
CGR Critical Raw Materials 2026
C:GR
Critical Raw Materials
Executive Summary
CIRCLE ECONOMY

Circle Economy

Circle Economy is a non-profit organisation founded in 2011 and based in Amsterdam. Our vision is an economic system that ensures the planet and all people can thrive. We work with partners worldwide, equipping them with the insights, strategies, and tools to accelerate the circular economy transition.

Our international team combines research, data analysis, advisory services, and capacity-building programmes across four focus areas: finance, cities, employment, and value chains. Circle Economy is the organisation behind the *Circularity Gap Report* (CGR®), the leading global benchmark for measuring and tracking circularity.

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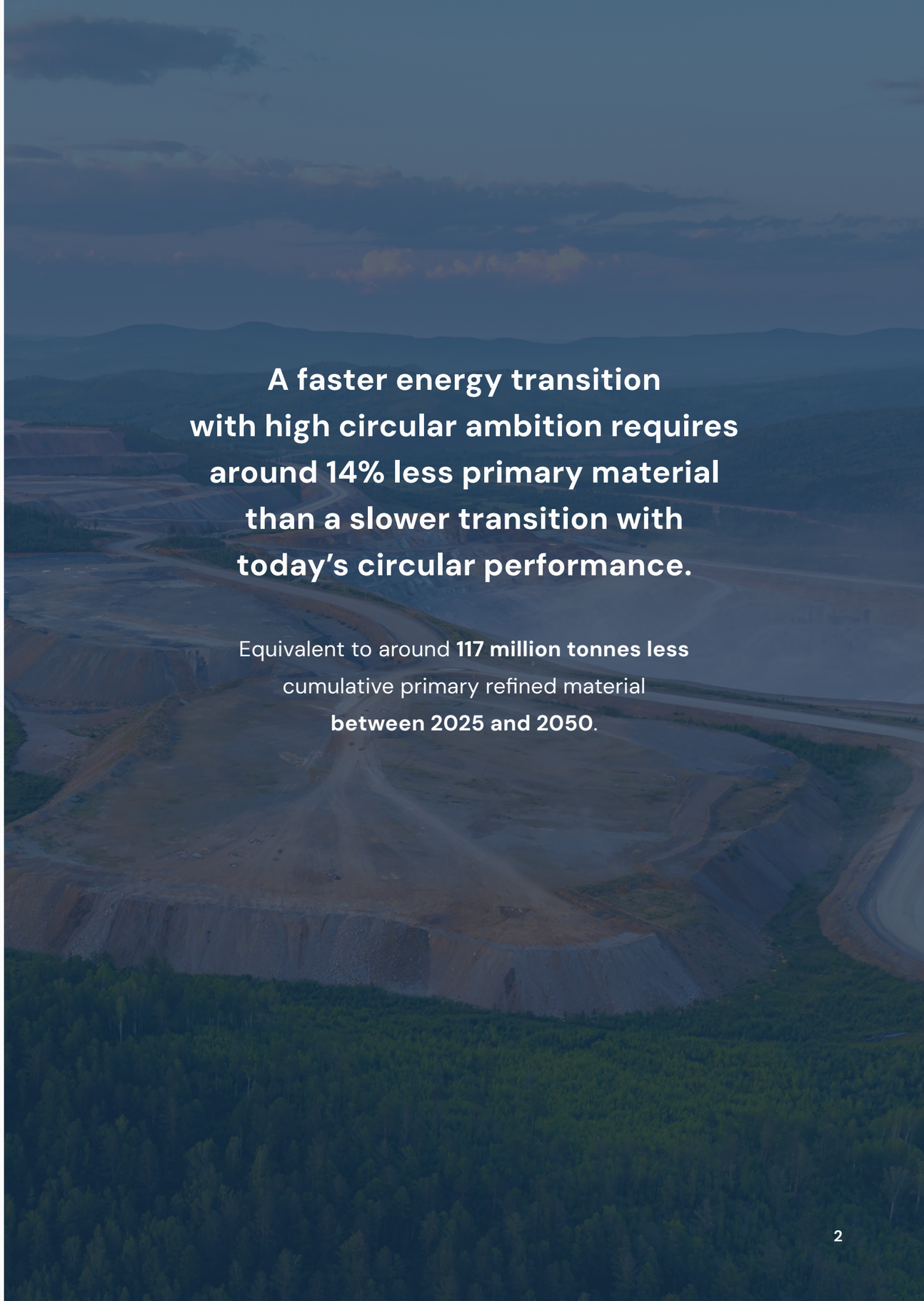
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Key messages

A shared agenda for security, resilience and sustainability

1 **Critical raw materials and circularity are part of environmental, economic and security agendas, and these shouldn't be treated as competing priorities.**

Under the right conditions, these objectives reinforce one another. Reducing dependence on primary materials strengthens supply security and economic resilience while lowering the environmental and social costs of extraction. Supply and processing concentration, along with changing geopolitical dynamics, make more circular critical raw material value chains a driver of supply security and economic resilience.

2 **Projected supply gaps for critical raw materials are structural, deep, and long-lasting, highlighting the need for alternative ways of managing these materials throughout their lifecycle.**

The analysis shows that four of the five material value chains spend prolonged periods unable to meet projected demand between 2020 and 2050. In a business-as-usual scenario, copper, silicon and lithium each face 14 to 15 years of supply stress, and cobalt around 11. Only nickel remains broadly in balance. The frequency, duration and depth of supply gaps vary independently: cobalt's shortfalls in meeting demand are frequent but limited in scale, while lithium's are both prolonged and severe. Interventions that address one dimension will not necessarily address the others.

3 **The level of circular ambition is one of the few levers within decision-makers' control, yet circularity for critical raw materials is often reduced to recycling rather than the broader set of interventions it encompasses.**

This analysis models three levels of circular ambition because it is one of the few variables governments and industry can meaningfully influence. For critical raw materials, circularity means using less material to deliver the same service, keeping products in use for longer, and recovering materials when they reach end of life. Each of these strategies can reduce the amount of primary material the system requires to meet rising demand. Rather than replacing primary supply, they moderate its expansion: extraction will still grow, but by less, and the system becomes less exposed when supply is disrupted. This means interventions should act across the full range of circular strategies—not only recovery or recycling—and target where material losses actually occur within each material system rather than relying on generic measures.



Key messages

What the evidence shows

4 The biggest constraints and opportunities differ not only between critical raw materials, but also between the distinct streams and grades within each material.

Critical raw materials share a policy classification, not a common physical reality. Production volumes differ by orders of magnitude, and each material responds differently to the same circularity levers. More importantly, the decisive bottlenecks often lie in specific grades and end uses rather than the material as a whole. Aggregate supply and demand projections can therefore mask grades that remain scarce. For example, silicon may appear abundant overall while high-purity polysilicon for semiconductors and solar technologies remains constrained. Interventions designed around the headline material can therefore miss where scarcity—and strategic value—actually lies.

5 Transition speed and material requirements are interdependent.

Rapid decarbonisation and lower resource requirements can be compatible, and should be pursued together. A faster and deeper energy transition increases material requirements, but circularity more than compensates. Rapid decarbonisation combined with high circularity ambition requires around 117 million tonnes less cumulative primary refined material between 2025 and 2050 than slow decarbonisation with today's circular performance. Accelerating decarbonisation therefore does not mean accepting greater material pressure, provided circular ambition rises alongside it. Pursued at low ambition, the same acceleration increases primary demand rather than reducing it.

6 Redesigning critical raw material value chains through circularity is important for resilience.

The analysis suggests that higher circular ambition delivers substantially better outcomes. A system that draws on recovered material and longer-lived products with lower material intensity can absorb disruption far better. It is typically more resilient to demand surges because lower structural demand creates headroom. It is less resilient to primary supply cuts because spare capacity to compensate for such disruptions is lower. This shifts some exposure onto end-of-life collection and waste management systems. They therefore need the redundancy, contingency planning, and coordinated investment expected of other critical infrastructure, with collection and processing treated as one connected system.

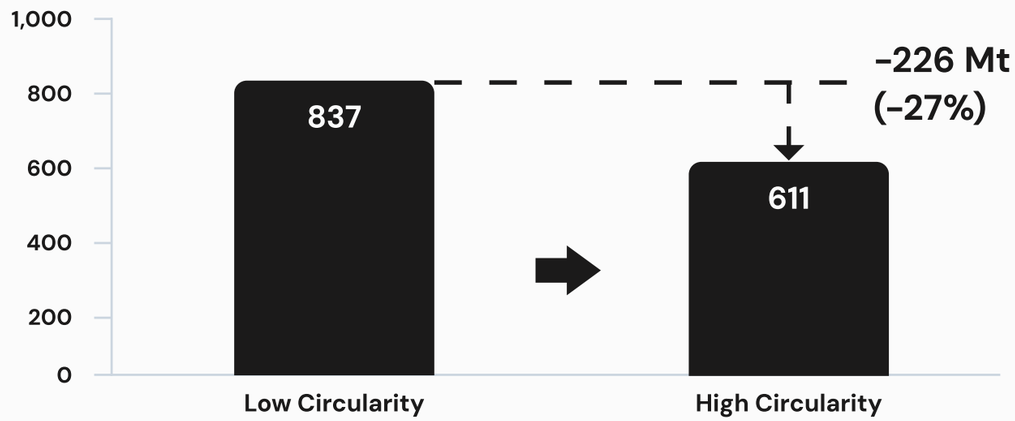
7 Circularity can close supply gaps for most materials, but not all.

Higher circular ambition nearly eliminates unmet demand for copper, nickel and cobalt, even under a faster decarbonisation pathway. Lithium and silicon are different: even at high ambition, around 8% of lithium demand and 4% of silicon demand goes unmet between 2025 and 2050, with peaks of 15% and 8% in individual years. These materials have younger in-use stocks and fewer recoverable applications. Closing their remaining gaps therefore requires other measures, including sufficiency, material substitution, or additional primary supply. It also requires asking not only how efficiently materials circulate, but what they are used for and which uses should take priority.

Decarbonisation and circularity go hand in hand

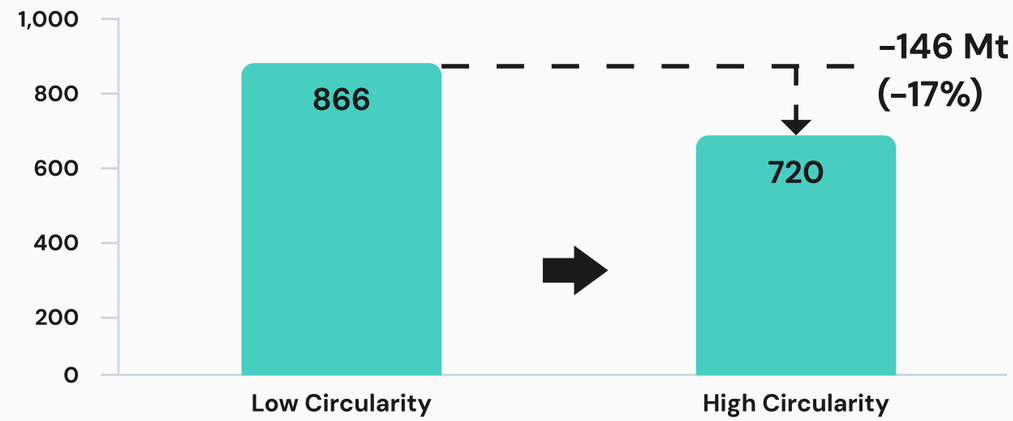
Cumulative primary materials required across copper, lithium, cobalt, nickel, and silicon, 2025-2050, in million tonnes

1. SLOW DECARBONISATION



Under slow decarbonisation, increasing circularity reduces more cumulative material use over time, but climate goals are not met in time and value chains remain more vulnerable to shocks

2. FAST DECARBONISATION



Under faster decarbonisation, greater circularity reduces cumulative material use over time, enables climate goals to be met, and enhances overall value chain resilience

Rapid decarbonisation with high circularity ambition achieves climate goals while using around **14% less** cumulative primary material than a slow decarbonisation with low circularity performance.

~14% LESS
cumulative primary material use (2025-2050)

Figure one: Cumulative primary material required, 2025-2050, million tonnes across copper, nickel, cobalt, lithium and silicon. Refined-metal-equivalent tonnes summed across the five materials; percentages calculated on those totals.

Key messages

What should happen next

8 **Not all circular economy levers are equally impactful.**

Reducing material intensity and extending product lifetimes can contribute more to lowering primary material demand than end-of-life recovery can for most of these materials. For materials with mature recycling systems, better circular performance can even mean less material being recycled because less flows through the system in the first place. Recycling remains essential, but its impact depends heavily on effective collection, sorting and processing. Where collection improves faster than sorting and processing capacity, additional material risks being diverted into lower-value uses rather than genuine recovery.

9 **Timing matters: Today's decisions determine what becomes recoverable tomorrow.**

Much of the material entering use during the next two decades will not reach end of life until well after 2050. Product design choices made now can therefore determine how much secondary supply becomes available during the transition decades, when supply constraints are projected to be greatest. The same principle applies to infrastructure: recovery capacity needs to be built before end-of-life volumes arrive, not in response to them. Capacity, standards, and design decisions made during this decade will shape recovery outcomes for decades to come.

10 **What gets measured determines which strategies are pursued.**

Circular performance is still assessed primarily through recycling rates, while broader resource-use indicators such as Domestic Material Consumption and Raw Material Consumption can reflect reduced material demand without revealing which circular strategies produced that outcome. As a result, many of the interventions driving the greatest gains often remain invisible. Assessment frameworks therefore need to capture the underlying levers—material intensity, product lifetime, and the quality of recovered material—alongside recycling volumes. This also helps set circular ambition at a level capable of changing the supply balance, rather than merely softening supply pressure.



The five materials at a glance

Each material faces different constraints and responds to different interventions. Applying generic circular strategies across the category risks missing where the greatest opportunities actually lie.

	Copper	Lithium	Cobalt	Nickel	Silicon
Supply-demand dynamics	Structural, continuous gap from the mid-2030s, with 14 consecutive years of supply stress. Driven by declining ore grades, long project lead times, and demand shifting towards energy-transition applications.	The deepest and longest supply gap of the five. Demand has shifted faster than for any other industrial metal, moving from niche industrial uses to lithium-ion batteries.	Supply stress is episodic rather than continuous. Supply responds to cobalt and nickel markets because it is produced as a by-product.	Broadly balanced overall, although aggregate figures conceal geographic and material constraints. Battery-grade Class I nickel remains scarce, while stainless-grade Class II does not.	A persistent and widening gap emerges from the 2030s onward. Demand outpaces primary supply growth while secondary supply remains negligible.
Circularity maturity and potential	One of the most mature end-of-life systems of the five: 56% collection and a 44% End-of-Life Recycling Rate in 2020. The largest in-use stock in the study, but wire and cable remain in service for around 40 years on average, meaning material returns slowly.	One of the least developed systems, with 20% collection in 2020 and both the Recycling Input Rate and the End-of-Life Recycling Rate below 1%. In-use stocks grow faster than for any other material, but benefits from circularity continue building after 2050.	A developing system, with 40% collection, a 21% End-of-Life Recycling Rate and a 10% Recycling Input Rate in 2020. While collection improves to 58% by 2050, secondary supply arrives only after supply pressure has already emerged.	The most mature end-of-life system in the study, with 78% collection and a 60% End-of-Life Recycling Rate in 2020. The Recycling Input Rate nonetheless rises from 25% to 37% between 2020 and 2050, as secondary supply grows faster than demand.	The weakest-performing system of the five. 15% collection in 2020, with a 0.8% End-of-Life Recycling Rate and a 0.2% Recycling Input Rate. Purity is the limiting factor: material recovered from steel scrap cannot be used in solar panels or semiconductors.
Key opportunities	Collection is already near its practical ceiling, so future gains depend on improving post-collection processing.	Today's design decisions will likely determine tomorrow's recoverable supply. Post-collection processing is the principal bottleneck.	Cobalt is infinitely recyclable, but recovery varies enormously by application.	Prevent quality loss during recovery. Post-collection processing needs improvement as processing losses grow faster than recycled volumes.	Prioritise material efficiency and substitution rather than recovery. Target recovery where purity can be preserved, particularly.

Why a *Circularity Gap Report* on Critical Raw Materials?

Securing critical raw materials has become one of the defining questions of the decade. Demand for the materials underpinning clean energy, digital infrastructure and advanced manufacturing is rising faster than supply systems were built to deliver, while extraction and processing remain concentrated in a small number of countries. Governments and companies are already responding with new mines, trade agreements, strategic reserves and industrial policy.

This report examines how the circular economy can reshape the dynamics of critical raw materials by reducing how much material is needed in the first place, extending how long it stays in use, and increasing how much returns to the economy when products reach end of life. This practical dimension of circularity has received less attention than circular economy initiatives in other sectors, yet the evidence presented here suggests it does much of the work.

In a context of intensifying demands over resource access, circularity is a strategic and economic necessity that also delivers environmental benefits. Reducing dependence on primary supply can strengthen supply security while lowering the environmental and social costs of extraction. These objectives are not competing. In fact, a faster energy transition combined with high circular ambition could require around 14% less primary material than a slower transition with today's circular performance, while creating a system that is better able to withstand disruption.

What was analysed?

The analysis tracks five critical raw materials—copper, nickel, cobalt, lithium and silicon—through the global economy from 2020 to 2050 using dynamic material flow analysis coupled with system dynamics modelling. It follows each material from ore through refining, manufacturing and use to end-of-life, capturing how much accumulates in products and infrastructure and when it becomes available for recovery. Outcomes are tested across three decarbonisation pathways and three levels of circular ambition, and then subjected to supply disruptions. The scope is global: it does not distinguish between countries or trade flows. All quantities are reported as refined materials, unless otherwise stated.

Going further

This summary presents the headline findings. The full digital report examines each material in detail, including how supply, demand, stocks and end-of-life flows evolve to 2050 and how each responds to different levels of circular ambition. An accompanying data explorer enables the underlying results to be explored by material and by theme, including at the material-stream level where several of the most consequential findings emerge. A separate methodology document outlines the modelling approach, data sources, and limitations in full.



For the digital report follow the link below

circularity-gap.world/report/cgr-crm



circle-economy.com