



MICRO-CREDENTIAL

CIRCULAR ECONOMY FOR LAND AND WASTE MANAGEMENT

5.- Waste Prevention and Eco-Design

Eco-design principles

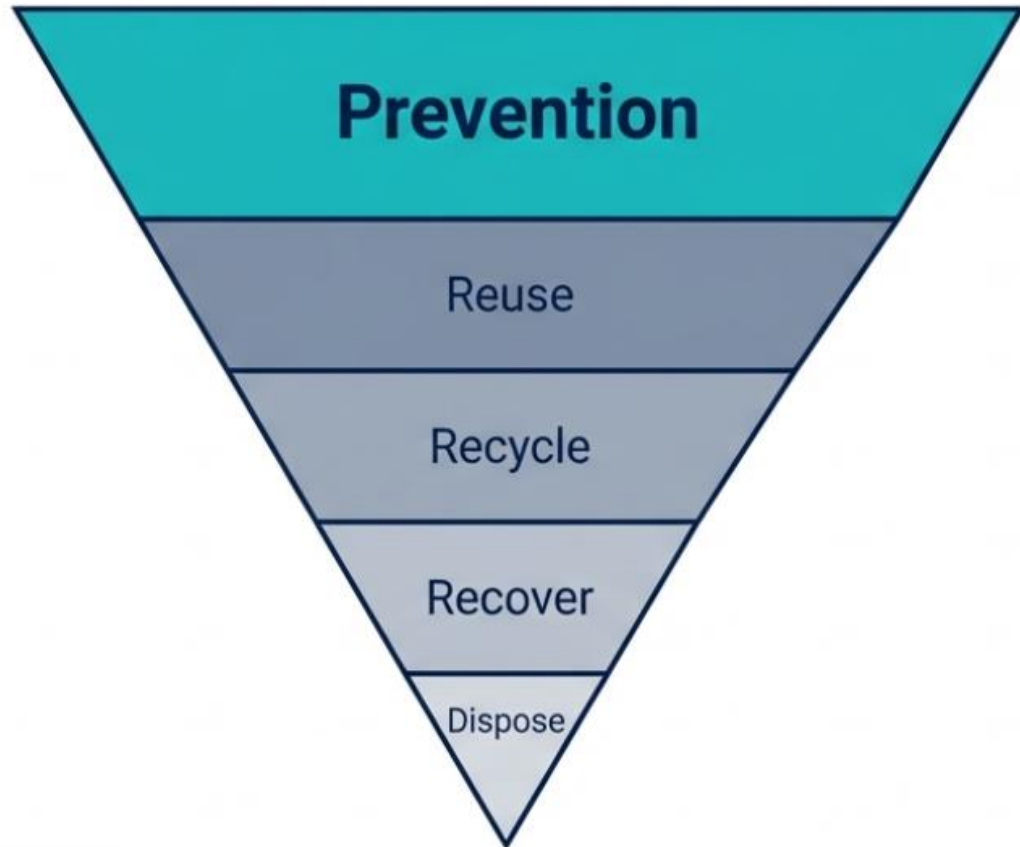
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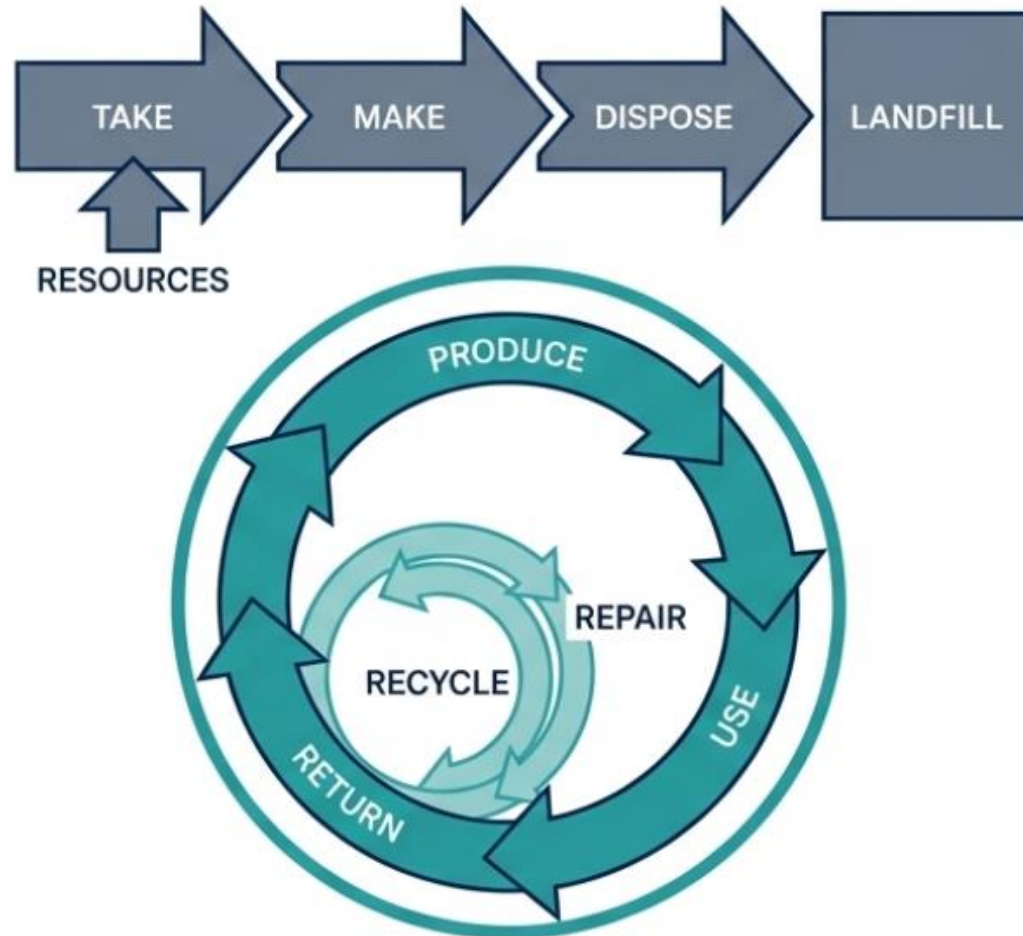


Waste Prevention as Highest Priority



- **Highest level in waste hierarchy:** The most effective intervention point.
- **Before waste generation:** Eliminating the concept of waste entirely.
- **Responsibility of producers/designers:** Shifting focus from downstream waste managers to upstream creators.
- **Reducing volume and toxicity:** Qualitative and quantitative source reduction.

Reiteration of Shift from Linear to Circular Systems

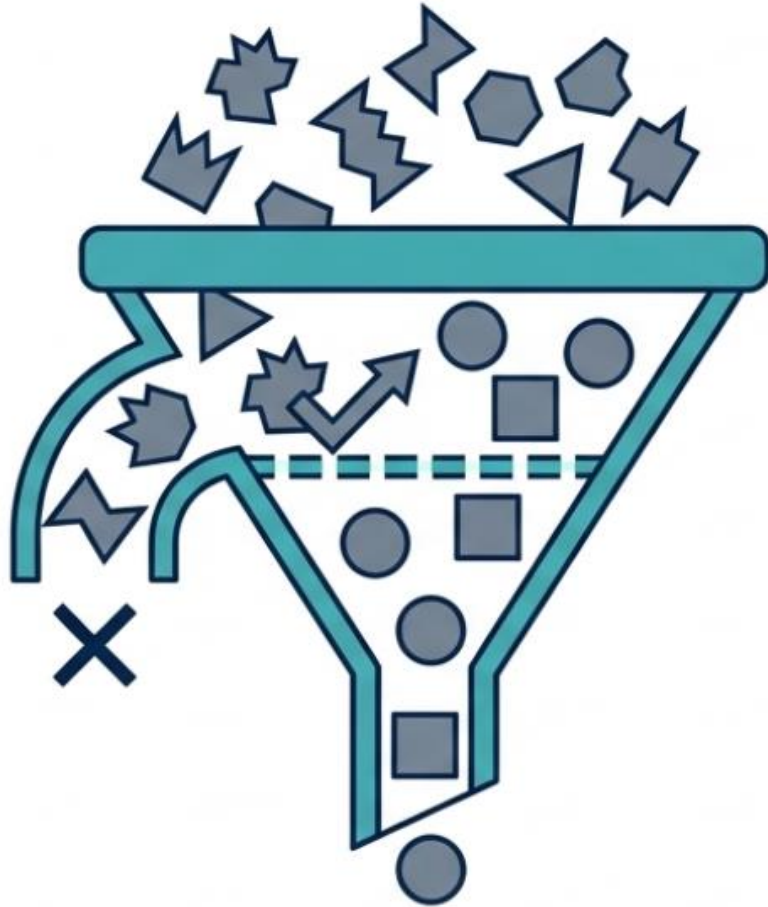


- **Take–make–dispose model:** Relies on infinite resources and infinite sinks.
- **Waste as externality:** Environmental costs are unpriced and ignored.
- **Circular closed loops:** Materials are retained at their highest utility.
- **Decoupling growth from resources:** Economic value creation without raw material depletion.

Concept of Eco-design: Definition and Perspective

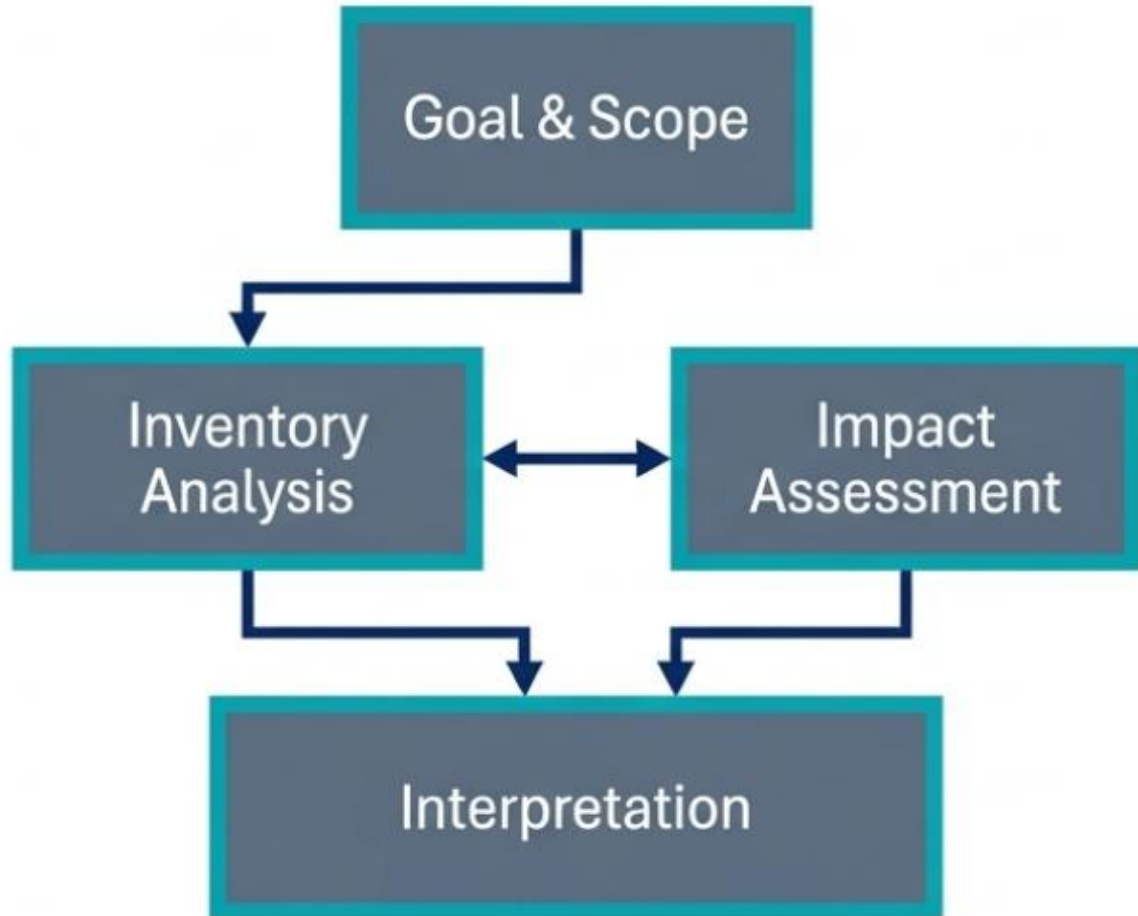


- **Lifecycle-based design approach:** Holistic view of the product's entire journey.
- **Environmental criteria integration:** Balancing ecology with cost and performance.
- **Shift from end-of-pipe:** Moving away from treating pollution after it is created.
- **Root-cause intervention:** Solving systemic flaws at the drawing board.



- **Pre-manufacturing decisions:** Dictating up to 80% of a product's environmental impact.
- **Material selection importance:** Prioritizing abundant, non-toxic, and renewable inputs.
- **Compatibility with loops:** Designing for designated biological or technical recovery.
- **Enables reuse and recycling:** Standardizing components for easy disassembly.

Lifecycle Thinking: Environmental and Monetary Flows

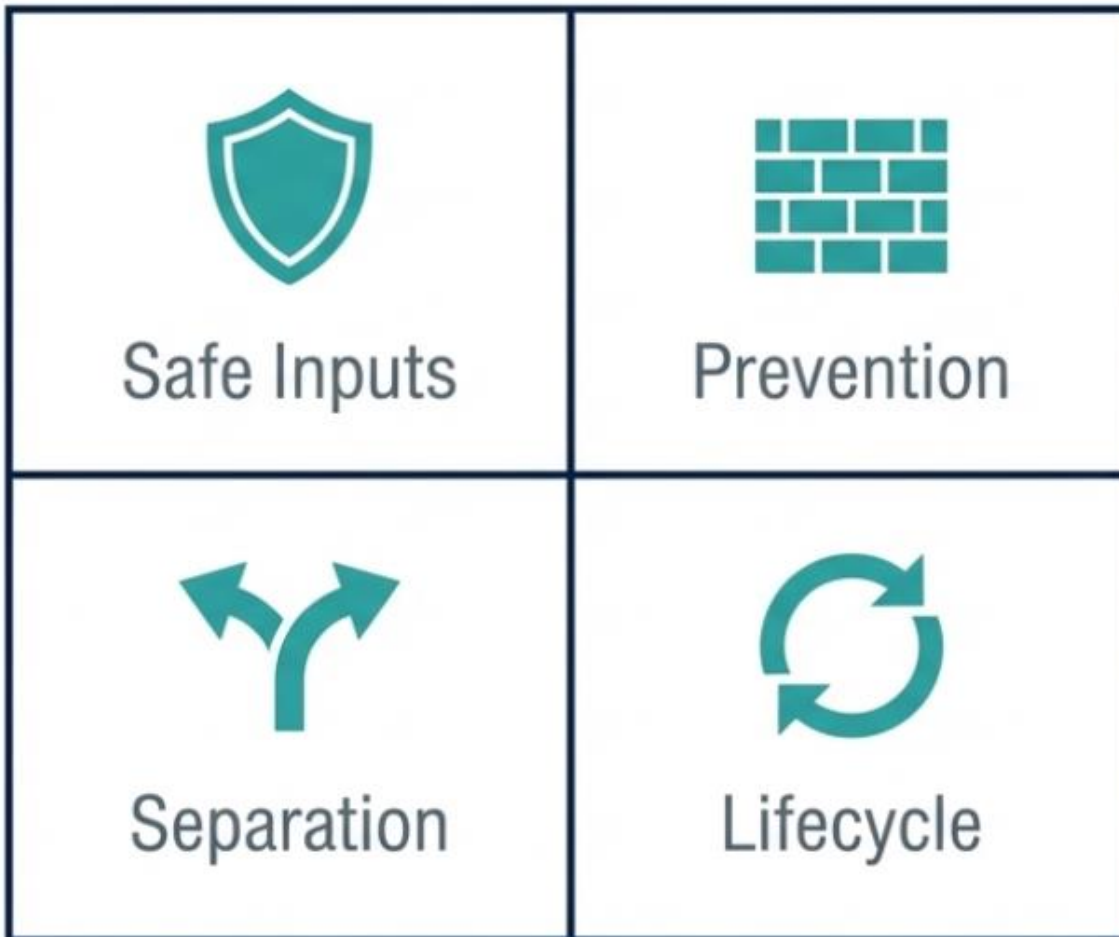


- Cradle-to-grave assessment: Tracking environmental loads from extraction to final disposal.
- Environmental and economic flows: Quantifying inputs (energy, water) and outputs (emissions, waste).
- System-wide evaluation: Establishing functional units for accurate comparisons.
- Avoiding problem shifting: Ensuring improvements in one phase don't cause damage in another.



- **Circular regeneration model:**
Moving beyond 'less bad' to fundamentally restorative design.
- **Biological vs technical cycles:**
Separating compostable organics from durable synthetics.
- **Waste equals resource:** Every output must become a safe input for another process.
- **Continuous material use:**
Eliminating the concept of a 'grave' entirely.

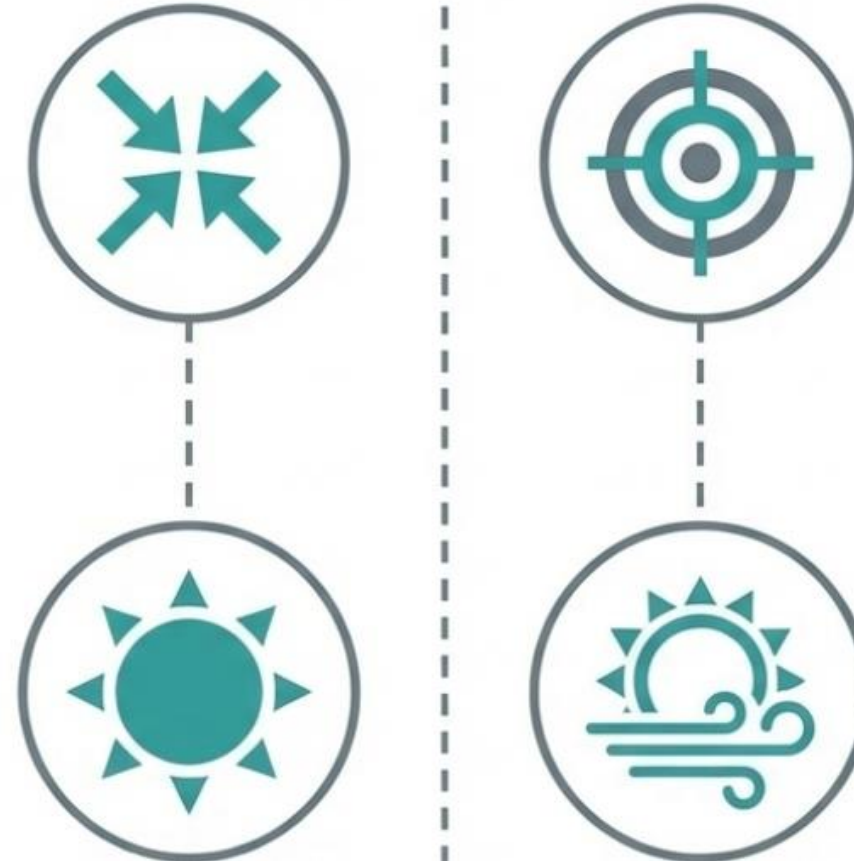
Principles of Green Engineering: Core Tenets



- **Non-hazardous materials:** Inherently safe molecular composition.
- **Prevention over treatment:** Designing out the need for scrubbers or hazardous waste management.
- **Safe recovery systems:** Ensuring disassembly does not expose workers or nature to toxins.
- **Design-stage decisions:** Locking in sustainability before capital is deployed.

Principles of Green Engineering: Efficiency and Inputs

- **Resource efficiency:** Maximizing functional output per unit of input.
- **Output-driven production:** Pull-manufacturing to eliminate overproduction waste.
- **Renewable inputs:** Transitioning from fossil energy and finite minerals to solar and biomass.
- **Reduced emissions:** Designing processes that inherently generate less CO₂ and pollutants.



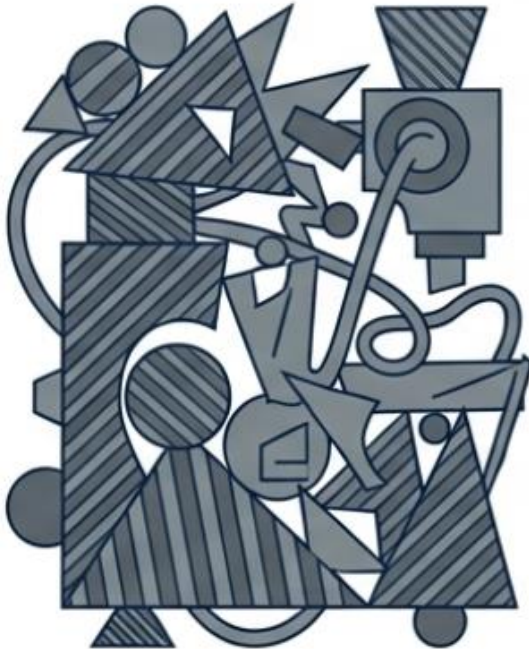
Risks of Contamination in Biological and Technical Cycles



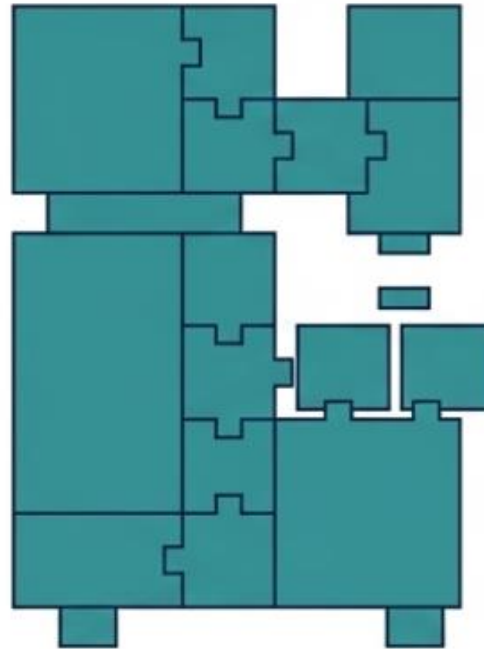
- **The Monstrous Hybrid:** Combining technical and biological materials (e.g., poly-cotton blends or paper lined with plastic) creates products that cannot be easily separated.
- **Value Destruction:** Cross-contamination prevents materials from safely composting or effectively recycling, forcing them into landfills or incinerators.
- **Design Imperative:** Material purity and ease of disassembly must be prioritized to preserve the integrity of both cycles.

Designing Out Waste: Structural Strategies

Complex



Simplified



Functional Output: Identical

- Less material per product: Dematerialization and digital substitution.
- Elimination of toxic inputs: Phasing out heavy metals and persistent chemicals.
- Simplified structures: Reducing the number of unique substrates and polymers used.
- Design for recovery: Incorporating standardized fasteners for rapid end-of-life disassembly.

Traditional Heavy Design



Material Volume



Transport Fuel



Production Energy



Lightweighted Design



Material Volume



Transport Fuel

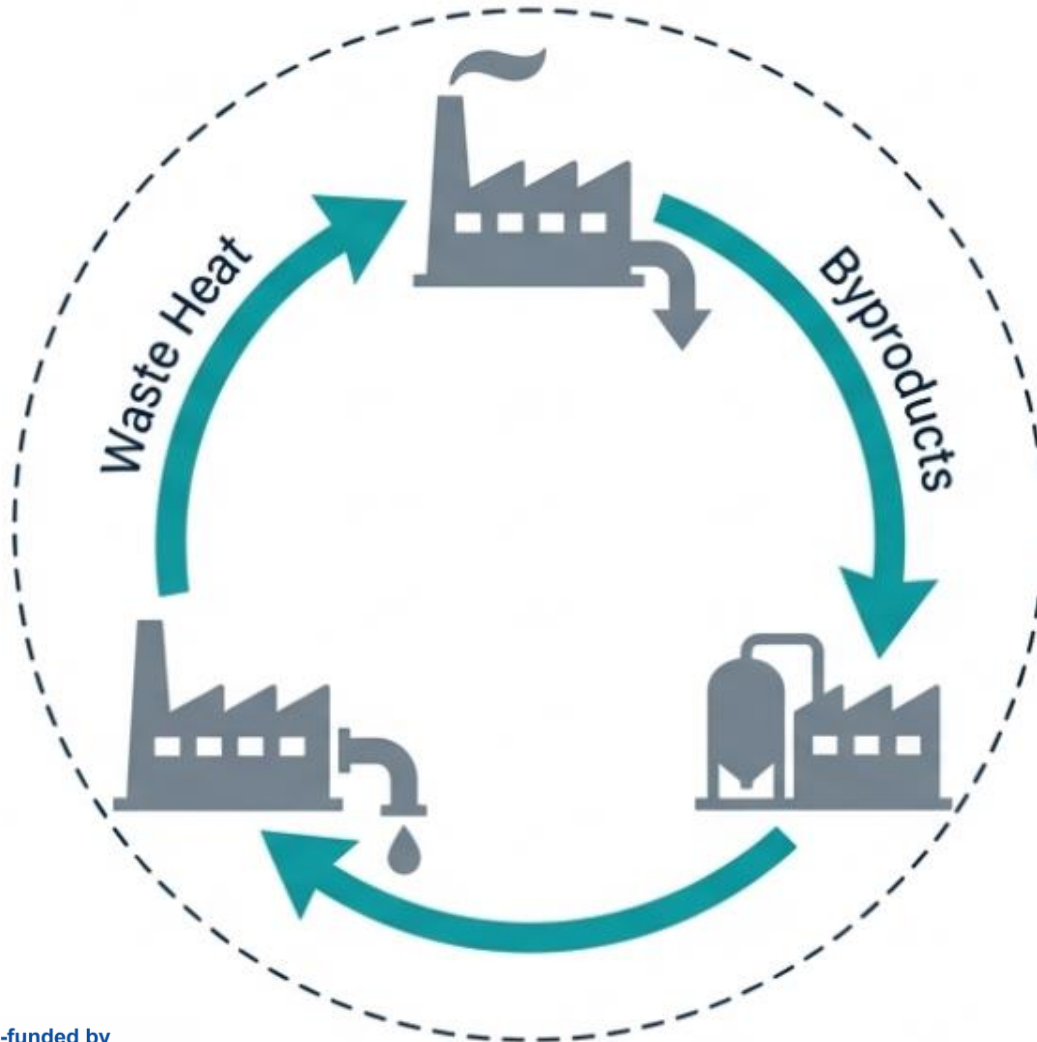


Production Energy

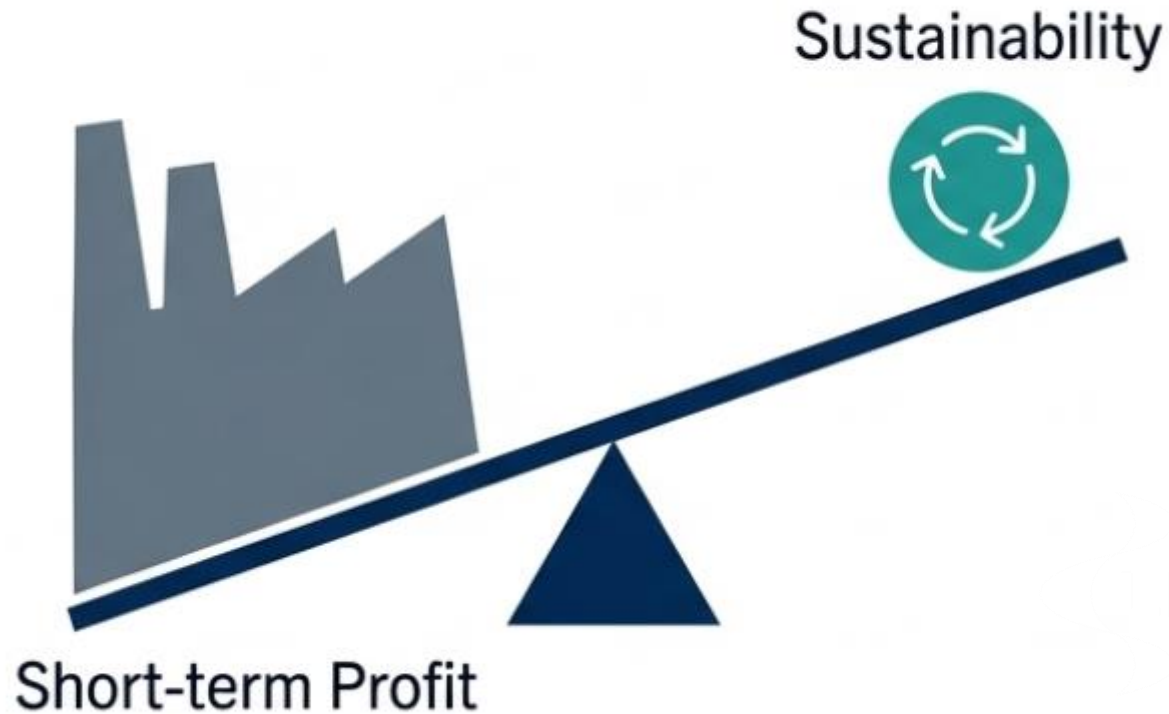


- **Source Reduction:** Using less material per product inherently reduces raw extraction and production waste.
- **The Cascading Benefit:** Lighter products require less energy to manufacture, demand less fuel during distribution, and result in lower end-of-life mass.
- **Functional Optimization:** Lightweighting often improves performance (e.g., in transport equipment and electronics) while shrinking the environmental footprint.

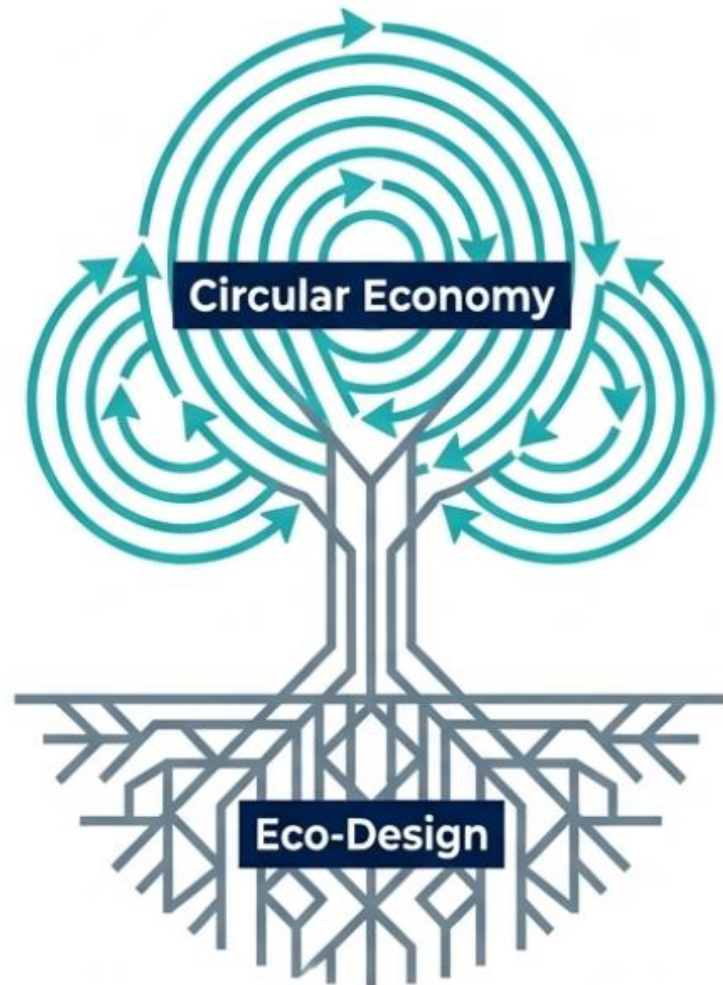
Industrial Symbiosis: System Interconnectivity



- **Waste as resource:** One facility's unusable byproduct is another's primary feedstock.
- **System interconnectivity:** Geographic clustering (Eco-Industrial Parks).
- **Closed-loop industry:** Elevating circularity from the micro (product) to meso (industry) level.
- **Example:** Exchanging excess steam, wastewater, or organic sludge between distinct corporate entities.



- **Market failures:** Virgin materials are often artificially cheaper than secondary recovered materials.
- **Misaligned incentives:** Producers rarely bear the financial cost of end-of-life disposal.
- **Technical limitations:** Complex alloys and laminates remain thermodynamically difficult to separate.
- **Knowledge gaps:** Lack of data sharing and lifecycle metrics across fragmented supply chains.



- **Design determines circularity:** You cannot recycle your way out of bad design.
- **Prevention before waste stage:** True sustainability requires upstream architectural shifts.
- **Foundation for circular strategies:** Enables repair, refurbishment, and high-value recycling.
- **Transition to durability:** Moving global markets from planned obsolescence to enduring value.



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5.- Solid Waste Streams and Material Flows

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