

TEACHERS HANDBOOK

Guide for the teacher



EDUCATION TOWARDS
CIRCULAR & SUSTAINABLE
ECONOMY



TABLE OF CONTENTS

INTRODUCTION	5
CIRCULAR ECONOMY	11
WHAT IS A CIRCULAR ECONOMY?	12
BENEFITS	26
THE BUTTERFLY MODEL	38
SUSTAINABLE CONSUMPTION	50
CASE STUDY	64
PRIORITY SECTORS	66
TOWARD THE INSPIRATION OF YOUNG CONSUMERS	77
FAST FASHION	78
FLOODED BY PLASTIC	90
E-WASTE	108
THE HIGH COST OF FOOD WASTE	118



INTRODUCTION

Navigating the Circular Future

The Purpose of this Handbook

We are living in a time of critical transition. As the world faces the limits of linear consumption—the "take-make-waste" model—the need for a sustainable alternative has never been more urgent. This handbook serves as a comprehensive guide for educators and students to navigate the complex world of the Circular Economy (CE).

Its primary purpose is to bridge the gap between abstract economic theory and daily reality. It is designed to equip teachers with the essential background knowledge they need to confidently teach these concepts, while providing students with the practical tools to shift from being passive consumers to active change-makers. By linking complex environmental challenges to everyday choices, this handbook aims to empower the next generation to build a future that is resilient, regenerative, and fair.



About the ET CASE Project

This resource was developed as part of the Education for Transition to a Circular Economy and Sustainable Consumption (ET CASE) project.

It is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

The project is targeted specifically at secondary school education, recognizing that today's youth will face a shortage of resources in the foreseeable future. To prepare them for this reality, it is crucial to adjust educational schemes to their specific needs and perceptions of the world. Teachers and schools require tools that are not only effective but also attractive to pupils, capable of influencing behaviors regarding sustainable consumption.

Based on extensive literature and practical examples, the ET CASE team has collected knowledge on the multifaceted nature of the Circular Economy. This handbook is the result of that effort—a curated collection of insights designed to support teachers in bringing these vital topics into the classroom.

Structure of the Handbook

The handbook is organized into two distinct but complementary parts, designed to take the reader from "understanding" to "acting."

Part 1:
The Theoretical Framework

In the first section, we lay the foundation. We outline the basic concepts, definitions, and history of the Circular Economy. The text highlights essential knowledge—stripping away academic jargon to reveal the core principles—to ease navigation and ensure a solid understanding of what the Circular Economy actually is and why it matters.

Part 2:
Sustainable Consumption in Practice

In the second section, we move from theory to specific, high-impact areas of consumption. Research conducted during the ET CASE project (specifically the MLTs Conceptual Screening Report) identified three critical sectors that require urgent attention in youth education:

- Fast Fashion & Textiles
- Plastics & Packaging
- E-Waste (Electronics)
- Food Waste

Consequently, Part 2 outlines the specific environmental concerns in these areas and provides actionable solutions. It focuses on how European Union regulations are shaping these sectors and how consumers can adapt. By focusing on these three pillars, the handbook provides a targeted approach to enhancing sustainable consumption where it counts the most.

Disclaimer:

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CIRCULAR ECONOMY

The Concept

WHAT IS A CIRCULAR ECONOMY?

In this chapter, you will find:

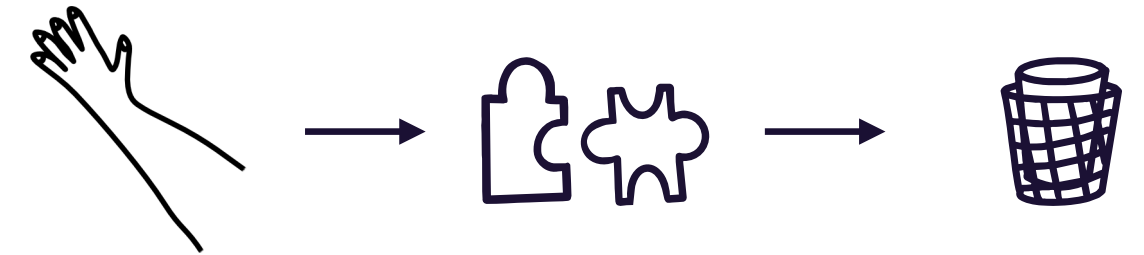
- What is the difference between a traditional "linear" and a "circular" economy?
- Why is this shift important for the environment and our economic security?
- Box 1.1: Characteristics of the linear economy.
- Box 1.6: Where to find data, including the latest EU circularity indicators.

The Problem: linear Economy

The traditional economic model is often described as the linear economy, or the "take-make-dispose" model. This approach relies on extracting large amounts of cheap materials and energy, resulting in massive waste. This approach relies on cheap, abundant energy and materials, resulting in massive pollution. Unfortunately, currently, only a small fraction of the materials we use are ever reused or recycled. According to The Global Circularity Gap Report (2025), this inefficiency drives major global crises, including climate change and resource scarcity. To better understand this unsustainable path, Box 1.1 outlines the key characteristics of the linear economy, while Figure 1.1 visualizes the flow.

BOX 1.1

CHARACTERISTICS OF LINEAR ECONOMY

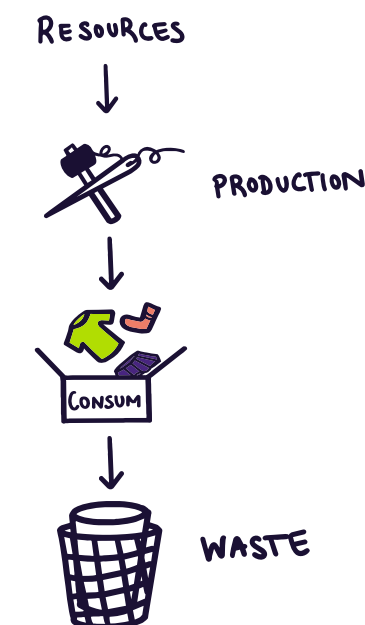


Resource Extraction:
The continuous removal of finite natural resources (like minerals, fossil fuels, and timber) faster than nature can renew them.

Production & Consumption:
Manufacturing goods focused on volume and short-term use rather than quality or longevity.

Disposal:
The "end-of-life" concept where, after use, products are viewed as waste with no value, usually ending up in landfills or incinerators.

FIGURE 1.1. A MODEL OF LINEAR ECONOMY



Common examples of the linear economy include single-use plastics (items like bottles and straws used once and discarded), fast fashion (clothing produced cheaply and discarded quickly), and disposable electronics (gadgets designed with short lifespans, contributing to massive e-waste).

The Solution: Circular Economy

Transitioning to a circular economy is essential. By designing products for durability, reuse, and recyclability, we can conserve resources and significantly reduce our environmental impact.

The concept is not new; it draws from various theories like Spaceship Earth (Boulding, 1966) and the Performance Economy (Stahel, 1977). However, the modern urgency is different.

Today, the circular economy is not just about environmental protection—it is about **security** and **resilience**.

WHY THE SHIFT MATTERS (NEW PERSPECTIVE)

- **Climate Change:**
Half of global greenhouse gas emissions come from extracting and processing raw materials. Circularity reduces this need.
- **Strategic Autonomy:**
In a volatile world, relying on other countries for raw materials (like rare metals for batteries) is risky. By recycling materials we already have, regions like the EU become less dependent on imports and more resilient to global shocks.

Box 1.2 provides the definition of the circular economy, followed by the graphical presentation of the circular economy model (Figure 1.2). The circular economy is based on three core principles. The first is to eliminate waste and pollution. This principle focuses on designing out waste from the start, ensuring that products and processes do not generate harmful by-products. The second is to circulate products and materials at their highest

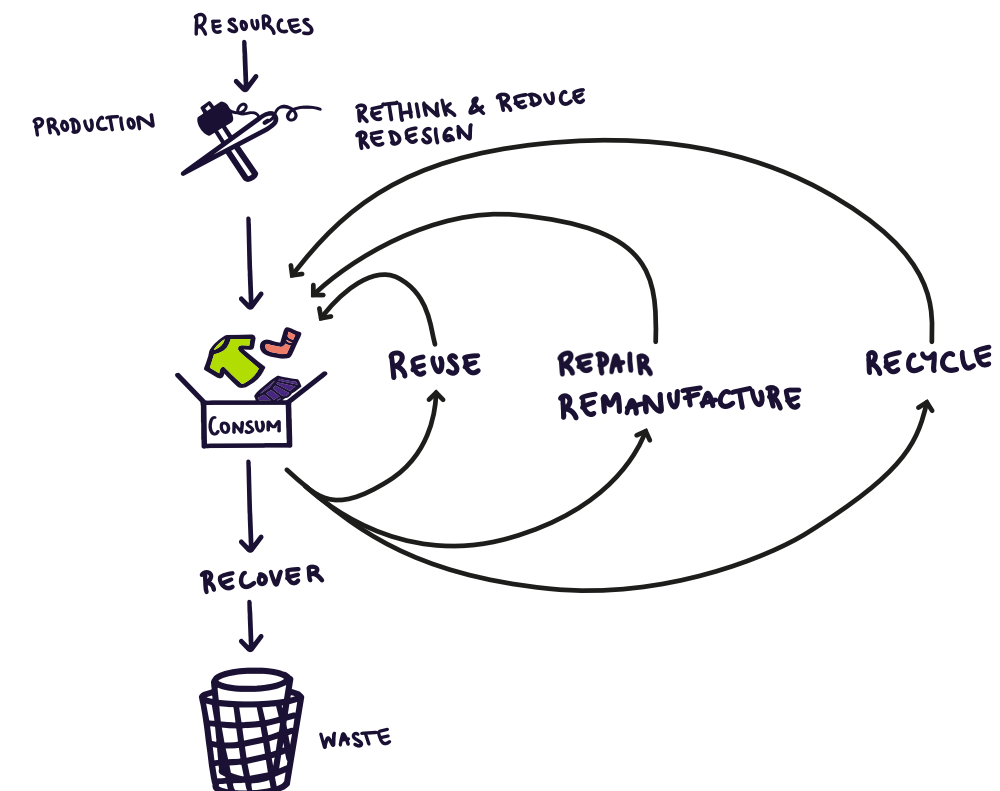
value. This involves keeping items in use for as long as possible through strategies like reuse, repair, and refurbishment, utilizing recycling only when necessary to maintain value within the economy. The third is to regenerate nature. By shifting from a linear to a circular model, we move from resource extraction to practices that restore and enhance natural ecosystems, promoting biodiversity and environmental health.

BOX 1.2

DEFINITION OF A CIRCULAR ECONOMY

The circular economy is a model of production and consumption that extends the life cycle of products. It involves **rethinking/redesigning, re-using (sharing), repairing, remanufacturing, and recycling** existing materials and products for as long as possible.

FIGURE 1.2. A MODEL OF CIRCULAR ECONOMY



BOX 1.3

THREE PRINCIPLES OF THE CIRCULAR ECONOMY

- 1 **Eliminate waste and pollution**
(Design it out from the start)
- 2 **Circulate products and materials**
(Keep them in use at their highest value)
- 3 **Regenerate nature**
(Improve the environment rather than just "doing less harm").

Box 1.3 lists the three core principles of the circular economy. Collectively, these principles aim to create a sustainable system that benefits businesses, society, and the environment.

Shifting to this model is a critical step in slowing climate change. One major driver of the climate crisis is how we use natural resources; the United Nations’ International Resource Panel has found that approximately half of all global greenhouse gas emissions come from extracting and processing raw materials.

If designed carefully, the circular economy does more than protect the environment—it supports economic growth and promotes social fairness. Sustainability is not just about nature; it is also about ensuring people are treated equitably. The traditional extraction and disposal of resources often have a disproportionate negative impact on vulnerable communities.

By reducing waste and using resources more wisely, the circular economy encourages smarter product design, longer use, and the regeneration of nature.

Several concrete examples are presented in Box 1.4. However, a circular world is not easily achieved. Significant hurdles exist, such as limited knowledge, lack of financing, and difficulties in assessing impact. These challenges are outlined in Box 1.5. Finally, there are tips, in Box 1.6, on where to seek data about the progress toward a circular economy.

Circular Challenges and Data

A circular world is possible, but the transition is complex. Teachers should be aware of the challenges, as well as where to find reliable data.

BOX 1.4

EXAMPLES OF THE CIRCULAR ECONOMY



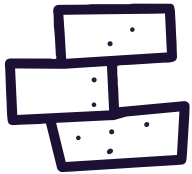
Textiles

Instead of "fast fashion," clothes are designed to be durable. Brands offer repair services or resale platforms to keep clothes in use longer.



Electronics

Modular phones allow you to replace just the broken camera or battery, rather than throwing away the whole device.



Construction

Builders recover bricks, metal, and wood from old buildings to use in new ones, reducing the need for new cement and steel.

SECTOR 1: ELECTRONICS & DESIGN

The Shift: From "Planned Obsolescence" to Modular Design.



The Problem

Most smartphones are "black boxes"—glued shut and impossible to repair. When a single component fails, the entire device becomes e-waste.

Fairphone (Netherlands)
They design modular phones held together by screws, not glue. Users can buy a new camera module or battery and swap it out themselves using a simple screwdriver.



The Circular Solution



The Lesson

This embodies Principle 1 (Design out waste). By making repair easy, we decouple economic activity from the consumption of finite raw materials.

SECTOR 2: FASHION & TEXTILES

The Shift: From "Fast Fashion" to Resale & Life-Extension.



The Problem

The fashion industry is responsible for 10% of global carbon emissions. "Fast fashion" treats clothing as a disposable commodity.

Vinted / Depop.
These platforms have turned "second-hand" into a primary market. They create a "digital wardrobe" where clothes circulate between users indefinitely.



The Circular Solution



The Lesson

This illustrates Principle 2 (Keep products and materials in use). Value is maintained through circulation rather than new production.

SECTOR 3: FOOD SYSTEMS

The Shift: From "Surplus Waste" to Resource Recovery.



The Problem

One-third of all food produced globally is lost or wasted. This wastes the water, land, and energy used to grow it.

Too Good To Go.
An app-based marketplace that allows retailers to sell "Surplus Bags" of unsold food at the end of the day at a discounted price.



The Circular Solution



The Lesson

This targets the Biological Cycle. It ensures that organic resources are consumed by humans rather than emitting methane in a landfill.

SECTOR 4: FURNITURE & RETAIL

The Shift: From "Ownership" to Product-as-a-Service.



The Problem

Furniture is often "linear"—bought, used, and dumped on the curb when a person moves or redecorates.

IKEA Buyback & Resell.
IKEA takes back used furniture in exchange for store credit. They refurbish the items and sell them in a dedicated "Circular Hub," keeping the raw materials within their own ecosystem.



The Circular Solution



The Lesson

This shifts the company's responsibility. They are no longer just "sellers"; they are stewards of the materials they put into the world.

TIP: THE "BUTTERFLY" CONNECTION

When discussing these boxes, refer students back to the Ellen MacArthur Foundation's Butterfly Diagram - see Chapter 3

- Fairphone/IKEA represent the "Inner Loops" (Maintain/Reuse).
- Vinted represents the "Redistribute" loop.
- Too Good To Go represents the "Cascades" in the biological cycle.

[Depop. About us: Powering the next generation of fashion.](https://news.depop.com/who-we-are/about/)
<https://news.depop.com/who-we-are/about/>

[Fairphone. Our story: Designing a phone that lasts.](https://www.fairphone.com/en/story/)
<https://www.fairphone.com/en/story/>

[IKEA. Buyback & resell: Give your used furniture a second life.](https://www.ikea.com/us/en/customer-service/services/buyback-resell/)
<https://www.ikea.com/us/en/customer-service/services/buyback-resell/>

[Too Good To Go. The movement: Our mission to reduce food waste.](https://toogoodtogo.com/en-us/movement)
<https://toogoodtogo.com/en-us/movement>

[Vinted. About Vinted: Making second-hand first choice.](https://www.vinted.com/about)
<https://www.vinted.com/about>

CHALLENGES OF THE CIRCULAR ECONOMY



Limited Awareness

Not all consumers or businesses understand the benefits yet.



Funding

Transitioning from "cheap and fast" to "durable and circular" requires initial investment.



Tracking Impact

It is hard to measure the full environmental footprint of a product (often called Scope 3 emissions) across a global supply chain.

WHERE TO SEEK DATA?



The Circularity Gap Reports (2024 & 2025) highlight that despite higher awareness, global circularity is actually declining.

<https://circularity-gap.world/report/2025/cgr-2025-overview>



Research shows that applying circular principles to key materials (cement, steel, plastics, and aluminium) could cut global emissions by 40% by 2050

<https://www.ellenmacarthurfoundation.org/completing-the-picture>

Research shows that if we use materials more carefully and follow circular economy ideas—like recycling and reusing—in just four important materials (cement, steel, plastics, and aluminium), we could cut global emissions by 40% by the year 2050. And if we also apply circular economy methods in the food system, like reducing food waste and reusing leftovers, we could reduce emissions by nearly half (49%) overall.



The European Commission monitors progress closely. As of 2023, the circular material use rate in the EU was 12.1%. The goal is to double this rate by 2030 to ensure Europe has a secure supply of materials.

https://ec.europa.eu/eurostat/databrowser/view/cei_sr-m030/default/table?lang=en

Right now, getting and using materials like metals, plastics, and building supplies causes about 70% of the world's greenhouse gas emissions. These gases are the main reason for climate change. To make a big difference in reducing these emissions, we need to focus on the biggest sources—especially industries, buildings and construction, and farming.

https://pdf.circularity-gap.world/?report=CGR_Global_2025_Report_0c90048033&page=1

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Circle Economy	2024	The circularity gap report 2024	https://www.circularity-gap.world/2024	United Nations Development Programme (UNDP)	2023	What is circular economy and why does it matter? UNDP Global Climate Promise	https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change
Circle Economy	2025	The circularity gap report 2025	https://www.circularity-gap.world/2025				
Environmental Protection Agency (EPA)	2025	What is a circular economy?	https://www.epa.gov/circular-economy/what-circular-economy	United Nations Environment Programme (UNEP)	2024	Circular economy: From indicators and data to policy-making	https://www.unep.org/resources/report/circular-economy-indicators-and-data-policy-making
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PBL Netherlands Environmental Assessment Agency	N. D.	Circular economy	https://www.pbl.nl/en/topics/circular-economy				
Pearce, D. W., & Turner, R. K	1990	Economics of natural resources and the environment	Johns Hopkins University Press				

BENEFITS

Why do we need to switch to a Circular Economy?

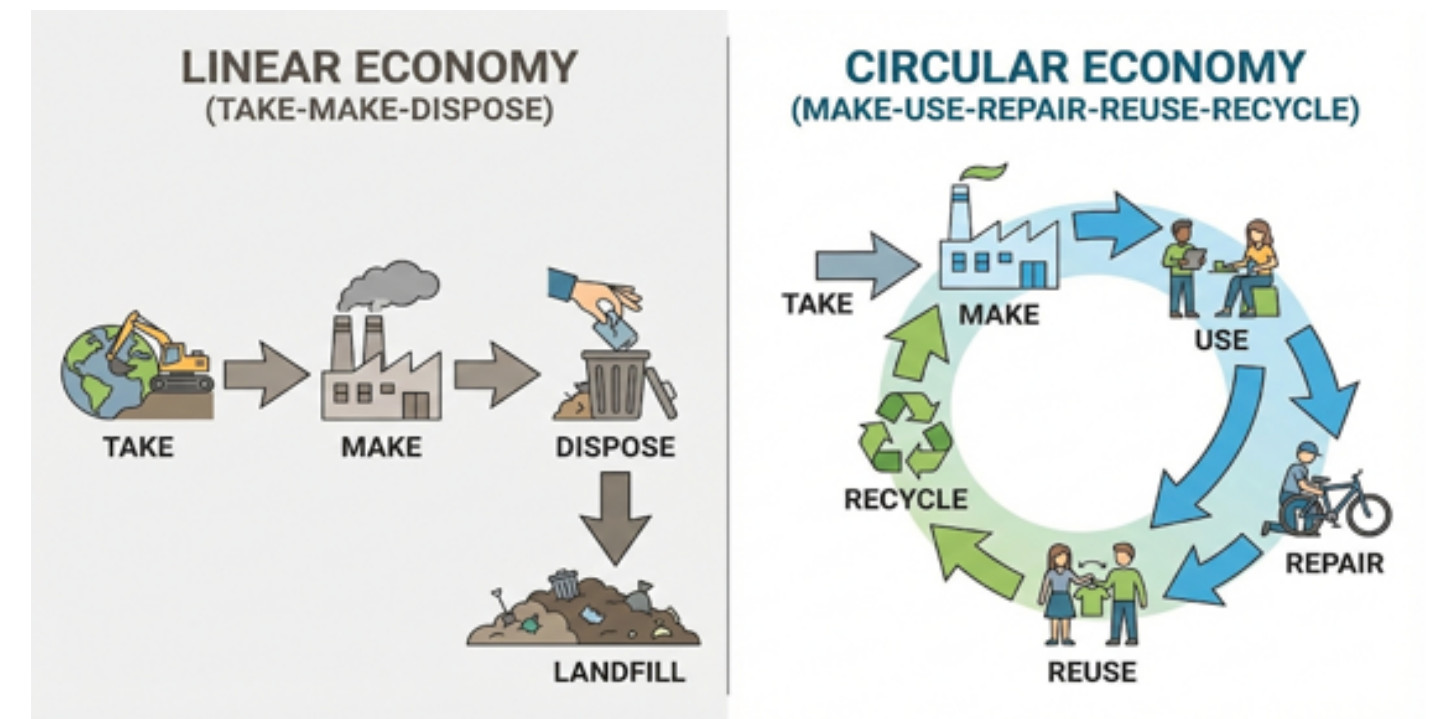
Transitioning to a circular economy is not just about saving the planet; it is a strategy to build a stronger economy and a fairer society. While the linear "take-make-dispose" model wastes value, the circular model captures it.

Implementing circular principles offers benefits in three major areas: protecting the environment, reducing dependence on raw materials, and boosting the economy (McGinty, 2021; European Parliament [EP], 2023). This chapter explores why this shift is essential for our future.

In this chapter, you will find:

- What is the difference between a traditional "linear" and a "circular" economy?
- Why is this shift important for the environment and our economic security?
- Box 1.1: Characteristics of the linear economy.
- Box 1.6: Where to find data, including the latest EU circularity indicators.

FIGURE 2.1: A SIDE-BY-SIDE COMPARISON OF THE LINEAR VS. CIRCULAR MODELS.



Source: own processing (using AI tools)



Packaging is a visible pollution issue. The average European generates about 190 kg of packaging waste per year (Eurostat, 2024). Circular strategies aim to eliminate excessive packaging and replace single-use wrappers with reusable systems.

Slowing Resource Extraction



By reusing and recycling products, we do not need to mine, log, or drill for new materials as often. This protects landscapes, habitats, and biodiversity that are often destroyed by extraction processes.

Tackling Packaging Waste

Protecting the Environment

The most immediate benefit of a circular economy is the reduction of pressure on our ecosystems. It protects the environment in three key ways:

Cutting Greenhouse Gases



A significant portion of global emissions comes from industrial production. By keeping materials in use, we skip the energy-intensive processes of extracting and refining raw materials, thereby reducing total annual greenhouse gas emissions.

Smarter Design



The circular economy tackles problems at the source. It is estimated that more than 80% of a product's environmental impact is determined during the design phase (European Commission, 2014). If products are designed to be durable and repairable, they consume far less energy over their lifetime.

Reducing Dependence on Raw Materials

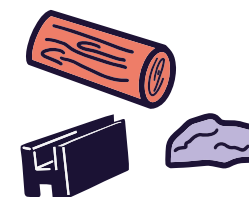
The world's population is growing, and so is the demand for resources. However, the supply of crucial raw materials is limited.

Security of Supply



Relying on imported raw materials makes countries vulnerable to price spikes and shortages. By recycling materials we already have, we reduce this dependency.

Critical Raw Materials (CRMs)



This is vital for modern technology. Materials like lithium and cobalt are needed for electric vehicle batteries and smartphones. A circular economy treats old electronics not as waste, but as "urban mines"—sources of valuable materials that can be recovered and used to build the next generation of technology (EP, 2021).

New Jobs



Moving away from a "disposable" culture creates jobs in labor-intensive sectors. Instead of automated mining, we need skilled workers for repair, maintenance, refurbishment, and recycling. For example, a "Repair Cafe" or a refurbishment factory creates local employment.

Creating Jobs & Saving Money

The shift to circularity is also an economic opportunity.

Consumer Savings

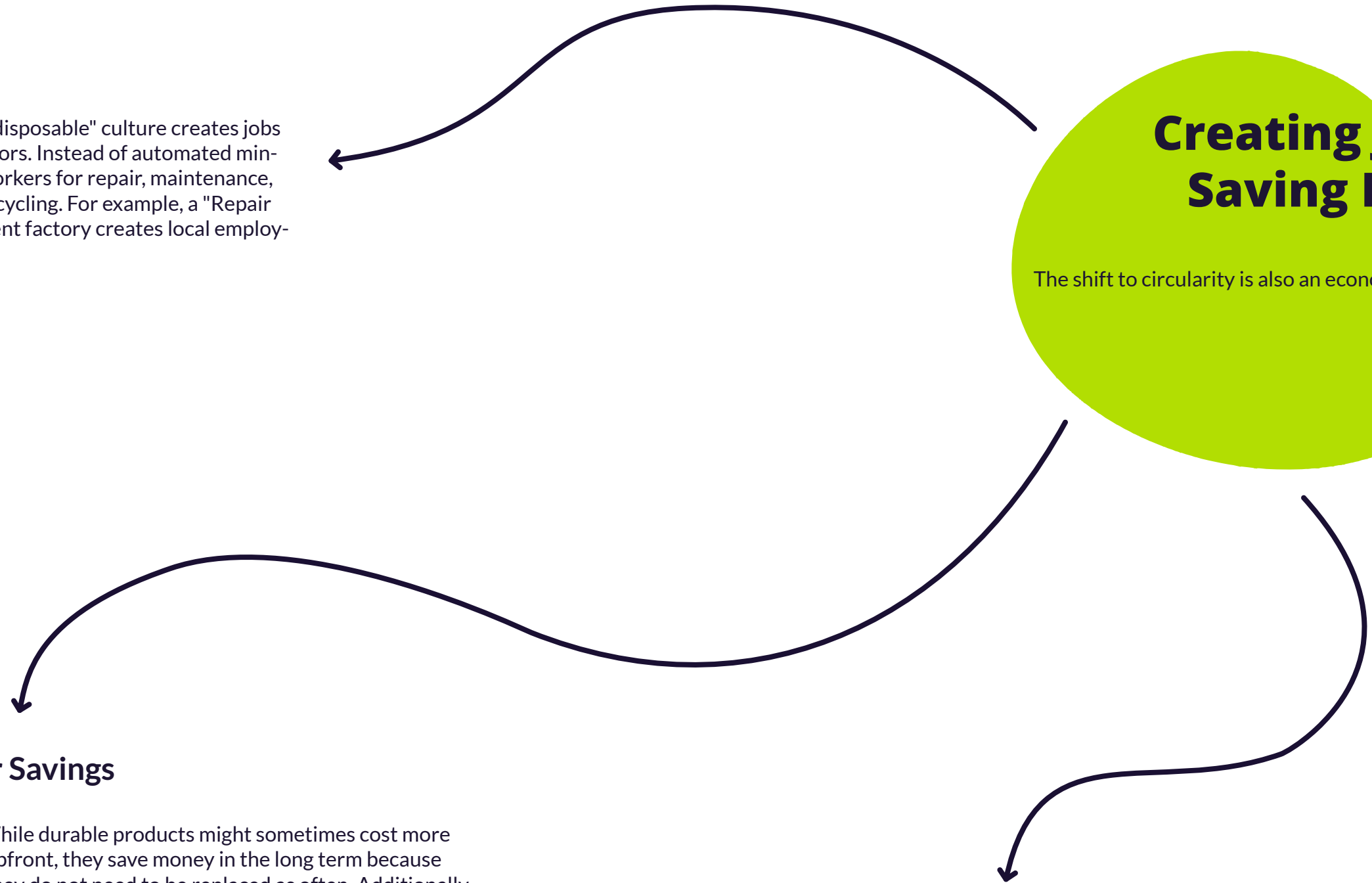


While durable products might sometimes cost more upfront, they save money in the long term because they do not need to be replaced as often. Additionally, new models such as "Product-as-a-Service" (e.g., renting a washing machine instead of buying one) allow consumers to access high-quality products without the high initial cost.

Innovation



Redesigning products to be circular requires creativity. This boosts innovation across sectors, from biodegradable textiles to modular electronics.



The Comparison

Linear

Box 2.1 provides a summary of why the shift is necessary, contrasting the risks of the old model with the opportunities of the new one.

vs. Circular

THE LINEAR ECONOMY (OLD MODEL)	THE CIRCULAR ECONOMY (NEW MODEL)
Environmental Impact High pollution, habitat destruction, and biodiversity loss due to constant resource extraction and waste dumping.	Circular Design Reduces waste to a minimum. It is "regenerative by design," meaning it aims to restore natural systems rather than deplete them.
Resource Depletion Places unsustainable pressure on finite natural resources, risking their exhaustion.	Resource Efficiency Keeps materials and products circulating for as long as possible. "Waste" is recaptured and viewed as a resource for new products.
Economic Risks Vulnerable to resource scarcity and price volatility (e.g., if a material runs out, prices spike).	Economic Resilience Decouples economic growth from resource use. It meets society's needs without needing to constantly mine more materials.
End of Life Products become "waste" and lose all value.	End of Life Materials are maintained at their "highest value" through repair and reuse, creating continuous economic value.

Source: Adapted from The Circularity Gap Report 2024

References for chapter 2:

Author	Date	Title	Source
Circle Economy Foundati-on	2024	The Circularity Gap Report 2024	https://www.circularity-gap.world/2024
European Commission	2014	Ecodesign: Your Future - How Ecodesign can help the environment and the economy. Publications Of-fice of the European Union	https://op.europa.eu/en/publication-detail/-/publi-cation/4d42d597-4f92-4498-8e1d-857c-c157e6db
European Parliament	2021	A European strategy for critical raw materials. Euro-pean Parliament resolution of 24 November 2021	https://www.europarl.eu-ropa.eu/doceo/document/TA-9-2021-0468_EN.html
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McGinty, D.	2021	5 Opportunities of a Circu-lar Economy. World Re-sources Institute (WRI)	https://www.wri.org/in-sights/5-opportunities-cir-cular-economy

THE BUTTERFLY MODEL

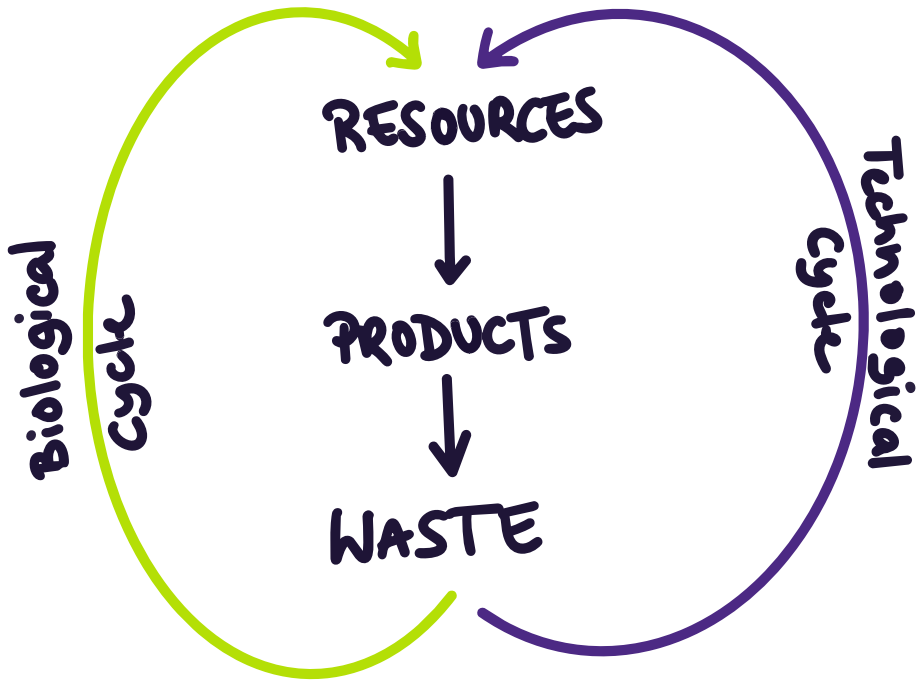
In this chapter, you will find:

- Who developed the "Butterfly Diagram" and what it represents.
- The Biological Cycle (Green Side): How nature recycles materials and how we can mimic it.
- The Technical Cycle (Blue Side): How we manage human-made products like electronics and plastics.
- Box 3.2: Real-world examples of both cycles to help explain them to students.

Visualizing the Circular Economy

The Butterfly Diagram is the most famous visual representation of the circular economy. Developed by the Ellen MacArthur Foundation, it illustrates the continuous flow of materials through two distinct cycles: the Biological Cycle (left side) and the Technical Cycle (right side).

FIGURE 3.1 THE CIRCULAR ECONOMY SYSTEMS DIAGRAM (THE SIMPLIFIED BUTTERFLY MODEL)



Source: Own processing (Adapted from Ellen MacArthur Foundation, 2025)

The diagram illustrates a key goal: keeping products, components, and materials circulating in the economy for as long as possible. Its roots trace back to the Cradle to Cradle framework (Braungart & McDonough, 2002), which proposes that waste should be eliminated by treating all materials as "nutrients."

1

Biological Nutrients

Materials that are biodegradable and can safely return to nature (e.g., food, wood, cotton).

2

Technical Nutrients

Synthetic materials that should stay in closed loops and never enter the natural environment (e.g., metals, plastics).

BOX 3.1

UNDERSTANDING THE VISUALIZATION

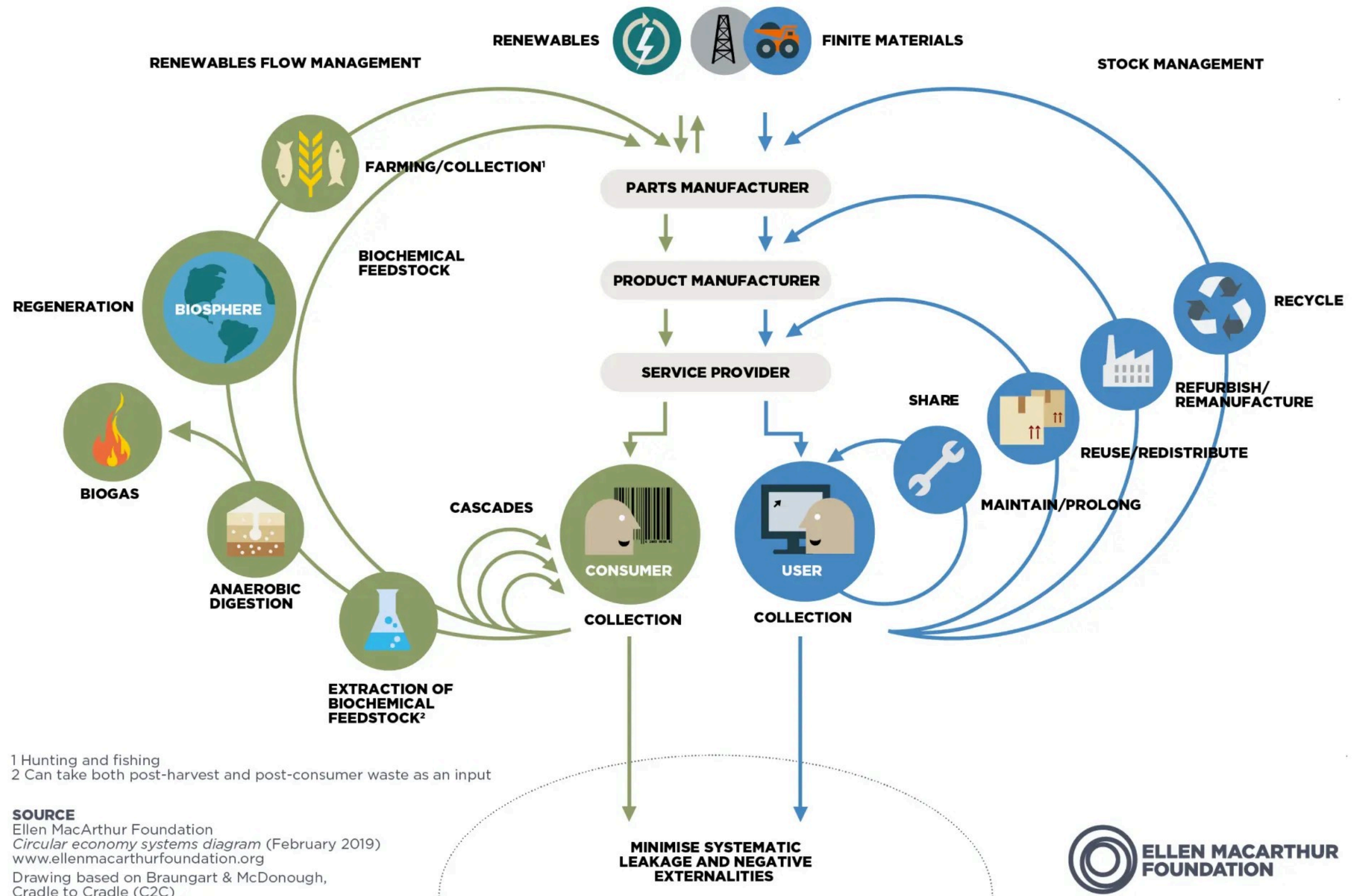
The Ellen MacArthur Foundation provides a detailed, interactive version of this diagram on their website, along with an explainer video that is excellent for classroom use.

The Central Spine

The vertical line down the middle represents the flow of materials from raw extraction to end-of-life. The goal of the circular economy is to divert materials away from the "trash" at the bottom and loop them back up to the top

The Video Resource

A helpful animated explanation is available here:
<https://www.youtube.com/watch?v=Lc-FQvPO89Y>



The Biological Cycle

(The Left Side)

The left side of the Butterfly diagram—often colored green—represents materials that can biodegrade and safely return to the earth. This cycle applies mostly to consumables (things we consume), such as food and biological fibres (cotton, wood). The goal here is not just to do less harm, but to actively regenerate nature. Key elements include:

Regeneration

In a linear economy, nature is degraded. In a circular economy, we aim to build natural capital. This means farming and production methods should rebuild soils and enhance biodiversity, rather than depleting them.

Farming and The Food System

- Farms, forests, and fisheries are managed to create positive outcomes for nature.
- **Regenerative Agriculture:** Practices that improve soil health and store carbon in the ground.
 - **Nutrient Return:** Instead of using chemical fertilizers, organic waste (like food scraps) is returned to the soil as compost. This closes the loop, feeding the

Cascades (Getting More Value)

- Before biological materials are returned to the soil, we should extract as much value as possible through "cascading."
- **Example:** An orange is used for juice. The peel is then used to extract oils for fragrances. The remaining pulp is used for animal feed. Finally, the manure from the animals is composted for soil. This uses the same material multiple times before it biodegrades.

Biochemical Extraction & Biogas

- **Biochemicals:** Post-harvest waste can be used in "biorefineries" to create valuable chemical products or bio-materials.
- **Biogas (Anaerobic Digestion):** Food waste can be broken down by bacteria without oxygen to produce biogas (a renewable energy source) and digestate (a natural fertilizer).

The Technical Cycle

(The Right Side)

The right side of the diagram—often colored blue—focuses on durables (things we use, but do not consume), such as phones, cars, and washing machines. These materials cannot return to the soil, so they must circulate within the economy.

The goal is to keep these items in the "inner loops" for as long as possible.

Sharing

This creates the tightest loop. By sharing products (e.g., car-sharing, tool libraries, or shared wardrobes), we maximize the use of a single item, reducing the need to manufacture new ones.

Maintaining

Regular maintenance (repairing a hem, servicing a car engine) prevents products from breaking down. This empowers users to keep their items functioning longer.

Reusing & Redistributing

This involves selling or giving a product to a new owner. Platforms like Vinted or eBay facilitate this. The product remains in its original form, requiring no energy to remanufacture.

Refurbishing & Remanufacturing

- Refurbishing: Repairing and cleaning a product (like a laptop) so it is "good as used."
- Remanufacturing: A comprehensive industrial process where a product is disassembled and rebuilt to "good as new" standards, often with a warranty.

Recycling

This is the outermost loop and the last resort. It involves breaking a product down into raw materials (melting plastic, shredding metal) to make something new. While it preserves materials, it requires significant energy and labor.

CLASSROOM EXAMPLES: THE TWO CYCLES

BOX 3.2

BIOLOGICAL CYCLE EXAMPLE	TECHNICAL CYCLE EXAMPLE
(The School Garden)	(The Lost & Found)
Action	Action
Students eat apples at lunch	A student outgrows their uniform or loses a jacket
Loop	Loop
Instead of the trash, cores go into a compost bin	Instead of throwing it away, it is washed and placed in a "Uniform Swap" shop
Result	Result
After a few months, the compost is added to the school garden soil to help grow new vegetables	Another student uses the jacket
Concept	Concept
Regeneration	Reuse/Redistribute

References for chapter 3:

Author	Date	Title	Source
Braungart, M., & McDonough, W	2002	Cradle to Cradle: Remaking the Way We Make Things	North Point Press
Ellen MacArthur Foundation	2021	The Butterfly Diagram: Visualising the circular economy	https://www.ellenmacarthurfoundation.org/circular-economy-diagram
Ellen MacArthur Foundation	2022	The Biological Cycle of the Butterfly Diagram	https://www.ellenmacarthurfoundation.org/articles/the-biological-cycle-of-the-butterfly-diagram
Ellen MacArthur Foundation	2022	The Technical Cycle of the Butterfly Diagram	https://www.ellenmacarthurfoundation.org/articles/the-technical-cycle-of-the-butterfly-diagram
Ellen MacArthur Foundation	N.d.	Video: The Butterfly Diagram. YouTube	https://www.youtube.com/watch?v=Lc-FQyPO89Y



TEACHER TIP: THE POWER OF "INNER LOOPS"

When teaching the Butterfly Diagram, emphasize that the smaller (inner) circles are better.

- Sharing or Repairing (Inner Loop) preserves the whole product and saves the most energy.
- Recycling (Outermost Loop) destroys the product to save only the material. It is better than a landfill, but worse than repair.

SUSTAINABLE CONSUMPTION

In this chapter, you will find:

- How does our current consumption put the planet at risk?
- Planetary Boundaries: What are the ecological limits of Earth?
- Doughnut Economics: How can we meet human needs without destroying the planet?
- Sustainable Consumption Corridors: Defining the "floor" and "ceiling" of fair consumption.
- The Link: How the circular economy helps us consume sustainably.

... and the Circular Economy

Global consumption patterns are currently putting the planet's ecological balance at risk. There is no doubt that our "take-make-waste" behavior harms ecosystems. However, consumption is also necessary; it provides us with food, housing, and the tools we need for well-being.

The challenge is balancing these two realities. High levels of consumption and production threaten the Earth's stability, but too little consumption leads to poverty and social injustice



Planetary Boundaries: The Ecological Ceiling

How do we know when we are consuming too much? Scientists monitor this through the concept of Planetary Boundaries.

Proposed in 2009 by the Stockholm Resilience Centre (led by Johan Rockström), this framework identifies nine critical processes that regulate the stability of the Earth (such as climate change, biodiversity loss, and freshwater use).

1

Safe Operating Space:
TAs long as we stay within these boundaries, humanity can thrive safely

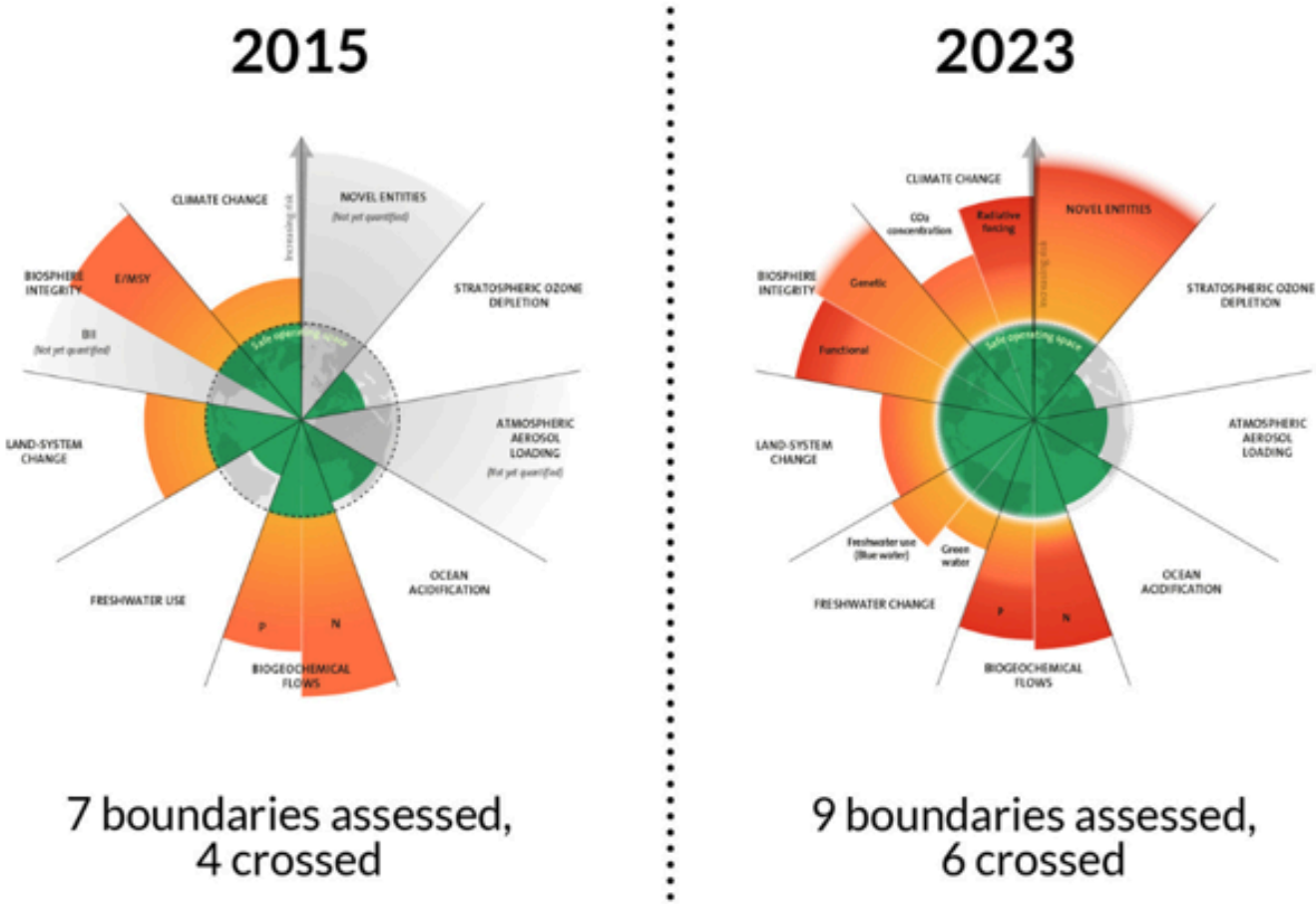
2

Crossing the Line:
Transgressing these boundaries increases the risk of irreversible environmental changes

3

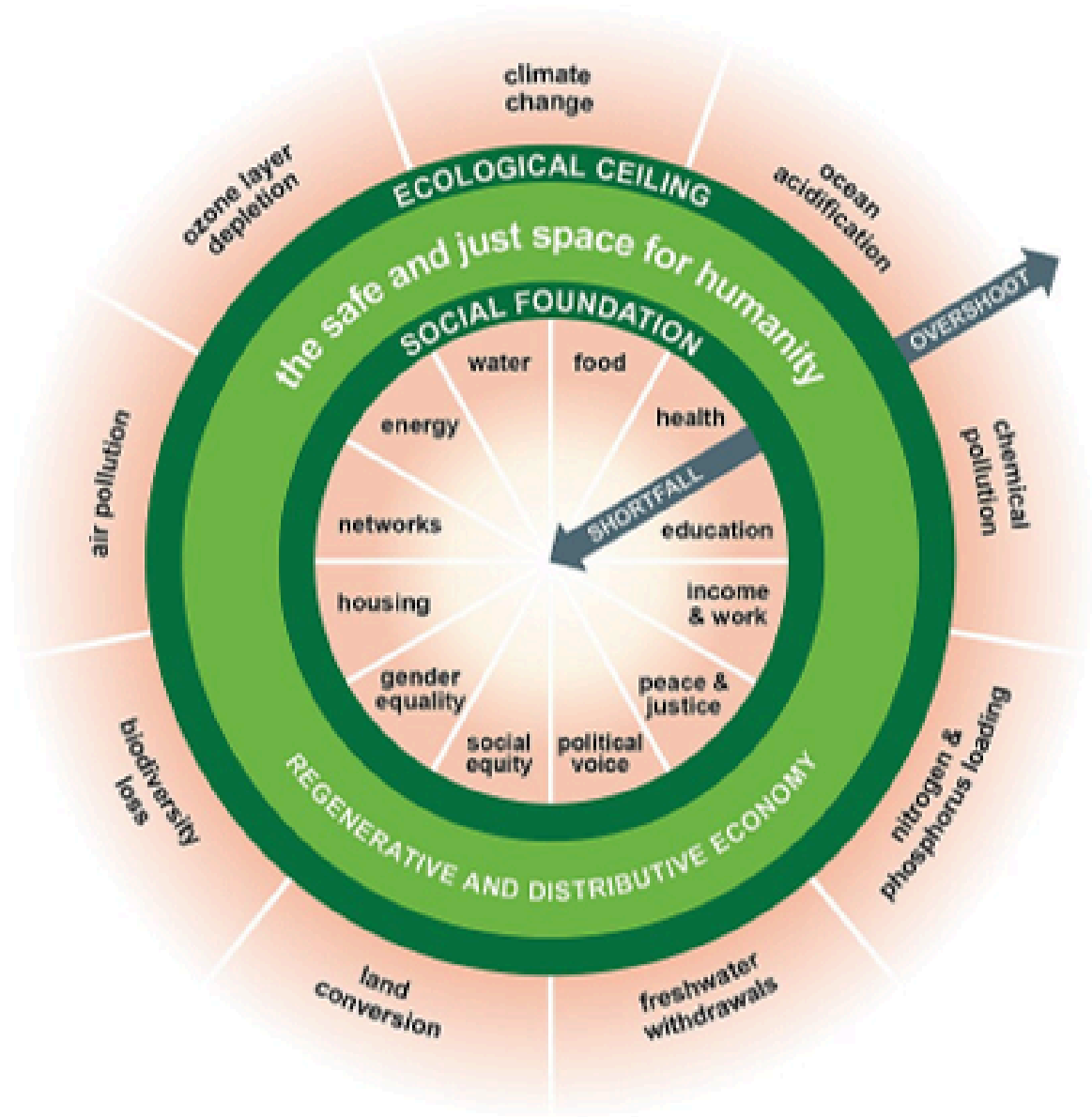
Current Status:
The 2023 update concluded that six of the nine boundaries have already been crossed, meaning we are operating in a high-risk zone (Stockholm Resilience Centre, 2023)

FIGURE 4.1. ROCKSTRÖM’S PLANETARY BOUNDARIES



Source: Stockholm Resilience Centre (2023). Available on <https://www.stockholmresilience.org/research/planetary-boundaries.html>

FIGURE 4.2. DOUGHNUT ECONOMICS: A FRAMEWORK FOR SUSTAINABLE CONSUMPTION



Source: Doughnut Economics Action Lab (2025). Available on <https://doughnuteconomics.org/about-doughnut-economics>

Currently, no government is fully operating within the Doughnut. Most wealthy nations are breaking the ecological ceiling, while many developing nations are falling below the social foundation (O'Neill et al., 2018).

The Doughnut Economy: A Safe and Just Space

While Planetary Boundaries tell us the maximum we can consume (the ecological ceiling), they do not address the minimum people need to survive.

Economist Kate Raworth (2012) added this social dimension, creating the Doughnut Economics model.



The Outer Ring (Ecological Ceiling):
We must not overshoot the planetary boundaries (e.g., climate change, pollution)



The Inner Ring (Social Foundation):
We must not undershoot human needs (e.g., food, water, health, education, social equity)



BOX 4.1

VIDEO RESOURCES

- **Planetary Boundaries**
A visual guide by the Financial Times explaining the limits of Earth's ecosystems
<https://www.youtube.com/watch?v=cXoMJKZTErU>
- **Doughnut Economics**
Kate Raworth explains the concept in a short animation
<https://www.youtube.com/watch?v=Mkg2XMTWW4g>

The Doughnut (The Sweet Spot):
The green ring between these two limits is the "safe and just operating space for humanity," where everyone has enough to thrive without destroying the planet.

Defining Sustainable Consumption

Sustainable consumption is about finding that balance. Defined at the Oslo Symposium (1994), it means using goods and services to meet basic needs and improve quality of life, while minimizing the use of natural resources and toxic materials so that we do not jeopardize future generations.

Source: <https://www.unep.org/explore-topics/resource-efficiency/what-we-do/sustainable-consumption-and-production-policies>



It is formally recognized in Goal 12 of the UN Sustainable Development Goals (SDGs): "Responsible Consumption and Production."

Source: <https://sdgs.un.org/goals/goal12>

BOX 4.2

MILESTONES IN SUSTAINABLE CONSUMPTION

1972 (Stockholm)	First global link made between environment and development
1987 (Brundtland Report)	Introduced "Sustainable Development"—meeting present needs without stealing from the future
1994 (Oslo Definition)	Officially defined sustainable consumption to include a "life-cycle" approach
2015 (SDGs)	Adopted SDG 12, making responsible consumption a global priority for 2030

Defining Sustainable Consumption

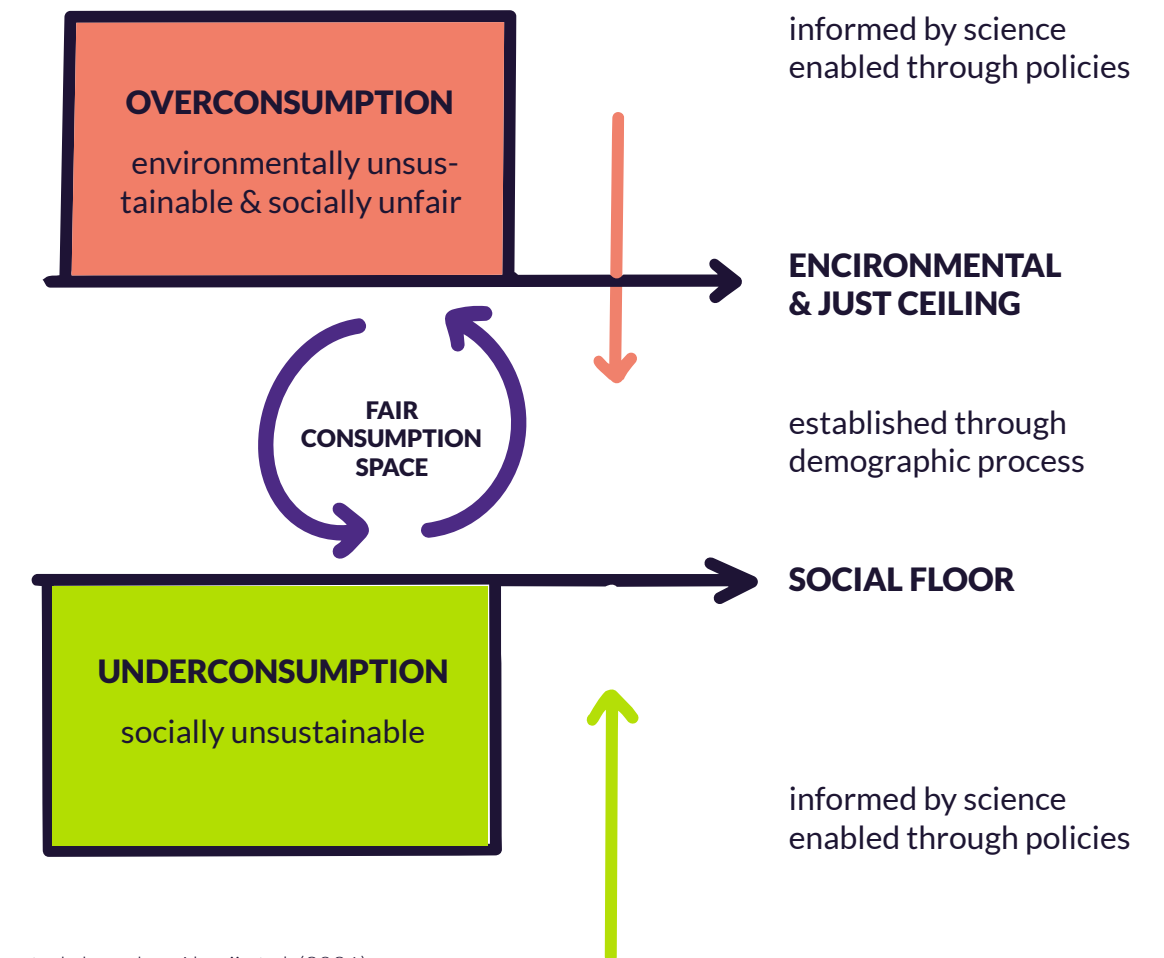
A helpful new concept for teachers is Sustainable Consumption Corridors. This builds on the Doughnut model by defining a "corridor" of acceptable consumption lifestyles.

1 The Floor (Minimum Standards)
Every individual must have access to enough resources to live a "good life" (satisfying needs like food, shelter, and mobility).

2 The Ceiling (Maximum Standards)
There must be a limit on resource use so that one person's excess does not prevent others (now or in the future) from having enough.

Living "in the corridor" means having enough to be happy, but not so much that it hurts others or the planet.

FIGURE 4.3. CORRIDORS FOR SUSTAINABLE CONSUMPTION



Source: Own study based on Akenji et al. (2021)

Linking Circular Economy & Sustainable Consumption

The circular economy is the practical "toolbox" to help us stay within the Doughnut and the Corridors. It links to consumption in three main ways:

1. CONSUMING DIFFERENTLY (THE "QUALITY" SHIFT)

Action
Switching to products made from renewable or recycled materials
Example
Buying a phone made of recycled plastics or choosing clothing made from organic cotton
Policy
EU regulations are making this easier by demanding higher recycling rates and better collection systems

2. CONSUMING LESS (THE "QUANTITY" SHIFT)

Action
Extending a product's life so we don't need to buy new ones as often
Challenge
We must fight planned obsolescence (products designed to break)
Solution
Product-as-a-Service models. Instead of buying a tool you use once a year, you rent it. This reduces the total number of products manufactured.

3. SCALING UP CIRCULAR DESIGN

Action	Designing products that are durable, repairable, and modular from the start
Goal	Making sustainable products the "norm" rather than a niche luxury. The EU's Ecodesign Regulation aims to push the market in this direction.

BOX 4.3

TEACHER'S CORNER EXPLAINING "THE CEILING"

Students often understand poverty (the floor), but the "ceiling" is harder to grasp.

Analogy	"Imagine a pizza party for the whole class. The Floor is ensuring everyone gets at least one slice so no one goes hungry. The Ceiling is saying no one can take 10 slices, because then there won't be enough pizza left for the others."
Discussion	"What are things we need (Floor)? What are things that are too much (Ceiling)?"

References for chapter 4:

Author	Date	Title	Source
Akenji, L., et al	2021	1.5-Degree Lifestyles: Towards A Fair Consumption Space for All. Hot or Cool Institute	https://hotorcool.org/wp-content/uploads/2021/10/Hot_or_Cool_1_5_lifestyles_FULL_REPORT_AND_ANNEX_B.pdf
Di Giulio, A., & Fuchs, D.	2014	Sustainable consumption corridors: Concept, objections, and responses	GAIA - Ecological Perspectives for Science and Society, 23(3), 184–192.
European Commission.	2022	Proposal for a regulation establishing a framework for setting ecodesign requirements for sustainable products	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0142
European Environment AgencyEuropean Environment Agency	2021	Plastics in textiles: towards a circular economy for textiles in Europe	https://www.eea.europa.eu/en/analysis/publications/plastic-in-textiles-towards-a-circular-economy-for-synthetic-textiles-in-europe
Raworth, K.	2012	A safe and just space for humanity: Can we live within the doughnut? Oxfam Discussion Papers	https://www-cdn.oxfam.org/s3fs-public/file_attachments/dp-a-safe-and-just-space-for-humanity-130212-en_5.pdf
Steffen, W., et al	2015	Planetary boundaries: Guiding human development on a changing planet	Science, 347(6223).
Stockholm Resilience Centre	2023	Planetary Boundaries	https://www.stockholmresilience.org/research/planetary-boundaries.html
United Nations	2024	The Sustainable Development Goals Report 2024: Goal 12	https://unstats.un.org/sdgs/report/2024/Goal-12/

What is the EU doing to become a Circular Economy?

For decades, Europe’s economy grew by consuming more resources. This created pollution and a dangerous dependency on imported raw materials. To fix this, the EU launched the European Green Deal—a roadmap to make Europe the first climate-neutral continent by 2050 (European Commission, 2019). The circular economy is a central pillar of this deal. However, the motivation has evolved. Today, it is not just about saving the environment; it is about strategic autonomy. By recycling critical materials (like lithium for batteries) inside Europe, the EU becomes less dependent on volatile global markets and ensures its industries remain competitive.

In this chapter, you will find:

- What is the European Green Deal and how does the circular economy fit in?
- What are the main goals of the Circular Economy Action Plan (CEAP)?
- Real-World EU Laws: From the "Common Charger" for phones to the ban on plastic straws.
- Key Sectors: How the EU is fixing electronics, fashion, and packaging.

The Strategy: Making Sustainable Products the Norm

The EU wants to end the "throw-away" culture. To achieve this, the Circular Economy Action Plan (CEAP), adopted in March 2020 as a pillar of the European Green Deal, laid the groundwork for a massive shift in how products are made (European Commission, 2020). This vision has since evolved into binding law through the Ecodesign for Sustainable Products Regulation (ESPR), which entered into force in 2024 (European Union, 2024a).

BOX 5.1

OBJECTIVES OF THE ACTION PLAN

Make sustainable products the norm	Goods should be durable, reusable, and repairable.
Empower consumers	People should have the "Right to Repair" and trustworthy information (no "greenwashing").
Focus on high-impact sectors	Prioritize areas that use the most resources: Electronics, Textiles, Plastics, Packaging, and Batteries.
Reduce waste	Stop exporting waste outside the EU and boost recycling at home

Adopted in March 2020, the second Circular Economy Action Plan is one of the main building blocks of the European Green Deal, Europe’s agenda for sustainable growth (European Commission, 2020).

PRIORITY SECTORS

Where is the EU Taking Action?

The Action Plan targets specific industries where the linear "take-make-dispose" model is most damaging. Here is what is changing in these sectors:

ELECTRONICS & ICT

represent the fastest-growing waste stream in the EU. To combat this, the EU has implemented the Right to Repair Directive, compelling manufacturers to make devices like phones and tablets easier to fix and ensuring spare parts remain available for years. A concrete example of this progress is the Common Charger Law (European Commission, 2022a). Since 2024, all new mobile phones, tablets, and cameras sold in the EU must use the same USB-C charging port. This simple standardization eliminates the need to buy a new charger with every device, reducing electronic waste by thousands of tons annually.

TEXTILES & FASHION

are another major target, as Europeans discard approximately 11 kg of textiles per person every year (European Parliament, 2023). The EU Strategy for Sustainable Textiles aims to end "fast fashion" through strict new rules. Under the new Ecodesign regulation, companies are now banned from destroying unsold clothes, forcing them to manage inventory more responsibly. Additionally, a Digital Product Passport—a scannable tag like a QR code—will soon appear on clothing, revealing where the material came from and how to recycle it, while design standards ensure clothes are built to last longer.

PLASTICS

are being addressed to tackle the visible crisis of pollution in oceans and cities. The EU is aggressively moving away from single-use plastics through the Single-Use Plastics (SUP) Directive (European Union, 2019). This law is the reason why plastic straws, cutlery, plates, and balloon sticks have disappeared from stores across Europe. These items were banned because sustainable alternatives, such as wood, paper, or reusable materials, are readily available.

PACKAGING

usage is at an all-time high, prompting the EU to propose strict new targets. Under the Packaging and Packaging Waste Regulation, the goal is for all packaging to be recyclable in an economically viable way by 2030. The new rules also target "empty space," requiring companies to stop shipping small items in huge boxes, and mandate clear labeling so consumers know exactly which bin to use for disposal.

BATTERIES & VEHICLES

are critical for the green transition, but they require rare materials like lithium and cobalt. The new Batteries Regulation ensures that these valuable resources are not lost in landfills (European Union, 2023). Every industrial and electric vehicle battery will now carry a "Battery Passport," a digital record of its health and history. This transparency helps recyclers recover valuable materials efficiently, reducing the EU's dependence on mining new resources.

Managing Waste

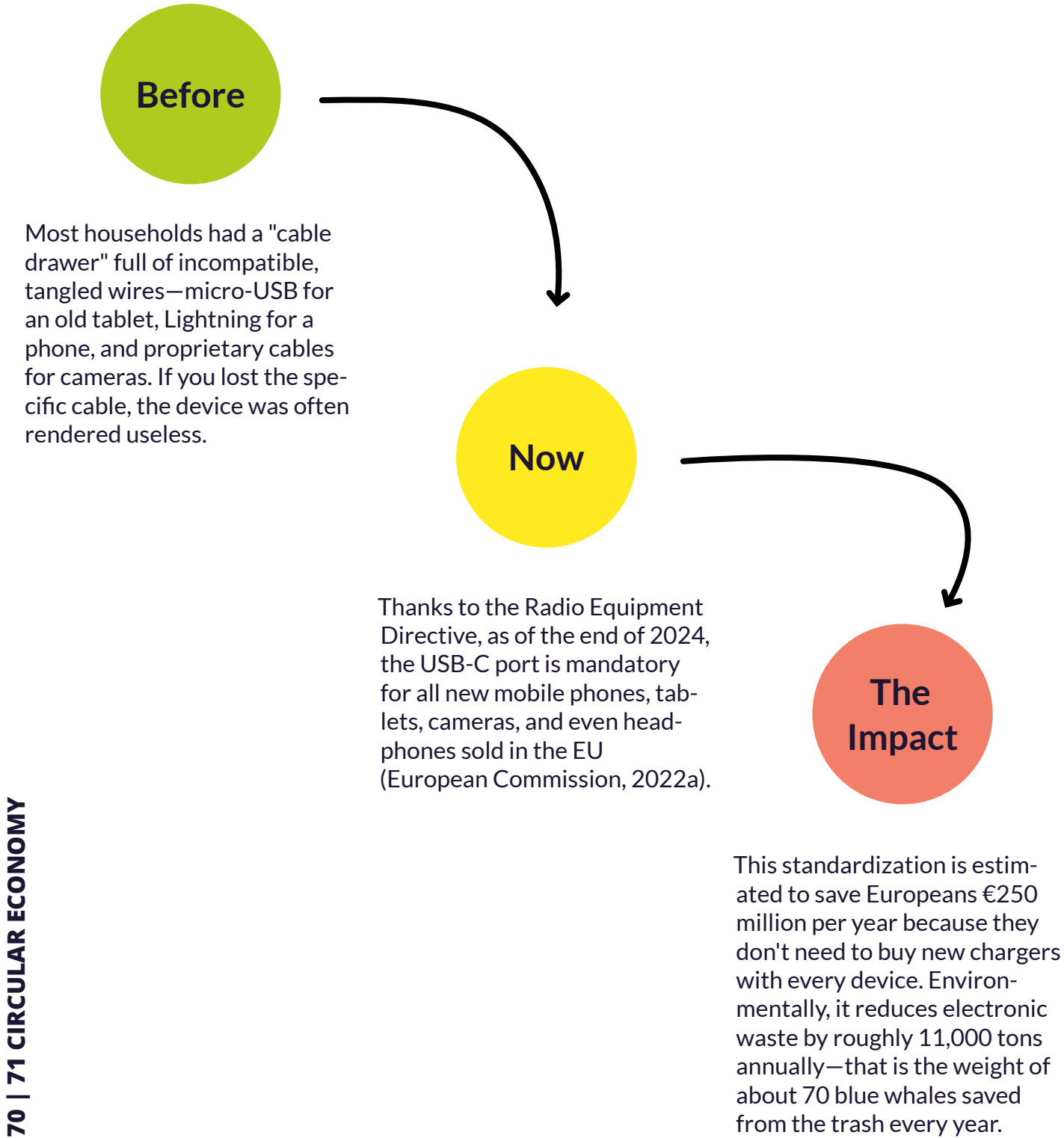
The final piece of the EU's circular strategy is rethinking how we handle the "end" of the line. The goal is to stop treating waste as a problem to be exported or hidden, and instead manage it as a resource to be recovered. For years, wealthy countries shipped millions of tons of plastic waste to developing nations, often claiming it was for "recycling." In reality, much of it was dumped or burned because those countries lacked the infrastructure to process it. To end this practice, the EU updated the Waste Shipment Regulation in 2024, strictly banning the export of plastic waste to non-OECD countries. This shift forces EU nations to take full responsibility for their own consumption and build the necessary infrastructure to deal with their own mess, rather than burdening the Global South.

Simultaneously, the EU is addressing the confusion that often happens at the recycling bin. "Wish-cycling"—throwing the wrong item in the recycling bin and hoping it works—contaminates waste streams and makes recycling impossible. To fix this, the EU is working toward harmonized waste sorting labels. The goal is simple but effective: the symbols on a yogurt pot or cereal box should match the colored symbols on street bins across every member state. This harmonization ensures that whether a citizen is in Madrid, Berlin, or Warsaw, they know exactly where their waste belongs, increasing the quality of recycled materials.

BOX 5.2. SUCCESS STORY:

THE USB-C CHARGER

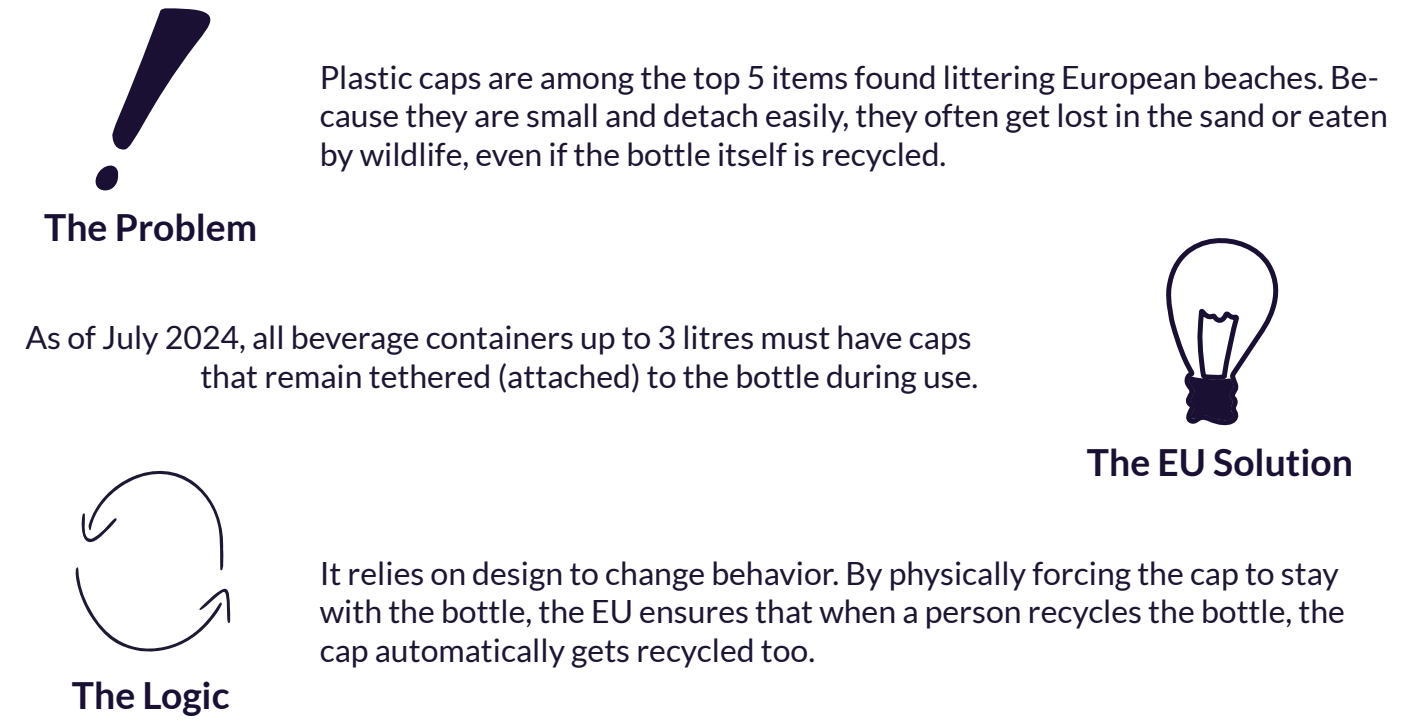
One of the most relatable examples for students is the Common Charger.



BOX 5.3. REAL-WORLD EXAMPLE

THE MYSTERY OF THE ATTACHED CAP

Have you noticed a change in your water or soda bottles lately? You might have noticed that plastic bottle caps are now attached to the plastic ring and don't fall off when you open them. This isn't an accident or a manufacturing defect—it is a direct result of the EU Single-Use Plastics Directive (European Union, 2019).



BANNING THE BURNING OF UNSOLD CLOTHES

Did you know that millions of brand-new shirts and sneakers are destroyed every year without ever being worn?



The Problem

In the "Fast Fashion" industry, brands produce huge amounts of clothing very quickly. When collections change or items don't sell, some companies burn or shred these perfectly good products rather than donating or discounting them, just to "protect their brand image" or clear warehouse space.

Under the new Ecodesign for Sustainable Products Regulation (ESPR), the EU is introducing a direct ban on the destruction of unsold textiles and footwear (European Union, 2024a; European Council, 2023).



The EU Solution



The Logic

Destroying new goods is the worst form of the linear economy—it wastes all the water, energy, and labor used to make them for absolutely no benefit. The new law forces companies to produce less, manage their stock better, or find circular ways to reuse these items.



TEACHER TIP:

Ask students: "What do you think happens to the clothes in the store that nobody buys?" Most assume they are donated. Discussing this ban helps reveal the hidden waste in the fashion system.

References for chapter 5:

Author	Date	Title	Source
European Commission	2019	The European Green Deal. COM(2019) 640 final	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3A-FIN
European Commission	2020	A new Circular Economy Action Plan: For a cleaner and more competitive Europe. COM(2020) 98 final	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:98:FIN
European Commission	2022a	Directive on common charger: Reducing e-waste	https://commission.europa.eu/strategy-and-policy/policies/internal-market/common-charger_en
European Commission	2022b	EU Strategy for Sustainable and Circular Textiles	https://environment.ec.europa.eu/strategy/textiles-strategy_en
European Commission	2022c	Proposal for a revision of EU legislation on Packaging and Packaging Waste	https://environment.ec.europa.eu/publications/proposal-packaging-and-packaging-waste_en
European Council	2023	Council and Parliament strike provisional deal on ecodesign regulation	https://www.consilium.europa.eu/en/press/press-releases/2023/12/05/circular-economy-council-and-parliament-strike-provisional-deal-on-ecodesign-regulation/
European Parliament	2023	The impact of textile production and waste on the environment	https://www.europarl.europa.eu/news/en/headlines/society/2021208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographic

Author	Date	Title	Source
European Parliament	2024	Waste shipments: MEPs adopt tougher EU rules	https://www.europarl.europa.eu/news/en/press-room/20240223I-PR18074/waste-shipments-meps-adopt-tougher-eu-rules
European Union	2019	Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment (Single-Use Plastics Directive)	https://eur-lex.europa.eu/eli/dir/2019/904/oj
European Union	2023	Regulation (EU) 2023/1542 concerning batteries and waste batteries	https://eur-lex.europa.eu/eli/reg/2023/1542/oj
European Union	2024a	Regulation (EU) 2024/1781 establishing a framework for the setting of ecodesign requirements for sustainable products (ESPR)	https://eur-lex.europa.eu/eli/reg/2024/1781/oj



TOWARD THE INSPIRATION OF YOUNG CONSUMERS

Pathways to Sustainable Consumption

FAST FASHION

... is out of Fashion

In this chapter, you will find:

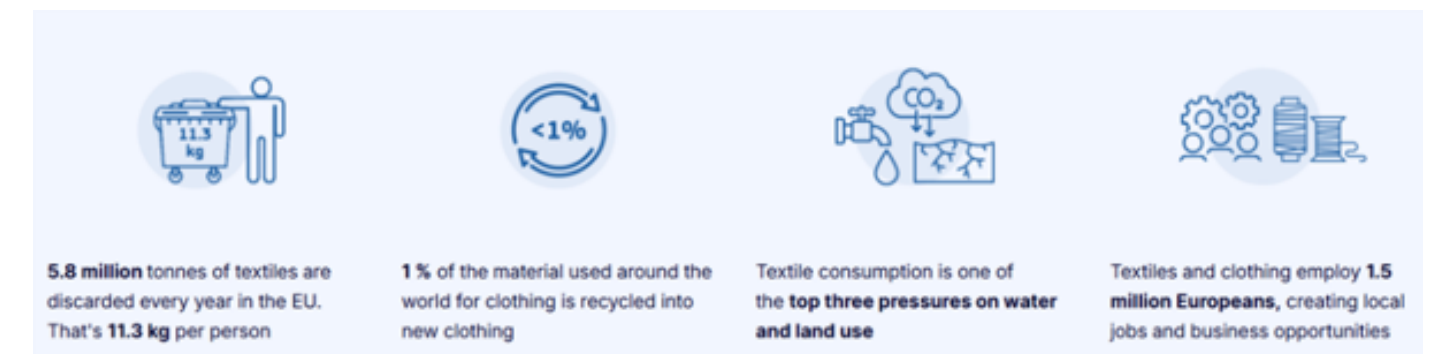
- Why does fast fashion have such a negative impact on the climate?
- What is the difference between the concepts of traditional fashion, fast fashion, slow fashion and sustainable fashion and between the linear and circular model?
- How does the circular economy work for fashion?

The primary role of clothing is to shield our bodies from weather conditions such as cold, wind, rain, or sunlight. However, clothing also serves as a powerful means of self-expression, signalling our profession, favourite sports team, or musical preferences. Textiles are deeply embedded in daily life: from garments and home furnishings to medical supplies, safety gear, construction materials, and transportation (Ellen MacArthur Foundation, 2017; European Environment Agency, 2022). Sadly, our passion for fashion has significant environmental consequences. As the ecological footprint of clothing steadily increases, urgent action is needed to mitigate its impact (UNEP, 2023).

The Economic and Cultural Context The fashion industry is a global powerhouse. It is a multibillion-dollar sector that drives employment and economic activity worldwide, playing a crucial role in manufacturing, retail, and marketing. For many low-income regions, cotton cultivation is a vital source of income (FAO & ICAC, 2021). Beyond economics, the industry shapes culture and social dynamics, influencing how we form our identities and relate to one another (ILO, 2014; McKinsey & Company, 2020).

The Rise of the "Fast Fashion" Model Despite its economic benefits, the industry has undergone a drastic shift in recent years. While textile production has expanded rapidly to meet rising demand, the average lifespan of a garment—how long we keep it and wear it—has significantly decreased.

FIGURE 6.1. THE TRENDS IN FAST FASHION



Source: ReSet the Trend (EC, 2025) https://environment.ec.europa.eu/topics/circular-economy-topics/reset-trend_en

These trends are driven by the Fast Fashion model. This approach is characterized by rapid production cycles, frequent style changes, and artificially low prices that encourage consumers to treat clothes as disposable (Ellen MacArthur Foundation, 2019). This shift has intensified the industry's environmental footprint, making it one of the leading sectors in the world for water pollution, land use, and greenhouse gas emissions (European Parliament, 2020; UNEP, 2021).

BOX 6.1

WHERE TO FIND DATA ABOUT FAST FASHION?

Title	Author	Source
EU strategy for sustainable and circular textiles	European Commission. (2025)	https://environment.ec.europa.eu/strategy/textiles-strategy_en
ReSet the trend: Become a role model!	European Commission. (2025)	https://environment.ec.europa.eu/topics/circular-economy/reset-trend_en
Circularity of the EU textiles value chain in numbers	European Environment Agency. (2025)	https://www.eea.europa.eu/en/analysis/publications/circularity-of-the-eu-textiles-value-chain-in-numbers
Fashion and the circular economy – Deep dive	Ellen MacArthur Foundation. (2019)	https://www.ellenmacarthurfoundation.org/fashion-and-the-circular-economy-deep-dive

Fast fashion vs. slow fashion

Fast fashion and slow fashion represent two fundamentally different approaches to how we make and consume clothes. Fast fashion is a business model focused on the rapid production of low-cost, trend-driven garments. Its goal is to move styles from the runway or social media to stores as quickly as possible, capitalizing on the latest fads to encourage consumers to buy more frequently. This model functions in a predominantly linear ("take-make-dispose") manner, relying on mass production, cheap labor, and low-quality materials. Consequently, garments are often treated as disposable; estimates suggest that over half of fast fashion items are discarded within a year of production (Ellen MacArthur Foundation, 2019). This cycle creates massive environmental harm through overconsumption and creates a culture of excess waste. A clear example of this is the rise of "ultra-fast fashion" brands that release thousands of new items every day, many made from synthetic fabrics like polyester that take centuries to decompose.

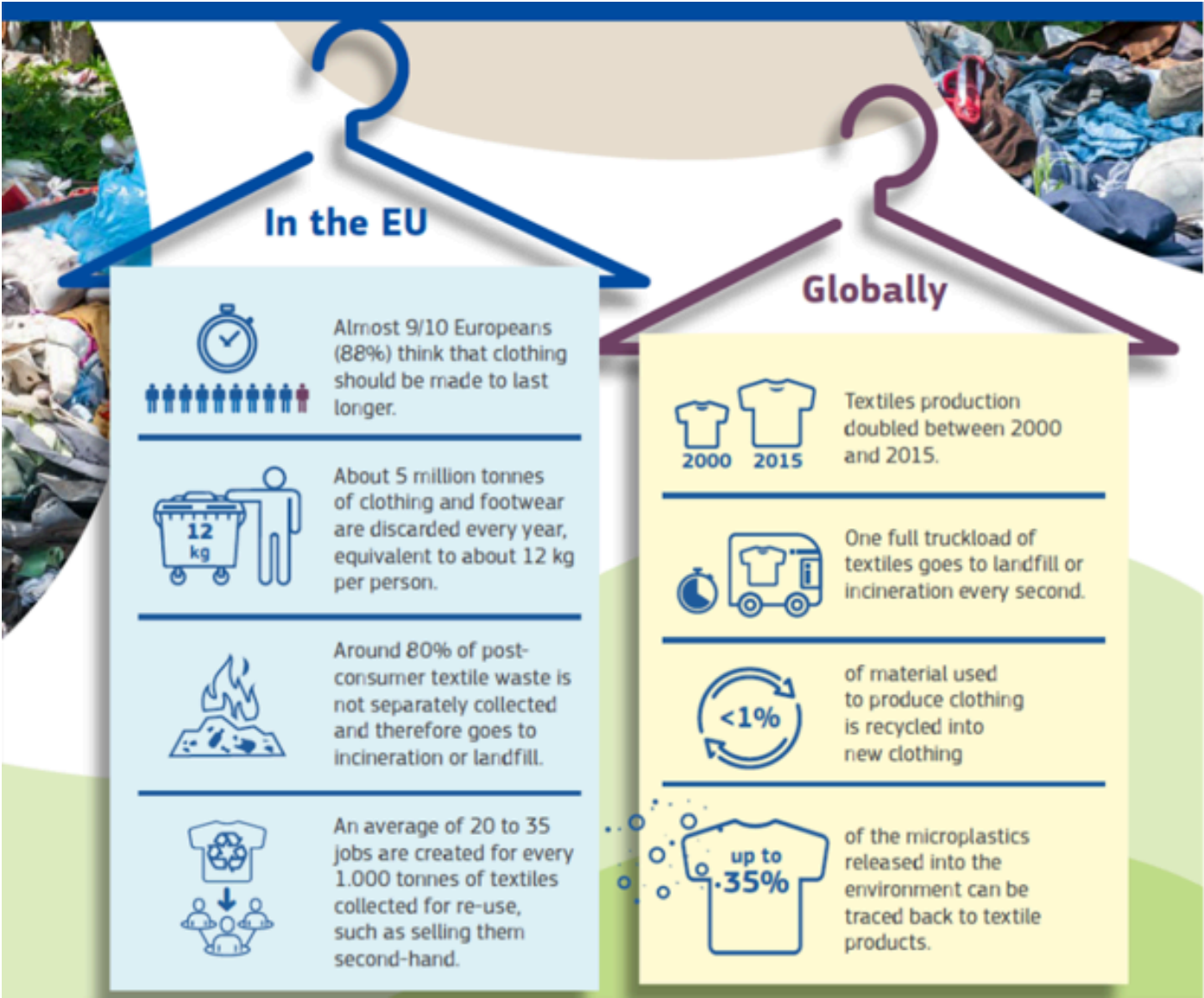
In direct contrast, slow fashion acts as an antidote to this "need for speed." It is a movement that prioritizes quality, longevity, and ethical production over volume. Instead of chasing weekly trends, slow fashion promotes timeless designs and durable garments that are meant to be worn for years rather than weeks. The core goal is to slow down the production cycle and encourage conscious consumer behavior, motivating people to buy fewer, better-made items that last longer. Specific examples of slow fashion practices include capsule wardrobes—where a person owns a small selection of versatile, high-quality items—and brands that offer lifetime repair warranties, encouraging users to fix a torn jacket rather than replacing it.

Understanding the Frameworks: Sustainable & Circular Fashion

While terms like "slow," "sustainable," and "circular" are often used interchangeably, they refer to different aspects of the industry. While slow fashion refers specifically to consumption habits and production speeds, sustainable fashion and circular fashion describe the broader systems behind the clothes.

Sustainable Fashion is the overarching "umbrella" term (UNEP, 2021). It encompasses a broad approach that prioritizes environmental integrity, social equity, and economic health throughout the entire value chain. It is not just about protecting the planet; it is equally about protecting people. Its key pillars include environmental responsibility, such as using organic cotton or water-saving dyeing techniques, and social equity, which ensures fair wages, safe working conditions, and human rights for garment workers. A sustainable brand might ensure its factory workers in Bangladesh are paid a living wage, even if the style of the clothing is modern and trendy. The goal is to create a business model that is economically viable without exploiting resources or labor.

FIGURE 6.2 SUSTAINABLE AND CIRCULAR TEXTILES BY 2030



Source: Sustainable and Circular Textiles by 2030. EU, 2025

Within this broad framework lies Circular Fashion, which focuses specifically on the mechanics of the circular economy. Its primary goal is to create a "closed-loop" system where waste is designed out entirely. While a garment might be "sustainable" because it is made of organic materials by fairly paid workers, it is only "circular" if it is designed to be easily repaired, reused, or recycled at the end of its life. For instance, a circular sneaker might

be designed so that the sole can be easily separated from the upper part for recycling, rather than being glued together permanently. Circular fashion rethinks the design process to ensure that materials remain in circulation and never become waste, effectively decoupling the fashion industry from the consumption of finite resources (Ellen MacArthur Foundation, 2019b).

BOX 6.1

HOW TO ACHIEVE SUSTAINABLE FASHION?		
Idea	Explanation	Example
Circular Economy Models	This involves shifting away from the "take-make-dispose" mindset. Brands must implement systems where products are designed to be reused, repaired, or recycled.	Take-back schemes, where brands like H&M or Levi's collect old clothes in-store to ensure they are recycled rather than thrown in the trash.
Sustainable Design Strategies	Designers have the power to reduce environmental impact before a garment is even sewn. This means choosing eco-friendly materials and designing for durability.	Using Lyocell (Tencel) instead of thirsty cotton, or using natural dyes instead of toxic chemicals. It also means designing "mono-material" clothes (e.g., 100% cotton), which are much easier to recycle than blends (e.g., cotton mixed with polyester).
Consumer Engagement	The most sustainable garment is the one you already own. We must educate consumers to make mindful choices.	Encouraging the #30Wears challenge (asking "Will I wear this 30 times?" before buying) or supporting the "Right to Repair" movement, which fights for affordable access to repair services for clothes and shoes.
By embracing these principles, the fashion industry can transition toward practices that benefit both people and the planet.		

The implementation of circular solutions in the fashion industry focuses on innovative models and practices that reduce waste, extend the lifecycle of clothing, and promote responsible consumption. To achieve this, the industry is moving away from the simple sale of products toward a diverse range of strategies that keep garments in use for longer.

One of the most prominent shifts is the rise of clothing rental models. These services offer customers access to diverse wardrobes without the need to buy new items, catering to the modern consumer's desire for novelty without the waste. Short-term and subscription-based options are proving successful; for instance, Rent the Runway allows users to borrow designer

dresses for special occasions, while MUD Jeans pioneered a "Lease A Jeans" model where customers pay a monthly fee to use organic cotton jeans, which are returned and recycled when worn out.

For rental and resale models to work effectively, the industry must prioritize durability enhancement. High-quality, durable clothing is the foundation of the circular economy; a coat that falls apart after three washes cannot be rented or resold. By establishing transparent quality standards, brands can guide customers toward making informed choices. Staples like heavy coats and denim represent significant opportunities here, as they naturally lend themselves to long-term use.

Closely linked to durability is the explosion of resale models. The second-hand market is growing rapidly, driven by a cultural shift among younger consumers who view vintage clothing as stylish and sustainable. Innovative partnerships are professionalizing this sector; for example, luxury brand Stella McCartney partnered with the resale platform The RealReal to encourage customers to consign their items, thereby maximizing the value and utilization of high-end garments.

Finally, brands are actively boosting clothing care to prevent premature disposal. Encouraging customers to maintain their garments significantly extends their lifespan. Leading outdoor brands like Patagonia and Houdini have set the standard by offering in-store repair services, restyling workshops, and guides on how

The Advantages of a Circular System

The implementation of these circular strategies offers profound advantages beyond just waste reduction. Socially, it democratizes fashion by ensuring access to high-quality, affordable clothing through flexible options such as rental and resale. It prioritizes access over ownership, allowing more people to enjoy durable, customized garments that might otherwise be too expensive to buy outright.

Environmentally, this system is designed to be regenerative. Ideally, a circular fashion industry is powered by renewable energy and utilizes sustainable resources, reducing the sector's heavy reliance on fossil fuels (which are currently used to make synthetic fibers like polyester). It also promotes environmentally responsible agricultural practices, such as regenerative cotton farming that restores soil health. By incorporating the true cost of environmental and social impacts into pricing, the model fosters transparency and accountability, ensuring that the price tag reflects the garment's real journey.

Ultimately, a circular fashion economy embraces inclusive and distributive design principles. By supporting businesses of all sizes—from local repair tailors to global rental platforms—it ensures that economic benefits are fairly shared across the value chain, creating a resilient industry that works for both people and the planet.

BOX 6.3

INSTITUTIONAL INVOLVEMENT IN SUSTAINABLE FASHION		
Institution	Explanation	Website
United Nations Environment Programme (UNEP)	UNEP highlights the fashion industry's significant environmental footprint, noting its reliance on natural resources and contribution to pollution. The organization advocates for systemic changes in how textiles are designed, produced, consumed, and disposed of, promoting a shift towards sustainability and circularity in the textile value chain	https://www.unep.org/
International Labour Organization (ILO)	The ILO emphasizes the need for sustainable fashion practices that consider both environmental and social dimensions. This includes addressing labor rights, promoting fair wages, and ensuring safe working conditions within the fashion industry	https://www.ilo.org/
United Nations Sustainable Development Goals (SDGs)	Sustainable fashion aligns with several SDGs, particularly Goal 12, which focuses on responsible consumption and production. Integrating sustainable practices in fashion contributes to achieving these global objectives by reducing environmental impacts and promoting ethical production methods	https://sdgs.un.org/goals
EU Strategy for Sustainable and Circular Textiles	addresses the production and consumption of textiles, whilst recognizing the importance of the textiles sector. It implements the commitments of the European Green Deal, the Circular economy action plan and the European industrial strategy	https://environment.ec.europa.eu/strategy/textiles-strategy_en

CASE STUDY: TEXTILE ECOSYSTEMS

On 18 July 2024, The Ecodesign for Sustainable Products Regulation (ESPR) entered into force. The directive is a cornerstone of the environmentally sustainable and circular products.The textile products are subject to this regulation and the textile industry will overcome significant changes to meet eco-design requirements, announced in the EU Textile strategy

https://environment.ec.europa.eu/strategy/textiles-strategy_en

The strategy aims to create a greener and more competitive textiles sector. It proclaims the Commission’s 2030 vision of sustainable and circular textiles, to ensure:

- durability, repairability, recyclability of textile products,
- promotion of customers’ awareness of long term benefits from high quality affordable textiles (to reduce the scale of fast fashion)
- re-use and repair services, widely available and profitable
- making the textiles sector competitive, resilient and innovative while taking responsibility for their products (including recycling and waste management)

The Strategy lays out a forward-looking set of actions. The core is the regulation on making textile products last longer, easier to repair and recycle. However, the regulation will also help to reduce overproduction and overconsumption, actions to reduce release of microplastic from synthetic textiles, tackling greenwashing to empower consumers and enhance a trend of sustainable fashion, and restricting the export of textile waste. To help sustainable textile products consumption, the regulation will introduce Digital Product Passport (that will provide clear information on the product), as well as the Extended Producer Responsibility rules for the textile sector.

MORE RESOURCES

Title	Author
Ecodesign for sustainable products regulation	European Commission. (n.d.).
https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en	
Strategy for textiles	European Commission. (n.d.).
https://single-market-economy.ec.europa.eu/sectors/textiles-ecosystem/strategy-textiles_en	

References for chapter 6:

Author	Date	Title	Source
Ellen MacArthur Foundati-on	2017	A new textiles economy: Redesigning fashion’s fu-ture	https://ellenmacarthur-foundation.org/a-new-textiles-economy
Ellen MacArthur Foundati-on	2019a	Completing the picture: How the circular economy tackles climate change	https://ellenmacarthur-foundation.org/completing-the-picture
Ellen MacArthur Foundati-on	2019b	Fashion and the circular economy – Deep dive	https://www.ellenmacarthurfoundation.org/fashion-and-the-circular-economy-deep-dive
European Environment Agency (EEA)	2022	Textiles and the environ-ment in a circular economy	https://www.eea.europa.eu/publications/textiles-and-the-environment
European Parliament	2020a	Environmental impact of the textile and clothing in-dustry	https://www.europarl.eu-ropa.eu/thinktank/en/doc-ument.html?reference=E-PRS_BRI(2020)646201
European Parliament	2020b	The impact of textile pro-duction and waste on the environment	https://www.europarl.eu-ropa.eu/topics/en/article/20201208STO93327/the-impact-of-textile-producti-on-and-waste-on-the-envi-ronment-infographics
FAO & International Cotton Advisory Commit-tee (ICAC)	2021	Sustainable cotton produc-tion and livelihoods	http://www.fao.org/3/cb2556en/cb2556en.pdf

Author	Date	Title	Source
International Labour Orga-nization (ILO).	2014	Wages and working hours in the textiles, clothing, lea-ther and footwear indus-tries.	https://www.ilo.org/global/publications/WCMS_300463/lang--en/index.htm
McKinsey & Company & Business of Fashion.	2020	The State of Fashion 2020	https://www.mckinsey.com/industries/retail/our-insights/state-of-fashion
Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissa-nen, T., & Gwilt, A.	2020	The environmental price of fast fashion. Nature Re-views Earth & Environ-ment, 1(4), 189–200	https://doi.org/10.1038/s43017-020-0039-9
United Nations Environ-ment Programme (UNEP).	2021	Sustainability and circulari-ty in the textile value chain: Global stocktaking	https://www.unep.org/re-sources/report/textile-va-lue-chain
United Nations Environ-ment Programme (UNEP).	2023	Sustainable fashion com-munication	https://www.unep.org/re-sources/report/sustaina-ble-fashion-communication

FLOODED BY PLASTIC

In this chapter, you will find:

- Why is plastic so crucial for the modern economy?
- How does plastic pollution affect the environment?
- What are bio-based plastics and how do they differ from conventional plastics?
- What are the most effective ways to solve the problems associated with plastic?

The term "plastics" refers to a broad family of synthetic and semi-synthetic materials known as polymers. While the scientific origins of these materials date back to the 19th century, the true "Age of Plastic" did not begin until the mid-20th century. The turning point was the discovery that plastics could be mass-produced cheaply using fossil fuels as raw materials. From that moment onward, the industry experienced an explosive expansion. This growth was driven by the material's unmatched versatility, durability, and low production costs. Almost overnight, plastic became the ideal substitute for traditional materials, replacing heavy metal, fragile glass, and expensive wood in countless applications. However, this success has created a global crisis. The widespread use of such persistent materials has led to severe environmental challenges, as our ability to produce plastic has far outpaced our ability to manage the resulting waste (UNEP, 2023).

BOX 7.1

WHERE TO FIND DATA ABOUT THE USE OF PLASTIC?

For more detailed and up-to-date information visit the following websites:

Title	Author	Source
Plastics – The facts 2022	Plastics Europe. (2022).	https://plasticseurope.org/wp-content/uploads/2022/10/PE-PLASTICS-THE-FACTS_V7-Tue_19-10-1.pdf
Plastics.	Organisation for Economic Co-operation and Development. (2024)	https://www.oecd.org/en/topics/sub-issues/plastics.html
Plastic pollution: Issues brief (May 2024 update).	International Union for Conservation of Nature and Natural Resources. (2024).	https://iucn.org/sites/default/files/2024-05/plastic-pollution-issues-brief-may-2024-update.pdf

Anatomy of plastics

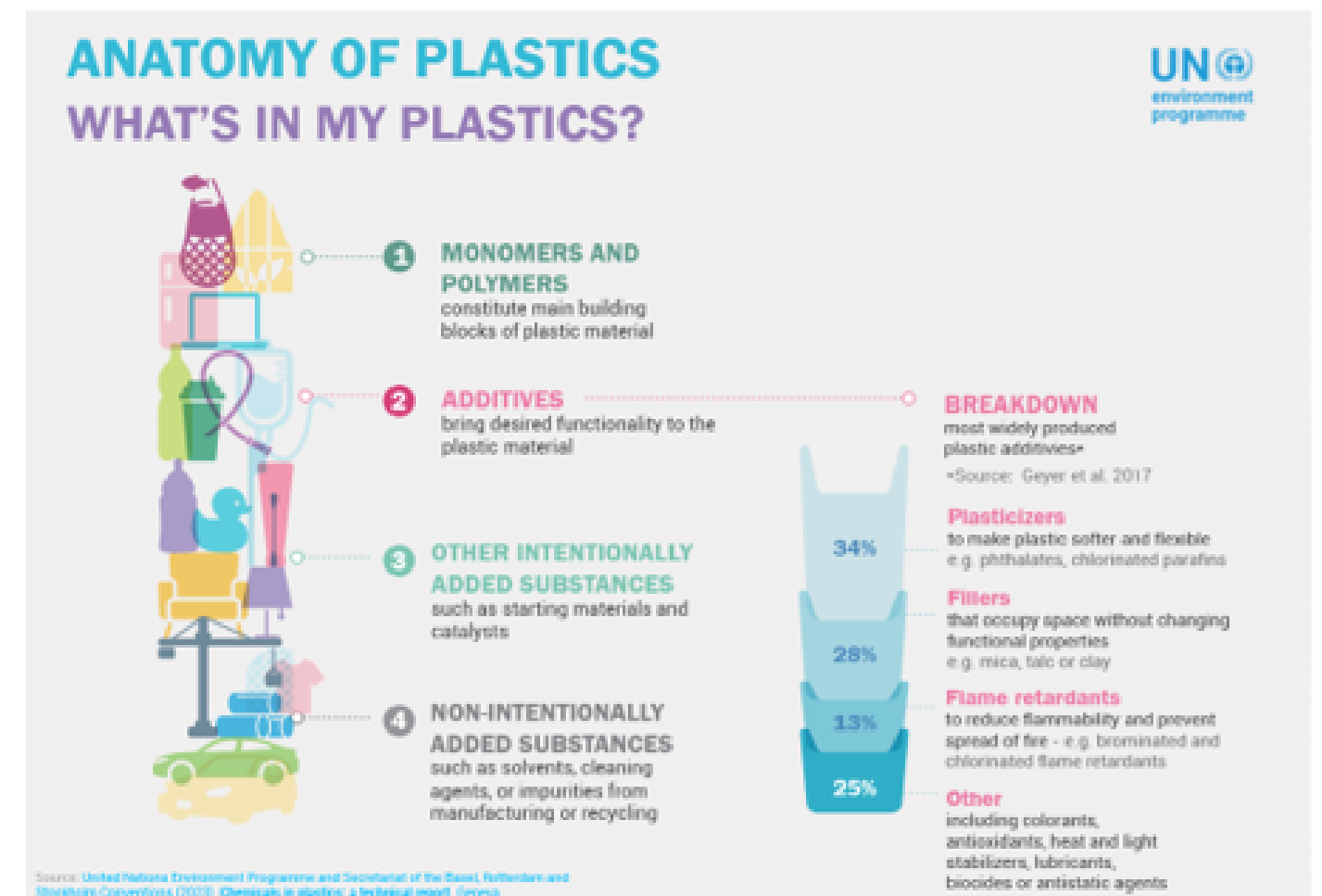
The driving force behind this exponential growth was plastic's unique ability to do it all. It possesses a rare combination of characteristics: it is lightweight yet incredibly strong, easily moldable into complex shapes, and resistant to both moisture and chemical degradation. Beyond its physical properties, it is remarkably inexpensive to produce. This allowed it to effectively replace traditional resources like glass, metal, wood, and natural fibres, while paving the way for innovations that were previously impossible—from extending the shelf life of food to enabling the lightweight design of modern electronics.

However, the lifecycle of this material is far from clean. The infographic below summarizes how hazardous chemicals are released at every stage of plastic's existence, permeating our air, water, and soil, and raising significant environmental and health concerns.

Plastics have become a cornerstone of the modern global economy, serving as an essential material across almost every industry. Their lightweight, durable, and adaptable properties make them indispensable in applications ranging from simple packaging to high-tech innovations in aerospace, renewable energy, and healthcare. Because they are both versatile and cost-effective, plastics have driven rapid progress in construction, automotive design, and technology, cementing their status as a key engine of industrial growth. However, this rapid expansion has brought growing environmental concerns that can no longer be ignored.

The accumulation of plastic waste, combined with historically limited recycling efforts, has led to widespread pollution that threatens ecosystems worldwide. To address this, the industry faces an urgent need to shift toward circular economy principles. By enhancing waste management systems and redesigning how we use these materials, society can maintain the significant economic value of plastics while drastically reducing their ecological footprint and ensuring long-term sustainability.

FIGURE 7.1 ANATOMY OF PLASTICS



Source: United Nations Environment Programme. (2023). Chemicals in plastics – Infographics.
<https://www.unep.org/resources/infographic/chemicals-plastics-infographics>

FIGURE 7.2 CHEMICALS IN PLASTICS



Source: United Nations Environment Programme. (2023). Chemicals in plastics – Infographics.
<https://www.unep.org/resources/infographic/chemicals-plastics-infographics>

How plastic pollution affects the environment

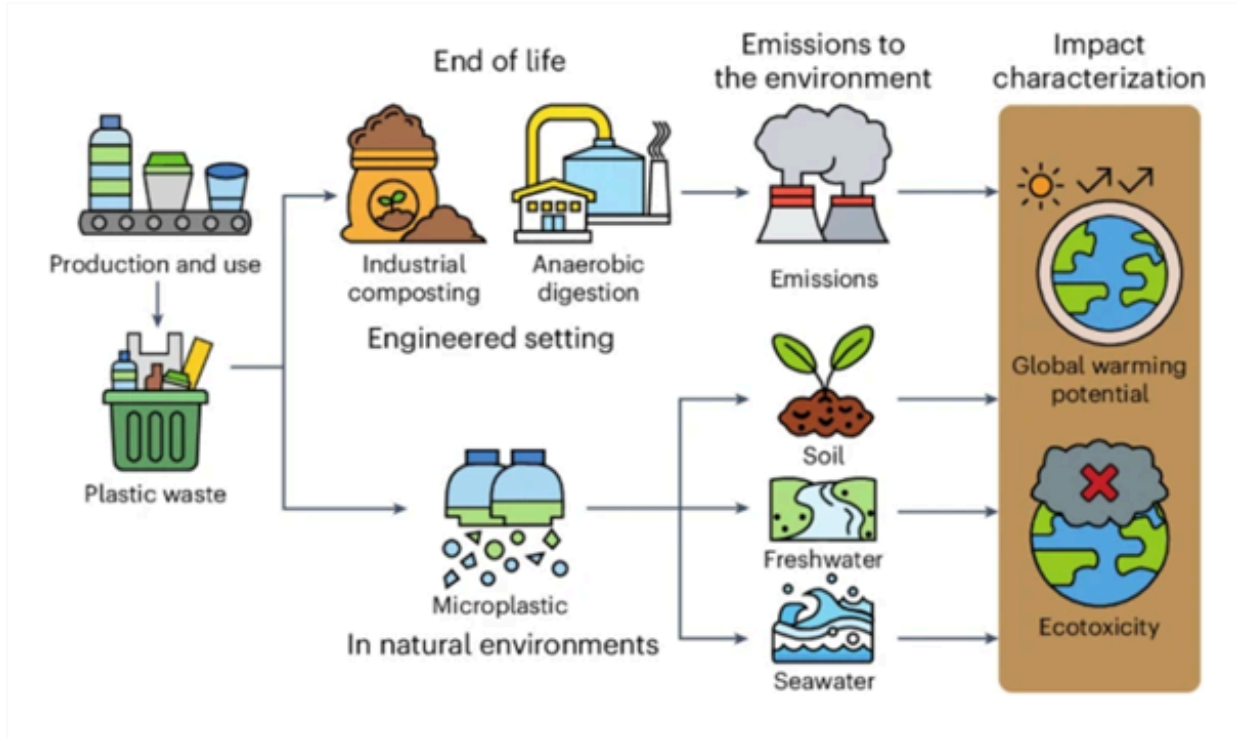
Plastic pollution has wide-ranging impacts on ecosystems, animals, and human health due to its persistence and widespread presence. In marine environments, the consequences are immediate and often fatal. Marine animals frequently mistake plastic debris for food or become entangled in abandoned fishing gear, leading to injury, starvation, or death. Beyond individual animals, accumulated debris smothers delicate ecosystems like coral reefs and mangroves, reducing biodiversity and weakening their ability to withstand other stressors (UNEP, 2021; WWF, 2020).

However, the threat is not just what we can see. Microplastics—tiny plastic particles found in water, soil, and even the air—pose a serious, invisible danger. These particles enter the food chain at the lowest levels and accumulate in organisms, eventually reaching human plates. Furthermore, microplastics act as magnets for toxic chemicals, concentrating pollutants and transporting them into biological systems where they disrupt hormonal and immune functions.

On land, the impact is equally severe. Plastic waste degrades soil quality by physically interfering with water flow and plant root systems. This blockage disrupts nutrient absorption, leading to reduced crop yields and the long-term degradation of agricultural land. The problem extends to the atmosphere as well; burning plastic waste releases toxic, carcinogenic substances that harm human health. Additionally, because plastics are derived from fossil fuels, they contribute to greenhouse gas emissions at every stage of their life cycle—from extraction and pro-

duction to incineration—thereby accelerating the global climate crisis (UNEP, 2021; Centre for International Environmental Law, 2019). Finally, plastic debris acts as a raft for invasive species and harmful bacteria, transporting them across oceans to new environments where they can decimate native biodiversity. Because plastic persists for generations, it accumulates in massive ocean gyres, continuing to harm wildlife and alter marine systems long after the original product has been discarded.

FIGURE 7.3 ENVIRONMENTAL IMPACTS OF MICROPLASTICS



Source: Piao, Z., Agyei Boakye, A.A., & Yao, Y. Environmental impacts of biodegradable microplastics. Nat Chem Eng 1, 661–669 (2024). <https://doi.org/10.1038/s44286-024-00127-0>

BOX 3.1

PLASTIC POLLUTION

The history of the polyethylene shopping bag is a powerful story of unintended consequences. Ironically, the ubiquitous "T-shirt" bag, designed in Sweden in 1959 by Sten Gustaf Thulin, was created to save the planet. Worried about deforestation caused by paper bags, Thulin designed a strong, lightweight plastic alternative meant to be reused hundreds of times.

However, market forces ignored this intent. By the 1980s, supermarkets adopted them as a cheap, disposable alternative, giving birth to the "single-use" culture. The environmental cost became undeniable in Bangladesh during the 1990s, when catastrophic floods were significantly worsened by millions of discarded bags clogging city drainage systems. Recognizing this threat, Bangladesh became the first country to ban thin plastic bags in 2002. Today, global policies—from bans in Kenya to mandatory fees in the EU—are attempting to reverse this damage and return to the original concept of reuse.

Source

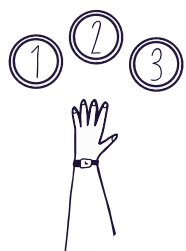
Faroni-Perez, L. (2023). Overcoming plastic pollution: Challenges faced by Brazilian policies and perspectives for stakeholder engagement and global governance opportunities [Policy position paper]. Journal of Science Policy & Governance, 22(2). <https://doi.org/10.38126/JSPG220204>

How to reduce plastic waste

Addressing plastic pollution



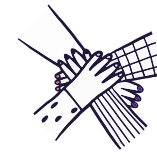
Combating plastic pollution requires a coordinated effort that spans from the individual household to the highest levels of international government.



The Power of Individual Choice

On a personal level, daily habits drive market demand. Reducing the consumption of disposable plastics—such as opting for a reusable water bottle or buying food in bulk—sends a powerful signal to producers. Beyond reduction, the proper sorting of waste is critical; when citizens separate their trash correctly, they significantly improve the efficiency of recycling systems, ensuring that valuable materials are recovered rather than lost in landfills (WWF, 2021).

Community Action and Policy



However, individual action must be supported by systemic change. On a broader scale, citizens can advocate for necessary regulations, such as bans on unnecessary single-use plastics or Extended Producer Responsibility (EPR) laws, which force companies to pay for the cleanup of their products. Supporting eco-friendly companies further accelerates this shift, encouraging businesses to adopt sustainable models.

Innovation and Technology



Technology is also a key part of the solution. Scientists and engineers are working to develop truly biodegradable materials and advanced recycling technologies that can process complex plastic waste. Crucially, we can also tackle invisible pollution through innovation; simple actions, like avoiding cosmetics with microbeads or using washing machine filters to capture synthetic fibers, can drastically reduce the flow of microplastics into our oceans.

Global Governance



Finally, because pollution knows no borders, coordinated global action is essential. Participation in international initiatives, particularly the support for a binding Global Plastics Treaty, strengthens our collective ability to enforce standards and hold nations accountable (UNEP, 2022). Ultimately, it is the combination of individual choices, corporate accountability, and robust policy reform that will protect the environment for future generations.

THE POWER OF A PRICE TAG

(GERMANY'S PFAND SYSTEM)

While many countries struggle to get recycling rates above 50%, Germany has solved the problem of plastic bottle waste through a simple economic incentive: the Deposit Return Scheme (DRS), known locally as Pfand.

How it Works:

Turning Trash into Money In Germany, when you buy a drink in a single-use plastic bottle or can, you pay a €0.25 deposit on top of the price. This isn't a tax; it's a loan. You get the money back only when you return the empty container to a "reverse vending machine" found in almost every supermarket.

Why it Matters for the EU

Germany's success is now the blueprint for the rest of Europe. Under new EU rules, all member states must achieve a 90% collection rate for plastic bottles by 2029. To reach this target, most countries (including Poland, Austria, and the UK) are now rushing to copy the German model.

Sources

- European Commission. (2018). A European Strategy for Plastics in a Circular Economy. COM/2018/028 final. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A28%3AFIN>
- European Union. (2019). Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment. Available at: <https://eur-lex.europa.eu/eli/dir/2019/904/oj>
- European Commission. (2024). Single-use plastics: New rules to reduce marine litter. Available at: https://environment.ec.europa.eu/topics/plastics/single-use-plastics_en

The Result:

98% Success Rate The impact of this system is undeniable. Before the law was introduced in 2003, billions of cans and bottles ended up in landfills or nature. Today, Germany achieves a return rate of over 98% for these containers.

- **High Quality:** Because the bottles are collected separately (not mixed with dirty trash), the plastic is clean and high-quality. This allows it to be recycled back into new food-grade bottles, closing the loop effectively.
- **Cultural Shift:** The system has been so successful that "Pfand" has become a cultural habit. It proves that when policy aligns financial incentives with environmental goals, individual behavior changes overnight.

SINGLE-USE PLASTIC PRODUCTS

Single-use plastic products (SUPs) represent the ultimate failure of design: materials built to last for centuries are used for mere minutes before being discarded. Because they are cheap and disposable, they frequently end up in nature. In fact, just ten specific plastic items, along with abandoned fishing gear, account for the majority of all marine litter found on European coastlines.

The EU Solution: Directive 2019/904 To address this crisis, the European Union adopted the Single-Use Plastics Directive. Instead of a blanket ban, the law applies a tailored approach depending on whether alternatives exist.



THE BANS:

Where sustainable and affordable alternatives are readily available (like wood, paper, or reusable materials), the plastic versions are strictly prohibited. This is why plastic cotton bud sticks, cutlery, plates, straws, stirrers, and balloon sticks have disappeared from EU shelves, along with expanded polystyrene food containers.



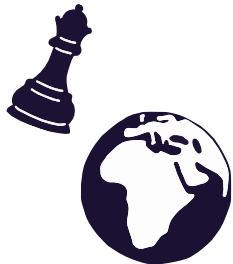
THE REDESIGN:

For items without easy alternatives, the EU focuses on changing the design and behavior. This includes the requirement for tethered bottle caps (so caps don't get lost) and mandatory labels warning consumers about the environmental damage of items like wet wipes and cigarette filters.



THE RESPONSIBILITY:

The Directive also enforces Extended Producer Responsibility (EPR). This means the companies that make these products must pay for the costs of waste collection and clean-up, shifting the burden from the taxpayer to the polluter.



THE BIGGER STRATEGY:

This Directive is not an isolated law; it is a key pillar of the European Strategy for Plastics in a Circular Economy (adopted in 2018). This broader strategy aims to protect the environment and reduce marine litter, but it also has strategic economic goals: reducing greenhouse gas emissions and cutting the EU's dependence on imported fossil fuels. It positions the EU as a global forerunner

MORE RESOURCES

- European Commission. (2018). A European Strategy for Plastics in a Circular Economy. COM/2018/028 final. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A28%3AFIN>
- European Union. (2019). Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment. Available at: <https://eur-lex.europa.eu/eli/dir/2019/904/oj>
- European Commission. (2024). Single-use plastics: New rules to reduce marine litter. Available at: https://environment.ec.europa.eu/topics/plastics/single-use-plastics_en

FRANCE'S PIONEERING "ANTI-WASTE" LAW

One of the best examples of how policy, innovation, and individual action work together is France's Anti-Waste Law for a Circular Economy (AGEC Law). Passed in 2020, it serves as a global testing ground for circular policies. But is it actually working? The data suggests yes.

1. CHANGING HABITS: THE FAST FOOD REVOLUTION

The Rule:

Since January 2023, fast-food restaurants with more than 20 seats (like McDonald's or Burger King) must use reusable tableware for dine-in meals.

The Impact:

This measure alone prevents an estimated 200,000 tonnes of waste per year (nearly 20 billion throwaway items). It forced chains to install dishwashers and hire staff, proving that a massive shift from "throw-away" to "reuse" is operationally possible.

2. EMPOWERING CONSUMERS: THE REPAIRABILITY INDEX

The Rule:

To fight microplastics, France is the first country to mandate that all new washing machines sold from 2025 must be equipped with microplastic filters.

The Impact:

This law is driving global innovation. Manufacturers are now rushing to re-design machines to capture synthetic fibres before they reach the ocean, a technology that will likely spread to the rest of the EU.

3. TACKLING INVISIBLE POLLUTION: A WORLD FIRST

The Rule:

To fight microplastics, France is the first country to mandate that all new washing machines sold from 2025 must be equipped with microplastic filters.

The Impact:

This law is driving global innovation. Manufacturers are now rushing to re-design machines to capture synthetic fibres before they reach the ocean, a technology that will likely spread to the rest of the EU.

4. ELIMINATING UNNECESSARY PLASTIC

The Rule:

The law banned plastic packaging for around 30 types of fruit and vegetables (like apples, cucumbers, and peppers).

The Impact:

This single measure eliminates approximately 1 billion pieces of single-use plastic annually, forcing supermarkets to return to selling loose produce or using cardboard alternatives.

MORE RESOURCES

- Ministry of Ecological Transition (France). (2023). The Anti-Waste Law for a Circular Economy (AGEC Law): Overview and Key Measures. Available at: <https://www.ecologie.gouv.fr/loi-anti-gaspillage-economie-circulaire>
- Ellen MacArthur Foundation. (2021). France’s Anti-Waste Law: A global precedent? Available at: <https://ellenmacarthurfoundation.org/policies/france-anti-waste-law>



TEACHER TIP:

Ask students if they would buy a phone with a low "repair score" (e.g., 3/10) if they knew it meant it couldn't be fixed. This illustrates how transparency changes market demand.

References for chapter 7:

Author	Date	Title	Source
Center for International Environmental Law (CIEL).	2019	Plastic & climate: The hidden costs of a plastic planet	https://www.ciel.org/plasticandclimate
Interreg Baltic Sea Region	2023	Global treaty on plastic pollution: What does it mean for the Baltic Sea?	https://interreg-baltic.eu/news/global-treaty-on-plastic-pollution
United Nations Environment Programme (UNEP)	2021	From pollution to solution: A global assessment of marine litter and plastic pollution	https://www.unep.org/resources/pollution-solution
United Nations Environment Programme (UNEP)	2022	Towards a global agreement to end plastic pollution	https://www.unep.org/global-plastics-treaty
United Nations Environment Programme (UNEP)	2023	Chemicals in plastics - Infographics	https://www.unep.org/resources/infographic/chemicals-plastics-infographic
WWF	2021a	Extended producer responsibility: A path to zero plastic waste	https://www.worldwildlife.org/publications/extended-producer-responsibility-a-path-to-zero-plastic-waste
WWF	2021b	Plastic pollution: Causes and consequences	https://www.wwf.org.uk/updates/plastics-what-happening-and-what-we-can-do
WWF Mediterranean Marine Initiative	2021b	Stop the flood of plastic: How Mediterranean countries can save their sea.	https://www.wwf.panda.org/discover/our_focus/oceans_practice/plastics/

In this chapter, you will find:

- What do we mean by electronic waste and discarded electronic devices?
- Why do we need to recycle electronic and electrical waste?
- What do we mean by bio-based plastic?
- Why is e-waste not just waste?

... is not a Waste!

E-waste, or electronic waste, refers to discarded electronic devices and their components, including smartphones, computers, televisions, and household appliances. This category encompasses both functional and non-functional products that are no longer in use, posing significant environmental and health challenges due to the presence of hazardous substances and the complexity of recycling processes.

The term covers any electronic product that no longer works or is no longer wanted. E-waste often still contains valuable materials such as gold, silver and copper or even hazardous substances such as lead, mercury and cadmium. If the devices or individual components are disposed of improperly, this can lead to environmental pollution and health risks due to the release of toxic components. If they are recycled, valuable resources can be at least partially recovered and damage minimized (European Commission, 2023; United Nations Environment Programme, 2022).

Informal recycling of e-waste can have various harmful effects on health, with children and pregnant women being particularly at risk. Organizations such as the World Health Organization (WHO) estimate that millions of women and children working in the informal recycling sector worldwide could be at risk of hazardous e-waste exposure (European Parliament, 2024).

BOX 8.1

EXTENDED RESOURCES AND DATA ABOUT E-WASTE

For more detailed and up-to-date information visit the following websites:

- European Commission. (2025). Waste from electrical and electronic equipment (WEEE).
https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en
- United Nations Institute for Training and Research, & International Telecommunication Union. (2024). The global e-waste monitor 2024.
<https://ewastemonitor.info/the-global-e-waste-monitor-2024/>
- Geneva Environment Network. (2024). The growing environmental risks of e-waste.
<https://www.genevaenvironmentnetwork.org/resources/updates/the-growing-environmental-risks-of-e-waste/>

Why do we need to recycle electronic and electrical waste?

Old electronic devices that have been discarded can contain potentially harmful materials that not only pollute the environment but also pose or increase health risks to people involved in the recycling of E-waste. Many countries have passed legislation to address the problems of pollution and health hazards by banning chemicals such as lead. However, many rare minerals used in electronic devices come from countries where human rights are not or hardly respected. In order to prevent unintentional support for armed conflicts and human rights violations, the European Parliament has issued corresponding regulations. European importers of rare earth minerals are therefore obliged to subject their suppliers to a background check.

E-waste contains various toxic substances that are typically safe during device use but become hazardous when these items are improperly managed as waste. Environmentally unsound practices such as scavenging, dumping, land-filling, open burning, acid baths, and manual disassembly release toxic pollutants into the air, soil, and water, posing serious environmental and health risks. Open burning is particularly hazardous due to the release of toxic fumes, and these pollutants can travel far from their source, exposing distant populations (WHO 2024). Children and pregnant women are especially vulnerable to the harmful effects of e-waste recycling. Children are often involved in hazardous

labor like waste picking, burning, and dismantling electronic items, exposing them to high levels of toxic substances. E-waste exposure has been linked to adverse health outcomes, including stillbirth, premature birth, impaired neurodevelopment, behavioral issues, reduced lung function, and respiratory conditions such as asthma. These risks are amplified in children due to their rapidly developing systems, including the respiratory, immune, and central nervous systems. Toxicants like lead and mercury from e-waste can cross the placenta and contaminate breast milk, causing potentially irreversible damage to children's health and development (WHO 2024).

Prevention and management of e-waste

Measures at national and international level are crucial to protect the population from the harmful effects of improper recycling practices. Effective measures and strategies include the adoption and enforcement of international agreements and the development of national e-waste management legislation. In addition, regulations to incorporate public health protection measures into these frameworks are also crucial. It is also important to regularly monitor e-waste sites and neighboring communities and implement measures that promote informal recycling practices while protecting public health and supporting community livelihoods. Educating health workers on e-waste related child health issues and eliminating child labor in e-waste activities are also important steps towards sustainable waste management.

Managing e-waste effectively is essential due to its growing volume, toxic composition, and valuable resource content. Electronic waste contains hazardous substances such as lead, mercury, cadmium, and brominated flame retardants, which pose serious risks to human health and the environment if not handled properly. Children and informal workers in low- and middle-income countries are especially vulnerable to exposure from unsafe recycling methods (World Health Organization, 2021).

FIGURE 8.1 E-WASTE RECYCLING MARKET CAGR (%), GROWTH RATE BY REGION, 2026 - 2031



Source: Mordor Intelligence (2025) <https://www.mordorintelligence.com/industry-reports/e-waste-recycling-market>

At the same time, e-waste is a rich source of secondary raw materials, including precious metals like gold, silver, and palladium. Recovering these materials through safe and efficient recycling reduces the need for virgin resource extraction, contributing to environmental conservation and climate goals. Therefore, sound e-waste management is not only a public health imperative but also a strategic opportunity for circular economy development, green job creation, and resource efficiency. It plays a vital role in achieving sustainable development and environmental justice, particularly in regions most affected by informal waste processing (United Nations Environment Programme, 2019).

E-waste is not a waste

E-waste should not be seen simply as discarded material, but rather as a valuable resource with significant potential for recovery and reuse (UNEP, 2022). It contains numerous precious and critical materials essential for modern technologies, including electronics and batteries (IU & UNITAR, 2024). By approaching e-waste as a resource, the need for extracting new raw materials can be reduced, thereby helping to conserve natural ecosystems and decrease environmental degradation (CIEL, 2019). Through recycling, components such as metals, plastics, and glass can be repurposed into new products. For instance, metals from electronic parts may be reused in other electronic devices, while plastics can find a second life in packaging or construction, lowering dependence on raw materials and diverting waste from landfills (World Economic Forum, 2022).

This perspective aligns with the principles of a circular economy, in which materials are reused and reintegrated into the production cycle rather than discarded. Effective e-waste management not only helps reduce environmental harm but also opens up new economic possibilities. It reduces the risks posed by hazardous substances—such as heavy metals and toxic chemicals—which can be harmful to ecosystems and human health if not managed properly [WHO, 2024]. Recycling also offers a more sustainable and cost-effective alternative to raw material extraction (OECD, 2022).

In addition to environmental benefits, the recycling and proper handling of e-waste contribute to economic development by creating employment opportunities and supporting emerging green industries [UNEP, 2022]. Reusing components such as processors and memory units can lower production costs and reduce the energy needed to manufacture new parts, fostering more efficient and sustainable technological development (World Bank, 2021).

Nonetheless, current practices often fall short. In many cases, only a portion of e-waste is processed through safe, formal channels. A significant share is still managed under informal or non-compliant conditions, particularly in lower-income regions, where environmental protections may be lacking. These methods, which include crude dismantling or uncontrolled dumping, pose severe risks to both human health and the environment (WHO, 2024).

While responsible e-waste management can provide economic value and reduce greenhouse gas emissions, these benefits are frequently undermined by the hidden costs of improper handling. These include long-term environmental damage, negative health outcomes, loss of biodiversity, and broader social and economic consequences. Many of these costs stem from toxic emissions, poor working conditions, and pollution caused by informal or poorly regulated recycling activities (OECD, 2022).

Addressing these challenges requires investing in sustainable infrastructure, enforcing environmental standards, and supporting global efforts to formalize e-waste handling. By doing so, e-waste can be transformed from a burden into an opportunity—fueling a greener, more resilient, and resource-efficient future (TU & UNITAR, 2024).

BOX 8.2. CASE STUDY

WHAT’S IN MY SMARTPHONE?

Smartphones are essential tools in modern life—but behind their sleek designs lie complex systems made from dozens of valuable and finite materials. When disposed of improperly, smartphones contribute to the rapidly growing problem of electronic waste (e-waste), which threatens both environmental and human health. However, when treated as a resource, smartphones can become rich urban mines, offering significant recovery potential for critical and precious elements.

According to The Global E-waste Monitor 2024 and the European Commission, a typical smartphone contains over 60 chemical elements, including:



precious metals

gold, silver, platinum, and palladium are used in circuit boards and connectors.



critical raw materials

cobalt and lithium in rechargeable batteries, neodymium and dysprosium in vibration motors and speakers.



base metals

copper and tin in wiring and soldering, aluminum and magnesium in the casing.

Many of these materials are present in higher concentrations in smartphones than in natural ores, making proper recovery not only environmentally important but economically viable.

Despite this, most used smartphones are not properly recycled. Devices are often stored unused in drawers, exported illegally, or processed informally in ways that harm human health and the environment. According to EU WEEE legislation (Directive 2012/19/EU), smartphones are classified as small electronic equipment and must be collected through designated channels, including:



mail-back return systems



municipal e-waste collection centers



retailer drop-off points

These collection schemes aim to increase recycling rates and enable the safe recovery of materials. Under the EU’s Extended Producer Responsibility (EPR) framework, manufacturers are obligated to contribute to the cost of collecting and recycling old devices. The European Commission’s Circular Electronics Initiative also promotes longer product lifespans, eco-design for easier disassembly, and access to repair information.

Treating smartphones as part of a circular economy—not as disposable gadgets—can reduce dependence on imported raw materials, limit environmental degradation from mining, and support innovation in materials recovery. Raising consumer awareness and improving collection infrastructure remain key to unlocking the full potential of what’s already in our pockets.

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European Commission	2018	A European strategy for plastics in a circular economy (COM(2018) 28 final).	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:28:FIN
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THE HIGH COST OF FOOD WASTE

How to Tackle Food Waste

In this chapter, you will find:

- What is the scale and economic cost of food waste in the European Union?
- What is the difference between "food loss" and "food waste," and what are their root causes?
- The Packaging Paradox: How does food waste connect to our plastic problem?
- How does the circular economy apply to the food system through upcycling and recovery?
- What are practical ways to reduce food waste at home and in schools?

Globally, approximately one-third of all food produced for human consumption is lost or wasted every year. While a discarded apple or a forgotten loaf of bread might seem insignificant on a personal level, the cumulative global impact is enormous.

When we throw away food, we are not just wasting the physical product; we are wasting all the resources that went into producing it. This includes the land cleared for farming, the huge amounts of fresh water used for irrigation, the fuel burned for transportation, and the human labor required to harvest and package the goods.



The Scale

Around 130 kg of food per person is wasted annually in the EU, totalling over 58 million tonnes (Eurostat, 2024).



The Economic Cost

This inefficiency is highly expensive. Food waste costs the EU economy over €130 billion each year (European Commission, 2023). This includes the market value of the lost food and the billions spent on collecting and treating it as rubbish.



The Environmental Cost

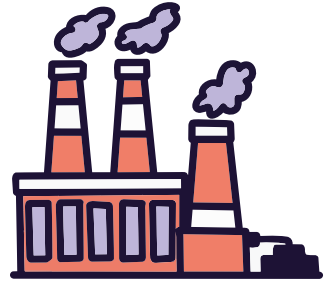
If food waste were a country, it would be the third-largest emitter of greenhouse gases globally (FAO, 2013). Within the EU, food waste accounts for approximately 16% of all greenhouse gas emissions from the food system. Furthermore, the water used to produce food that is ultimately thrown away accounts for 12% of the total water used in EU food production (JRC, 2020; European Commission, 2023).

Furthermore, as this discarded organic matter decomposes in landfills, it releases methane—a greenhouse gas significantly more potent than carbon dioxide. To truly comprehend the scale of this environmental and economic burden, it is essential to look beyond global generalizations and examine specific regional impacts. The data from the European Union paints a clear picture of this crisis:

**EXTENDED RESOURCES AND
DATA ABOUT FOOD WASTE**

For more detailed and up-to-date information visit the following websites:

- European Commission. (2025). Food waste and food waste prevention – estimates.
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates
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<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019D1597>



Almost a fifth of the waste is created during the factory production of food and beverages. This includes edible trimmings, by-products that aren't repurposed, and perfectly safe items discarded simply because they don't meet strict cosmetic standards or weight requirements for packaging.

Manufacturing and Processing (19%):

Restaurants and Food Services (11%)



Leftovers from dining out, catering events, and school or hospital canteens make up the next segment. The main culprits here are oversized restaurant portions, unpredictable daily customer demand, and strict hygiene regulations that prevent the reuse of unserved buffet food.

Retail and Distribution (8%):



While often highly visible to the consumer, supermarket and grocery store waste actually accounts for the smallest share. This waste generally stems from spoilage during transport, damaged packaging, or the industry practice of overstocking shelves to maintain an image of endless abundance.

Primary Production (10%)



A tenth of the waste happens before the food even leaves the farm or fishing boat. These losses are frequently caused by crops left unharvested due to extreme weather, fluctuating market prices that make harvesting unprofitable, or produce failing to meet the strict "perfect" aesthetic standards demanded by retailers.

Who is Wasting What?

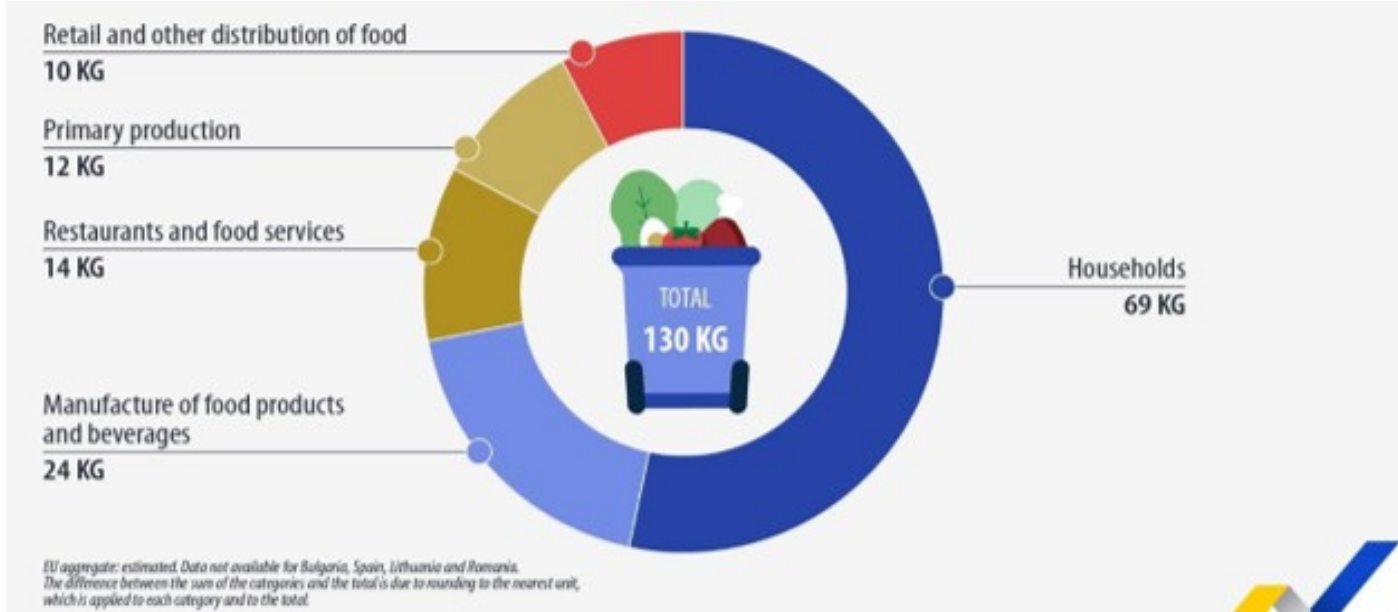
To effectively tackle the food waste crisis, we must first understand exactly where the breakdown occurs. While public perception often points the finger at giant supermarkets, the data reveals a different reality. According to Eurostat, EU food waste is distributed across the supply chain as follows (Eurostat, 2024):

Households (53%)



Surprisingly, more than half of all food waste in the EU is generated right in our own homes, amounting to approximately 69 kg per inhabitant annually (Eurostat, 2024). This massive share is often driven by everyday habits: over-purchasing groceries, misunderstanding the critical difference between "use by" and "best before" dates, improper storage, and cooking portions that are simply too large to finish.

**FIGURE 9.1 FOOD WASTE IN THE EU BY MAIN ECONOMIC SECTORS, 2023
(KG PER INHABITANT)**



Source: Eurostat (2025) <https://www.mordorintelligence.com/industry-reports/e-waste-recycling-market>

Loss or Waste?

The terms "loss" and "waste" refer to different stages and causes within the supply chain:

In contrast, food waste occurs at the end of the chain—in supermarkets, restaurants, and our own kitchens—and is deeply tied to human behavior and the modern psychology of abundance. In households, it is frequently driven by "wishful buying," where consumers purchase an excess of fresh, highly perishable produce with the best of intentions, only to let it wilt in the fridge. This is heavily compounded by a widespread misunderstanding of expiration labels: consumers often confuse "best before" (a mere indicator of peak quality) with "use by" (a strict safety deadline), leading them to throw away perfectly safe food. Furthermore, cooking oversized portions and lacking the knowledge to store ingredients properly accelerate spoilage. In restaurants and catering, the problem is often fueled by standardized, overly generous portion sizes, the wasteful nature of "all-you-can-eat" buffets, and the inherent difficulty of accurately predicting fluctuating customer demand.

This type of waste occurs early in the supply chain—typically at the farm level, during storage, or in transit. It is largely driven by systemic, infrastructural, or environmental challenges rather than direct consumer choices. In agricultural settings, massive losses can be caused by pest infestations, extreme weather events, or inadequate harvesting and refrigeration technology. However, in developed markets, a significant portion of food loss is entirely artificial: it is driven by the rigid, cosmetic standards imposed by large supermarket chains. Every year, tons of perfectly healthy, nutritious, and delicious produce are left to rot in the fields simply because they are deemed "ugly"—perhaps a carrot is too crooked, an apple is slightly blemished, or a cucumber doesn't have the perfect, standardized shape.

The Packaging Paradox

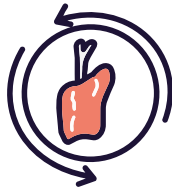
When discussing food waste, we must also address packaging (connecting back to Chapter 7: Plastics). This is known as the "Packaging Paradox."

On one hand, plastic packaging is an environmental burden. On the other hand, it is highly effective at extending the shelf life of food. For example, wrapping a cucumber in a thin layer of shrink-wrap can extend its shelf life from 3 days to up to 14 days, drastically reducing the chance it becomes food waste. Because the environmental footprint of growing the cucumber (water, land, emissions) is much higher than the footprint of the plastic wrap, the plastic technically "saves" carbon emissions by preventing food waste.

The Circular Challenge: The circular economy seeks to resolve this paradox not by returning to food spoilage, but by developing bio-based, compostable packaging, or entirely new supply chain models (like local, package-free shopping) that eliminate the need for long-term preservation.

The Circular Solution for Food

In a true circular economy, organic materials are viewed as valuable resources rather than disposable waste (see Butterfly Model, chapter 3), meaning they should never end up in a landfill to produce harmful methane (Ellen MacArthur Foundation, 2019). To navigate this, environmental experts and policymakers utilize the Food Recovery Hierarchy - a strategic, inverted pyramid that prioritizes the most impactful and sustainable ways to handle surplus food, from the most preferred action to the least (US EPA, 2023):



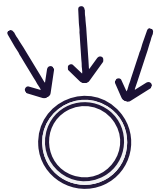
Upcycling Food (The Innovation Tier)

A rapidly growing and highly innovative trend in the circular economy is "upcycling" (Up-cycled Food Association, 2021) - creatively transforming perfectly safe but otherwise wasted ingredients into new, high-quality, and marketable products. This retains the highest possible nutritional and economic value of the food. For example, some breweries now use surplus bread from local bakeries to brew craft beer, while innovative companies extract leftover fruit pulp from juice manufacturing to create healthy, high-fiber snacks.



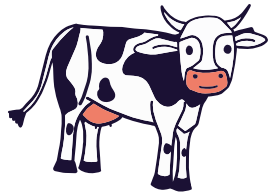
Feed Hungry People

If surplus food is perfectly edible and safe, the next logical step is to keep it in the human food supply. This involves building robust logistical networks to safely and swiftly donate excess meals, fresh produce, and packaged goods to food banks, community pantries, and shelters, thereby addressing food insecurity while simultaneously reducing environmental damage.



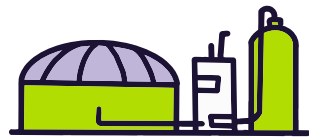
Reduce at Source

The absolute peak of the pyramid and the most effective solution. This means stopping waste before it is even created by aligning agricultural production, supermarket inventory, and household purchasing strictly with actual demand. It requires systemic changes, such as relaxing strict cosmetic standards for produce, improving supply chain technologies, and shifting consumer behavior.



Feed Animals

When food is no longer suitable or legally permitted for human consumption, it should be diverted to livestock. Safely processing food scraps - such as spent brewer's grain, dairy by-products, or vegetable peelings - into animal feed reduces the need to grow resource-intensive crops specifically for livestock, thus saving vast amounts of land and water.



Industrial Uses

If the organic matter cannot be consumed by humans or animals, it enters the energy recovery phase. Sending food waste to specialized anaerobic digesters allows us to capture the methane released during decomposition and convert it into biogas (a renewable energy source to power homes or vehicles). Additionally, the leftover by-product, known as digestate, can be used as a nutrient-rich fertilizer.



Composting

The final acceptable tier before a landfill. Returning organic matter back to the earth through residential or commercial composting enriches soil health, improves its water retention, and reduces the agricultural reliance on synthetic chemical fertilizers. It is the ultimate way to close the ecological loop.

THE EU CONTEXT

Legally Binding Targets

To ensure accountability, the EU is revising the Waste Framework Directive to introduce legally binding targets for member states to reduce food waste by 2030. Specifically, proposed targets require member states to reduce food waste by 10% in processing and manufacturing, and by 30% per capita jointly at the retail and consumption levels (European Commission, 2023).

The Farm to Fork Strategy

At the heart of the European Green Deal, this comprehensive strategy aims to accelerate the transition to a food system that is fair, healthy, and environmentally-friendly. It directly commits to halving per capita food waste at the retail and consumer levels by 2030, aligning with UN Sustainable Development Goals, and includes practical steps like revising EU rules on date marking to prevent consumer confusion (European Commission, 2020).

FRANCE'S SUPERMARKET BAN



The Problem

Supermarkets frequently threw away unsold but perfectly edible food, sometimes even intentionally destroying it with bleach to prevent foraging.

In 2016, France became the first country in the world to legally ban large supermarkets from destroying unsold food, passing the historic anti-waste law known as the Loi Garot (French Republic, 2016).



The Solution



The Impact

Stores with a footprint of 400 square meters or more are now legally required to partner with NGOs and food banks to donate their surplus. This policy has been a massive success, significantly boosting donations to charities and rescuing millions of meals annually (Zero Waste Europe, 2020; French Food Bank Federation).

BOX 9.3. SUCCESS STORY:

THE RESCUE APP (TOO GOOD TO GO)



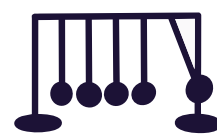
The Problem

Bakeries, restaurants, and grocery stores often face a daily dilemma: having fresh, perfectly edible food left over at closing time that must legally or practically be discarded.

The globally successful app Too Good To Go connects consumers directly with local businesses that have this surplus food. Users can safely purchase a "Surprise Bag" of high-quality, unsold food at a steeply discounted price just before the shop closes (Too Good To Go, 2023).



The Solution



The Impact

This model perfectly illustrates Principle 1 of the circular economy: Eliminate waste and pollution (Ellen MacArthur Foundation, 2019). It ensures that the embedded energy, human labor, and water used to create the food are not lost to a landfill, while simultaneously providing a financial win for both the business (recovering sunk costs) and the consumer (accessing affordable food).

THE "LOOK, SMELL, TASTE" TEST

A major driver of household food waste is the widespread confusion over date labels. By discussing these terms in the classroom, educators can empower students to become "waste warriors" at home, correcting misconceptions that lead families to throw away perfectly good food. Discuss these critical distinctions with your students:

"Use By"

(The Safety Deadline)



This is a strict safety indicator. Food should not be eaten, cooked, or frozen past this date, even if it looks and smells completely normal, as invisible but dangerous bacteria could be present. This label is typically found on highly perishable items like fresh meat, poultry, fish, and ready-to-eat salads.

"Best Before"

(The Quality Promise)



While durable products might sometimes cost more upfront, they save money in the long term because they do not need to be replaced as often. Additionally, new models such as "Product-as-a-Service" (e.g., renting a washing machine instead of buying one) allow consumers to access high-quality products without the high initial cost.

Classroom Challenge

The Sensory Test Transform this lesson into an interactive challenge! Encourage students to rely on their natural senses rather than blindly following a printed "Best Before" date. Teach them the practical "Look, Smell, Taste" method:



Look

Is there any visible mold or severe discoloration?



Smell

Does the food have an unusual, sour, or rancid odor?



Taste

If it looks and smells completely fine, taste a tiny amount. If it tastes normal, it is perfectly safe to eat!



CRUCIAL NOTE FOR TEACHERS:

Always emphasize that this sensory test applies strictly to "Best Before" items, and never to "Use By" products).

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