Interreg Danube Region

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Plan-C

# Plan-C

## THE CIRCULAR MACHINE LIFE CYCLE PHASES

**The life of a machine does not start when it leaves the factory and it should not end when it stops working.**
In a circular system, machines are designed and managed **to keep materials, components, and value in use for as long as possible.** This approach replaces the "sell and replace" model with one that prioritizes **repair, upgrading, refurbishment, remanufacturing, and efficient material recovery** as standard business practices.

### Why the circular machine life cycle matters

For machine producers and users, circularity brings practical benefits:

- **Longer machine lifetime** and better utilisation of assets
- **Less downtime** through predictive maintenance and planned servicing
- **Lower total cost of ownership** by extending use phases and avoiding premature replacement
- **Stronger resilience** against raw material price volatility and supply risks
- **New revenue streams** through services, upgrades, take-back and second-life markets

Circularity is therefore not only a sustainability topic — but also a **competitiveness strategy.**

## The 8 phases of a circular machine life cycle

Each phase offers concrete opportunities to keep value in the loop.

### 1) Design & Development

Circularity starts at the drawing board. The strongest lever is designing machines to be long-lasting and easy to improve over time.

**Key approaches:**

- **Design for longevity:** durable materials, robust construction, extended lifespan targets
- **Modular design:** machines built from modules that can be replaced, upgraded or reconfigured
- **Design for disassembly:** easy separation into components for repair, refurbishment or recycling
- **Standardised parts:** easier service, faster repairs, compatibility across product generations
- **Eco-design:** energy efficiency and lower environmental impact across the whole lifetime

### 2) Material Sourcing

Material choices influence both performance and end-of-life potential. Circular sourcing reduces dependence on virgin materials and strengthens regional loops.

**Key approaches:**

- Increase the use of **recycled and renewable materials** where feasible
- Ensure **traceability** of materials and components across the supply chain
- Build a **closed-loop material system** with suppliers and recyclers
- Strengthen partnerships for **high-quality secondary raw materials**

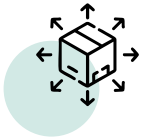
### 3) Manufacturing & Assembly

Production is a major point for efficiency gains. Circular manufacturing aims to reduce waste and enable component life extension.

**Key approaches:**

- **Lean manufacturing** to minimise waste, scrap and energy use
- **Additive manufacturing (3D printing)** for on-demand parts and localised repair
- **Remanufacturing** for restoring used machines/components to “like-new” condition
- **Process optimisation** to reduce material losses and improve yield

## 4) Distribution & Logistics



Logistics is often overlooked, yet it is critical — especially for future take-back and reverse logistics systems.

**Key approaches:**

- **Optimise transport** routes, loads and packaging to reduce emissions
- Encourage **local production/distribution** wherever possible
- Introduce **reusable or returnable packaging** solutions
- Plan reverse logistics (take-back, spare parts, refurbishment)

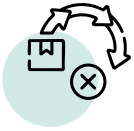
## 5) Use Phase & Maintenance

This is where circularity becomes visible in day-to-day operations. Extending use phases is one of the highest impact actions in machinery.

**Key approaches:**

- **Predictive maintenance** using IoT/AI to prevent failures and reduce unplanned downtime
- **Service programs** that ensure timely maintenance and performance optimisation
- **Upgrading and retrofitting** with latest technology instead of replacing whole machines
- **Shared use / leasing** models to increase utilisation rates

## 6) End-of-Life Management



In a circular system, “end-of-life” is not the end — it is the start of the next loop. The goal is to capture value before it becomes waste.

**Key approaches:**

- Establish **take-back schemes** and clear end-of-life pathways
- Implement **reverse logistics** to return machines/components to producers or service hubs
- Improve **recycling and material recovery** processes, especially for high-value parts
- Introduce **Product-as-a-Service (PaaS)** to keep ownership and lifecycle responsibility with the manufacturer

## 7) Refurbishment & Reuse

Refurbishment gives machines multiple lives and supports a strong second-hand market. This creates jobs and regional value while cutting resource use.

**Key approaches:**

- **Encourage component reuse** in new or refurbished equipment
- Establish structured **refurbishment programs** with quality assurance and certification
- Create marketplaces for **refurbished/second-hand machines**
- **Build customer** trust through transparency, standards and guarantees

## 8) Waste Management

Zero Waste to Landfill is the aim supported by strategies for recycling, composting or other waste management techniques.

**Key approaches:**

- **Zero Waste to Landfill** ambitions through recovery, recycling and reuse
- Invest in **material recovery facilities** and regional processing capacity
- Where relevant: explore **low-impact / biodegradable or compostable** components
- Support industrial symbiosis where one sector's waste becomes another's treasure

*Let's keep machines—and their value—in the loop.*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