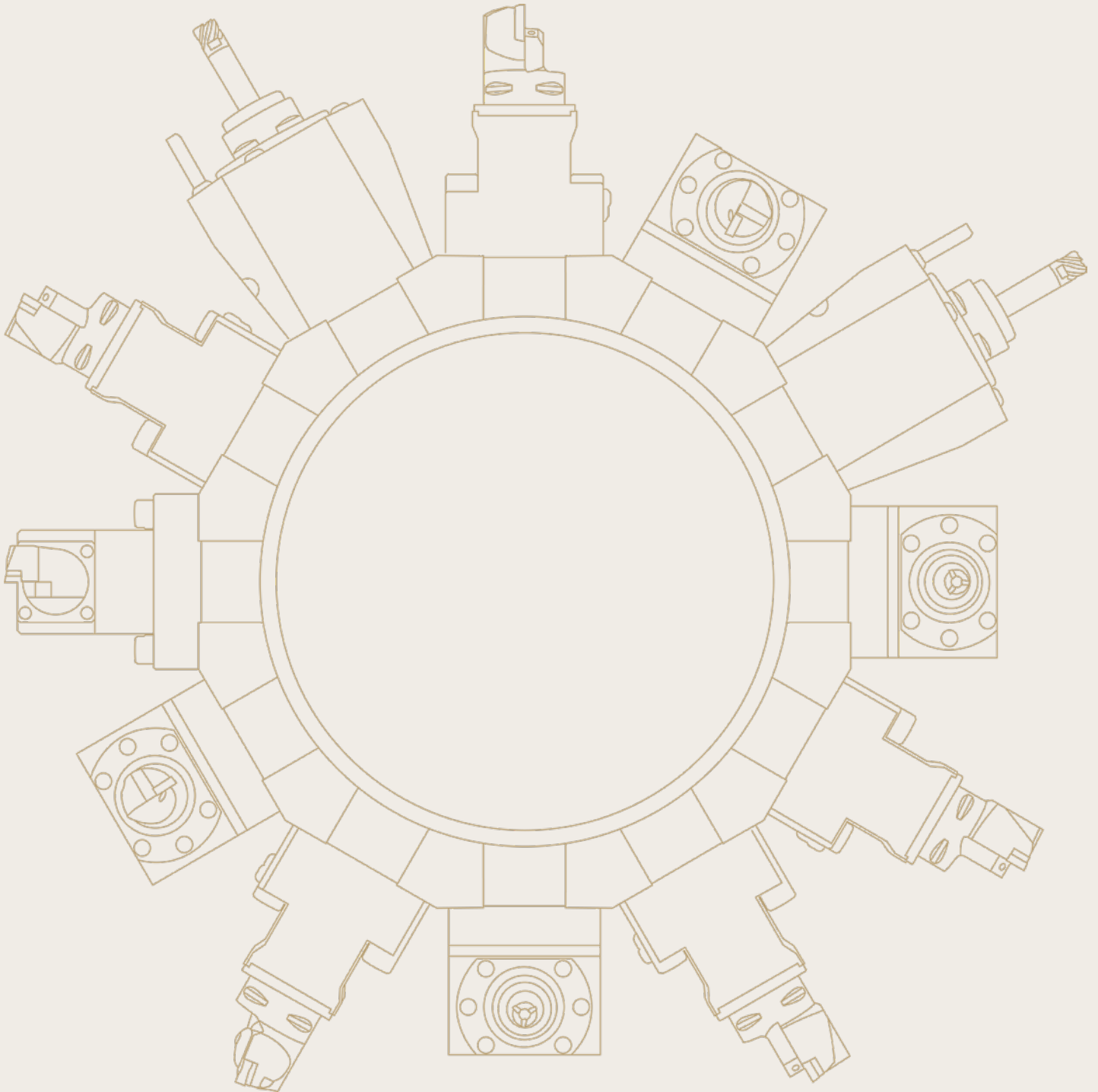


Closing the loop

Making steps towards
circular manufacturing



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Introduction

When British sailor Ellen MacArthur set out alone to circumnavigate the globe, she carried everything she would need for more than two months at sea. Every drop of fuel, every tool, every meal — finite, carefully managed and impossible to replace once gone. As she navigated the vast oceans, she came to a realization that would later reshape her life's work: the way she managed resources on her boat mirrors how humanity must manage the resources of our planet.

That thought at sea became the Ellen MacArthur Foundation, which has since helped define and champion the concept of the circular economy. Ellen's story is a reminder that efficiency, resilience and stewardship are not abstract ideals; they are survival principles. Just like in MacArthur's sailboat, success in industry increasingly depends on how intelligently we design, use and recover what we create. This perspective underpins the circular economy and the requirement for a practical, data-driven model that connects design, service and recovery into one continuous loop of value.

This whitepaper seeks to define what circularity means for the manufacturing industry, and the approaches companies must take to advance circular value chains.



The butterfly effect

Let's first begin by examining how resources are used and reused. One helpful mechanism to illustrate this is the Butterfly Diagram, created by the Ellen MacArthur Foundation to demonstrate how materials can circulate through the economy in continuous loops rather than moving linearly from extraction to disposal.

The model visualized two main systems:

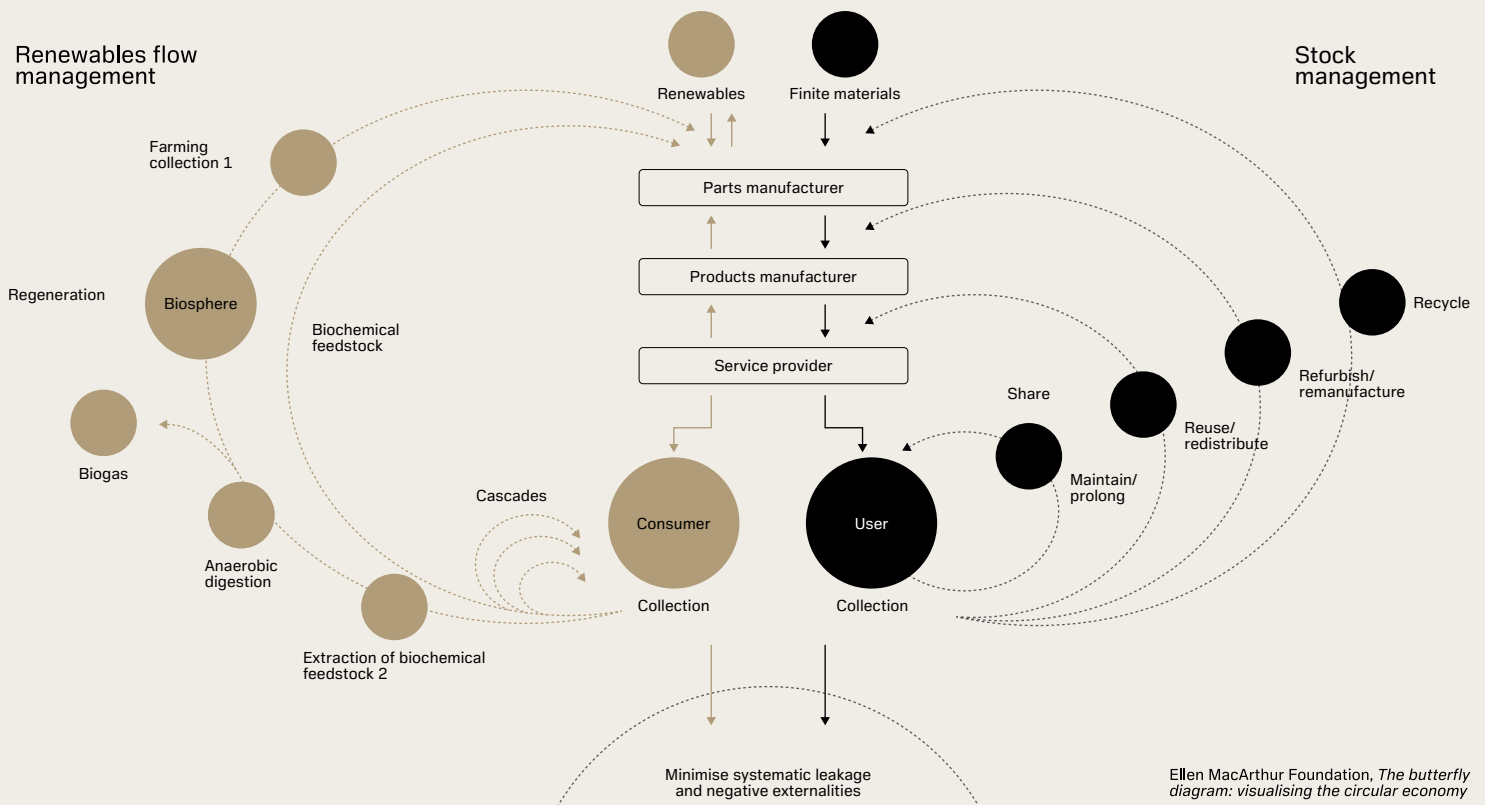
1. The biological cycle

Representing materials that can return safely to the biosphere. These are renewable resources such as organic matter, which can be regenerated through processes including composting, anaerobic digestion and farming. Here, value is preserved through natural regeneration processes, like returning nutrients to the soil or creating biogas.

2. The technical cycle

Representing manufactured products made from finite materials such as metals, alloys and plastics. These materials are retained in circulation through a hierarchy of strategies that maximize value and minimize waste:

- a. **Share:** Increase material use through shared access or leasing models
- b. **Maintain:** Prolong life through repair, maintenance or upgrades
- c. **Reuse:** Redistribute products to new users with minimal processing
- d. **Remanufacture:** Restore components to as-new condition
- e. **Recycle:** Recover raw materials for new production when other options are no longer viable



For industrial companies, this framework highlights where design, service and other recovery strategies can have the greatest impact. Every action that keeps materials circulating, whether that's through repair, remanufacturing or recycling, directly contributes to resource efficiency, lower emissions and business resilience.

Exploring circular business models

Achieving a circular value chain relies on multiple strategies. While prioritizing recycling and repairing worn components are valid, important parts of circularity, they are pieces of a much wider picture. We can categorize the key circular enablers into four distinct areas:

Traceability

Knowing where materials are during every stage of their lifecycle

Data sharing

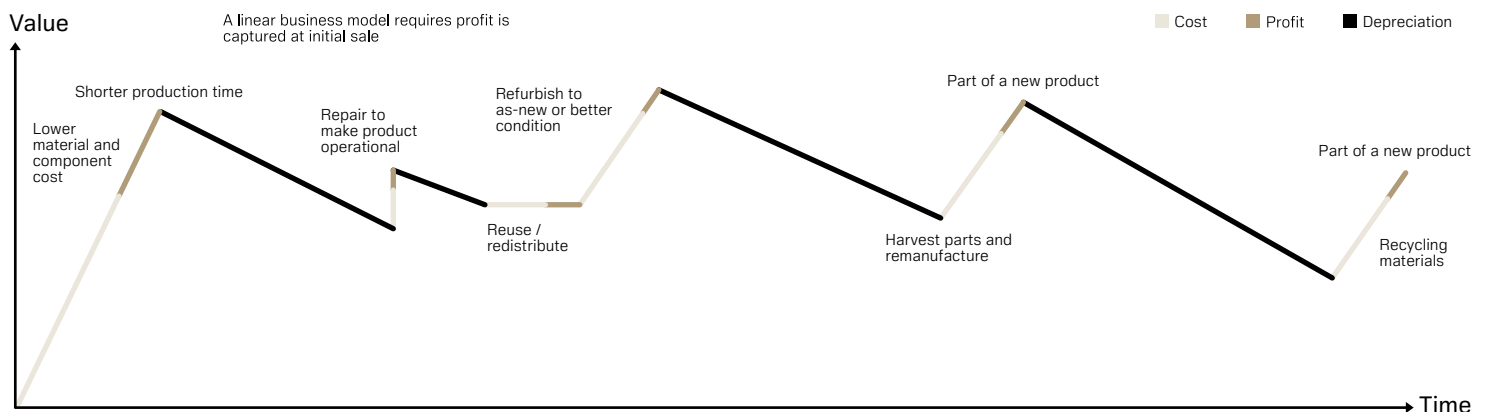
Backing up decisions with the correct data, and using it to inform best practice

The right partners

Expanding a product or material's ecosystem with experts who are on board with circular practices and can continue its journey in the supply chain

Strategy inclusion

Circularity makes business sense; it must be integrated and aligned with wider technological and financial goals



Designing for circularity

Designing products to withstand wear and damage can help them last longer. This can be achieved through durable materials, protective coatings or resilient geometries.

Providing clear and transparent product information, supported by digital tracking and visibility into material origin and composition, helps other parts of the value chain make better decisions. With this information, it becomes easier to understand how products and components can be repaired, repurposed or recycled. This ultimately improves the effectiveness of circular processes and encourages more efficient use of materials.

Extending product life

Products should be built to remain in use for as long as possible through reconditioning, upgrades, repair or engineering support. Extending product life reduces the need for new materials while delivering sustained value to customers.

Service-based models

Instead of selling products outright, companies offer access or performance as a service. This encourages manufacturers to build longer-lasting products since they maintain responsibility for performance and maintenance. Examples include “product as a service” and “performance-based service”.

Resource recovery

At the end of product use, resources are reclaimed through recycling, repurposing or remanufacturing. This reduces raw material demand and promotes a closed-loop system within the value chain.

Business value in a circular business

Transitioning to circular business models is often viewed through the lens of sustainability, but the benefits extend far beyond that. When implemented effectively, it creates advantages across four interconnected areas: environmental, sourcing, customer and informational value.

Environmental value

By reducing the need for virgin raw materials, increasing the use of recycled or bio-based inputs and lowering waste, circular practices can support environmental performance. This contributes to compliance with tightening global sustainability targets and helps organizations demonstrate credible action towards both their own and wider goals.

Sourcing value

Materials recovered at the end of a product's life should not be treated as waste, but as assets that retain value. Secondary materials can help reduce reliance on volatile raw material markets to build a more stable and flexible supply chain, rooted in resource efficiency over resource depletion.

Customer value

Circular models encourage deeper and longer-term relationships with customers. Offering maintenance, upgrades and performance-based services promotes loyalty and retention, while high-quality, durable products protect brand reputation and customer satisfaction. Customers benefit from increased reliability, reduced downtime and solutions tailored to lifecycle outcomes rather than one-time transactions.

Informational value

A circular value chain generates data that did not previously exist. Retaining ownership or visibility of products throughout their lifecycles provides deeper insight into how equipment performs, how materials degrade and where improvements can be made. This information becomes a strategic asset that enables better product design, optimized service offerings and more accurate forecasting of materials available for recovery. The result is a feedback loop where every lifecycle informs the next, steadily improving performance and reducing waste over time.



Circularity is not only a sustainability strategy, but also a way to reduce tooling costs, secure critical materials, improve operational efficiency and simplify compliance reporting.

Market drivers and regulatory landscapes

The shift toward circular manufacturing is not emerging in isolation. It is being accelerated by a combination of material scarcity, economic risk, customer expectation and regulatory change. Manufacturers are increasingly operating in a world where linear production models no longer serve their needs. This isn't just from an environmental outlook, but also from strategic, financial and compliance perspectives.



Understanding these drivers provides essential context for why circular value chains are rapidly becoming an operational imperative.

These global policies explicitly report, and in some cases require, circular material flows:

- The EU's Critical Raw Materials Act (CRMA) sets specific, ambitious benchmarks to be achieved by 2030 to strengthen domestic supply chains and enhance a circular economy. These include at least 25% of the EU's annual consumption of strategic raw materials coming from recycled materials within the EU.
- Digital Product Passports (DPPs) will require manufacturers to disclose material origins, composition and end-of-life pathways, enabling traceability across the value chain.
- The EU's Directive on common rules promoting the repair of goods ((EU) 2024/1799) creates a robust framework to incentivize reconditioning, repair services and designed-in durability.
- Regulations such as the EU's Corporate Sustainability Reporting Directive (CSRD) expand the requirement for organizations to report on emissions, resource use, circularity performance and material footprints.

Why we must protect our resources

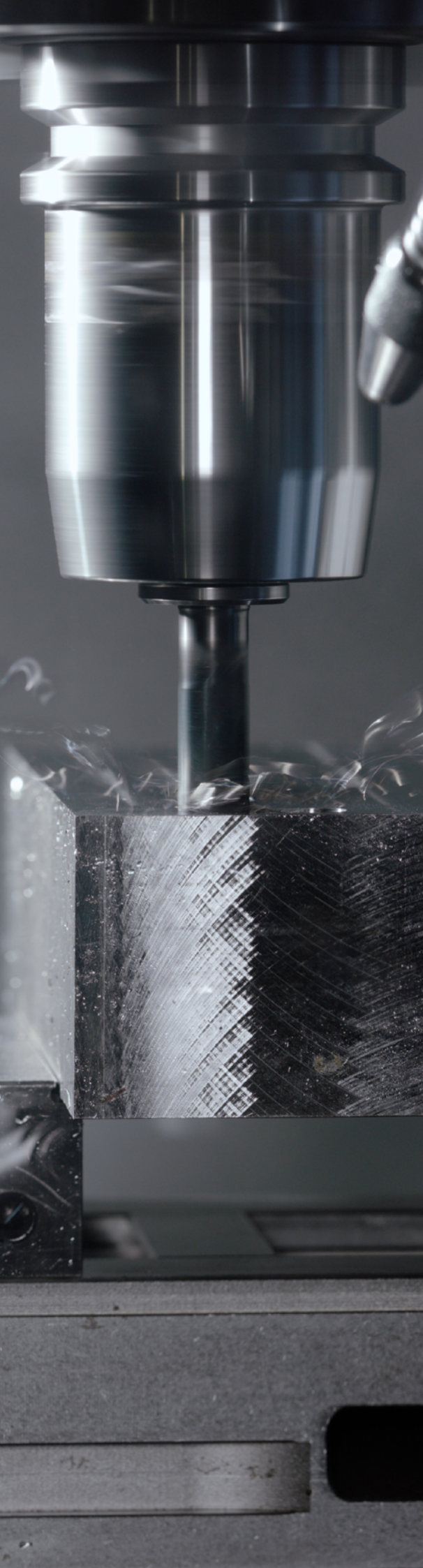
There are minerals and materials that remain essential in modern manufacturing. Metals such as tungsten, gold, tantalum and cobalt are critical in the production of durable, long lasting cutting tools and precision-engineered components. However, the availability of some of these finite materials is becoming increasingly constrained, with growing concerns around supply concentration, export controls and long-term access.

Their role in vital products and systems is undeniable, and so is our responsibility to manage their use with care and accountability. This includes ethical sourcing, which also hinges on the ability to recycle and repurpose materials to maximize their value.

Sandvik Coromant has set a goal to buy back 100% of used carbide tools by 2030 for recycling purposes. Our products, predominantly made from carbide — a compound of carbon and tungsten — face limited tungsten reserves, estimated to last about 100 years. By recycling used carbide from old metal cutting tools, we can manufacture new ones, minimizing the need for raw materials and reducing environmental impact.

As well as recycling tools at the end of their life, we must consider reconditioning them to extend their time in action. Our reconditioning centers extend the lifespan of solid round tools, such as carbide drills and end mills, restoring them to original quality and prolonging their total lifecycle. This process not only maximizes the utilization of raw materials in manufacturing but also reduces cutting tool costs for customers.





Sandvik Coromant's approach to tool recycling

Did you know that most of the raw materials used in our cemented carbide tools come from what many would call scrap?

Sandvik Coromant has encouraged the recycling of cemented carbide for several decades. Sandvik acquired Wolfram Bergbau und Hütten, a world-leading tungsten powder and tungsten carbide producer, in 1997 and launched a buyback scheme to recycle carbide material through the division that is used by Sandvik Coromant to this day.

Instead of allowing worn cutting tools to become waste, they are collected, processed and returned to production as high-quality inputs for new tooling.

The process begins at the customer's site, where used carbide inserts, drills and end mills are gathered through dedicated collection systems. Once returned, the material is refined using specialist recycling methods to separate and reclaim the precious carbides to near-virgin purity. These recovered materials are then reintroduced to new tool manufacturing, maintaining performance and reliability while significantly reducing the need for freshly mined resources.

This approach delivers value in three ways:



Resource efficiency

By reclaiming carbide material, demand for virgin tungsten and cobalt is reduced



Environmental benefit

Recycling consumes far less energy and generates fewer emissions than raw material extraction and processing



Economic resilience

Used cutting tools retain inherent material value — value that can be returned to the customer and reinvested into the manufacturing loop

Carbide tools from all manufacturers are accepted into Sandvik Coromant's recycling program.

Thanks to upgrades to the program in December 2023, Sandvik Coromant customers can benefit from a more streamlined and data-driven recycling process. Customers wanting to sell their recycled tools to Sandvik Coromant can log into an online portal and receive an instant price quote for the volume they are looking to recycle, as well as secure an order pick-up time and receive recycling boxes in advance. To help customers understand the impact their recycling efforts have on the environment, the portal also provides data on the amount of carbon emissions that have been reduced by the metal they have recycled.

10 Recycling in numbers

90%

of carbide in Sandvik Coromant tools will come from recycling by 2030

*Sandvik Coromant's ambition based on allocation method

Today, an average of over

50%

of carbide comes from recycled materials

*This is a conservative number of recycled materials

95%

of a used carbide insert can be recycled, with roughly three-quarters of this being tungsten

*Tungsten supplied via Wolfram Bergbau und Hütten AG

Making tools from recycled solid carbide requires

70%

less energy

*Related to the use of a Powder Reclamation by Zinc (PRZ) process to form tungsten, with data taken from the Furberg study

40%

less CO₂ is emitted

Over

90%

of cobalt is recycled

Some products contain over

70%

recycled material

*Relevant to some grades that are recycled with PRZ



The second life of tools

In the circular economy, a tool's lifecycle does not end at wear. It can be extended, renewed and re-entered into production — sometimes several times over.

The most common form, flank wear, results from friction against the workpiece surface and gradually affects accuracy and finish. Crater wear, often driven by high temperatures, can weaken the cutting edge. But while performance may diminish, the material value remains.

Wear does not signal the end of a carbide tool's usefulness. Sandvik Coromant operates specialist reconditioning centers across multiple regions, enabling consistent quality regardless of location.

Tools such as solid carbide drills and milling cutters can often be reconditioned multiple times. This approach lowers total tooling cost, improves sustainability and reduces demand for newly mined raw materials.

In four simple steps, customers can extract the most out of their machine tools while benefiting from cost savings of up to 50%:



1. Send an email to Sandvik Coromant to order a tool transportation box



3. Carefully pack tools into the specially crafted box, designed for protection during transportation



2. Select the tools to recondition.
Our tool wear guide can help customers identify whether tools are eligible



4. Once reconditioned, Sandvik Coromant will ship the tools back to the customer

Reconditioning Q&A

How long does reconditioning take?

Expect to wait around four weeks to receive your reconditioned tools.

Will all my tools be reconditioned?

A technical inspection will determine which tools are suitable for reconditioning and the team will mark and return any that cannot be regenerated. To ensure tools meet the criteria for reconditioning, you can learn more [here](#).

How can I track how many times my tools have been reconditioned?

When reconditioning, our team will add a laser mark to the tool shank to indicate when a reconditioning service has been performed. A tool's maximum number of regrinding (NORGMX) value is available by entering the tool's product number into the search bar on the Sandvik Coromant website.



Adjusting your sails

Moving toward circularity is not a single shift, but a series of practical decisions that change how resources are managed over time. Just as MacArthur needed to plan, monitor and adjust course continuously when at sea, manufacturers must navigate their resource flows with intention. Circularity is not achieved through one action, but through a system of connected practices that help maintain materials in circulation and preserve value. **The following roadmap provides a clear and structured way for organizations to begin.**



1. Assess current consumption and waste streams

Understand your current situation. In the context of metal cutting tools, you'll want to measure how many tools are purchased, how long they remain in use and what happens when they are no longer functional. This establishes a baseline for improvement and reveals where material and financial value is being lost.

2. Map material flow

Next, trace the journey of materials from sourcing, through production, to end-of-life. Mapping these flows makes it possible to identify where resources leak out of the system and where recovery or reuse could be introduced.

3. Introduce data-based tracking

Circularity depends on information. By tracking tools and collecting data on wear patterns, manufacturers can determine the optimal point for maintenance, reconditioning and replacement.

4. Embed reconditioning and recycling

With data in place, tool life can be extended through systematic reconditioning. Tools that can no longer be restored should be collected for recycling or buy-back. This is where the loop closes: materials are not lost, but returned to the beginning of the cycle. Here is where you can begin to see economic gains, too.

5. Establish performance metrics

To make progress measurable, set internal KPIs that reflect circular outcomes, such as:

- **Percentage of tools reconditioned per year**
- **Reduction in end-of-life waste or disposal cost**
- **Carbon savings linked to recycling**

These metrics help ensure circularity is not aspirational, but operational.

6. Strengthen collaboration

Circular systems work best when they extend beyond the boundaries of a single organization. Manufacturers, distributors, recyclers and customers play linked roles in the material lifecycle. Establishing shared processes reinforces resilience and improves outcomes for all parties.

The transition from a linear to a circular manufacturing model is no longer an abstract ambition – it is a practical, data-driven necessity. As this whitepaper has shown, circularity is built on systems that preserve materials, extend product life and strengthen resilience across the value chain. It requires visibility, collaboration and a deliberate shift in how products are designed, used and recovered.

For manufacturers, the path forward is clear. Circularity offers not only environmental benefits, but also strategic advantages: reduced reliance on finite raw materials, deeper customer relationships, expanded service opportunities and a richer understanding of material flows. These combined strengths position circular businesses to operate with greater stability and competitiveness in an increasingly resource-constrained world.

Ultimately, circularity is about designing a future where materials retain their value, businesses operate with greater foresight and innovation, and resources are protected for generations to come. Like navigating an ocean voyage, progress relies on clear direction, continuous adjustment and shared responsibility. By embracing circular practices today, manufacturers can build a more resilient industrial landscape for tomorrow.

Learn more about Sandvik Coromant's approach to circular business by visiting [**sandvik.coromant.com/about-us/sustainable-business/circularity**](https://sandvik.coromant.com/about-us/sustainable-business/circularity).

