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LA STATALE

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Dallo scarto alla risorsa: come l'economia circolare costruisce la bioeconomia

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(2% top scientist, Standford, 2025)

Definizione di Bioeconomia

According to the European Union, bioeconomy "*encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries*" [1].

Sillapaa ad Mcibi, 2017

Which is the goal of Bioeconomy ?

energy, products and services." The objectives of this strategy is to "*reduce dependence on fossil natural resources, to prevent biodiversity loss and to create new economic growth and jobs in line with the principles of sustainable development*" [3].

Sillapaa ad Mcibi, 2017

Basically, bioeconomy cannot succeed unless it satisfies the needs of three "big babies": industrials, consumers, and the environment.

1. Industrials have a huge appetite for raw material and energy, and they are not expected to induce any measure of change susceptible to reduce their revenues, at least willingly. Profitability is their main concern and bioeconomy has to take this attitude very seriously because without the industry, it will remain as an abstract notion.
2. Consumers and their growing requirements for food, energy, and clean water. Bioeconomy has to satisfy those basic needs worldwide, but also it has to retain the level of prosperity and welfare for consumers in developed nations and to meet the aspiration of consumers from developing countries to reach the same level of welfare.
3. The environment, the most patient of the big babies, is the easiest to please. It just needs to be left alone. All it asks from us is to limit our wastes and emissions to tolerable levels that could be dealt with using its arsenal for biological and geological resources.

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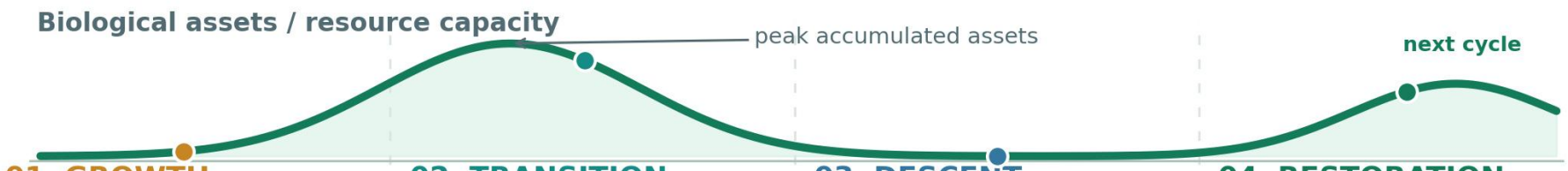
Le imprese industriali hanno un enorme fabbisogno di materie prime ed energia e difficilmente adotteranno, almeno volontariamente, cambiamenti che possano ridurre i loro ricavi. La redditività è la loro principale preoccupazione e la bioeconomia deve tenere seriamente conto di questo atteggiamento, perché senza il coinvolgimento dell'industria rimarrà una nozione astratta.

Food security has four dimensions:

1. *Availability* of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid). Available land and food production play an important role.
2. *Access* by individuals to adequate resources for acquiring appropriate foods for a nutritious diet. Land, income and consumer prices play an important role
3. *Utilisation*: Utilisation of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. Income and local consumer food prices play an important role.
4. *Stability*: To be food secure, a population, household or individual must have access to adequate food at all times. Macro-economic conditions play an important role in stability.

THE PULSING PARADIGM IN THE BIOECONOMY

From extracting biological resources to regenerating them



01 GROWTH
Expand biomass use
High resource demand; environmental pressure grows.

02 TRANSITION
Increase efficiency
Avoid waste; use biomass in cascades where viable.

03 DESCENT
Reduce new inputs
Keep value in use; recover materials and nutrients.

04 RESTORATION
Regenerate resources
Rebuild soil fertility, biomass and ecosystems.

A CIRCULAR BIOECONOMY IN PRACTICE

Renewable biomass is used, its value is retained, and biological resources are replenished.

SOIL SYSTEM → Sunlight · water · nutrients

BIOMASS → Food · feed · bioproducts

RESIDUES → Prevention · reuse · cascading

RETURN TO SOIL → Biogas energy · digestate / compost

Nutrients and organic matter return to productive soils

KEY IDEA Circularity helps during transition and descent; regeneration prepares the next cycle.

Conceptual diagram adapted from the pulsing paradigm in the supplied slide (Odum & Odum; Ghisellini et al., 2015).

FOSSIL RESOURCES VS BIOMASS

The key difference is the timescale of replenishment

FOSSIL RESOURCES

A geological stock

Available stock

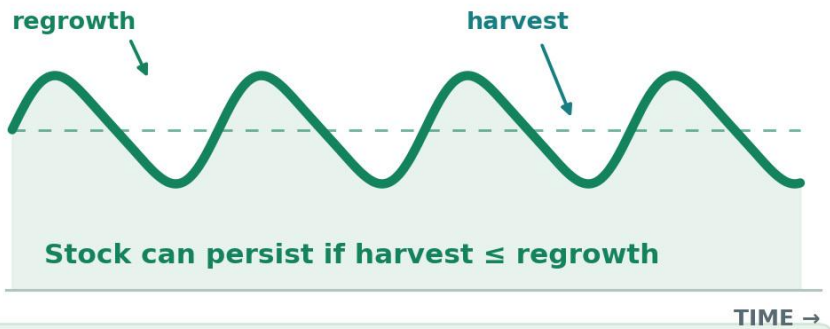


Replenishment: millions of years

BIOMASS

A renewable flow supported by living systems

Regenerating biomass



Replenishment: seasons to decades*

CARBON PATH

Geological carbon → fuel use → atmospheric CO_2

Emissions add carbon from a long-stored reservoir.

CARBON PATH

CO_2 → plant growth → uses → CO_2 / soil carbon

Net climate impact depends on the whole life cycle.

CIRCULAR BIOECONOMY: use biomass efficiently, cascade its uses, recycle nutrients and restore ecosystems.

*Depending on the biomass source; renewal is limited by land, water, nutrients and ecosystem health. Conceptual, not to scale.

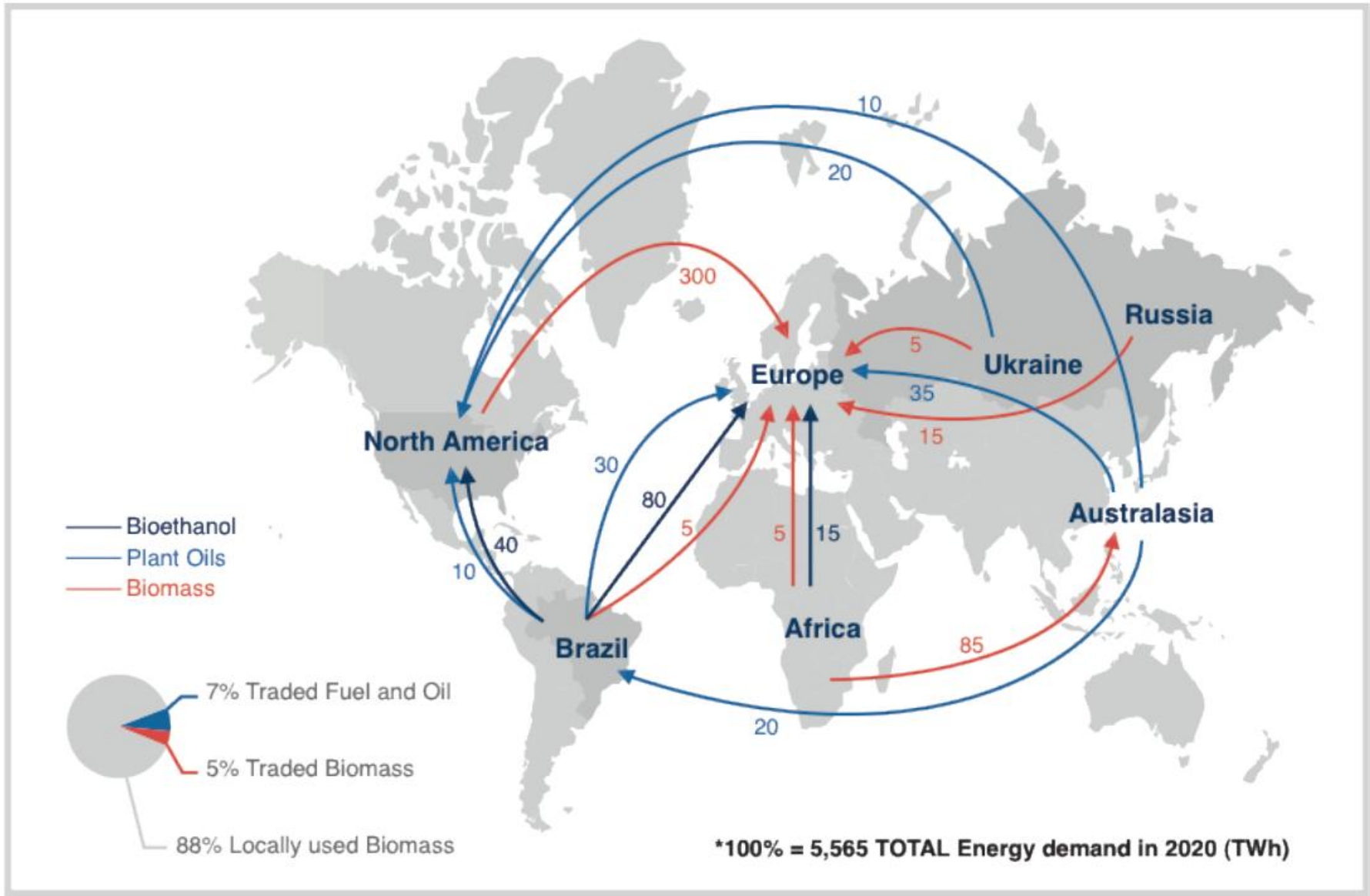


Figure 5: *Expected Biomass Trade Routes.* Values represent final energy demand in 2020.

WOOD PELLET TRADE

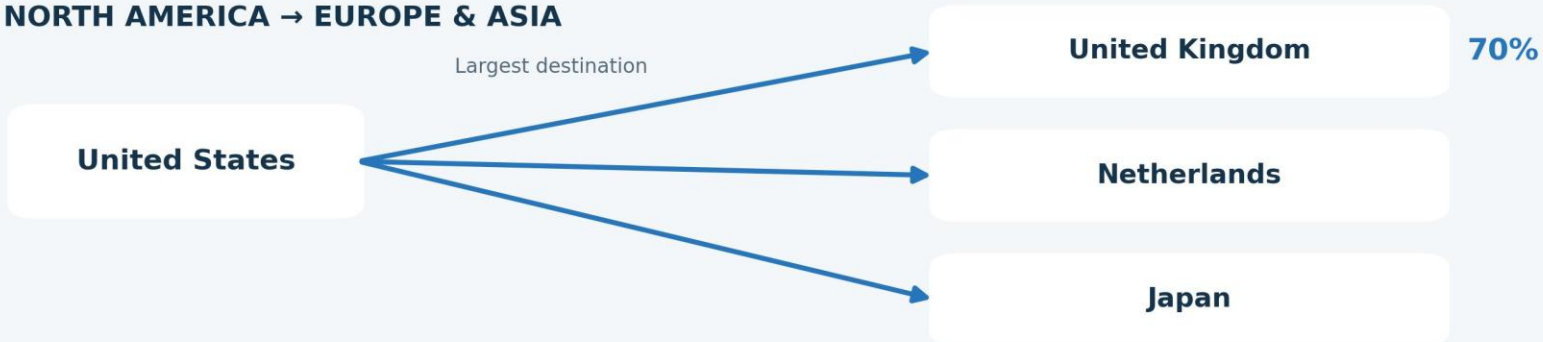
Observed 2024 data | Selected trade links, not a complete world trade balance

33.5 Mt
Global pellet exports

10.4 Mt
U.S. pellet exports

70%
UK share of U.S. pellet exports

NORTH AMERICA → EUROPE & ASIA



SOUTHEAST ASIA → EAST ASIA

Vietnam & Malaysia → Japan & South Korea

Mt = million metric tonnes. Arrows indicate direction only; widths do not represent traded volumes.

Source: Bioenergy Europe, Statistical Report 2025 — Pellets, pp. 25, 28–32. Figures rounded.

ETHANOL, BIODIESEL & HVO TRADE

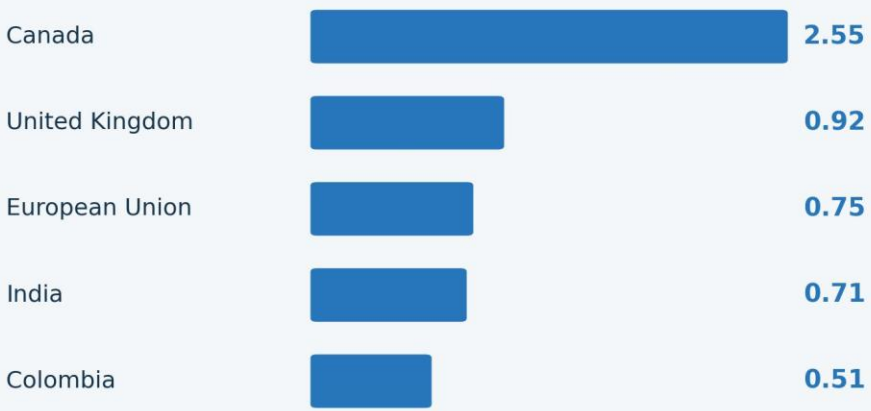
2024 reference year | Quantified U.S. ethanol exports and selected diesel trade links

ETHANOL

7.25 billion litres

Total U.S. ethanol exports in 2024

Selected destinations | billion litres



Includes fuel and other ethanol uses.

BIODIESEL / HVO

Selected finished-fuel trade links

China → **European Union**

European Union → **United States**

Trade routes changed during 2024–2025

EU duties and U.S. tax incentives affected imports and exports.

Keep feedstock trade (oils, UCO, fats) separate from finished-fuel trade.

HVO = hydrotreated vegetable oil / renewable diesel. UCO = used cooking oil. Arrows are qualitative.

Sources: RFA, 2024 Ethanol Trade Summary (2025), pp. 1–3; USDA FAS, EU Biofuels Annual (2025), pp. 24–25.

Ethanol: 1 U.S. gallon = 3.785411784 L; totals and destination values rounded. Diesel panel is not a global inventory.

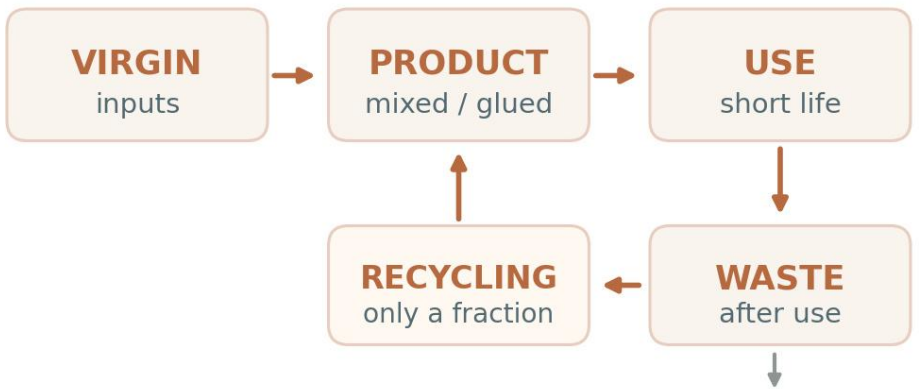
RECYCLING A PRODUCT VS DESIGNING A CIRCULAR SYSTEM

The difference is made before the product becomes waste.

CHAIN

Recycle what you can

The product is designed first; recycling comes later.



CIRCULAR

Design for multiple lives

Plan the return routes before production.

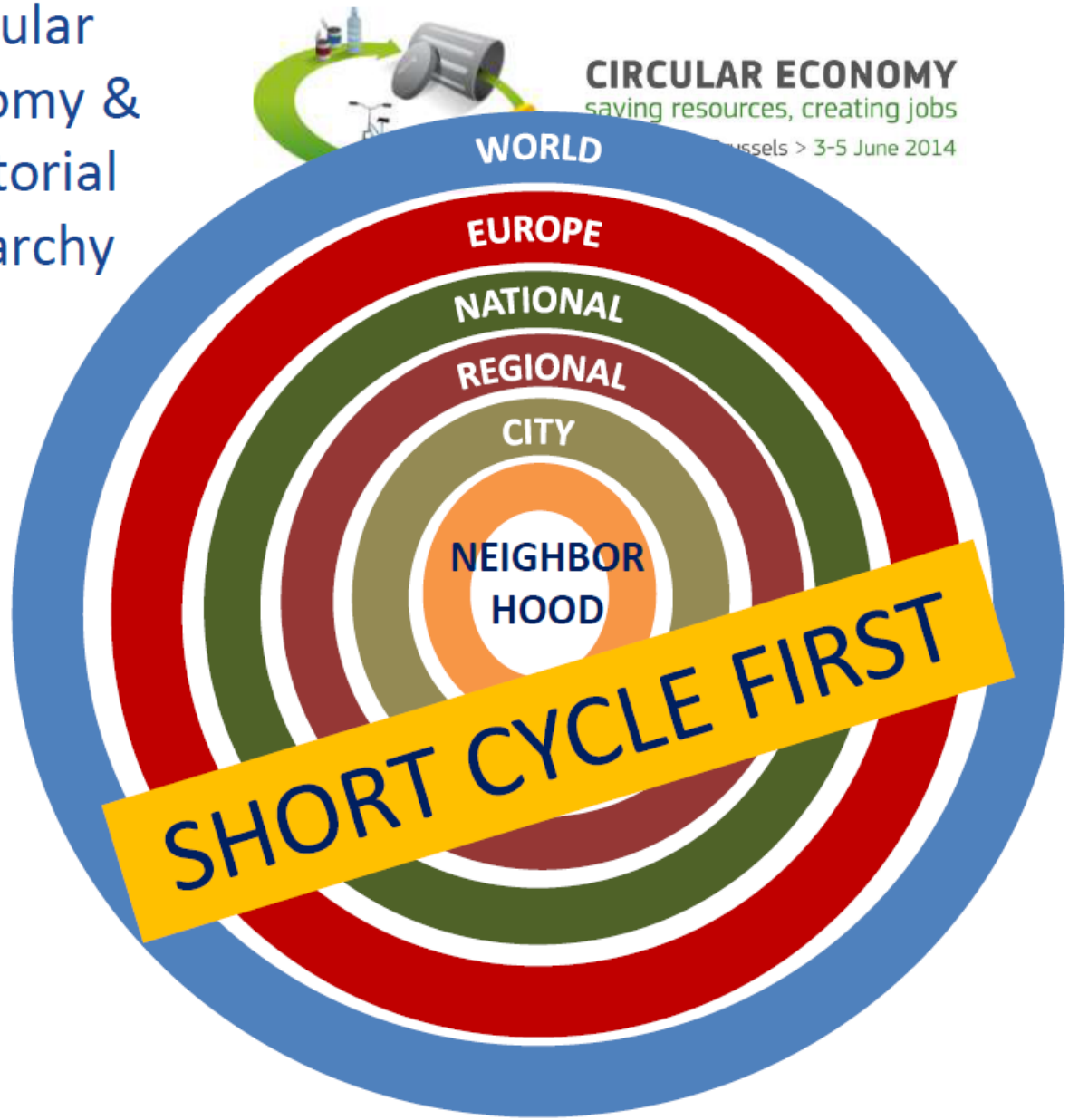


BIOECONOMY EXAMPLE

A bio-based package is not necessarily circular: its materials and end-of-life route must be designed together.

CORE IDEA Recycling is one loop. Circular design creates several useful loops and reduces losses.

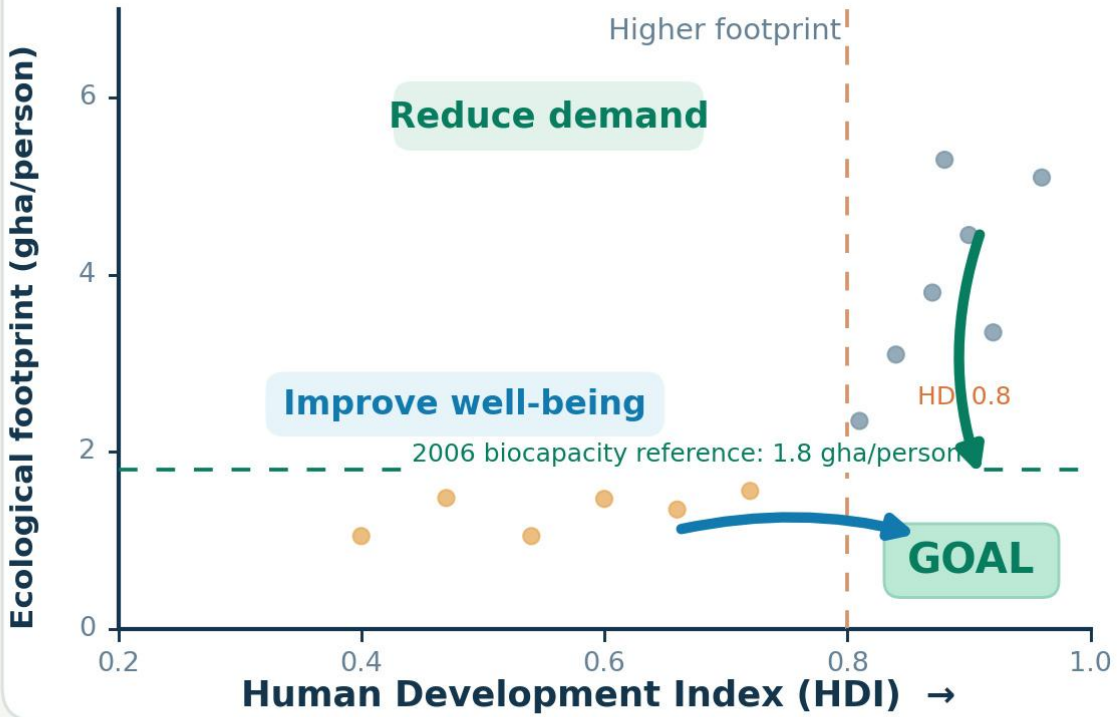
Circular economy & territorial hierarchy



BIOECONOMY + CIRCULAR ECONOMY

A route toward high human development within ecological limits

Development × ecological footprint



1 BIOECONOMY

Renewable biomass for food, materials and energy can support livelihoods and access to services.

Example: livestock manure → useful resources

2 CIRCULAR ECONOMY

Design to prevent waste; keep value in use; recover nutrients and regenerate ecosystems.

Effect sought: less virgin resource demand per service

TOGETHER: A CIRCULAR BIOECONOMY



KEY CONDITION

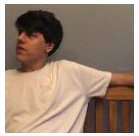
Renewable does not mean impact-free: protect land, food supply, water and biodiversity; check life-cycle GHG and nutrient losses. Arrows show goals, not measured country shifts.

Diagram based on the supplied 2009 slide · 2006 reference is historical

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