ISEG /Universidade de Lisboa

SD
Circular Economy
2025/2026

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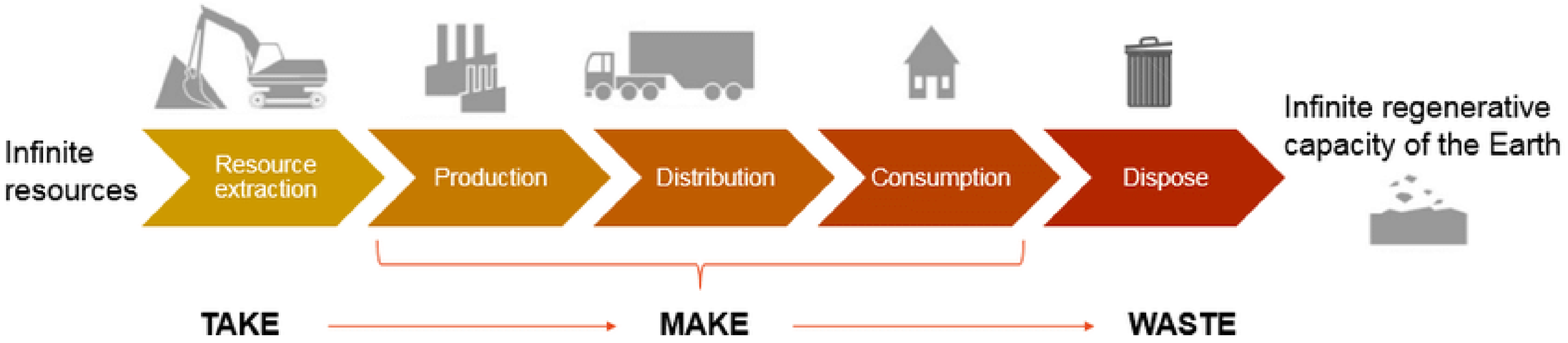
What is the biggest challenge preventing the adoption of circular economy practices in businesses?

Who holds the greatest responsibility in the transition to a circular economy: businesses, governments, or consumers?

Is it possible to completely eliminate the concept of “waste” in our society? Or will there always be some level of discard?

Our Curent model



The traditional linear economic model is a straightforward one: it follows a straight line from the extraction of resources to the disposal of products. The model is encapsulated by the three simple steps of "take, make, and dispose," and it has been the dominant economic model since the Industrial Revolution.

This model assumes that **resources are abundant**, easily accessible, and cheap to dispose of, which has led to numerous economic, environmental, and social issues

Take - Resource Extraction

- **Environmental Degradation:** The extraction of raw materials often leads to significant harm to ecosystems, such as deforestation, loss of biodiversity, soil erosion, water shortages, and pollution of air, water, and soil.
- **Resource Depletion:** Non-renewable resources, like fossil fuels and certain metals, are being used at a much faster rate, leading to the possibility of depletion and increased scarcity, which can drive up costs.
- **Social Impact:** Extractive industries can have negative impacts on local communities, including displacement, health risks, and the disruption of traditional ways of life.

Make - Manufacturing

- **Energy Intensive:** The manufacturing process is often energy-intensive and relies heavily on fossil fuels, contributing to greenhouse gas emissions and global warming.
- **Pollution:** Manufacturing can lead to the release of pollutants and toxic substances, which can have serious health impacts on both workers and local populations.
- **Waste:** The focus on mass production can lead to significant amounts of waste during the manufacturing process, due to inefficiencies and the overproduction of goods.
  Ex: Textile Industry

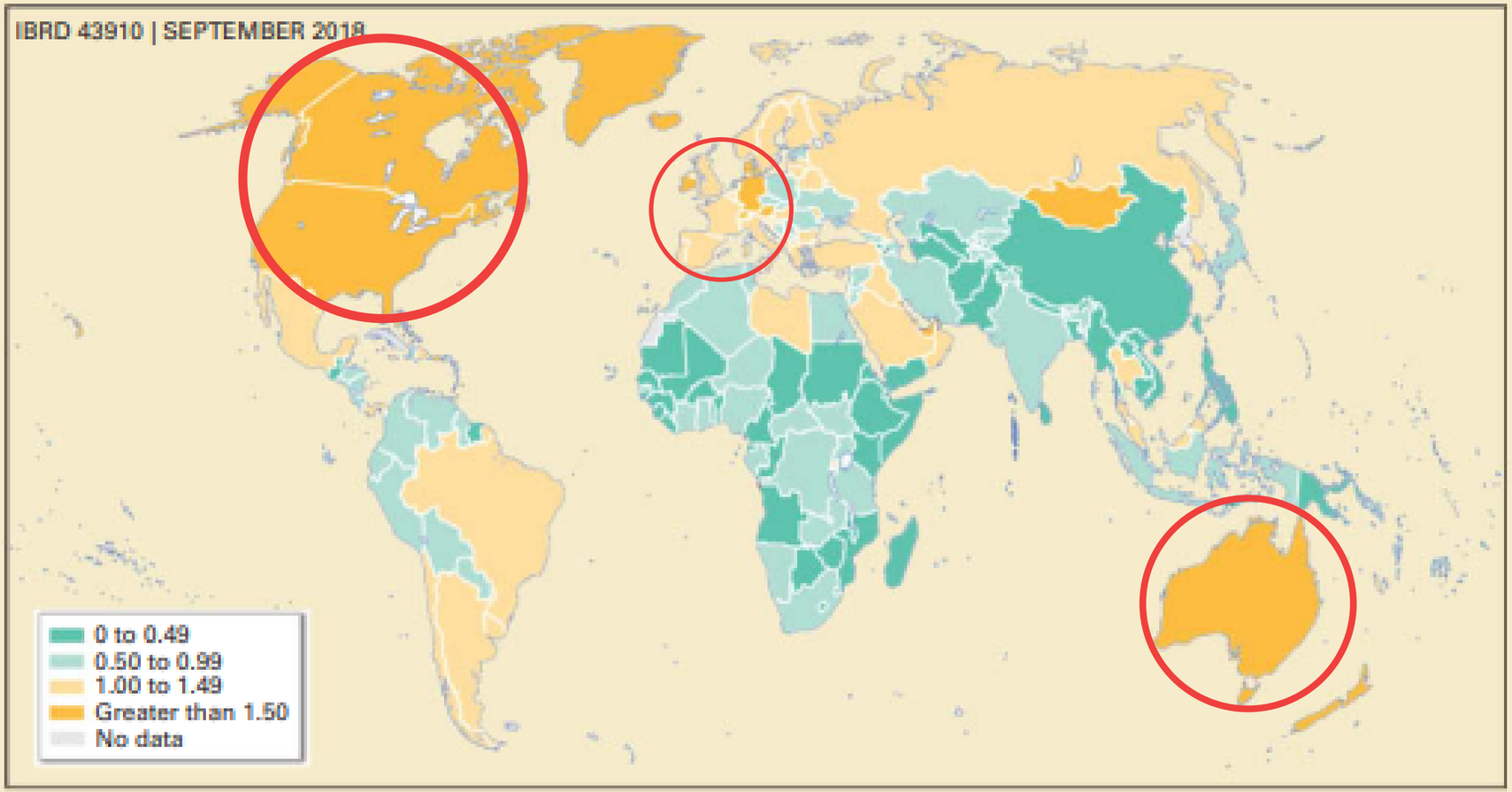
Dispose - Waste

- **Landfill Overflow:** The end of the product life typically sees the product ending up in a landfill, where it contributes to methane emissions, a potent greenhouse gas, and can leach toxins into the soil and groundwater.
- **Plastic Pollution:** A significant amount of waste is plastic, which is not biodegradable and can accumulate in natural environments, particularly in oceans, harming wildlife and ecosystems.
- **Resource Loss:** Valuable materials are lost when products are not recycled, requiring additional extraction and processing to replace them, perpetuating the cycle.

THE REALITY

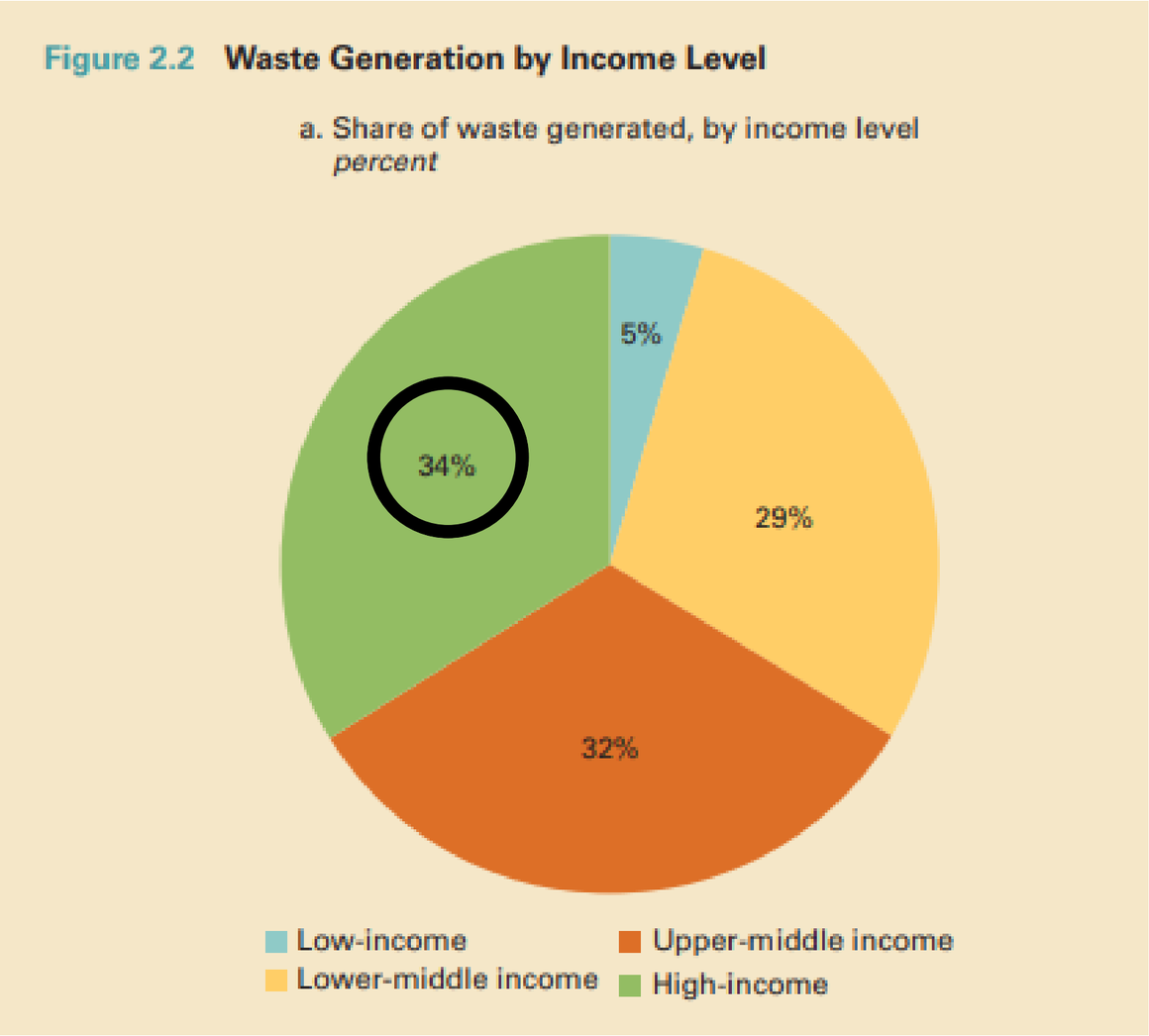
Sources: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.
World Bank, 2018

Map 2.1 Waste Generation Per Capita



Note: kg = kilogram.

Sources: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.
World Bank, 2018

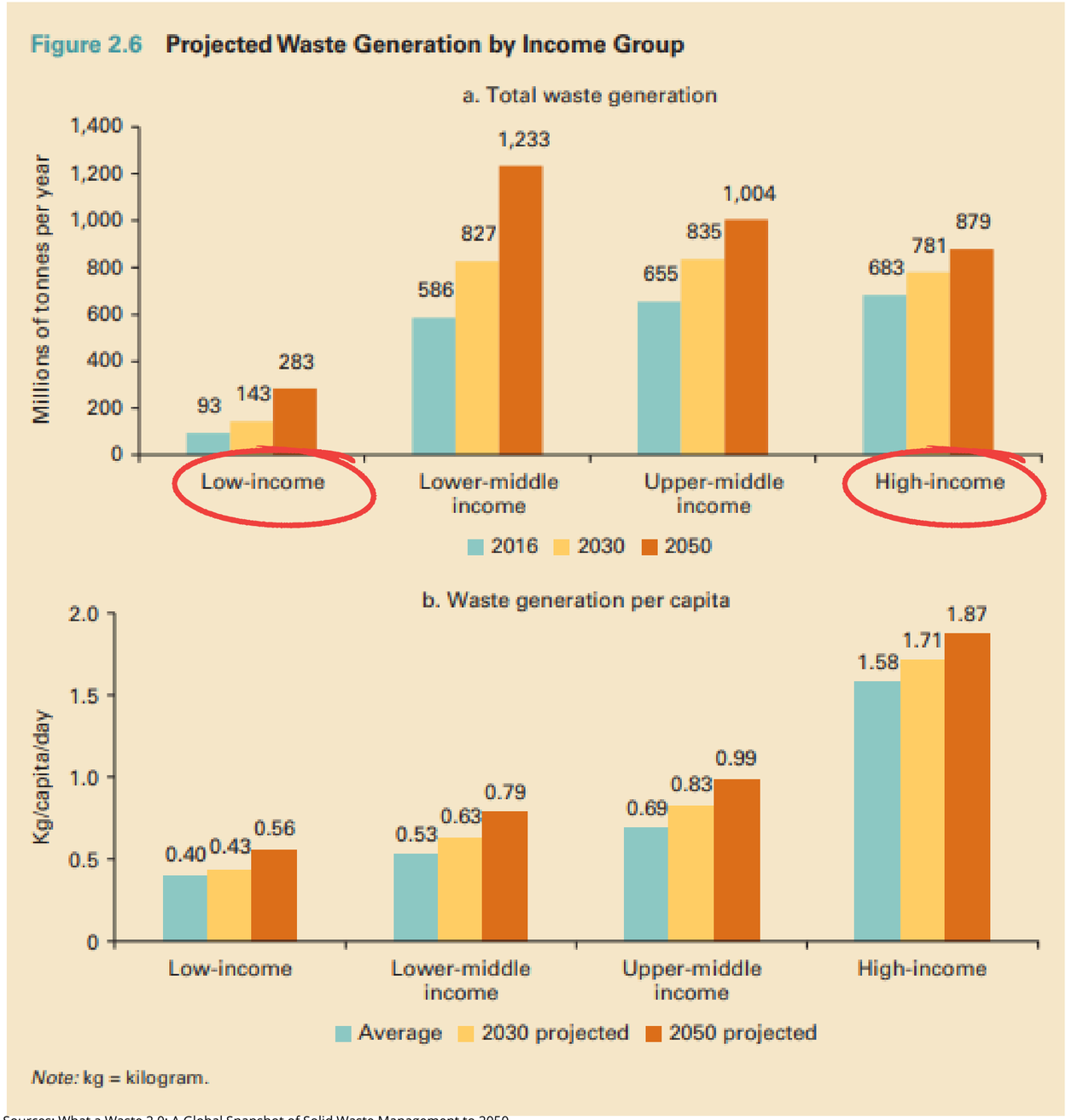


Although they only account for 16% of the world's population, high-income countries generate 34%, or 683 million tonnes, of the world's waste.

Low-income countries account for 9% of the world's population but generate only about 5% of global waste, or 93 million tonnes.

Waste generation has an overall positive relationship with economic development

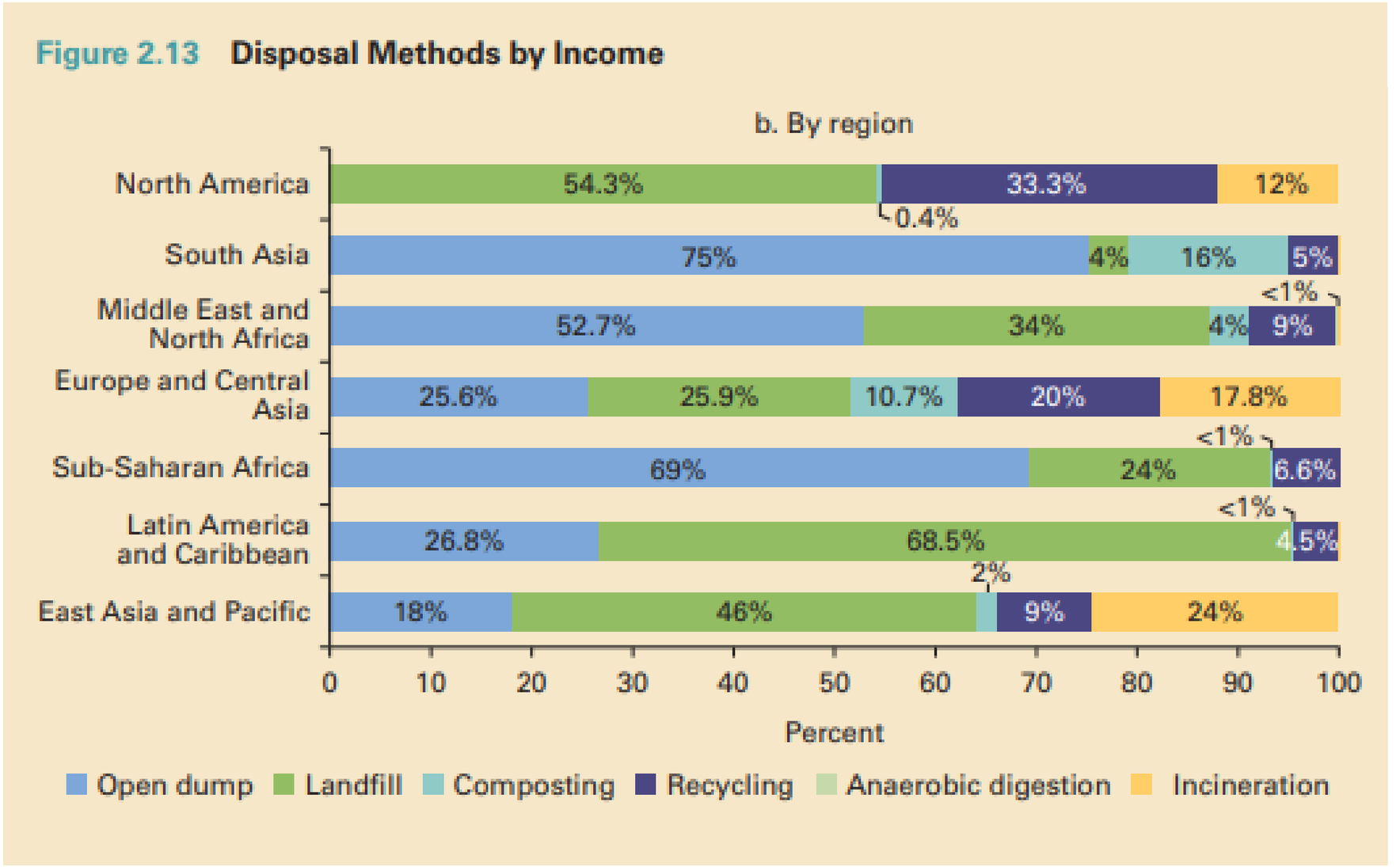
Sources: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank, 2018



Sources: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.
World Bank, 2018

Lowincome countries are positioned for the greatest amount of growth in economic activity as well as population, and waste levels are expected to more than triple by 2050.

Sub-Saharan Africa and South Asia regions are expected to see waste levels approximately triple and double, respectively, in the next three decades with economic growth and urbanization.



what calls your attention in this graph?

Sources: What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank, 2018

Waste Atlas: http://www.atlas.d-waste.com/

Circular Economy

The term circular economy appears to be formally used in an economic model for the first time by Pearce & Turner (1990), Drawing on the principle that ‘’everything is an input to everything else’’.

The circular economy applies the principles of the **first and second** laws of thermodynamics:

The first law of thermodynamics stipulates that energy cannot be created or destroyed, only transformed. Therefore any natural resources used will return to the environment in the form of solid waste or emissions.

According to the second law of thermodynamics, there are physical boundaries that prevent the set-up of a system in which all waste is recycled and transformed back into natural resources with 100% efficiency (Pearce & Turner, 1990; Čiegis & Čiegis, 2008).

The transition to a circular economy is a complex process involving fundamental changes to production-consumption systems that affect the environment. These include financing mechanisms, consumer behaviour, government intervention such as tax policy, and technological, social and business innovation.

Circular Economy definitions

Defined as a restorative and regenerative model that aims to keep products, components, and materials in a closed loop at their highest level of utility and value (Ellen MacArthur Foundation [EMF] 2015).

For European Commission is "an economic system that keep[s] the added value in products for as long as possible and eliminate[s] waste" (European Commission [EC] 2014, p.2).

Sauvé et al. (2016, p. 49), "production and consumption of goods through closed loop material flows that internalize environmental externalities linked to virgin resource extraction and the generation of waste (including pollution)''.

CE represents a "win-win" philosophy, hypothesising that a prosperous economy and healthy environment can co-exist (Fonseca, 2018).

CE can become an accelerator for the targets set in worldwide initiatives towards sustainable development such as those included in the Agenda 2030 (United Nations, 2015).

CE Objective

CE minimises the need for new inputs of materials and energy, while reducing environmental pressures linked to resource extraction, emissions and waste. This goes beyond just waste, requiring that natural resources are managed efficiently and sustainably throughout their life cycles.

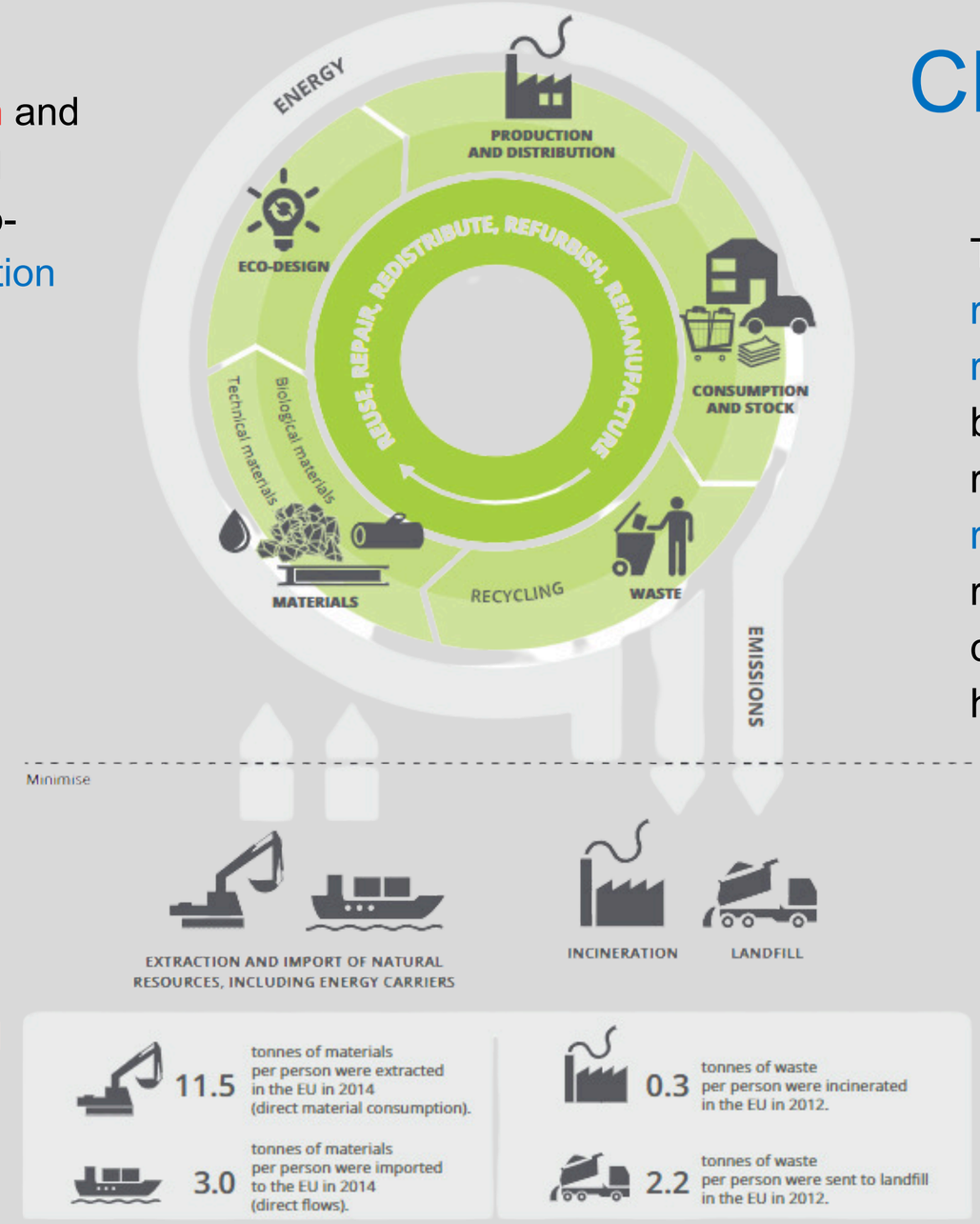
A circular economy thus provides opportunities to create well-being, growth and jobs, while reducing environmental pressures.

The concept can, in principle, be applied to all kinds of natural resources, including biotic and abiotic materials, water and land .

CE Model

The main idea is that waste generation and material inputs are minimised. This will create economic and environmental co-benefits, as the dependency on extraction and imports declines in parallel with a reduction in the emissions to the environment caused.

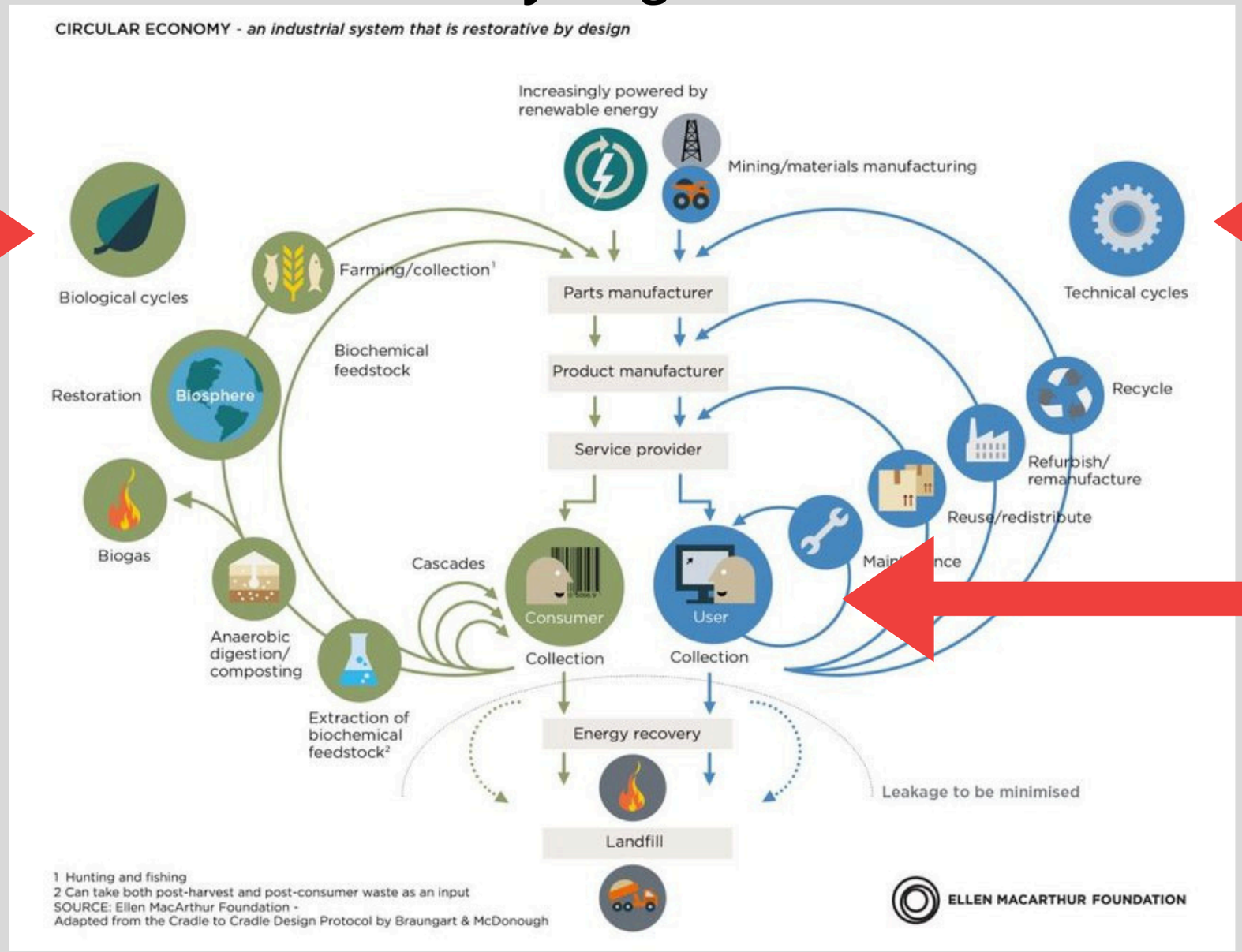
The middle circle represents the material flows in the recycling loop, distinguishing between abiotic technical materials (such as metals and minerals) and biological materials. An increased share of the latter would, in principle, be beneficial, as they are truly renewable, whereas technical materials are not. In practice, technical and biological materials are often mixed, which has implications for biodegradability and recyclability.



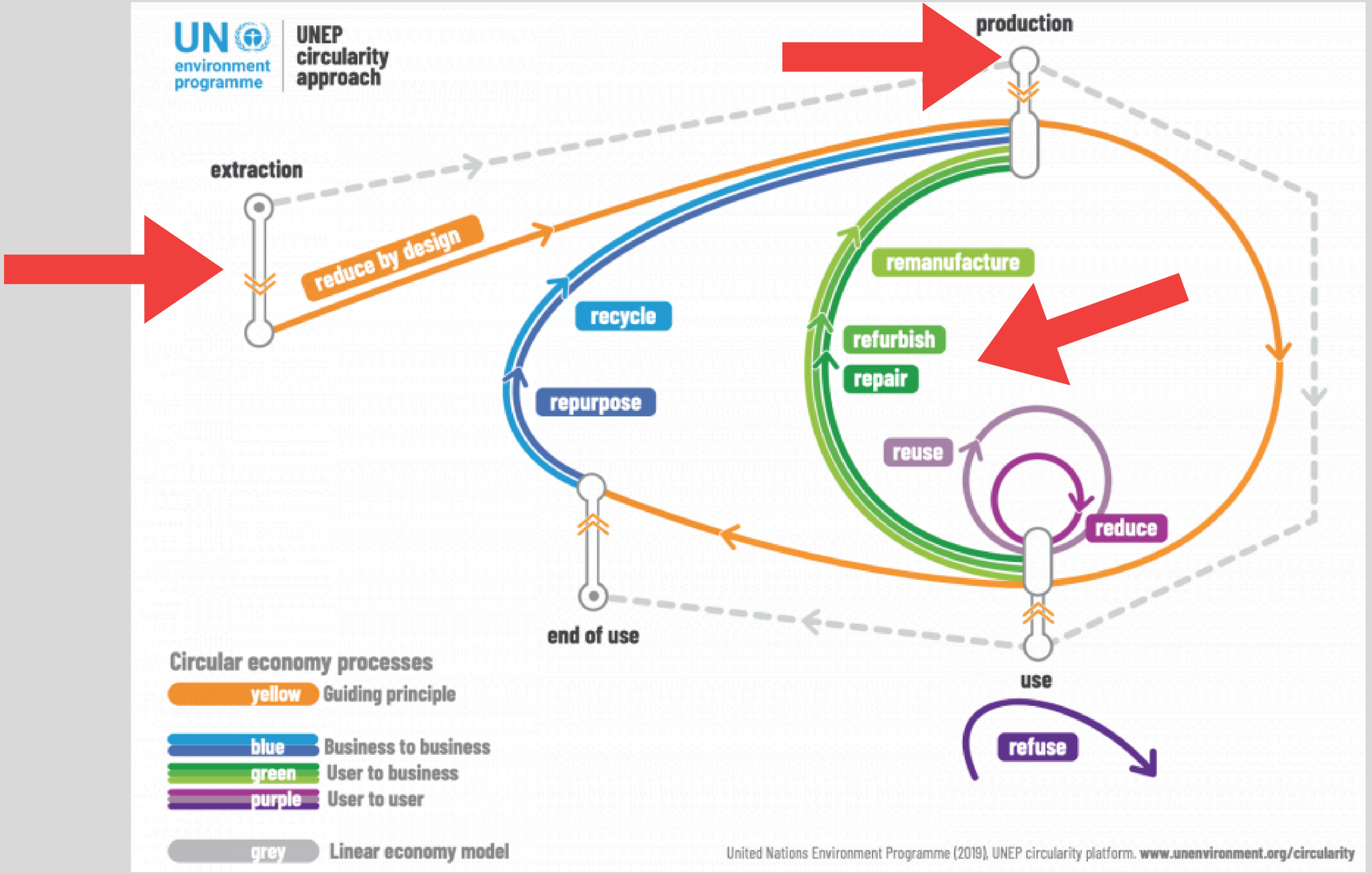
Source: EEA Report No 2/2016

The inner circle represents the 5 r´s: reuse, redistribution, repair, remanufacture and refurbishment, bypassing waste generation and recycling and thus requiring minimal resource input. These approaches retain the value of products, components and materials at the highest possible level.

The Butterfly Diagram for Circular Economy



The closer to the loop, the higher the value retained. Example: repairing a phone screen keeps more value than recycling the whole device, which is costly and less efficient.


UN environment programme
UNEP circularity approach
production
extraction
reduce by design
recycle
repurpose
remanufacture
refurbish
repair
reuse
reduce
end of use
use
refuse
Circular economy processes
yellow Guiding principle
blue Business to business
green User to business
purple User to user
grey Linear economy model
United Nations Environment Programme (2019), UNEP circularity platform. www.unenvironment.org/circularity

Key Characteristics - CE

Less input and use of natural resources

minimised and optimised exploitation of raw materials, while delivering more value from fewer materials; • reduced import dependence on natural resources; • efficient use of all natural resources; • minimised overall energy and water use

Increased share of renewable and recyclable resources and energy

non-renewable resources replaced with renewable ones within sustainable levels of supply; • increased share of recyclable and recycled materials that can replace the use of virgin materials; • closure of material loops; • sustainably sourced raw materials

Reduced emissions

reduced emissions throughout the full material cycle through the use of less raw material and sustainable sourcing; • less pollution through clean material cycles.

Fewer material losses/residuals

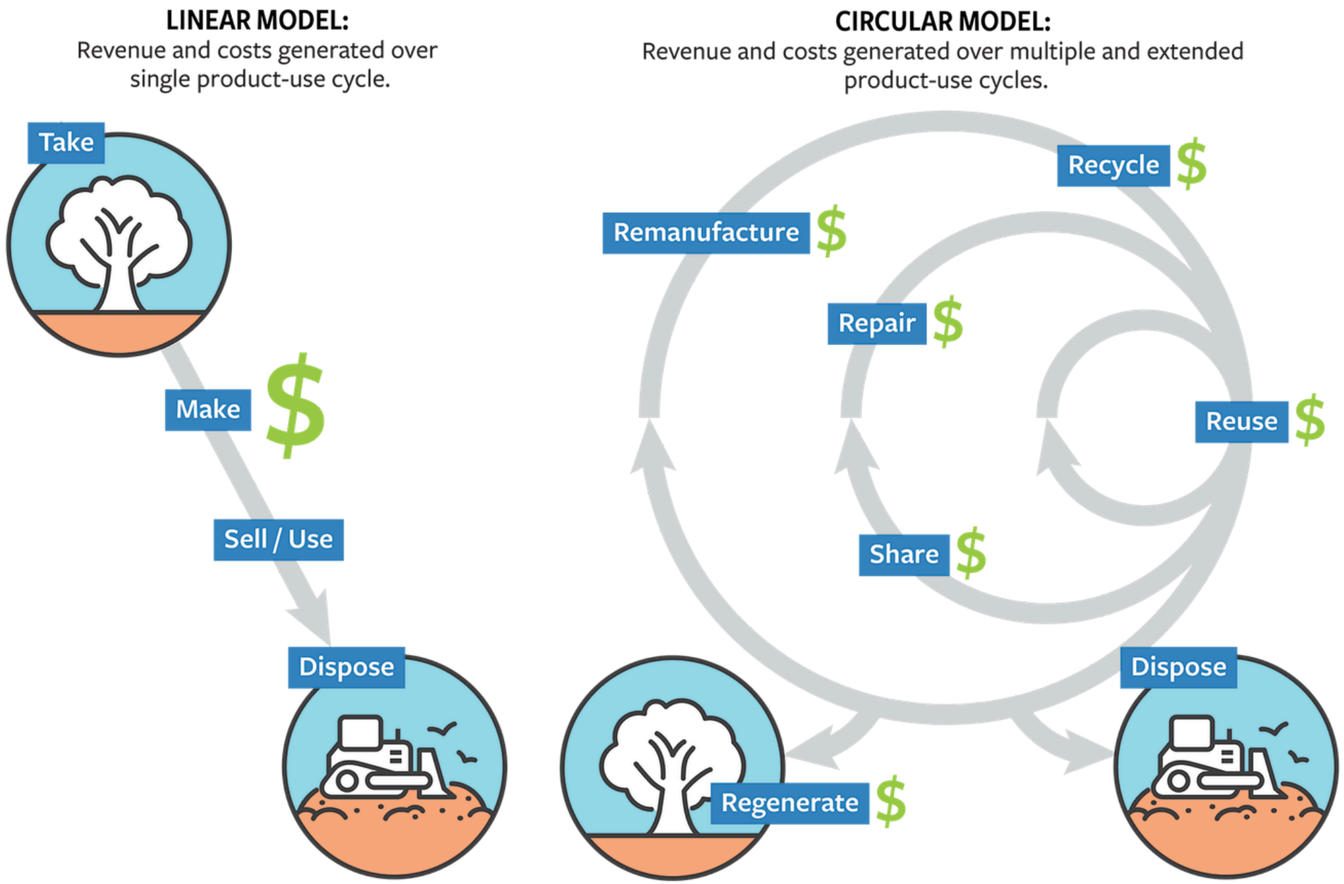
build up of waste minimised; • incineration and landfill limited to a minimum; • dissipative losses of valuable resources minimised.

Keeping the value of products, components and materials in the economy

extended product lifetime keeping the value of products in use; • reuse of components; • value of materials preserved in the economy through high-quality recycling

How Revenues and Costs Differ for Direct and Circular Business Models

The linear model generates revenue and incurs costs from one time sales before disposal. In a circular model, revenues and costs are considered across multiple cycles. The dollar signs indicate revenue opportunities.



Initial Design and Production Cost per Unit	$220
Primary Sales	
Initial selling price per unit	$250
Initial gross profit	$30
Initial gross margin	12%
Secondary Sales: Refurbished Items	
Recovery and refurbishment cost	$30
Resale price (as "certified refurbished")	$100
Gross profit	*$70*
Residual Value: End-of-Life Material Recovery	
Recovery cost (logistics, dismantling)	$10
Residual value of recovered parts/materials (resale or use as raw materials)	$30
Gross profit	*$20*

ENABLING FACTORS - CE

Eco-design

• products designed for a longer life, enabling upgrading, reuse, refurbishment and remanufacture;
• product design based on the sustainable and minimal use of resources and enabling high-quality recycling of materials at the end of a product's life;
• substitution of hazardous substances in products and processes, enabling cleaner material cycles.

Repair, refurbishment and remanufacture

• repair, refurbishment and remanufacture given priority, enabling reuse of products and components.

Recycling

• high-quality recycling of as much waste as possible, avoiding **down-cycling** (converting waste materials or products into new materials or products of lesser quality);
• use of recycled materials as secondary raw materials;
• well-functioning markets for secondary raw materials;
• avoidance of mixing and contaminating materials;
• cascading use of materials where high-quality recycling is not possible.

ENABLING FACTORS - CE

Economic incentives and finance

• shifting taxes from labour to natural resources and pollution;
• phasing out environmentally harmful subsidies;
• internalisation of environmental costs;
• deposit systems;
• extended producer responsibility;
• finance mechanisms supporting circular economy approaches.

Innovative Business models

• focus on offering product–service systems rather than product ownership;
• collaborative consumption;
• collaboration and transparency along the value chain;
• industrial symbiosis (collaboration between companies whereby the wastes or by-products of one become a resource for another).

Eco-innovation

• technological innovation;
• social innovation;
• organisational innovation

Governance, skills and knowledge

• awareness raising about changing lifestyles and priorities in consumption patterns;
• participation, stakeholder interaction and exchange of experience;
• education;
• data, monitoring and indicators.

Eco-design ≠ Eco-innovation

Eco-design ≠ Eco-innovation

Eco-design refers to the practice of **developing products with special attention to their environmental impact throughout their entire life cycle,** from the extraction of raw materials to production, use, and final disposal. The goal is to minimize negative environmental effects by designing products that are resource-efficient, recyclable, repairable, and long-lasting.

Eco-innovation, on the other hand, encompasses a broader range of initiatives and is not limited to product design alone. **It includes any innovation that leads to significant improvements in the environmental performance of companies and society as a whole.** This can involve the development of new products, processes, market practices, or business models that contribute to sustainability by reducing environmental impacts and promoting the efficient use of resources.

Eco-design ≠ Eco-innovation

Eco-design Example

Modular Smartphone: The concept of a modular smartphone is an excellent example of eco-design. Instead of replacing the entire device with a new model, users can simply swap out specific modules that need an upgrade or repair, such as the camera, battery, or screen. This design extends the device's lifespan, reduces electronic waste, and decreases the need for resources to produce new devices. The modularity encourages a more sustainable approach to technology consumption, allowing users to customize and upgrade their devices without discarding the entire product.

Eco-innovation Example

Photovoltaic Tiles: Photovoltaic tiles represent a remarkable eco-innovation, combining the traditional functionality of roofing with solar energy generation. Instead of installing solar panels over an existing roof, photovoltaic tiles themselves serve as the roofing material that produces energy. This not only enhances the aesthetics of homes, avoiding the often bulky appearance of conventional solar panels, but also maximizes the efficient use of urban spaces. Additionally, this innovation contributes to building sustainability by reducing reliance on conventional energy sources and lowering greenhouse gas emissions.

Eco-design specifically focuses on the development of sustainable products, eco-innovation is a broader concept that includes any form of innovation with environmental benefits.

One "simple" ideia that changes everything

Link:https://www.youtube.com/watch?v=NylKef0N2LI

ASSESSING THE FEASIBILITY OF A GIVEN CIRCULARITY STRATEGY REQUIRES A CAREFUL CALCULATION OF **VALUE** AND **COSTS**, AS WELL AS A CERTAIN AMOUNT OF EXPERIMENTATION AND PILOTING.

IT IS NECESSARY TO ANSWER TWO QUESTIONS:

1 - How easy is it to get my product back?

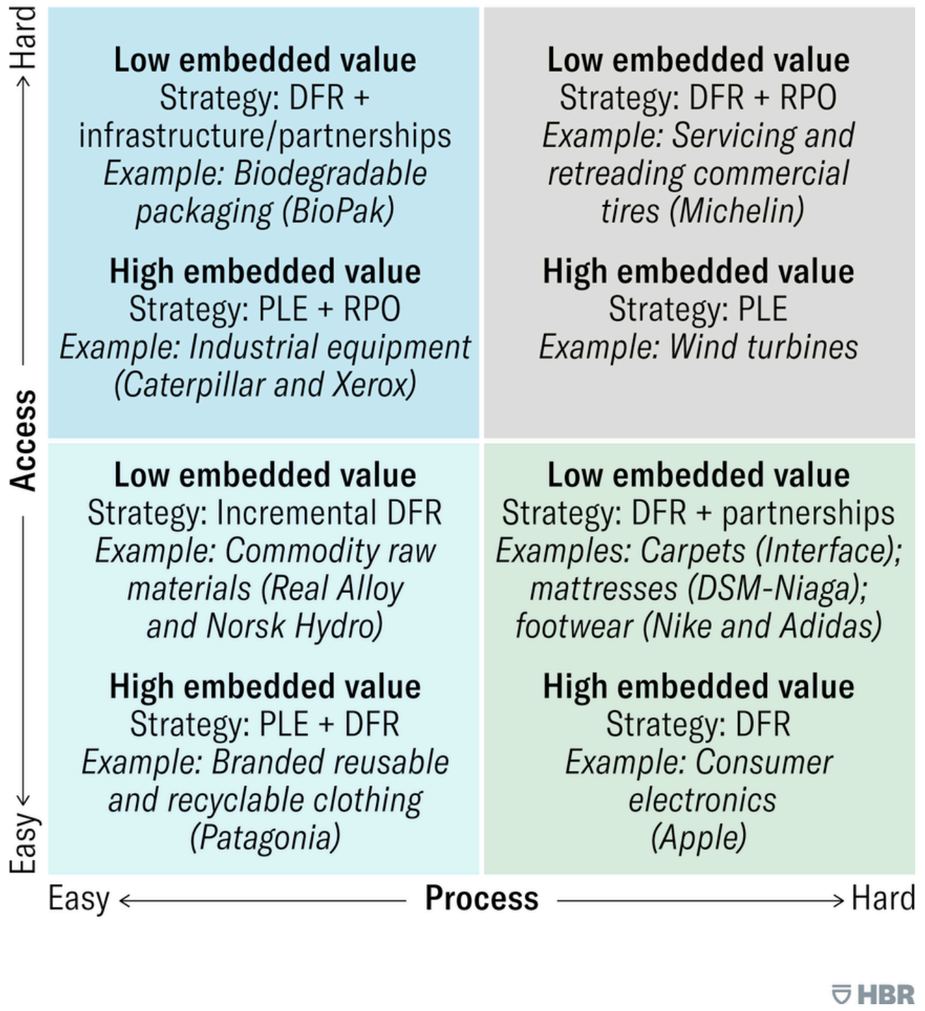
2 - How easy is it to recover value from my product?

The Circularity Matrix

For companies looking to create circular business models for their products, the right model will involve one or more of **three basic strategies**:

Retain product ownership (RPO)
Product life extension (PLE)
Design for recycling (DFR)

The right strategy can be determined by how easily the manufacturer can get the product back and how easily value can be recovered from it. The challenges each company faces along each dimension will depend on its capabilities and competitive context and may change in response to innovations it and its competitors make.



Source: Harvard Business Review,The Circular Business Model (2021).

3 basic estrategies

Retain product ownership (RPO):

In the classic version of this approach, the producer rents or leases its product to the customer rather than selling it. Thus the producer is responsible for products when consumers have finished with them. RPO is an interesting strategy for companies that offer complex products with a lot of embedded value.

Product life extension (PLE).

Companies applying this strategy focus on designing products to last longer, which may open up possibilities for markets in used products. Because a longer product lifespan means fewer purchases over time, this may seem like a bad idea for original-equipment manufacturers. But durability is a key competitive differentiator and provides a strong rationale for premium pricing.

Design for recycling (DFR).

Companies applying this strategy redesign their products and manufacturing processes to maximize recoverability of the materials involved for use in new products. This strategy often involves partnering with companies that have specific technological expertise or that may be best able to use the materials recovered.

Circular Economy Action Plan - EU

The case of the EU, since the Directive 2008/98/EC on the implementation of best waste management practices, the EU has given continuity to its CE strategy through the development of different policies. They include the programme:

1. "Towards a Circular Economy: A Zero Waste Programme for Europe" (COM 398, 2014);
2. "Closing the Loop: An EU Action Plan for the Circular Economy" (COM 614, 2015);
3. The Circular Economy Action Plan (EC, 2018);

More recently: "Circular Economy Action Plan for a Cleaner and More Competitive Europe" (EC, 2020).

What provides: Circular Economy Action Plan provides a future-oriented agenda for achieving a cleaner and more competitive Europe in co-creation with economic actors, consumers, citizens and civil society organisations.

Objective: Accelerate the transformational change required by the European Green Deal, while building on circular economy actions implemented since 2015.

....EU will continue to lead the way to a circular economy at the global level and use its influence, expertise and financial resources to implement.

Core principles

1. **Design Out Waste and Pollution:** This principle emphasizes the need to eliminate waste and pollution through design of products and processes.
2. **Keep Products and Materials in Use:** This involves extending the lifecycle of products through reuse, repair, refurbishment, and recycling, ensuring that materials remain in the economy for as long as possible.
3. **Regenerate Natural Systems:** This principle focuses on restoring and enhancing natural ecosystems by returning valuable nutrients to the soil and other natural systems.

The Waste Footprint: Each European citizen generates, on average, about 5 tonnes of waste per year. Of this, only about 38% is recycled on average (even though targets are much higher).

The Economic "Gold": It is estimated that the circular economy could increase the EU's GDP by an additional 0.5% by 2030.

Job Creation: The circular transition has the potential to create 700,000 new jobs in the EU by 2030, especially in the repair, maintenance, and recycling sectors.

Portugal: https://rea.apambiente.pt/content/reciclagem-%E2%80%93-fluxos-espec%C3%ADficos-de-res%C3%ADduos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Legislative Framework

- **Ecodesign Framework Directive:** This directive aims to improve the environmental performance of products throughout their lifecycle by setting requirements for energy efficiency and resource use.
- **Waste Framework Directive:** This directive sets the basic concepts and definitions related to waste management, including waste hierarchy and the polluter pays principle.
- **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation:** This regulation ensures the safe use of chemicals, promoting alternatives to hazardous substances .

Circular Economy - EU

The Commission will consider establishing sustainability principles and other appropriate ways to **regulate** the following aspects:

- Improving product durability, reusability, upgradability and reparability, addressing the presence of hazardous chemicals in products, and increasing their energy and resource efficiency;
- Increasing recycled content in products, while ensuring their performance and safety;
- Enabling remanufacturing and high-quality recycling;
- Reducing carbon and environmental footprints;
- Restricting single-use and countering premature obsolescence;
- Introducing a ban on the destruction of unsold durable goods;
- Incentivising product-as-a-service or other models where producers keep the ownership of the product or the responsibility for its performance throughout its lifecycle;
- Mobilising the potential of digitalisation of product information, including solutions such as digital passports, tagging and watermarks;
- Rewarding products based on their different sustainability performance, including by linking high performance levels to incentives.

Key Product Value Chains that EU will focus

1. Electronics and ICT
2. Batteries and vehicles
3. Packaging
4. Plastics
5. Textiles
6. Construction and buildings
7. Food, water and nutrients

MANDATORY TARGETS FOR THE COMING YEARS

Circularity Rate: Currently, the circular material use rate in the EU is around 11.5% to 12%. The goal is to double it to 24% by 2030.

Packaging: By 2030, all packaging on the EU market must be reusable or recyclable in an economically viable way.

Urban Waste: Reduce waste sent to landfills to less than 10% by 2035.

Sector	Relevant Data for Debate
Plastics	By 2029, the EU requires the separate collection of **90% of single-use plastic bottles**.
Electronics	E-waste is the fastest-growing waste stream in the EU. The **Common Charger (USB-C) law** saves 11,000 tonnes of annual waste.
Textiles	Less than **1% of clothing worldwide** is recycled into new clothes. The EU intends to ban the destruction of unsold textiles starting in 2026.
Construction	This sector is responsible for more than **35% of the EU's total waste production**.

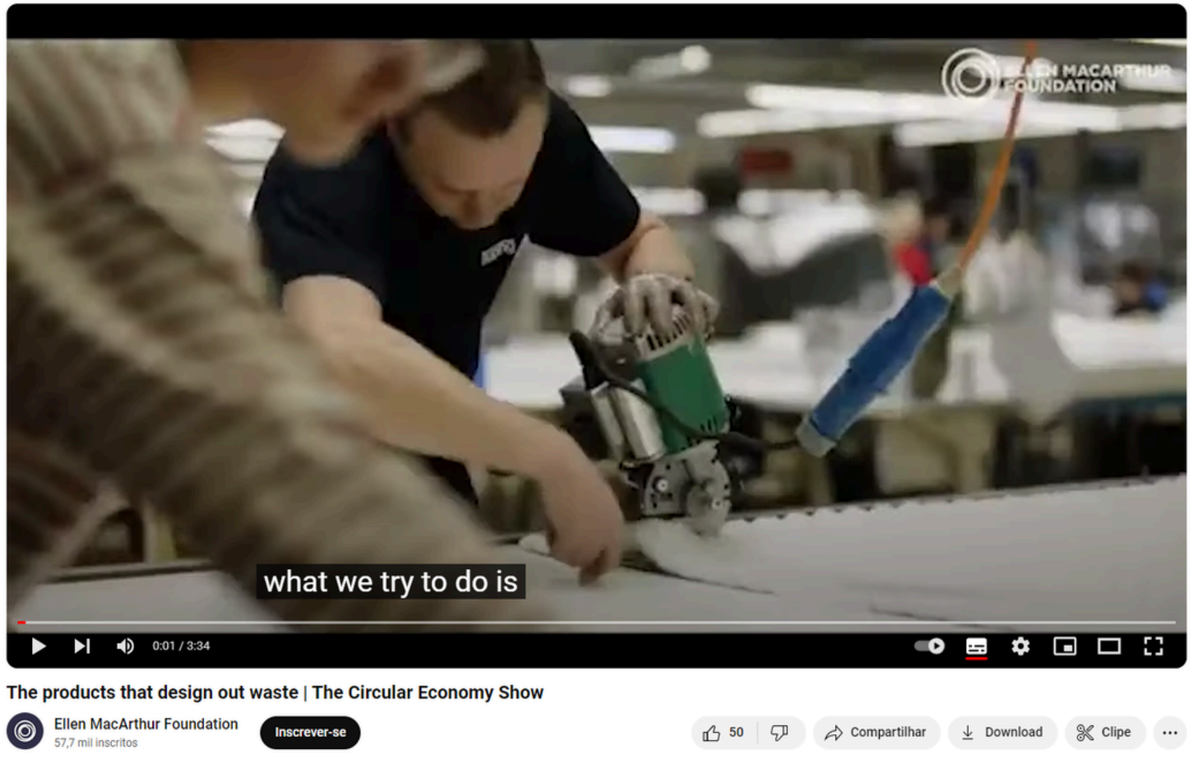
IMPLEMENTATION STRATEGIES - THE NEW "CIRCULAR ECONOMY ACT" (2026)

Focus: Creating a single market for secondary (recycled) raw materials.

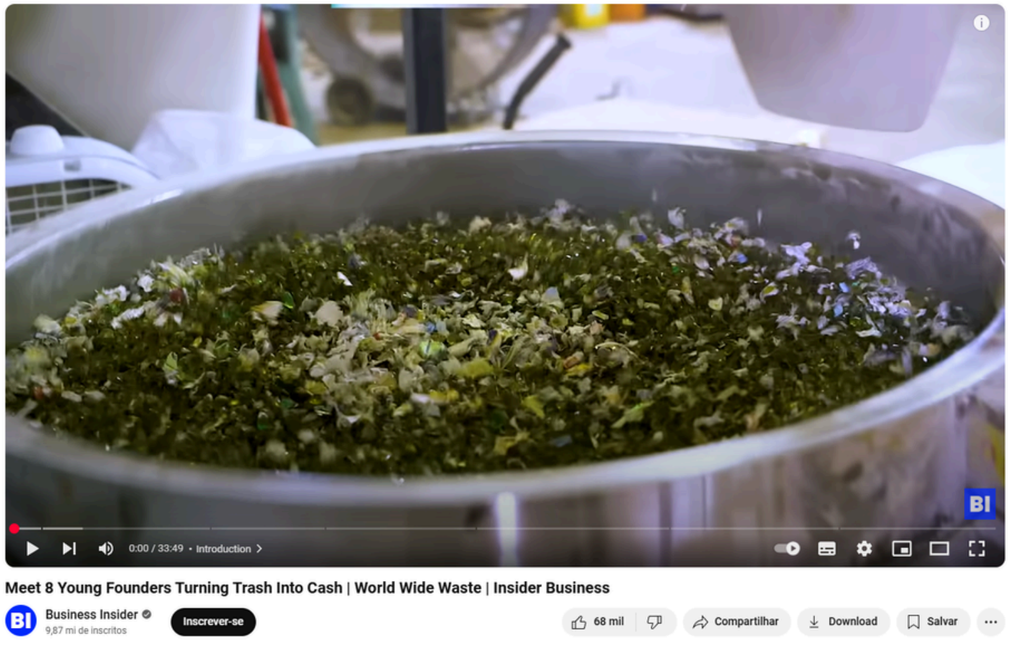
- **Product Passports and Online Databases:** These tools facilitate the tracking and sharing of information about products, enhancing transparency and enabling better recycling and reuse.

- **Waste Management Hierarchy:** This hierarchy prioritizes waste prevention, followed by reuse, recycling, recovery, and disposal as the last resort .

- **Economic Incentives:** Policies such as environmental taxes and incentives for eco-innovation for promoting circular economy practices.



https://www.youtube.com/watch?v=dgEkyZ9k4Kk



https://www.youtube.com/watch?v=_XTYv-AP4Jk

Class activity

Find a product or a service that illustrates these enabling factors and present why it can be considered a circular model. Pitch of 3min per group.

1 - Innovative business models
2 - Eco-design
3 - Extending the lifetime of products through reuse and repair
4 - Waste prevention programmes

Innovative business models:

Example: In 2010, Xerox, a producer of copying machines, ventured into the managed service sector by enabling customers to lease printing and copying machines, paying per print or copy made, with maintenance costs included in the cost per click. The managed print services business model has been so successful that, by 2011, it accounted for nearly 50 % of the company's revenue.

Why this model is circular: is a user-oriented services, which are based on product leases, rentals, sharing and pooling, reduces the dispersion of waste, became more easy to the manufacturer to get the product back and easily value can be recovered from it. Move from purchase-based models to service and function-based business models.

	Circular process	Examples of sectors where circular processes can be applied
USE OF LESS PRIMARY RESOURCES	Recycling	Automobile industry, Textile industry, Building sector, Packaging sector, Critical Raw materials, Forest sector, Chemical industry
	Efficient use of resources	Building sector, Plastics industry, Mining and metals industry, Food sector
	Utilisation of renewable energy sources	Chemical industry, Food industry, Forest sector
MAINTAIN THE HIGHEST VALUE OF MATERIALS AND PRODUCTS	Remanufacturing, refurbishment, and reuse of products and components	Automobile industry, Manufacture of computer, electronic and optical products, Building sector, Furniture sector, Transport
	Product life extension	Manufacture of computer, electronic and optical products, Automobile industry, Household appliances, Building sector, Food industry, Textile industry, Defence industry
CHANGE UTILISATION PATTERNS	Product as service	Household appliances, Transport, Building sector, Printing industry
	Sharing models	Automobile industry, Transport, Accommodation, Clothing
	Shift in consumption patterns	Food sector, Publishing sector, E-commerce sector

References

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