Circular Economy

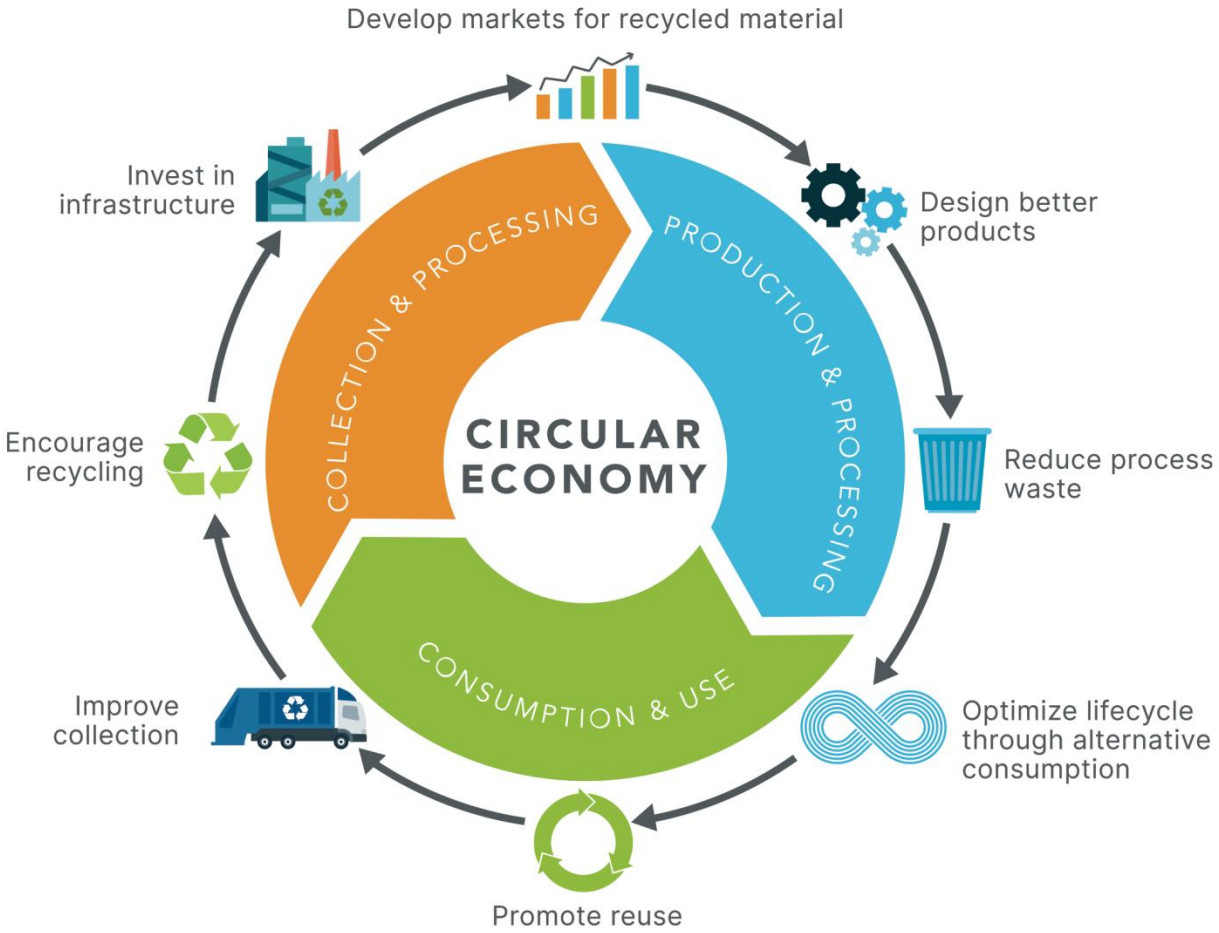
Drivers, Regulations and the Path Forward

ESTAINIUM Association

CLIMATE CONNECTION

Starting Point: This is circular economy

From a linear to the circular system



Definition
"The circular economy is a model of **production** and **consumption**, which involves **sharing**, **leasing**, **reusing**, **repairing**, **refurbishing** and **recycling** existing materials and products **as long as possible**. In this way, the life cycle of products is extended." (EU)

It aims to reduce
- waste
- EU's dependency of imported materials
- EU's vulnerability to geopolitics
- environmental damages by mining minerals
- CO_2e emissions through mining and transporting

It enhances
- business resilience
- new business models

Source: https://pressbooks.bccampus.ca/cicancarpentryproject/chapter/circular-economy-and-life-cycle-approach/

The 9R-strategy breaks down circular economy into 9 distinct levels

R0 Refuse

Avoid unnecessary products & functions

R1 Rethink

Intensify use, sharing models

R2 Reduce

Resource efficiency in manufacturing

R3 Reuse

Products reused by other users

R4 Repair

Restore defective products to working condition

R5 Refurbish

Restore & update old products

R6 Remanufacture

Use components for equivalent new product

R7 Repurpose

Use parts in a different product

R8 Recycle

Recover material, maintain quality

R9 Recover

Energy recovery from materials

Four central drivers explain the current attraction to circularity; circular economy is becoming a central field of action for businesses

Regulation

- 2020: EU Circular Economy Action Plan (CEAP)
- 2024: EU Critical Raw Materials Act (CRMA)
- 2024: Ecodesign for Sustainable Products (ESPR)
- 2024: Industrial Emissions Directive 2.0 (IED 2.0)
- 2024: Packaging & Packaging Waste Regulation (PPWR)

Economics

- Raw material price volatility & supply risks
- New business models: Product-as-a-Service
- Lower production costs through efficiency
- Growing attractiveness for ESG investors
- Competitive advantage via circular design

Ecology

- 45% CO_2 reduction potential through CE
- Preserving natural resources & biodiversity
- Reducing waste & plastic pollution
- Global climate targets (Paris Agreement)
- Corporate carbon footprint reduction

Geopolitics

- Critical raw materials: import dependencies
- Resource nationalism & export restrictions on critical minerals
- Nearshoring & supply chain resilience
- Strategic autonomy through resource efficiency
- Trade conflicts as accelerators

Regulation: EU follows a strict course to foster circular economy

Snapshot of upcoming regulation

Legislative Act	Content & Circularity Relevance	Applies / In Force	Status
IED 2.0 (Industrial & Livestock Rearing Emissions Directive)	Tightens industrial emission limits and integrates lifecycle thinking. Relevant for CE in industrial processes: energy efficiency, waste minimisation, best available techniques (BAT). Only partially relevant to circularity — focus on emissions, not material flows.	In Force	Transposition by 2026
Critical Raw Materials Act (CRMA)	Reduces EU dependency on imported CRMs (lithium, cobalt, rare earths). Sets benchmarks: 10% domestic extraction, 40% processing, 25% recycling of annual consumption by 2030. Mandatory CE element: strategic raw material recycling targets directly tied to circular loops.	In Force	Since Mar 2024
Industrial Accelerator Act	Streamlines permitting and investment for clean industrial manufacturing. Supports scale-up of recycling infrastructure and circular manufacturing hubs. Complements CRMA and ESPR by enabling faster deployment of CE-enabling technologies.	Proposed	Proposed 4 Mar 2026 negotiations ongoing
Circular Economy Act	Aims to double the EU's circularity rate from 12% to 24% by 2030 by creating a Single Market for secondary raw materials. Harmonises EPR schemes, reforms Waste Framework and WEEE Directives, sets end-of-waste criteria, and introduces mandatory circularity criteria in public procurement.	Proposed	Should come into force in 2026
Right to Repair Directive	Obliges manufacturers to offer repair services and supply spare parts for min. 10 years. Bans design features that obstruct repair (e.g. software locks, non-standard screws). Repairability requirements feed into ESPR product scores. Boosts product lifespans — core R4 strategy.	In Force	Since July 2024; transpose by 2026
ESPR (Ecodesign for Sustainable Products Regulation)	Cornerstone CE product regulation. Mandates Digital Product Passport (DPP), minimum recycled content, repairability index, restricted substances, and end-of-life design requirements. Applied via product-specific Delegated Acts. Deep dive: next slide.	In Force	Since July 2024; Delegated Acts rolling
PPWR (Packaging & Packaging Waste Regulation)	Replaces Packaging Directive. 100% recyclability grades required by 2030; grades A & B only by 2038. Mandatory recycled content thresholds for plastics. Harmonised recyclability labelling from 2028. Deep dive: next slide.	In Force	Since Feb 2025; phased obligations

Regulation: Timeline of circular economy-based EU-regulations

Packaging and Packaging Waste Regulation (PPWR)

2025	2026	2028-29	2030	2035	2038
• Regulation published in Official Journal • **PPWR** enters into force	General application begins after **18-month** transition (August, 12th)	Harmonised **labelling** becomes **mandatory**	• Only **packaging** with recyclability grades (**A-C**) **permitted** on the EU market • Thresholds for recycled content apply for plastic packaging	**Recyclability** must be demonstrated in practice at scale	Only **packaging** grade **A & B permitted** on the EU market; **all other** packaging grades are **prohibited**

Ecodesign for Sustainable Products Regulation (ESPR)

2020	2024	2025	2026	2030
Circular Economy Action Plan adopted	ESPR entered into force	• First ESPR working Plan adopted and published • Acts on digital product pass registry, service provides, data carriers and digital cedentials expected	• New digital registry for unique identifiers • Prohibition of destroying certain unsold products (large companies)	Prohibition of destroying certain unsold products (mid-sized companies)

HOW ESPR WORKS: DELEGATED ACTS

The ESPR sets broad product sustainability goals but implements them through product-specific Delegated Acts — secondary legislation issued by the European Commission. Each Delegated Act targets one product group (e.g. textiles, electronics, furniture) and defines precise requirements: minimum recycled content, repairability scores, restricted substances, Digital Product Passport data fields and end-of-life obligations. Companies must monitor the pipeline and adapt product design well before a Delegated Act enters into force.

Regulation: The many upcoming rules have general baselines; only adjusted product-specific

Three layers of circular economy regulation businesses must prepare for:

Information Requirements

Material Origin

Disclosure of raw material sourcing, country of origin, and supply chain traceability

Recycled Content (PCR)

Reporting of post-consumer recycled material share per product or component

Product Carbon Footprint (PCF)

Lifecycle CO2 emissions per product unit, scope 1-3 coverage required

Critical Raw Materials (CRM)

Identification of CRMs as listed in EU CRM Act; sourcing alternatives required

Hazardous Substances

Flag and disclose environmentally incompatible substances (SVHC, PFAS, heavy metals)

Technical Requirements

Digital Product Passport (DPP)

Machine-readable data carrier covering full lifecycle from design to end-of-life

Standardised Supply Chain Data

Common data formats (e.g. Catena-X, GS1) enabling interoperability across value chains

Traceability & Verifiability

Audit-proof documentation of material flows, processes and supplier declarations

Data Containers & Interfaces

Open APIs for data exchange; compatible with European data spaces (Gaia-X)

Third-Party Verification

Independent auditing of claims; conformity declarations and certifications

Design Requirements

Modular Construction

Products must be designed for disassembly, part replacement and upgradeability (ESPR)

Recyclability Improvement

Minimum recyclability rates; design choices must not impede material recovery

Repairability Index

Mandatory repairability scores; spare parts & repair info available for min. 10 years

Reduce Hazardous Inputs

Phase-out of substances that hinder recycling or harm the environment

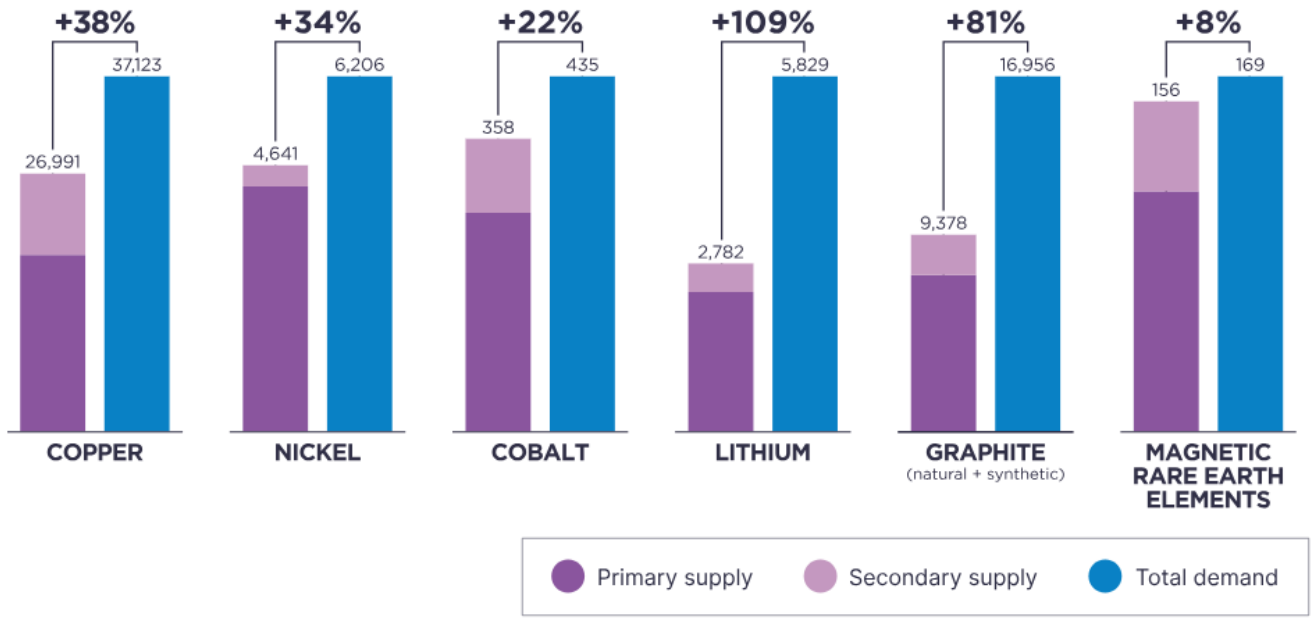
Reduce CRM Dependency

Design-out of critical raw materials sourced outside the EU; substitution roadmaps

Source: ESPR (EU) 2024 | PPWR | CSRD 2022/2464 | EU CRM Act 2023 | REACH | Catena-X | Gaia-X

Economics: The transition to clean energy and electrification of the global economy represents a fundamental shift from fuel-intensive to a materials-intensive system

Demand for many critical minerals is projected to exceed supply in 2035 (Kt p.a)



SOURCE: SYSTEMIQ ANALYSIS DRAWING ON INTERNATIONAL ENERGY AGENCY CRITICAL MINERALS DATA EXPLORER (2024)

Recycling and circularity are no longer optional — We need it for our energy transition

Even with maximum primary extraction, the supply gap cannot be closed by mining alone.

Scaling secondary supply through:

- Circular design
- Take-back & return systems
- Urban mining

...is the only viable path to material security for the green transition.

Economics: Volatile prices of critical minerals make circular economy a competitive necessity

Source: Trading Economics

Ecology: A more circular economy would reduce CO_2 emissions significantly

Planetary boundaries are being crossed — circular economy is the systemic response

45%
CO2 reduction via circular economy

>90%
Biodiversity loss driven by resource extraction

8 bn t
Plastic in oceans by 2050 without action

3x
Rise in global material use since 1970

Climate Change & CO_2

- 55% of global GHG emissions stem from production of goods & food (Ellen MacArthur Fdn.)
- Circular strategies (longer use, remanufacturing, recycling) can cut industrial CO2 by up to 45%
- EU target: climate neutrality by 2050 — CE is a core pillar of the Green Deal
- Scope 3 emissions increasingly regulated; circular sourcing reduces upstream footprint

Biodiversity & Land Use

- Resource extraction is the primary driver of >90% of biodiversity loss (IPBES 2019)
- Mining, logging & agriculture destroy habitats — circular loops reduce primary extraction needs
- EU Biodiversity Strategy 2030 links circular economy to nature restoration targets
- Reduced virgin material demand = less land conversion, deforestation & ecosystem degradation

Waste & Pollution

- 2.3 billion tonnes of municipal solid waste generated globally per year (World Bank 2023)
- Plastic production set to triple by 2060 without policy action (OECD Global Plastics Outlook)
- Microplastics detected in human blood, lungs and placentas — a systemic health risk
- Circular design eliminates waste at source rather than managing it at end-of-life

Resource Scarcity & Water

- Global material use has tripled since 1970; will double again by 2060 (UNEP IRP)
- Water footprint of linear production is enormous — CE significantly reduces water-intensive mining
- Circular economy could reduce global primary material consumption by 28% by 2050 (Circle Economy)
- Planetary boundaries for freshwater, nitrogen and land already breached (Stockholm Resilience Centre)

Source: Ellen MacArthur Foundation | IPBES Global Assessment 2019 | OECD Global Plastics Outlook 2022 | UNEP IRP | Circle Economy (2023) | Stockholm Resilience Centre | World Bank 2023

Geopolitics: Political instability, trade disputes and military conflicts significantly challenge supply chain stability; self sufficiency is the key

2020	2021	2022 (ongoing)	2023 - 2025	2026
COVID-19 pandemic	Suez canal blockage	• Russia's full-scale invasion of Ukraine • US LNG as a new dependency for Europe	Israel and Hamas conflicts attacking shipping routes in the Red Sea and Bab el-Mandeb strait	Strait of Hormuz blockage

Consequences:
Increased supply chain risks, persistently high and volatile energy prices (fossil fuels), rising production costs and inflationary pressure, reduced industrial competitivess, investment uncertainties, …

Solution:
Scaling up renewable energy as the core pillar, building circular economy to reduce resource and energy demand, securing ciritcal raw materials through innovation and circularity, boosting energy efficiency, …

Building independence energy, material and therefore strategic independence (self-sufficiency) will secure competitiveness, resilience and sovereignty!

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