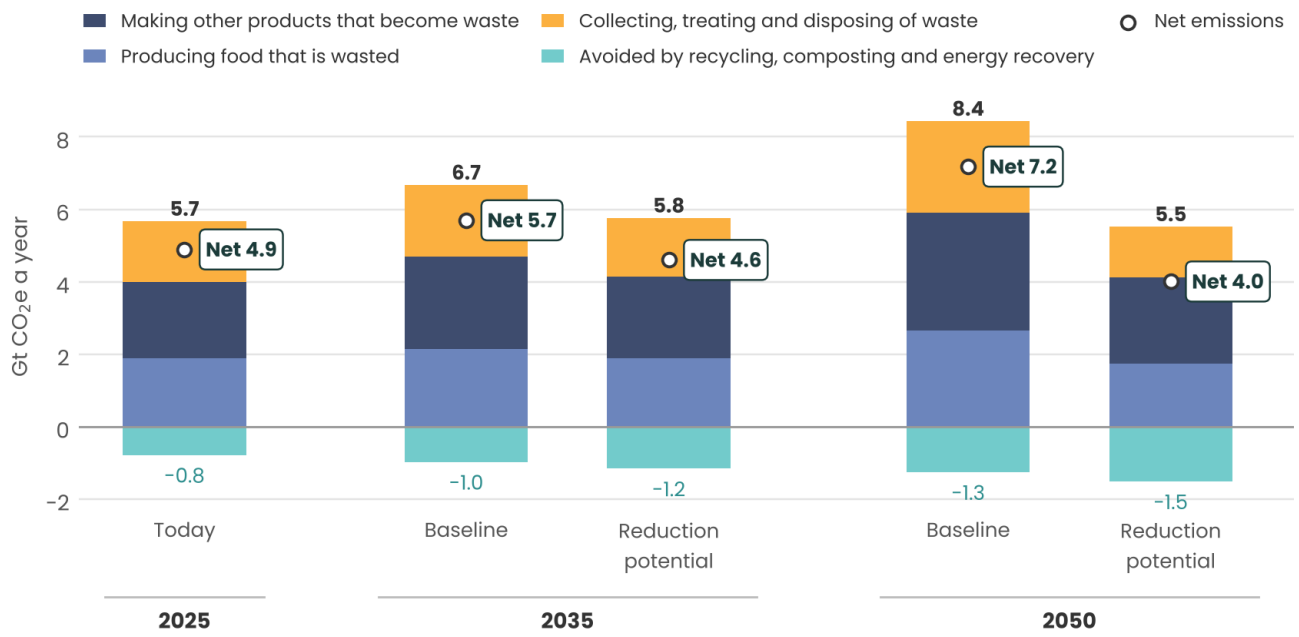


Figure 6: Emissions linked to municipal waste by source, 2025, 2035 and 2050 ($GtCO_2e$ a year)

Source: Eunomia global municipal waste model, Avoided emissions come from recycling, composting and energy recovery replacing new materials and energy.

[30] Eunomia Research & Consulting, global municipal solid waste material flow model (SSP2), preliminary emissions outputs, November 2026.

COMMON BUT DIFFERENTIATED RESPONSIBILITIES

Countries that consume most can change most, while others build once and build well

Material use per person varies many times over between countries. A just transition means convergence, not uniform cuts.

The IPCC places *"sustainable consumption by intensive use of longer-lived repairable products"* within a wider system of circular material flows and reduced material consumption.[31] But high-income countries (per person) use six times more materials, and produce three times more municipal waste, than low-income countries.[32]

With better waste management, reduction and reuse, waste per person falls by about 40% in high-income countries by 2050 and by about 15% in upper-middle-income countries, while it still grows in lower-income countries as they develop. The gap between high- and low-income countries narrows from threefold to about 1.5-fold.

Scaling reuse, repair and share models lets higher-income countries cut material use while keeping, or improving, the products and services people rely on. It allows lower-income countries to expand access to material prosperity whilst bypassing the wasteful path taken by industrialised nations and staying within planetary boundaries. Where homes, infrastructure and waste systems are still being built, the opportunity is to build them to last. This means protecting and enhancing the reuse and repair economies that already exist and bringing these ideas into the heart of economic development and investment strategy.

What this means

Convergence in prosperity is compatible with lower material use, if the countries that consume most change most, and material inequality is addressed in lower-consuming economies by learning history's lessons of inefficient and wasteful growth.

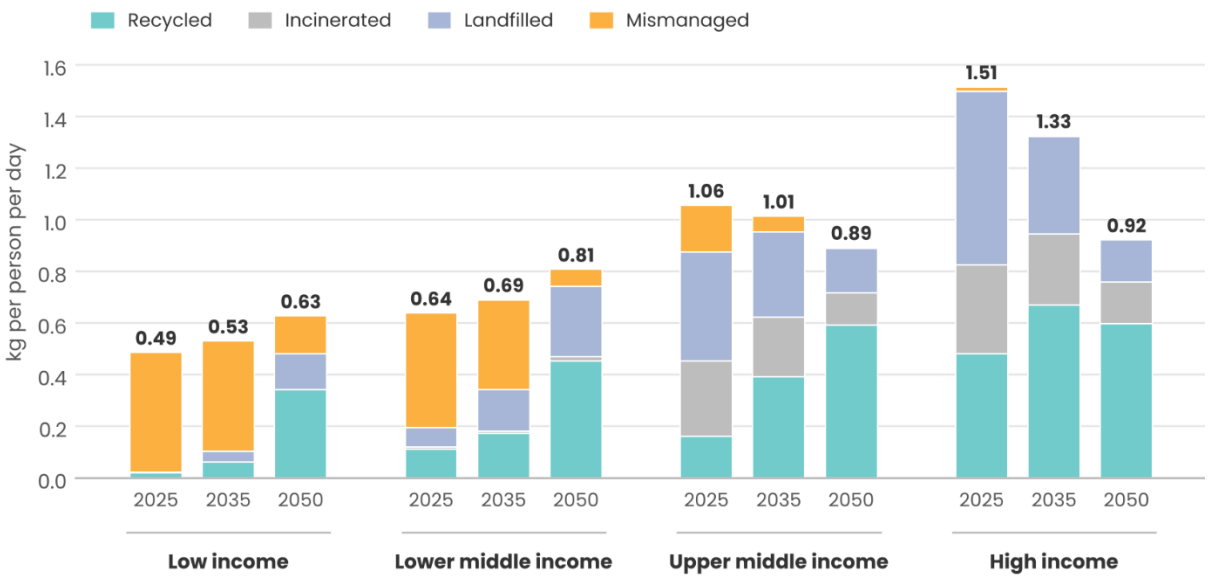


Figure 7: Municipal waste generated per person by income group and destination, 2025 and with better waste management, reduction and reuse in 2035 and 2050 (kg per person per day)

Source: Eunomia global municipal waste model, combined scenario. Countries are grouped by their 2025 income level. Reduction rates for middle-income countries are rebalanced in proportion to waste per person in 2025. Recycled includes reuse, composting and anaerobic digestion; landfilled covers sanitary landfill and controlled disposal; mismanaged covers dumpsites, informal dumping, open burning and aquatic dumping.

[31] IPCC, Climate Change 2023: Synthesis Report. Summary for Policymakers (Geneva: IPCC, 2023), 29.
[32] UNEP International Resource Panel, Global Resources Outlook 2024.

What we throw away is the tip of the iceberg

Municipal waste is a necessary starting point for transforming our material economy. Behind it sit far larger flows of steel, cement and other materials in buildings, vehicles and infrastructure.

25x

more opportunity for tackling steel and aluminium by looking beyond the metals collected in municipal waste.

For paper, glass and plastics, most of the world output will pass through municipal waste.[33] That means that applying upstream and end-of-pipe interventions to municipal waste can tackle most of the emissions associated with these materials.

However, the opposite is true for metals and concrete. For example, around 83 Mt of metal is collected in municipal waste, out of about 1,975 Mt of steel and aluminium made each year.[34]

Reuse, repair and share models can save about 2.5 $GtCO_2e$ annually for municipal waste by 2050; the same levers applied to the rest of the economy could do far more. About 15–21% of material production emissions sit in products that become municipal waste; but the rest lies upstream.

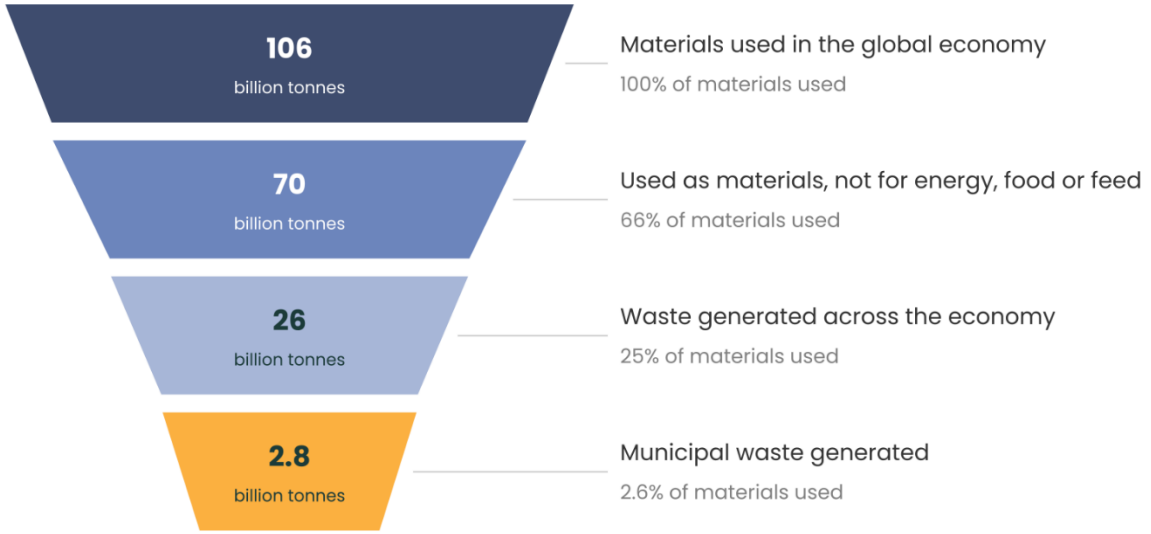


Figure 8: Global material flows, from materials used to municipal waste recycled (billion tonnes a year)

Sources: materials used, materials used as materials, and waste generated: Circle Economy (data year 2021) Municipal waste generated: Eunomia global municipal waste model (2025). Years differ. Waste generated covers municipal, industrial, construction and demolition and other waste, including liquid waste and estimates of unreported waste such as manure, at wet weight. Percentages are shares of materials used.

What this means

The same levers that work for municipal waste, applied to buildings, vehicles and infrastructure, reach the largest share of material emissions.

[33] Food and Agriculture Organization of the United Nations, Global Forest Products Facts and Figures 2023 (Rome: FAO, 2024); Corine D. Westbroek, Jennifer Bitting, Matteo Craglia, José M. C. Azevedo, and Jonathan M. Cullen, "Global Material Flow Analysis of Glass: From Raw Materials to End of Life," Journal of Industrial Ecology 25, no. 2 (2021): 333, https://doi.org/10.1111/jiec.13112; OECD, Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options (Paris: OECD Publishing, 2022), 35, https://doi.org/10.1787/de747aef-en.

[34] Mission Possible Partnership, Making Net-Zero Steel Possible: An Industry-Backed, 1.5°C-Aligned Transition Strategy (Mission Possible Partnership, September 2022), 14; Mission Possible Partnership, Making 1.5°C-Aligned Aluminium Possible: An Industry-Backed, 1.5°C-Aligned Transition Strategy (Mission Possible Partnership, April 2023); Mission Possible Partnership, Making Net-Zero Concrete and Cement Possible: An Industry-Backed, 1.5°C-Aligned Transition Strategy (Mission Possible Partnership, 2023)

Part 2: The global materials picture

Material emissions beyond waste management.



MATERIAL EMISSIONS OVER TIME

GHG emissions from making materials more than doubled in twenty years, with demand still rising rapidly

Investment in buildings, infrastructure and machinery drove the increase, and business-as-usual demand keeps rising to 2050.

+120%

rise in GHG emissions from making materials, 1995 to 2015

GHG emissions from producing materials rose from about 5 $GtCO_2e$ in 1995 to 11 $GtCO_2e$ in 2015, lifting their share of global emissions from 15% to 23%. China's rapid economic transition accounted for three-quarters of the growth, and building new capital stock or replacing old stock now drives 60% of material-related emissions.[35]

Steel and cement account for more than half of these emissions. On current trends, demand for steel rises by about a third by 2050, cement by almost half and aluminium by four-fifths, while primary plastics more than triples at 4% a year growth.[36]

What this means

Decarbonising production is essential but not enough on its own. How much material we need, and how long it stays in use, are crucial climate levers in their own right.

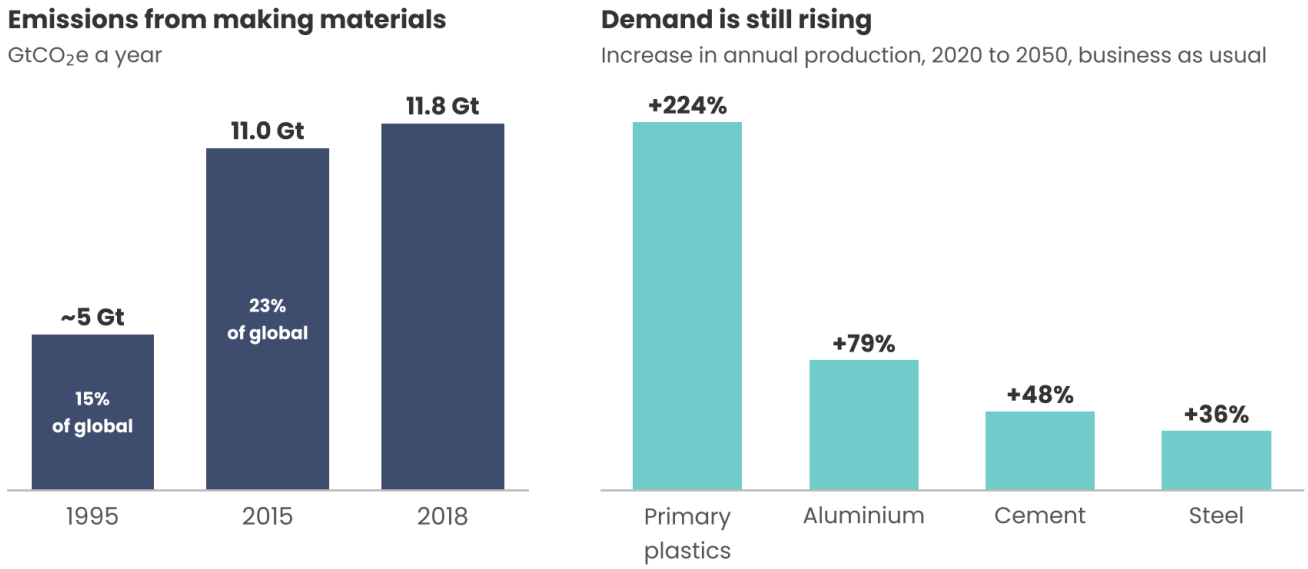


Figure **9**: GHG Emissions from material production, 1995–2015, and business-as-usual growth in demand, 2020–2050

Sources: Hertwich (2021); IPCC AR6 WGIII (2018 update); Mission Possible Partnership steel, aluminium and cement reports; Eunomia (2022) and LBNL (2024) for plastics.

[35] Hertwich, "Increased Carbon Footprint," 151.

[36] Mission Possible Partnership, Making Net-Zero Steel Possible, 14, 34; Mission Possible Partnership, Making 1.5°C-Aligned Aluminium Possible, 15; Mission Possible Partnership, Making Net-Zero Concrete and Cement Possible, 29; Nihan Karali, Nina Khanna, and Nihar Shah, Climate Impact of Primary Plastic Production, LBNL-2001585 (Berkeley: Lawrence Berkeley National Laboratory, 2024), 57. Plastics demand grows at 4% a year from 2020, the business-as-usual rate in Eunomia Research & Consulting, Is Net Zero Enough for the Material Production Sector? (Bristol: Eunomia, 2022), 22–24, and the higher of the two cases in the LBNL report. The 224% increase is calculated by compounding that rate over 2020 to 2050; the lower LBNL case of 2.5% a year gives about 110%.

Decarbonising material production is key, but not enough

On today's path, four materials alone would emit more than twice the remaining 1.5°C budget by 2050. Decarbonising production could cut that by half, saving 172 $GtCO_2e$, but this vast undertaking still falls short.

172 $GtCO_2e$

difference between today's path and decarbonised production of four materials, 2020–2050

Business as usual for the four materials adds up to 348 $GtCO_2e$ to 2050.[37] Decarbonising production based on industry pathways brings steel to 47 $GtCO_2e$, cement to 58 $GtCO_2e$ and aluminium to 19 $GtCO_2e$, excluding their measures to use less material.[38] For plastics, Eunomia's own estimated pathway (low-carbon production, recycling, bio-based feedstock and carbon capture) brings 129 $GtCO_2e$ down to 52 $GtCO_2e$.[39]

Near-zero steel alone could need up to 6,700 TWh of clean electricity and 75 Mt of hydrogen a year by 2050, and cement relies on carbon capture at almost every kiln globally. Using less avoids part of that build-out.[40]

What this means

Decarbonising production is essential but takes time, is costly and still falls short. Getting more use out of less material makes the task smaller, cheaper and faster.

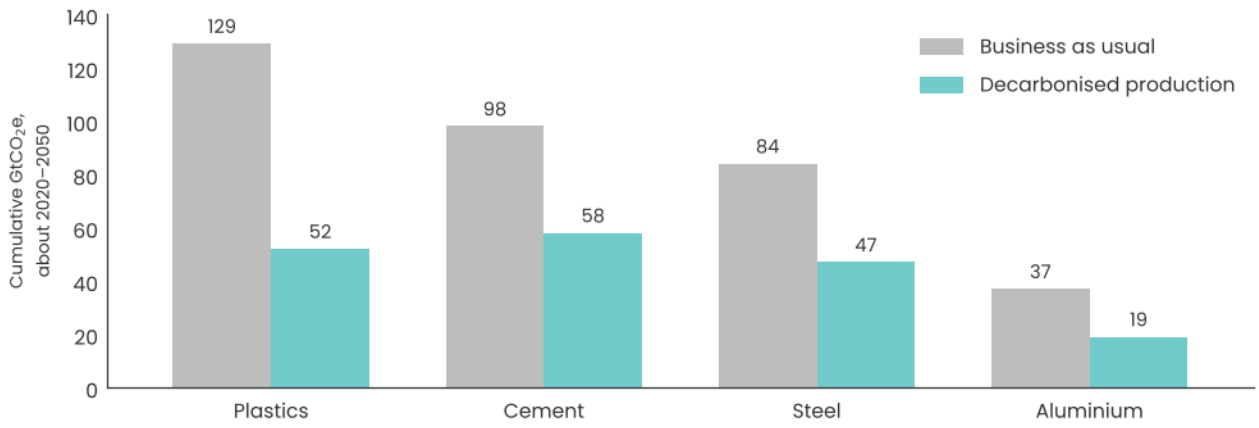


Figure 10: Cumulative emissions 2020–2050, business as usual against decarbonised production ($GtCO_2e$)

Source: Mission Possible Partnership steel, aluminium and cement reports; Eunomia (2022) for plastics, life-cycle emissions. Cement and aluminium exclude the pathways' demand-side measures (11 Gt and 4 Gt); steel and aluminium include scrap-based recycling.

WHY THE CARBON BUDGET HAS SHRUNK

The remaining 1.5°C carbon budget was about 500 $GtCO_2$ at the start of 2020, according to the IPCC, or 400 $GtCO_2$ for a 67% chance of staying below the threshold. By the start of 2025, it had fallen to around 130 $GtCO_2$.[41] Most of the decline reflects five years of emissions, with updated estimates of warming from methane, other greenhouse gases and declining air pollution accounting for the rest. At current emissions rates, the budget will be exhausted around 2028, making an overshoot of 1.5°C all but inevitable. **Even with overshoot, every tonne of steel, cement, aluminium or plastic *not produced* reduces how far, and for how long, warming exceeds 1.5°C.**

[37] Mission Possible Partnership, Making Net-Zero Steel Possible, 30.
38 Mission Possible Partnership, Making Net-Zero Concrete and Cement Possible, 13.
39 Eunomia Research & Consulting, Is Net Zero Enough for the Material Production Sector? (Bristol: Eunomia, 2022), 22–24. Life-cycle emissions, demand growing 4% a year.
[40] Mission Possible Partnership, Making Net-Zero Steel Possible, 18, 20; Making Net-Zero Concrete and Cement Possible, 13, 63; Making 1.5°C-Aligned Aluminium Possible, 42.
[41] IPCC, "Summary for Policymakers," in Climate Change 2021: The Physical Science Basis (Cambridge: Cambridge University Press, 2021), 29; Piers M. Forster et al., "Indicators of Global Climate Change 2024," Earth System Science Data 17 (2025): 2641.

WHERE MATERIAL EMISSIONS GO

Three quarters of material emissions go to things built to last

Buildings, infrastructure, vehicles and machinery are where longer use and longer life matter most.

77%

of material emissions go first to construction or to machinery, vehicles and other durables

Construction takes 42% of material emissions, and machinery, vehicles, metal products and electronics another 35%. The formation and replacement of capital stock accounts for 60% of material-related emissions, and 94% of cement emissions go to construction.[42]

These capital goods stay in use for decades. That makes their design, specification and lifetime the decisions that matter most for climate.

And where their emissions occur is shifting. On current trends, emissions from building materials rise from 3.5 to 4.6 Gt a year by 2060, and the share from low- and lower-middle-income regions from 22% to 51%.[43]

What this means

For long-lived goods, zero waste means making them last, using them more intensively, and designing them to be repaired, adapted and reused.

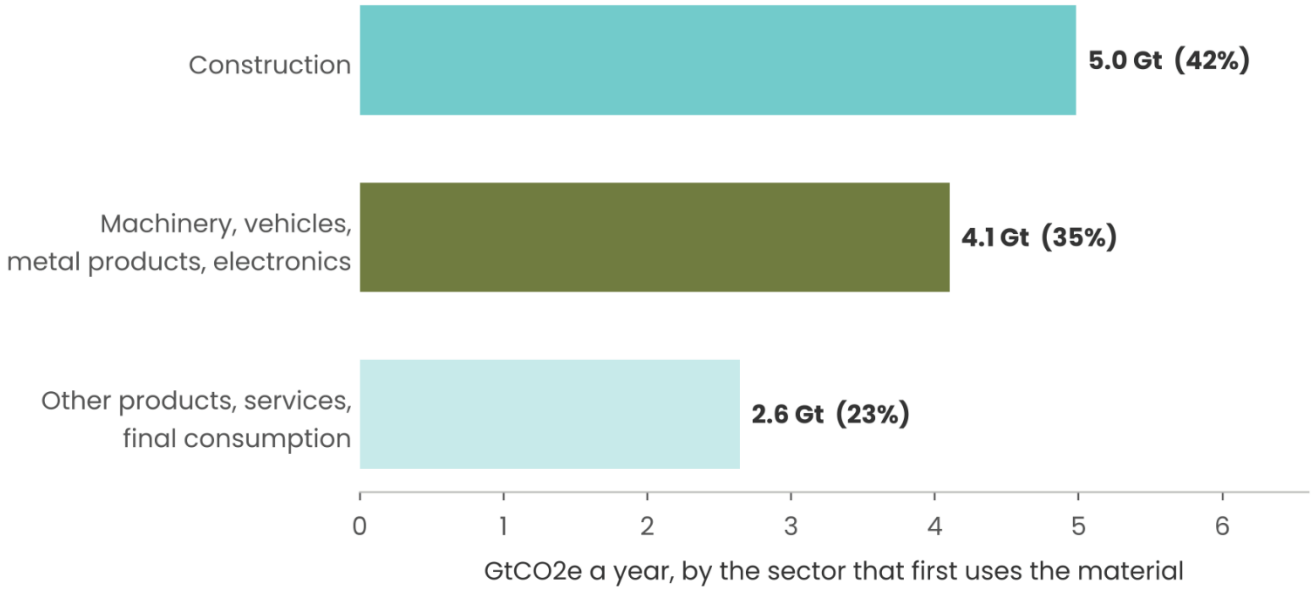


Figure 11: Material production GHG emissions by the sector the material goes into (for example, construction for cement) ($GtCO_2e$ a year)
Source: Eunomia analysis of Hertwich (2021) table 1b, scaled to 11.8 $GtCO_2e$.

[42]Hertwich, "Increased Carbon Footprint," 151–53, table 1b.
[43] Xiaoyang Zhong, Mingming Hu, Sebastiaan Deetman, et al., "Global Greenhouse Gas Emissions from Residential and Commercial Building Materials and Mitigation Strategies to 2060," Nature Communications 12 (2021): 6126, 1, https://doi.org/10.1038/s41467-021-26212-z.

USING LESS

Using materials better is the biggest lever of all

Longer-lived, lighter and better-used buildings and vehicles could save tens of gigatonnes by 2050.

56–112 $GtCO_2e$

saved to 2050 by using materials better in all durable goods

Getting more use from the materials already in circulation could avoid 20-52 $GtCO_2e$ in housing and 13-26 $GtCO_2e$ in cars by 2050.[44] Applied across all durable goods, the potential rises to 56-112 $GtCO_2e$ (see Appendix). The opportunities are straightforward: make products and buildings last longer, use them more intensively, design them with less material, and reuse what already exists.

Industry studies point in the same direction. A high-circularity steel pathway avoids around 19 $GtCO_2e$, while more efficient use of concrete delivers 22% of the cement sector's emissions savings.[45]

Real-world examples illustrate the scale. In one Danish study, demolishing and rebuilding a structure used 19 times more material than deep renovation. Shared mobility could provide Lisbon's daily travel needs with just 3% of today's car fleet, while doubling the number of times clothing is worn could reduce emissions from the sector by around 44%.[46]

What this means

These levers build on the 2035 targets and reach the materials with the largest emissions. Most of them also make homes, travel and goods more affordable.

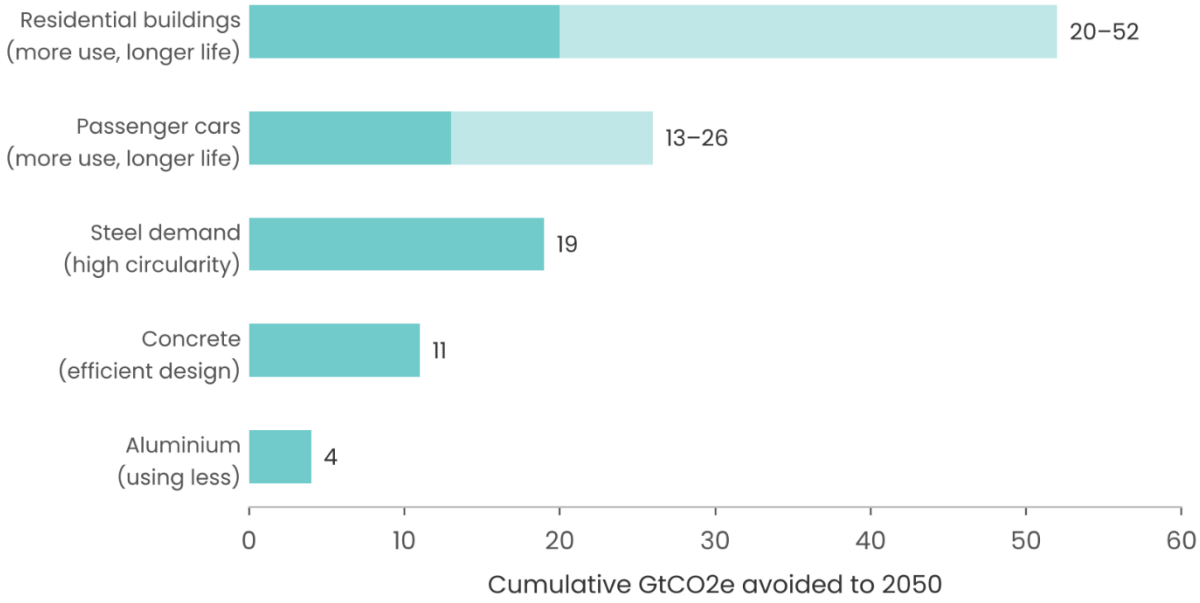


Figure 12: Cumulative GHG emissions avoided to 2050 by measure ($GtCO_2e$)

Source: Pauliuk et al. (2021); Mission Possible Partnership; Eunomia analysis.

44Pauliuk et al., "Global Scenarios of Resource and Emission Savings," 1.
45Mission Possible Partnership, Making Net-Zero Steel Possible, 33–34.
46 Shape Foundation, "Four Futures."

Half of municipal waste is food and green waste, and little of it returns to the soil

Preventing food waste and composting or digesting the rest cuts methane quickly, eases pressure on land and rebuilds soils.

49%

of municipal waste, on average, is food and garden waste; 14% of it is composted or digested

In 2025, around 1.35 billion tonnes of food and garden waste were generated, but only 185 Mt was composted or treated through anaerobic digestion.[47] Much of the rest was landfilled or dumped, where it produced methane.

With better prevention, collection and treatment, food and green waste in 2050 could fall to 1.2 billion tonnes (1.9 billion under business as usual), while composting and anaerobic digestion could rise to 550 Mt.

Renewable biomass accounts for around one-fifth of the materials entering the economy.[48] Keeping it regenerative means returning nutrients and carbon to soils rather being lost as waste. Across the food system, circular approaches could reduce emissions by 5.6 $GtCO_2e$ a year by 2050, most of which is excluded from our overall analysis.[49]

What this means

Preventing food waste, collecting it separately and composting or digesting the rest closes the biological loop, cutting methane, improving soil health and reducing pressure on land.

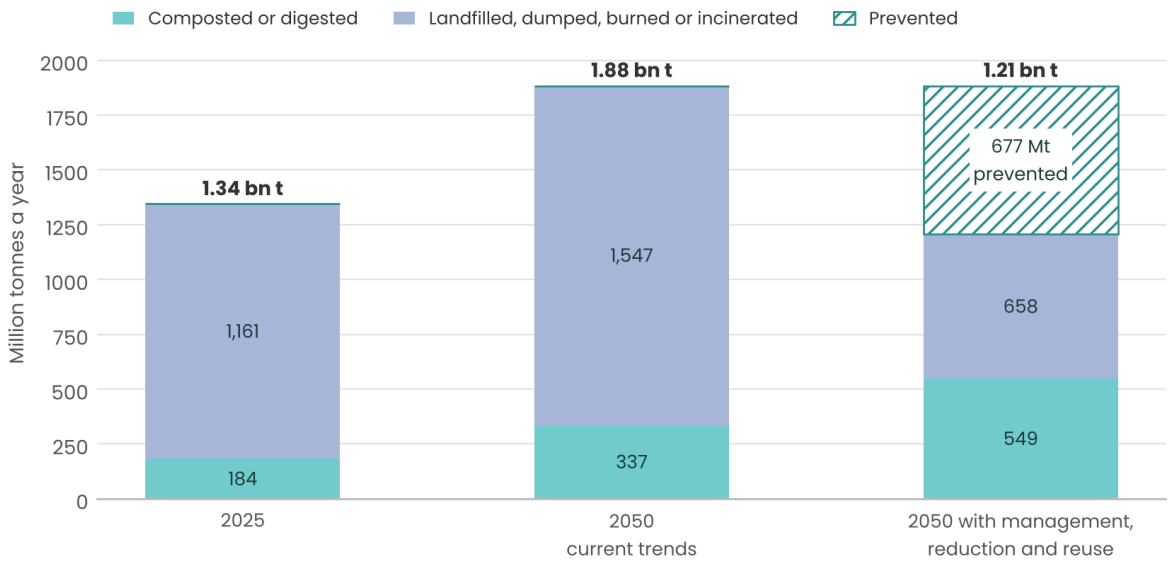


Figure 13: Food and green waste by fate, 2025 and 2050 (million tonnes)

Source: Eunomia global municipal waste model. The 2050 scenario combines better waste management with reduction and reuse.

[47] Eunomia global municipal waste model, 2025. For comparison, the World Bank puts food and garden waste at 38% of municipal solid waste globally: Cook et al., *What a Waste 3.0*.
[48] Circle Economy, The Circularity Gap Report 2025 (Amsterdam: Circle Economy, 2025), 24.
[49] Ellen MacArthur Foundation, Completing the Picture: How the Circular Economy Tackles Climate Change (Cowes: Ellen MacArthur Foundation, 2019), 37.

Keeping materials in use keeps value in the economy

The linear economy loses an estimated €25.4 trillion a year, close to a third of global GDP.

Near-zero steel would add about 0.5% to the price of a car and 2.1% to the cost of a building in 2030, and near-zero concrete 1.5–3% of building cost[50] — cheap per product but requiring a vast build-out of energy and infrastructure.

More durable products reduce the need for new extraction and reduce decarbonisation infrastructure needs.

Reuse, repair and sharing shift spending from new materials towards local services, maintenance and logistics.

Circle Economy and Deloitte estimate that the linear economy loses €25.4 trillion of value a year, about 31% of global GDP. The biggest losses come from products and materials thrown away while they still have value (€10.0 trillion) and energy wasted between extraction and use (€8.7 trillion). Buildings, infrastructure and machinery wearing out faster than necessary account for another €5.2 trillion.[51]

These losses reach households. Food lost or wasted is worth about €650 billion a year, and homes sit under-used despite housing shortages.[52] The figures highlight the value at stake, though capturing it would require investment in repair, reuse and collection systems.

What this means

Keeping materials and products in use is a cost-of-living policy as well as a climate one: the same services from less material, less spent on replacement and more value kept in local economies.

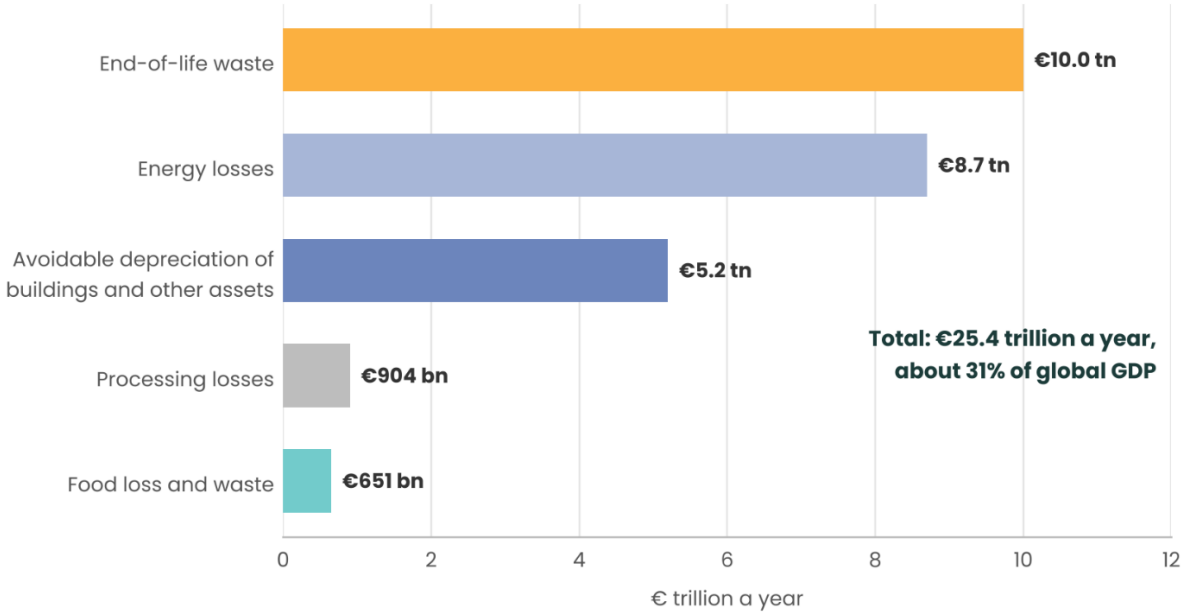


Figure 14: Annual value lost to linear material use, by pathway (€ trillion)

Source: Circle Economy and Deloitte, The Circularity Gap Report 2026. Indicative upper-bound estimates, not net of transition costs.

[50] Mission Possible Partnership, Making Net-Zero Steel Possible, 58; Mission Possible Partnership, Making Net-Zero Concrete and Cement Possible, 24.
[51] Circle Economy and Deloitte, The Circularity Gap Report 2026: The Value Gap (Amsterdam: Circle Economy, 2026), 6–7, 19–23, 26.
[52] Circle Economy and Deloitte, The Value Gap, 10, 21.

Part 3: Sector perspectives

What a zero waste world looks like in practice



FOOD

Wasting less food is the fastest climate win in municipal waste

49%

of collected municipal waste is food, organic and garden waste[53]

WHAT IT LOOKS LIKE

Less food lost and wasted from farm to plate, surplus redistributed, and what remains collected separately for composting or anaerobic digestion. Around 1.05 billion tonnes of food were wasted in 2022, 19% of the food available to consumers. Together with food lost earlier in the supply chain, this generates 10% of global GHG emissions.[54]

WHAT IT MEANS FOR PEOPLE

Lower food bills, higher farm incomes, better food security more adapted to climate change, and cleaner air and water around disposal sites.

IN PRACTICE

In Nigeria, ColdHubs puts 100% solar-powered walk-in cold rooms in farm clusters, produce aggregation centres and outdoor markets. Farmers rent crate space on a pay-as-you-store basis instead of buying equipment. The cold rooms extend the shelf life of perishables from two to 21 days, giving farmers, retailers, and wholesalers more time to sell produce at a higher price. By 2024, ColdHubs was serving over 11,100 farmers, retailers and wholesalers using 58 installed cold rooms and 10 refrigerated trucks and had created over 100 new jobs for women as managers of the hubs. By eliminating previous spoilage, the users in this supply chain have seen their average monthly incomes double.[55]

In UK, WRAP runs a voluntary agreement that brings businesses, government and NGOs together to halve UK food waste by 2030. The method is “Target, Measure, Act.” In 2024, 59% of participating businesses were reducing food waste against their baseline year, and some cut it by 40%. WRAP is exporting the model through a Food Pact Network, including South Africa’s Food Loss and Waste Voluntary Agreement.[56]

WHAT IT NEEDS

Separate collection of food waste, landfill diversion, prevention targets backed by measurement and public reporting, pricing signals that reward prevention such as pay-as-you-throw, finance and innovation for decentralised food preservation chains, capacity building and support for farmers to reduce food loss.



[53] Eunomia, municipal solid waste flow model. For comparison, the World Bank puts food and garden waste at 38% of municipal solid waste globally: Cook et al., *What a Waste 3.0*.
[54] United Nations Environment Programme, Food Waste Index Report 2024 (Nairobi: UNEP, 2024).
[55] ColdHubs self reported; ColdHubs – Nigeria’s Largest Cold Chain Network
[56] WRAP - UK Food and Drink Pact | WRAP - The Waste and Resources Action Programme

PACKAGING

Reuse systems can cut packaging, litter and emissions together

40%

of the world's plastic waste is packaging[57]

WHAT IT LOOKS LIKE

In-store refill and return systems for drinks, food and home and personal care products, shared containers and collection systems, deposit schemes that keep packaging in use, innovation in systems and materials.

WHAT IT MEANS FOR PEOPLE

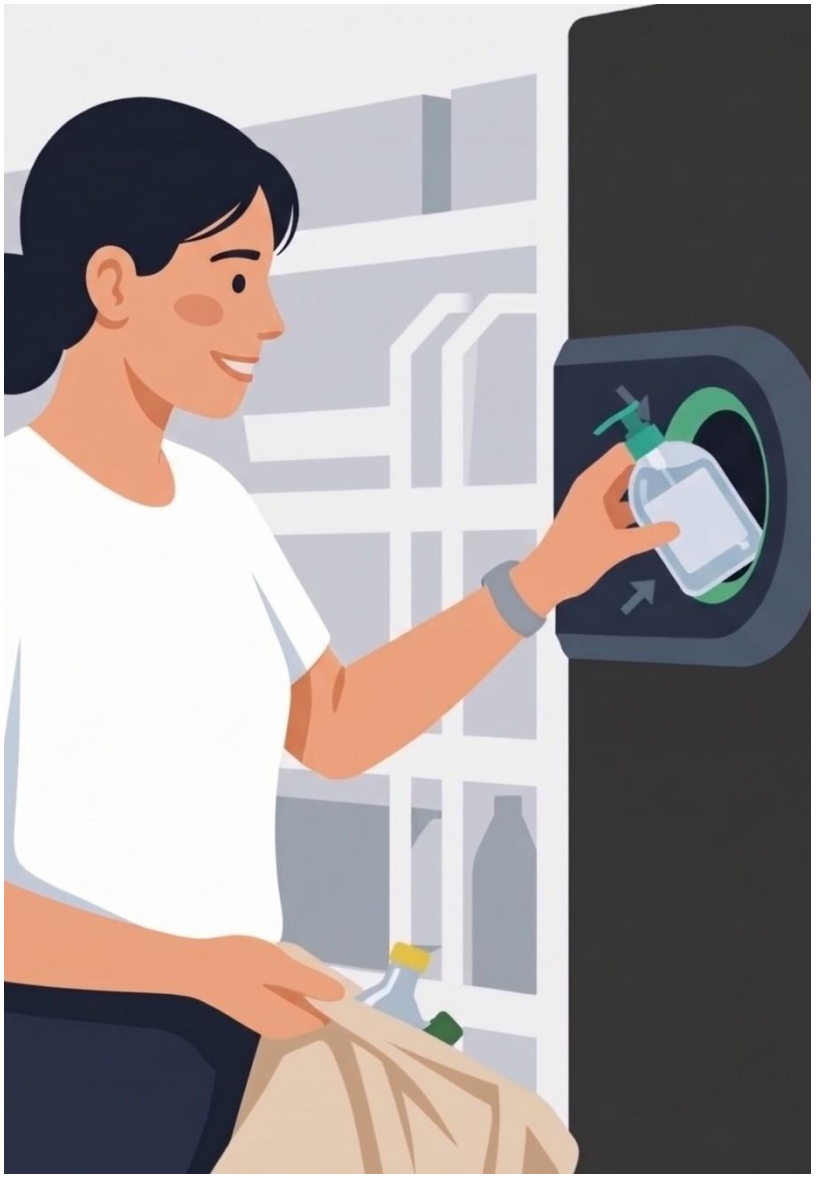
Less litter in streets and waterways, lower costs for shoppers and local jobs in washing, logistics and refilling. Engagement with innovative retail supply chains that deliver 'close to disposable' convenience and pass on savings from less packaging and more efficient supply chain logistics to consumers.

IN PRACTICE

Shared containers already work at scale. German mineral water bottlers fill more than 6.8 billion identical pool bottles a year, and shoppers can return them to virtually any supermarket.[58] CHEP shares around 348 million pallets and crates across some 60 countries.[59] In Jakarta, the packaging-as-a-service company Alner brings the same model to replace single-use sachets: brands fill its returnable bottles, which are sold and collected through more than 200 women-led neighbourhood shops and reuse points, with cashback for every empty bottle returned. They also turn neighbourhood shops into refill and return points for everyday goods.[60] Scaling reuse starts with harmonising formats and collection or dispensing systems, at least at a city level. Aarhus shows how: one deposit cup system, shared by over 50 cafés and restaurants, got back more than one million cups at an 85% return rate in its first 17 months.[61] Aligning deposits across industries lets people return or fill packaging anywhere, with reverse vending, reverse home delivery logistics, smart parcel shops and lockers giving convenience comparable to single-use.

WHAT IT NEEDS

Reuse targets, producer responsibility fees that drive reuse investment, shared infrastructure for logistics and washing, convenient options to return, a range of interoperable formats agreed across competing brands, convenient, robust and accurate dispensing technologies to fill your own container and save more material and money where possible.



[57] OECD, Global Plastics Outlook, 20.
[58] Deutsche Umwelthilfe (DUH), *Informationen Zum Umweltfreundlichen Deutschen Mehrwegsystem* (Mehrweg, 2014)
[59] Brambles, *Leading a Future of Connection and Illumination* (Brambles, 2025), www.brambles.com/Content/cms/FY25-Results/pdf/Brambles-FY25-Annual-Report.pdf
[60] Reducing Indonesia's Plastic Consumption Through a Reuse Packaging Alternative | Development Asia

TEXTILES

Clothes that last longer and change hands

82 Mt

of textiles are collected in municipal waste each year[62]

WHAT IT LOOKS LIKE

Clothes designed for durability and repair, thriving second-hand and rental markets, financing innovation, collection and sorting systems that keep textiles in use for longer and recycled at end of life.



WHAT IT MEANS FOR PEOPLE

Quality clothes that remain affordable, a wardrobe that changes with you, repaired, cared for and traded locally and with access to unique items for special occasions.

IN PRACTICE

Kantamanto market in Accra shows how much reuse is possible. Some 15 million second-hand garments arrive each week, and around 30,000 traders, tailors and upcyclers put about 25 million a month back into use by sorting, washing, mending, altering and dyeing them.[63] Those skills now reach buyers worldwide: in 2024, a dozen Ghanaian designers sold a collection made of Kantamanto materials through the resale platform Vestiaire Collective, with the proceeds going back to the market community.[64] Reuse works best when it starts with quality, and brands are building in reuse closer to home. Patagonia now sells used gear alongside new on its own website and resells nearly 160,000 items a year, selling almost everything it takes back.[65] Brands without in-house capacity can use resale as a service: ThredUp runs collection, sorting and resale shops for more than 60 brands.

Every extra life a garment gets means less need to be made. 100 second-hand garments replace 60 to 85 new ones. Wearing each garment twice as often over its lifetime, through repair, resale or a second owner, would cut the sector's emissions by around 44%.[66]

WHAT IT NEEDS

Producer responsibility fees that follow clothes across borders, brands and retailers innovating business models and technology that keeps clothes in use, sorting and reselling locally, durability standards for new items entering the market, making them worthwhile to keep and repair.

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[61] Aarhus- REUSEABLE - Environment - European Commission

[62] Eunomia, municipal solid waste flow model.

[63] The Or Foundation, 'Stop Waste Colonialism', *Stop Waste Colonialism*, 2024, https://stopwastecolonialism.org/stop-waste-colonialism/; Deutsche Umwelthilfe (DUH), *Informationen Zum Umweltfreundlichen Deutschen Mehrwegsystem* (Mehrweg, 2014);

[64] Vestiaire Collective - Vestiairecollective.com

[65] Patagonia now sells its Worn Wear collection of refurbished gear right alongside new products | Popular Science

[66] Farrant, L., Olsen, S.I. & Wangel, A. (2010), "Environmental benefits from reusing clothes", *Int J Life Cycle Assess* 15, 726–736: https://doi.org/10.1007/s11367-010-0197-y; Ellen MacArthur Foundation - A New Textiles Economy: Redesigning Fashion's Future | Ellen MacArthur Foundation

ELECTRONICS

Repair and remanufacture keep value in use

62 Mt

of e-waste generated in 2022, with only 22% documented as collected and recycled.[67] About a third, some 21 Mt, ends up in municipal waste.[68]

WHAT IT LOOKS LIKE

Products designed to last, retain value and be repairable and upgradable (software as well as hardware), spare parts and repair information readily available, and refurbished and remanufactured devices as a mainstream choice.

WHAT IT MEANS FOR PEOPLE

Affordable, reliable, high-quality devices and appliances, skilled repair jobs in every community, driving access to high-quality, high-performing technology to wider demographics.

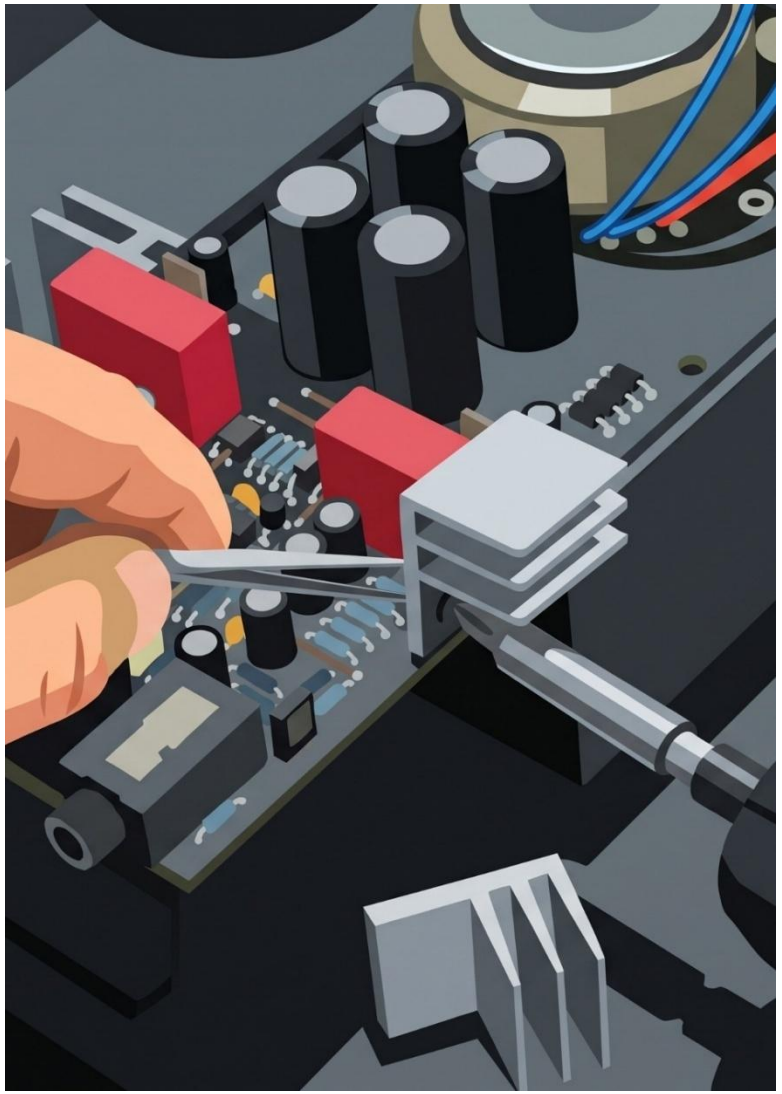
IN PRACTICE

Beko, the Turkish appliance manufacturer, runs repair and refurbishment as a factory-scale business. Its European "Reduce–Refurbish–Recycle" programme first tries to fix faults in the home, through engineer visits or remote diagnostics. Units that still come back are tested, repaired and graded, then resold at up to 30% below the price of new. In 2024, more than 114,000 appliances were refurbished at centres in the UK, Italy and Romania, backed by more than 450,000 spare parts. The model started in Türkiye, where Beko's plants have run refurbishment since 1997.[69]

Online platforms are also taking repair and refurbishment mainstream. Back Market, founded in Paris in 2014, has sold more than 30 million refurbished devices across 17 markets through some 1,800 professional refurbishers, avoiding around 1.6 million tonnes of CO_2.[70] iFixit makes the know-how open to everyone. Its free library holds more than 115,000 step-by-step repair guides, and it's now the official parts distributor for Google Pixel phones, Microsoft Xbox and Logitech.[71]

WHAT IT NEEDS

Ecodesign requirements, repairability standards, longer warranties supported by the OEMs, even if repair is done elsewhere, access to affordable spare parts and repairer training, a good network of local repair stores and repair that visibly costs less than replacement.



[67] Cornelis P. Baldé et al., *The Global E-waste Monitor 2024* (Geneva and Bonn: International Telecommunication Union and United Nations Institute for Training and Research, 2024), https://ewastemonitor.info/the-global-e-waste-monitor-2024/.
[68] Eunomia Research & Consulting, global municipal solid waste material flow model (SSP2), preliminary outputs, November 2026.
[69] Beko, "Reduce–Refurbish–Recycle" (PR Newswire, Sept 2025): https://prod-ss.aap.com.au/aapreleases/cision20250929ae85374/; Beko corporate, Product Stewardship: https://www.bekocorporate.com/sustainability/in-touch-with-business/product-stewardship/
[70] Back Market, "About us": https://www.backmarket.com/about-us ; refurbisher partner figure: ChannelX, "Back Market says downgrade now to celebrate 10th birthday": https://channelx.world/2024/09/back-market-says-downgrade-now-to-celebrate-10th-birthday/
[71] iFixit, memo to the Rhode Island legislature (Feb 2025): https://rilegislature.gov/Special/comdoc/House%20Corporations%202025/02-11-2025--H5246--IFIXIT%20-%20Kyle%20Wiens.pdf

TRANSPORT

Sharing and lighter vehicles could save 13–26 Gt by 2050

13–26 Gt

saved to 2050 by using materials better in passenger cars[72]

WHAT IT LOOKS LIKE

Car sharing and ride sharing supported by digital and engineering innovation, investment in greater use of public transport, walking and cycling, smaller and lighter vehicles, and vehicles kept in use for longer.

WHAT IT MEANS FOR PEOPLE

Access to high-quality, convenient, flexible mobility without the cost and responsibility of owning a car, quieter and safer streets, more room for nature and cleaner air.

IN PRACTICE

Sharing already works at scale. BlaBlaCar, the carpooling platform, filled empty seats for 150 million passengers across 21 countries in 2025. Its drivers saved €568 million on fuel and tolls, and the company estimates 4 million tonnes of CO_2 were avoided.[73] In Belgium, Cambio's 3,000 shared cars in 152 towns made almost 1.2 million trips in 2025, and each one replaces up to 13 private cars.[74] Bremen shows what happens when a city plans for sharing. Since 2003, it has turned on-street parking into "mobil.punkte" sharing stations, now more than 150, and each shared car there replaces about 18 private ones.[75] Simulations for Lisbon found the same daily trips could be served with just 3% of today's vehicles, using shared taxis and on-demand minibuses alongside the metro.[76] Vehicle numbers fall fast because each remaining vehicle works harder. Similar to many high-income countries, the average car or van in England is driven just 4% of the time.[77]

WHAT IT NEEDS

Innovation in self-driving and digital platforms will facilitate making sharing the convenient option. Cities giving shared vehicles guaranteed space on the street, close to every front door. Planning codes allowing developers to allocate spaces for shared mobility, instead of requiring one for every home. Shared fleets as feeders to frequent public transport that can carry the peak, with one ticket for both. Adapted insurance and simple apps to facilitate sharing the cars people already own, so sharing becomes the easy default between neighbours.



[72] Pauliuk et al. 2021; Global scenarios of resource and emission savings from material efficiency in residential buildings and cars | Nature Communications
[73] BlaBlaCar, 2025 Sustainability Report (June 2026): https://newsroom.blablacar.com/news/4-million-tonnes-of-co%E2%82%82-avoided-blablacar-publishes-its-2025-sustainability-report
[74] Cambio, press release 2026, "72 miljoen gedeelde kilometers": https://www.cambio.be/sites/default/files/2026-01/Perstekst%20BEL_Persbericht2026.pdf
[75] Interreg Europe, "Bremen's mobil.punkt" good practice, 2026: https://www.interregeurope.eu/good-practices/bremens-mobilpunkt
[76] ITF (2016), *Shared Mobility: Innovation for Liveable Cities*: https://www.itf-oecd.org/shared-mobility-innovation-liveable-cities
[77] RAC Foundation, 2021 - Still standing still

CONSTRUCTION

Longer-lived, lighter buildings could save 20–52 Gt by 2050

42%

of material emissions go first into construction[78]

WHAT IT LOOKS LIKE

Existing buildings refurbished rather than demolished, floorspace used more intensively, lighter structural design, reuse of components and low-clinker concrete. Using materials better in homes alone could save 20–52 Gt to 2050.[79]

WHAT IT MEANS FOR PEOPLE

Affordable, comfortable homes, a city with room in it and skilled local construction and retrofit jobs.

IN PRACTICE

São Paulo is turning old, often empty buildings in its historic centre into homes. Since 2021, its Requalifica Centro programme has given tax and planning incentives to retrofit buildings from before 1992. A city fund pays up to 25% of the building works, with 60% of the money reserved for social housing.[80] Forty-nine buildings are now being converted, with the potential to deliver 5,238 homes, and 15 are already finished. In 2026 the city approved the programme's first project for families earning a maximum of three times the minimum wage, facilitating access to high-quality housing for low income families.[81]

A Danish study modelled one 1970s apartment block five ways, from light to deep renovation to demolition and a new hybrid-timber building. The renovations used 9 to 33 kg of new material per square metre. Rebuilding used 633 kg, nineteen times more, and over twice the lifetime emissions of the best renovation. Every renovation stayed within the researchers' proposed carbon limit for apartment buildings; the new building did not.[82]

WHAT IT NEEDS

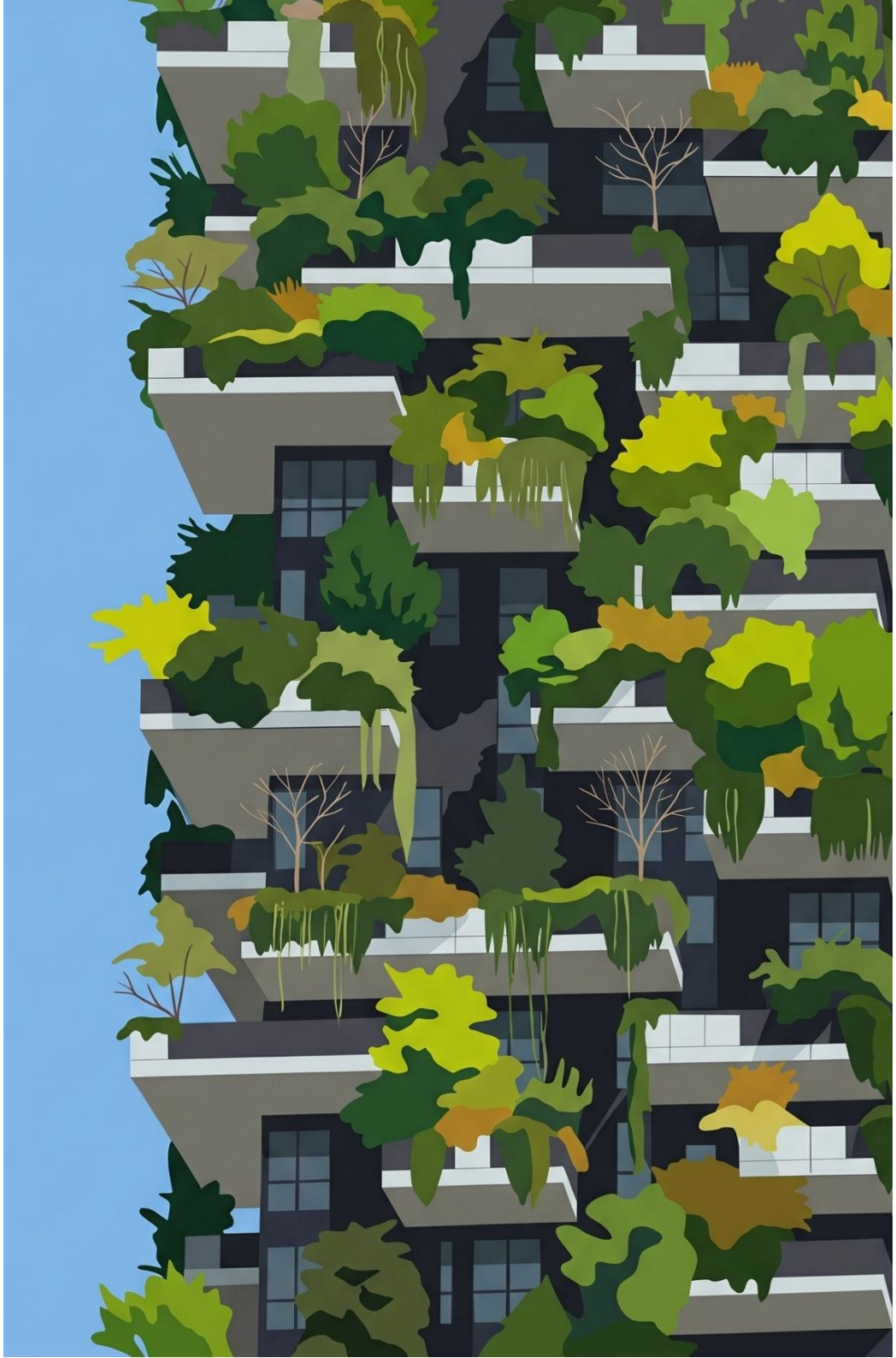
Whole-life carbon limits for new buildings and infrastructure that make renovation the default and demolition the exception, incentives to bring vacant buildings back into use, and a major focus on green public procurement, as public bodies buy 40–60% of concrete.[83]



[78] Hertwich, "Increased Carbon Footprint," 153, table 1b.
[79] Pauliuk et al. 2021; Global scenarios of resource and emission savings from material efficiency in residential buildings and cars | Nature Communications
[80] Prefeitura de São Paulo, "São Paulo apresenta projetos de requalificação do centro" (May 2025): https://prefeitura.sp.gov.br/web/licenciamento/w/s%C3%A3o-paulo-apresenta-projetos-de-requalifica%C3%A7%C3%A3o-do-centro-no-ii-encontro-brasileiro-de-urbanismo-em-%C3%A1reas-centrais-1
[81] first low-income project: https://gestaourbana.prefeitura.sp.gov.br/noticias/prefeitura-aprova-primeiro-empreendimento-do-requalifica-centro-para-familias-com-renda-de-ate-tres-salarios-minimos/
[82] Beyond the Roadmap — Reduction Roadmap
[83] World Economic Forum (2022); https://www.weforum.org/stories/climate-action/6-countries-taking-action-to-solve-concretes-emissions-problems/

Part 4: Discussion and recommendations

The scale and significance of the opportunity



The scale of the opportunity: 149 $GtCO_2e$ saved by 2050

The ambition: a zero waste future, guided by the COP31 Presidency targets, with the measures delivered in full.

Municipal waste (Part 1). Better waste management, reduction and reuse save about 37 $GtCO_2e$ from 2025 to 2050: 13 $GtCO_2e$ from sound waste management for all, 12 from preventing food waste and 12 from reuse, repair and sharing.

Buildings, infrastructure and durable goods (Part 2). In this ambitious scenario, longer lifetimes, more intensive use, sharing, reuse and lighter design reach their full potential by 2040 across buildings, infrastructure and durable goods, cutting material production emissions by 67% and avoiding around 112 $GtCO_2e$ by 2050.[84] By comparison, industry pathways with more modest reductions in demand for steel, cement and aluminium deliver around 34 $GtCO_2e$ of savings.[85]

Taken together, the municipal waste measures and the wider material efficiency opportunities could avoid around 149 $GtCO_2e$ by 2050, more than the remaining 1.5°C carbon budget, with annual savings reaching 9.6 $GtCO_2e$ by mid-century.

These savings partly overlap with those from cleaner production, but both are necessary. While decarbonisation reduces the emissions that material efficiency can avoid, material efficiency reduces the amount that needs to be decarbonised. For example, high circularity in steel avoids around 19 $GtCO_2e$ relative to business as usual, but only about 9 $GtCO_2e$ once steel production is decarbonised. Net-zero steel production alone could require up to 6,700 TWh of clean electricity, roughly a quarter of global electricity generation today, and 75 Mt of hydrogen annually by 2050, highlighting how much lower material demand can ease the clean energy transition.[86]

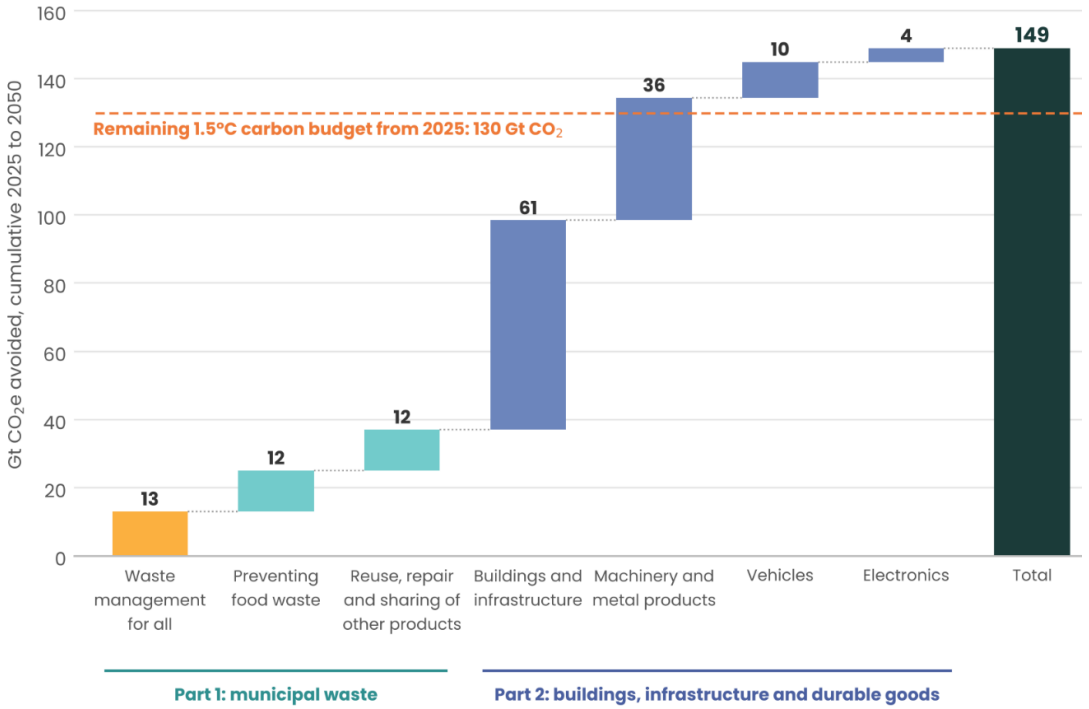


Figure 15: GHG emissions avoided, cumulative to 2050 by lever ($GtCO_2e$)

Source: All figures are cumulative, 2025–2050. Part 1: Eunomia global municipal waste model. Part 2: Eunomia analysis applying the upper material efficiency savings rate for homes and cars (two thirds; Pauliuk et al. 2021) to the material GHG emissions of all durable goods (Hertwich 2021); materials only, excluding use-phase energy savings. The carbon budget is for CO_2 only (Forster et al. 2025). Method in Appendix A.4.

What this means

Using less material, reusing more and managing waste well could save 149 $GtCO_2e$ by 2050, more than the whole remaining 1.5°C carbon budget. Every tonne of GHG emissions avoided is a tonne that will not have to be removed later.

[84] Eunomia analysis of Pauliuk et al., "Global Scenarios of Resource and Emission Savings," 1–2, and Hertwich, "Increased Carbon Footprint," table 1b. See Appendix.
[85] Mission Possible Partnership, Making Net-Zero Steel Possible, 33–34; Mission Possible Partnership, Making Net-Zero Concrete and Cement Possible, 13; Mission Possible Partnership, Making 1.5°C-Aligned Aluminium Possible, 42.
[86] Mission Possible Partnership, Making Net-Zero Steel Possible, 18, 20.

THE SHIFT

The change required is systemic

These savings require a transformation in our relationship to materials, not just a marginal reduction in our wastefulness.

EFFICIENCY ALONE WILL NOT BE ENOUGH

Decarbonising production is crucial, but gains made at the per-tonne level have been consistently outpaced by growth in volume. Getting more utility from less material must be prioritised alongside low-carbon production.

DESIGNED TO LAST

It is difficult and inefficient to extend the life of a product designed to be short-lived. Reuse, repair and sharing depend on design for longevity and repair. Done well, they can put high-quality products within reach of far more people.

FROM MATERIAL TO SERVICE

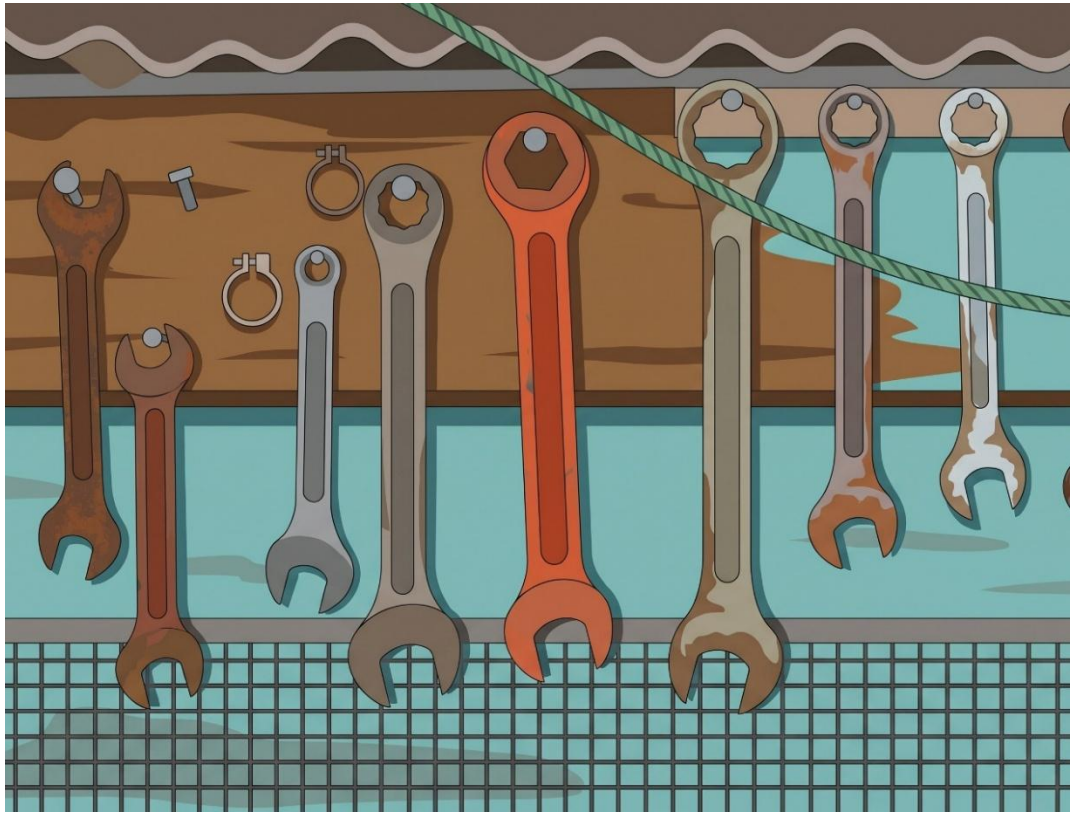
Whether with cars, packaging, or clothes, a zero waste world requires innovation in business models relative to the linear, take-make-waste economy. A common feature is servicisation of products and materials, often incorporating recurring revenues.

THE STARTING POINT IS NOT THE SAME EVERYWHERE

In higher-income countries, much of the cultural and economic infrastructure for reuse, repair, and share models must be rebuilt; in many lower-income countries, these economies already exist, but can lack visibility due to informality. There, the task is to organise, finance, scale and enhance.

What this means

Twenty-five years is long enough for the unimaginable to become ordinary. In 2000, nobody imagined you could summon a car from an app on your phone. The next twenty-five years will require us to go beyond efficiency gains to imagine a different way of relating to materials and the prosperity they bring.



CONCLUSIONS

Stepping stones to 2050: a brighter future for more people

The benefits reach well beyond climate: jobs, cleaner neighbourhoods, lower costs and less pressure on land and nature.

WELLBEING

Providing affordable access for more people to better homes, mobility and higher quality goods, with less pollution where they live.

WORK

The labour required in upstream circular interventions such as repair can create more local and skilled employment.[87] The informal workers already carrying out much of the world's upstream circularity must be included to ensure that their practice is supported rather than displaced.

TRANSITION

Lower-income countries can accelerate the transition away from the take-make-waste model of industrialised economies, building on existing repair and reuse practices.

RESILIENCE

Spare capacity, local capability and more than one way to get to work, to clothe a child or to keep things going is becoming increasingly important as adaptation to climate change becomes a priority for more communities.

NATURE AND BIODIVERSITY

Extracting and processing materials drives over 90% of land-use-related biodiversity loss.[88] More utility from less material is one of the most tangible ways we can ease that pressure.



[87] Shukla et al., *Climate Change 2022*, 1221.
[88] International Resource Panel. *Global Resources Outlook 2024: Bend the trend – Pathways to a liveable planet as resource use spikes*. Nairobi: United Nations Environment Programme, 2024

RECOMMENDATIONS

Six steps to build on the 2035 targets

Each step builds on the COP31 targets. None needs a new negotiated outcome: all can be taken forward through the Action Agenda, NDCs, cities, national policy and cross-sectoral action.

01

Count what reuse, repair and share models save

Develop shared methods for counting the emissions they avoid, so countries can include them in national climate plans (NDCs) and policies.

02

Build on the 2035 targets

Deliver sound waste management for all, with separate food waste collection and a role for informal recyclers. Publish the waste target baseline and report progress.

03

Scale what works

Coordinate globally to scale proven zero waste models and remove the legal, competition and cultural barriers that hold them back. Establish pre-competitive platforms where businesses can share good practice, agree shared standards, formats and infrastructure, and that give the reuse, repair and sharing enterprises a stronger, coordinated voice.

04

Share responsibility fairly

Higher-income countries lead on cutting material use. Concessional climate finance supports systems in lower-income countries.[89]

05

Value existing practice

Support the reuse, repair and sharing already found in the Global South, informal economies, and indigenous communities. Support with funding and real distribution of power, including through support of the Belém-Antalya Mechanism.

06

Design for longevity

Longevity and repairability standards, whole-life carbon in decision-making, and procurement that rewards longer life.

Zero waste is the right direction. Its potential grows as it reaches from the waste we all produce to the way we build, travel and make things.

[89] Wilson et al., "Unlocking the Significant Worldwide Potential," 10.

Appendix

Key Definitions

Zero Waste. An approach that prioritises preventing waste before it occurs by using fewer materials, designing products to last, and enabling reuse, repair, refurbishment and sharing. Waste management remains essential, but the largest environmental benefits come from reducing the need for new material extraction and production in the first place.

Materials and products. Material emissions are the CO_2e emissions from producing basic materials such as steel, cement, aluminium, plastics, paper and glass, including the energy used to make them: 11.8 $GtCO_2e$ in 2018. They stop at the factory gate and exclude making, using or disposing of products. Emissions linked to municipal waste (Part 1) cover a narrower set of goods but more sources: producing what ends up in household and commercial waste, including food, plus collecting, treating and disposing of it, net of savings from recycling, composting and energy recovery. The savings for buildings, infrastructure and durable goods (Part 2) use the material boundary only. Neither part counts emissions from using products, such as fuel for cars or power for electrical appliances. Some of the sector examples quote whole-life figures from other studies, which do include use, but these are not used in the report's headline emissions reduction analysis.

Municipal Waste. Waste generated by households and similar sources such as shops, offices, schools and public services. It is the part of the material economy that people encounter most directly in everyday life.

Upstream Measures. Actions taken before products become waste, such as reducing material demand, extending product lifetimes, reuse, repair, remanufacturing and sharing. These measures reduce the need for producing new materials and products, so avoid waste from being generated in the first place.

Methods and assumptions

Municipal waste management

We used Eunomia's global municipal waste material-flow model, covering 217 countries and 18 material streams, to estimate waste generation and management in 2022 and 2025 and at five-year intervals to 2050. Results presented here used the Shared Socioeconomic Pathway 2 (SSP2) after Dellink et al. (2025).

We estimated waste generation per person using a quantile regression forest with four predictors. These were GDP per capita[90], the share of employment in services,[91] the proportion of people living below US$3 per day at 2021 purchasing power parity (PPP)[92], and agriculture's share of total sectoral value added.[93] GDP per capita was expressed in constant 2021 international dollars and log-transformed for the generation model. Predictions were anchored to waste data reported by Cook et al. (2026)[94] which was adjusted for collection coverage, informal waste worker activity and scope. Annual growth projections of waste generation per person were capped at 2.4%.

Collection coverage was estimated using a separate random-forest model with seven predictors. These were GDP per capita (PPP), a modified Human Development Index[95], the proportion of the population aged 65 and over,[96] annual population growth,[97] the proportion living below the same poverty threshold, the urban population share, and agriculture's share of total sectoral value added. Projected collection coverage was constrained to remain at or above its 2025 level.

Recycling was projected using a nonlinear relationship between GNI per capita and the proportion of municipal waste recycled. Projections were anchored to national recycling data adjusted for informal waste worker participation using data from Cottom et al (2024).[98] For countries without national recycling data, recycling shares were estimated directly from the relationship. Projected recycling tonnages were constrained by collection coverage and material-specific treatment limits.[99] Collected waste was allocated sequentially to dry recycling, biological treatment and incineration, with the remainder sent to disposal. Each allocation was constrained by the mass remaining and material-specific treatment limits.

[90] World Bank (2026) *World Development Indicators* [dataset]. Indicators NY.GDP.PCAP.PP.KD, 'GDP per capita, PPP (constant 2021 international $)', and SP.POP.65UP.TO.ZS, 'Population ages 65 and above (% of total population)'. Washington, DC: World Bank.
[91] Poblete Cazenave, M., Aktas, A., Zhong, J. and O'Neill, B. (2026) *Dataset for "Gini and subnational income distributions for the Updated Shared Socioeconomic Pathways"* (version 1) [dataset]. Zenodo. https://doi.org/10.5281/zenodo.22845467.
[92] Ibid
[93] Leimbach, M., Marcolino, M. and Koch, J. (2022) *SSP structural change scenarios* (version 1) [dataset]. Zenodo. https://doi.org/10.5281/zenodo.7433139.
[94] Ed Cook, Kremena Ionkova, Perinaz Bhada-Tata, Sonakshi Yadav and Frank van Woerden, *What a Waste 3.0: Global Snapshot of Solid Waste Management Toward Circularity until 2050*, Urban Development Series (Washington, DC: World Bank, 2026), https://doi.org/10.1596/978-1-4648-2309-1.
[95] Liu, K., Wang, R., Schrijver, I. and Hoekstra, R. (2024) 'Can we project well-being? Towards integral well-being projections in climate models and beyond', *Humanities and Social Sciences Communications*, 11, 457. https://doi.org/10.1057/s41599-024-02941-6.
[96] KC, S. (2026) *SSP Population and Human-Capital Projections, 2025-Rebased, 2025–2100* (version zen2025V01) [dataset]. Zenodo. https://doi.org/10.5281/zenodo.21738149.
[97] United Nations, Department of Economic and Social Affairs, Population Division (2025) *World Urbanization Prospects 2025* [dataset]. New York: United Nations. https://population.un.org/wup/.
[98] Cottom JW, Cook E and Velis CA (2024) A local-to-global emissions inventory of macroplastic pollution. *Nature* 633(8028): 101–108. https://doi.org/10.1038/s41586-024-07758-6.
[99] Ed Cook, Kremena Ionkova, Perinaz Bhada-Tata, Sonakshi Yadav and Frank van Woerden, *What a Waste 3.0: Global Snapshot of Solid Waste Management Toward Circularity until 2050*, Urban Development Series (Washington, DC: World Bank, 2026), https://doi.org/10.1596/978-1-4648-2309-1.

The model also represented informal worker recycling and reuse. Uncollected waste was allocated between open burning and dumping on land or in water. Known international shipments of waste for recycling, recovery and disposal are included using 2023 trade data.[100]

We attributed the lifetime waste management GHG emissions associated with each year's waste to that reporting year. Landfill methane was therefore assigned to the year of deposition, including emissions expected to occur subsequently. Estimates used IPCC (2006)[101] parameters for methane generation, with site-specific assumptions for methane correction, recovery and oxidation. Methane was converted to CO_2-equivalent using a 100-year global warming potential of 28 (IPCC, 2013).[102] Electricity emission factors were taken from Ember's yearly electricity dataset (Ember, 2026).[103] We used the latest available national lifecycle generation intensity from 2023–2025, with regional proxies where national estimates were unavailable. These factors were applied to electricity consumption and used as proxies for emissions displaced by electricity exports. Factors were held constant from the 2025 model baseline through 2050.

In a separate production account, we assigned material-production emissions to the mass of waste generated. Lower waste generation therefore reduced the associated production emissions. Recovered materials received credits for displaced virgin production, using a substitution ratio of 1.0 as an upper-bound assumption.

Municipal waste upstream circularity levers

The reduction and reuse scenario lowers waste generated per person, compared with the baseline. Each rate was informed by published evidence and reviewed by Eunomia and WRAP technical specialists.

The reduction and reuse scenario lowers waste generated per person compared with the baseline. The rates below apply to high-income countries by 2050, phased in from 2025; the levers for metal, electrical and electronic equipment, wood and rubber reach their full value by 2040.

Middle-income countries share the reduction effort in proportion to their waste per person in 2025: upper-middle-income countries reach about 62% of these rates by 2050 and lower-middle-income countries about 37%. Low-income countries reach about 10%, with extending waste collection assumed to be prioritised.

Food and other organic: 56%. Prevention of household, retail and food service waste, in line with SDG 12.3.

Garden: 50%. Reduction in garden waste entering municipal collection.

Plastic: 57%. Packaging reuse and refill, and reduction.

Paper and card: 50%. Reduction in packaging and printed paper.

Glass: 50%. Reuse in pooled bottle and jar systems with local filling.

Textiles: 50%. Longer use, resale and repair.

Electrical and electronic equipment: 30%. Durability, repair, refurbishment and sharing.

Wood: 30%. Longer-lived furniture, repair and second-hand sales.

Inert waste: 30%. Reduction in rubble and other inert material in municipal waste.

Metal: 20%. Packaging reuse and refill, and reduction.

Rubber and leather: 10%. Footwear repair and longer use.

Hygiene products, hazardous and unclassified waste are not reduced. Reused items carry burdens for washing and return logistics and earn a credit for the material production they avoid.

Global materials analysis

GHG emissions from producing materials are taken as 11.8 $GtCO_2e$ in 2018 (IPCC), split by material and by the sector that first uses each material, following Hertwich (2021), which is also the source for the trend since 1995. About 15–21% of these GHG emissions sit in products that become municipal waste. This is estimated from end-use data and by comparing collected municipal waste with annual production for each material.

Future demand for steel, cement and aluminium follows the Mission Possible Partnership's business-as-usual projections. Plastics demand is assumed to grow by 4% a year, as in Eunomia's Is Net Zero Enough for the Material Production Sector? (2022). Cumulative GHG emissions to 2050, on today's path and with decarbonised production, come from the same sources. The decarbonised case counts only cleaner production, not the sectors' measures to use less material, which discussed further below.

The remaining 1.5°C carbon budget is about 130 $GtCO_2$ from the start of 2025 (Forster et al. 2025). As it covers CO_2 only, comparisons with it are indicative.

[100] BACI - Gaulier, G. and Zignago, S. (2010) *BACI: International trade database at the product-level. The 1994–2007 version*. CEPII Working Paper No. 2010-23. Paris: CEPII.

[101] Intergovernmental Panel on Climate Change (IPCC) (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5: Waste*. Edited by H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara and K. Tanabe. Japan: Institute for Global Environmental Strategies (IGES).

[102] Intergovernmental Panel on Climate Change (IPCC) (2013) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Edited by T.F. Stocker et al. Cambridge and New York: Cambridge University Press. https://doi.org/10.1017/CBO9781107415324.

[103] Ember (2026) *Yearly electricity data* [dataset]. Global dataset, snapshot downloaded 28 October 2026. https://ember-energy.org/data/yearly-electricity-data/.

Scaling savings from using materials better

The scale-of-opportunity estimate combines the municipal waste model (Part 1) with an estimate of the savings from using materials better in buildings, infrastructure and durable goods (Part 2).

Construction, machinery, metal products, vehicles and electronics take 77% of GHG emissions from producing materials, or 9.1 $GtCO_2e$ in 2018 (Hertwich 2021). Without action, these GHG emissions are assumed to average 5% above the 2018 level over 2025–2050. This reflects current trends, including the gradual efficiency gains in production that happen anyway, but no deliberate decarbonisation of production. This is consistent with the Mission Possible Partnership's business-as-usual projections for steel, cement and aluminium.

Pauliuk et al. (2021) find that material efficiency strategies for homes and cars cut the remaining GHG emissions from making their materials by 33% to 67% once fully in place. This report uses the upper rate of 67% as the ambition, assuming longer lifetimes, more intensive use, sharing, reuse and lighter design reach their full potential by 2040. The rate is applied to all durable goods, rising from 2025 to its full value in 2040 and held to 2050. The result is about 112 $GtCO_2e$ to 2050; the lower rate would give about 56 $GtCO_2e$.

The estimate counts only GHG emissions from making materials, not the energy saved in use. Part 1 and Part 2 overlap little, as most durable goods sit outside municipal waste. Neither part counts the savings from cleaner production, such as low-carbon steel, carbon capture and clean electricity, estimated at about 172 $GtCO_2e$ for steel, cement, aluminium and plastics. The two only partly overlap. Decarbonisation reduces the GHG emissions that material efficiency can avoid, because each tonne avoided is cleaner. Material efficiency in turn reduces how much production needs to be decarbonised, and with it the demand for clean electricity and hydrogen. The savings in this report are measured against production as it is today.

Shape exists to rewire the systems that are pushing people and planet past the brink. Not just tweaking around the edges - but transforming how societies work so that all life thrives within the limits of our planet.

We have a blueprint for systems change that works with real science and real power, and we apply it to the most impactful sectors of industry and consumption. We define safe operating spaces in these key sectors and build coalitions to transform ambition into rapid, collective impact.

Shape is a group of organisations working as one: unified by purpose, strategic by design, and driven to shift entire systems. Our work bridges the critical gap between insight and implementation.

Because what's at stake is more than sustainability. It is a future where the wellbeing of people and planet comes first; and one that we have the agency to shape.

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