TU Clausthal

Institute for Software and Systems Engineering

Emerging Technologies for the Circular Economy

Lecture 2: Circular Economy I

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M.Sc. Anant Sujatanagarjuna (Clausthal)

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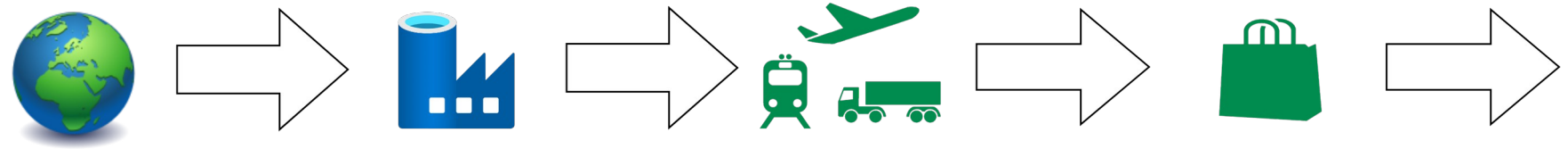
The Linear (Industrial) Economy

LINEAR INDUSTRIAL ECONOMY

PRODUCERS *IN-CONTROL*



RESOURCES | **MANUFACTURING** | **DISTRIBUTION** | **POINT OF SALE**

GLOBALIZED INDUSTRIALIZED PROCESSES

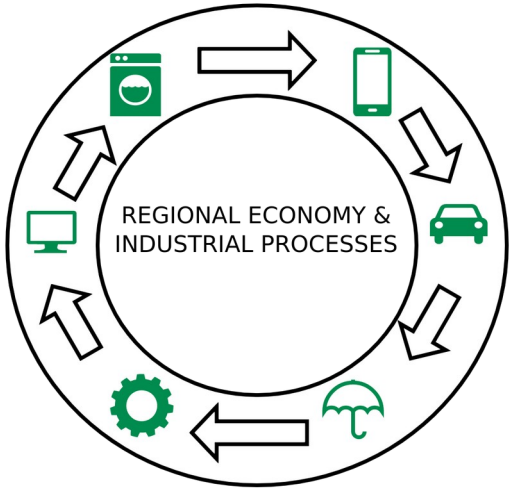
NATURAL RESOURCES (Water, Energy, Materials) and Human Resources (Labor and Skills) are used to produce manufactured **objects** (infrastructure, buildings, equipment, durable projects).

GLOBALIZED DISTRIBUTION LOGISTICS

COMMERCIALIZATION at the factory gate or at point of sale these objects are put to use (sold, leased, rented, sold as service)...

CIRCULAR ECONOMY

USERS *IN-CONTROL*

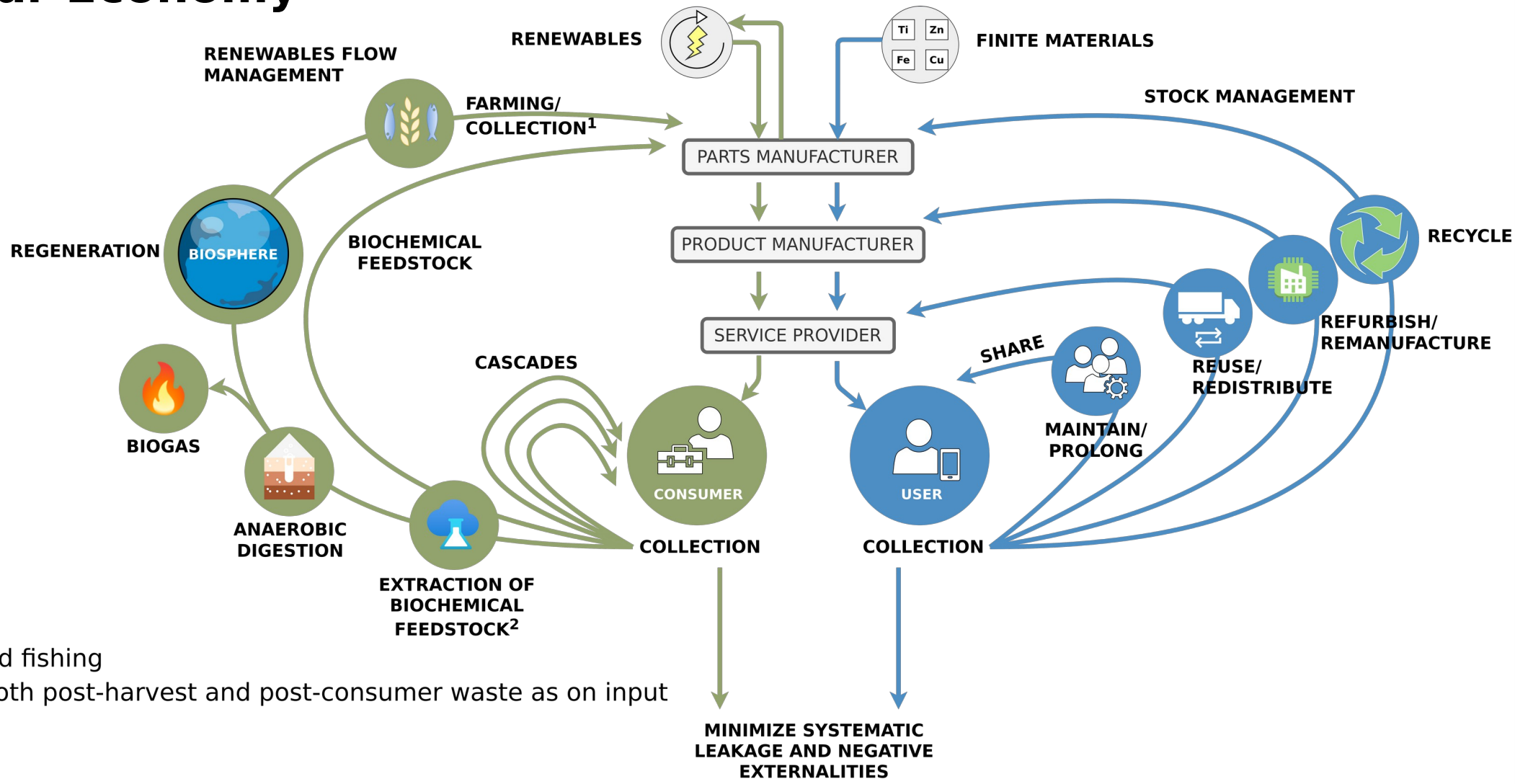


... and later **REUSED** as objects **AT THEIR HIGHEST VALUE** and function, or recovered as molecules at their highest value and purity

Image adapted from: Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

THE CIRCULAR ECONOMY

Circular Economy



[1] Hunting and fishing
[2] Can take both post-harvest and post-consumer waste as on input

Image adapted from https://www.ellenmacarthurfoundation.org/circular-economy/concept/infographic

Circular Economy

Circular Economy – Definitions

“Conceptualizing the circular economy: An analysis of 114 definitions.”

Kirchherr, Julian, Denise Reike and Marko P. Hekkert. Resources Conservation and Recycling 127 (2017): 221-232.

https://doi.org/10.1016/J.RESCONREC.2017.09.005

Circular Economy – Definitions

> “A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.”
>
> – Ellen MacArthur Foundation

https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

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– Ellen MacArthur Foundation

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

– European Parliament

https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf
https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefts

Circular Industrial Economy – Definitions

"The circular industrial economy manages stocks of manufactured assets, such as infrastructure, buildings, vehicles, equipment and consumer goods, to maintain their value and utility as high as possible for as long as possible; and stocks of resources at their highest purity and value."

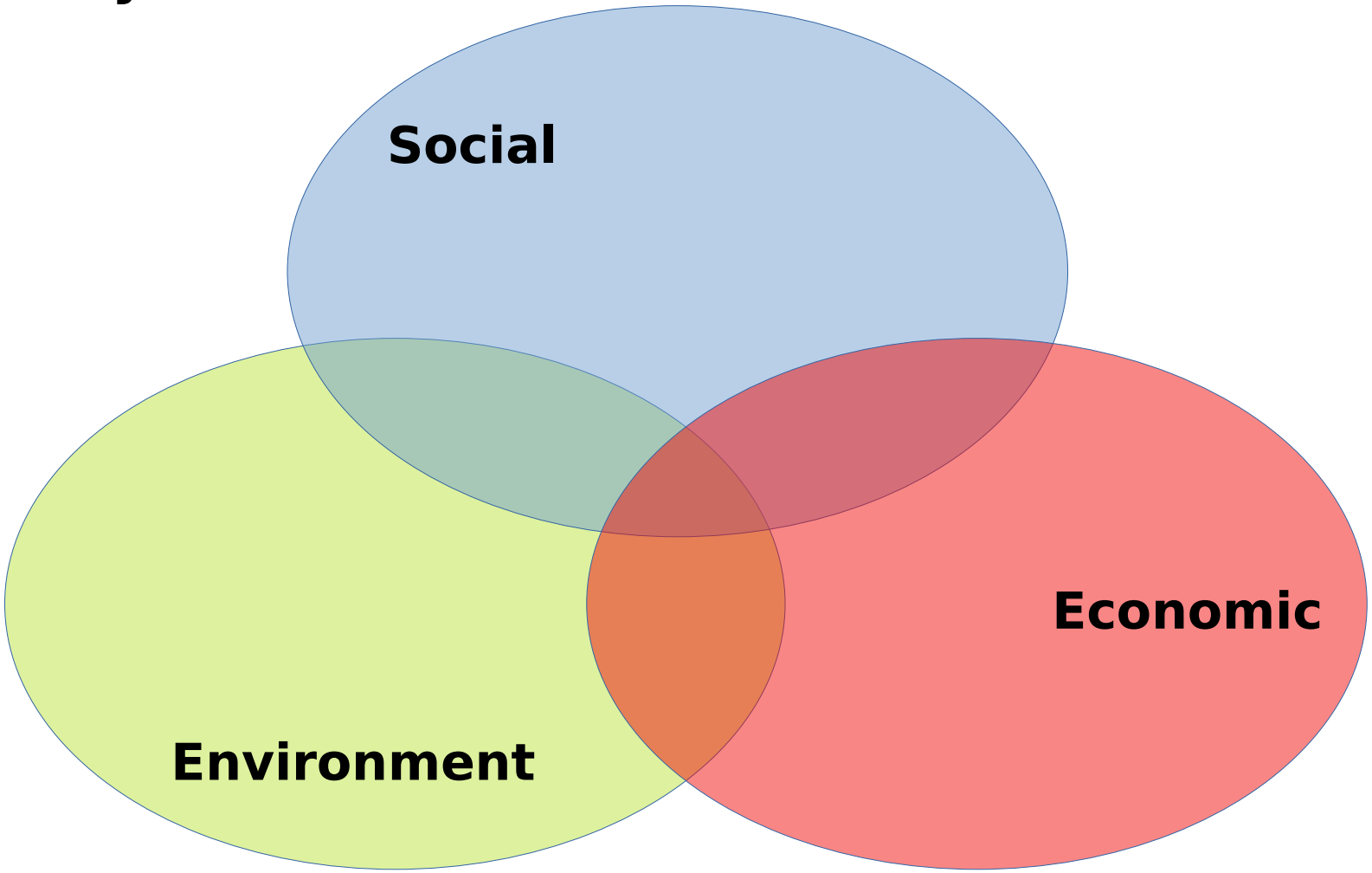
Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

Sustainability – Definition

„Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Report of the World Commission on Environment and Development: Our Common Future (1987) – http://www.un-documents.net/our-common-future.pdf

Sustainability – Definition



Based on: Thomsen C. (2013) Sustainability (World Commission on Environment and Development Definition). In: Idowu S.O., Capaldi N., Zu L., Gupta A.D. (eds) Encyclopedia of Corporate Social Responsibility. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-28036-8_531

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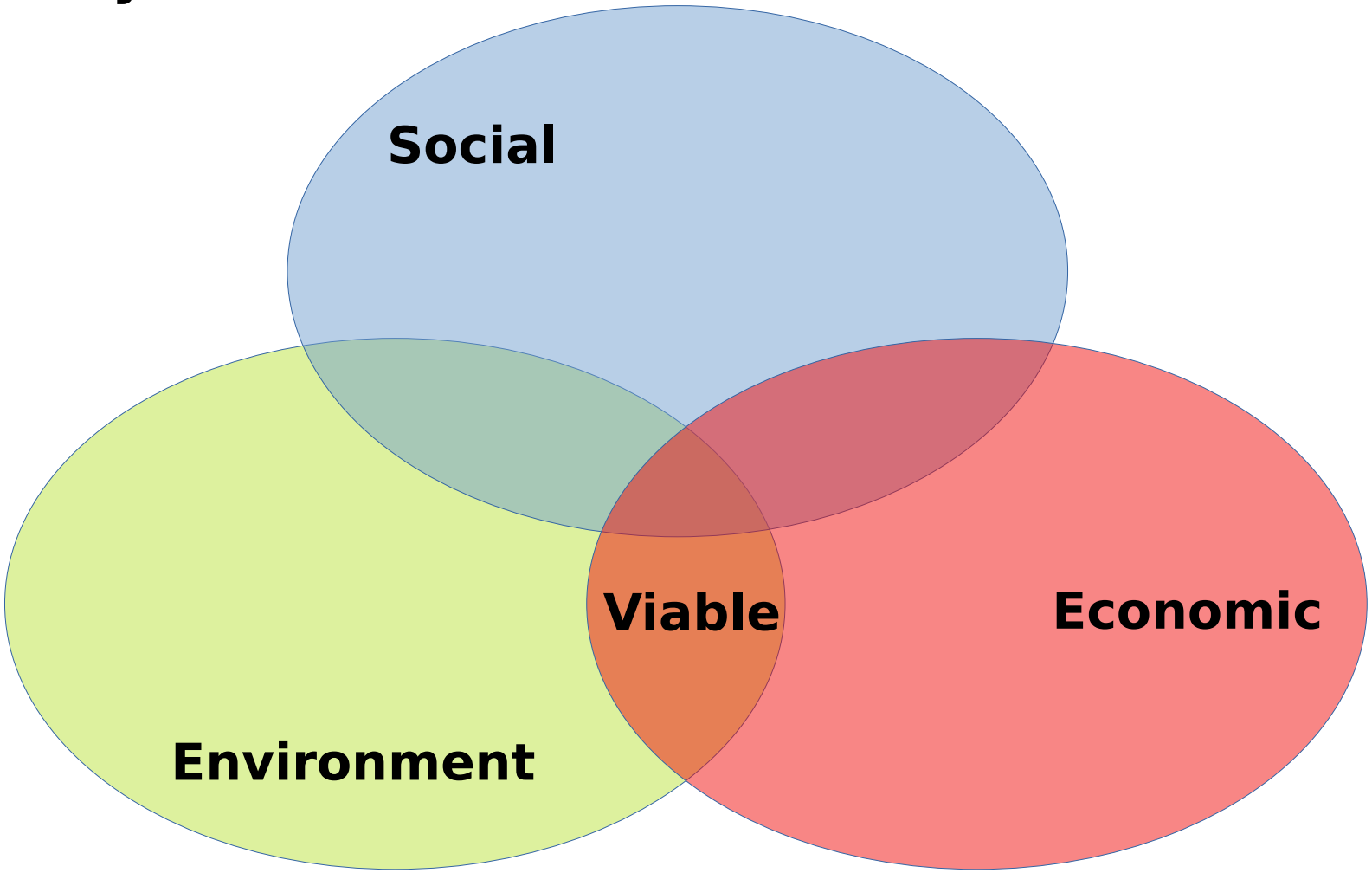

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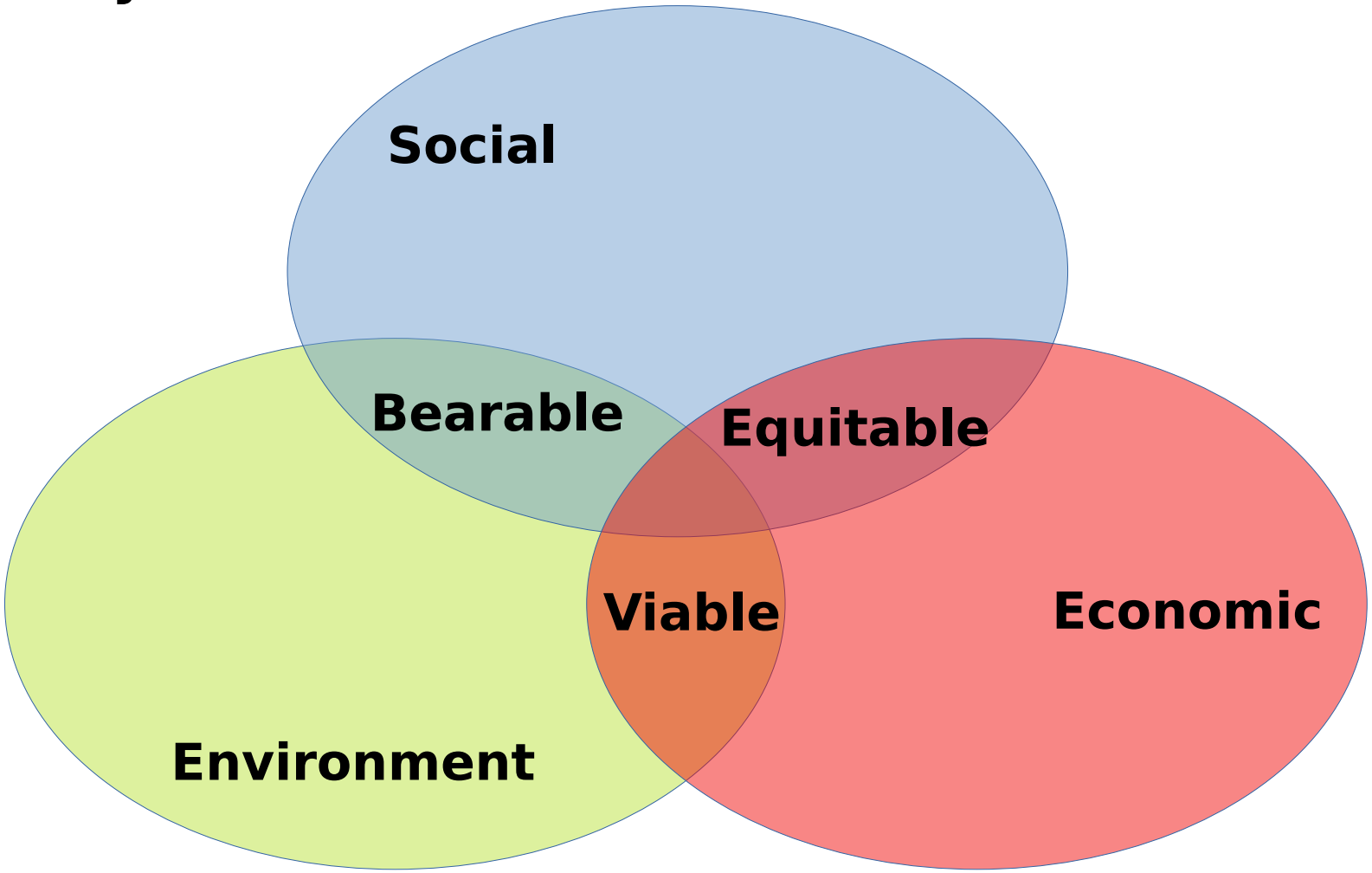

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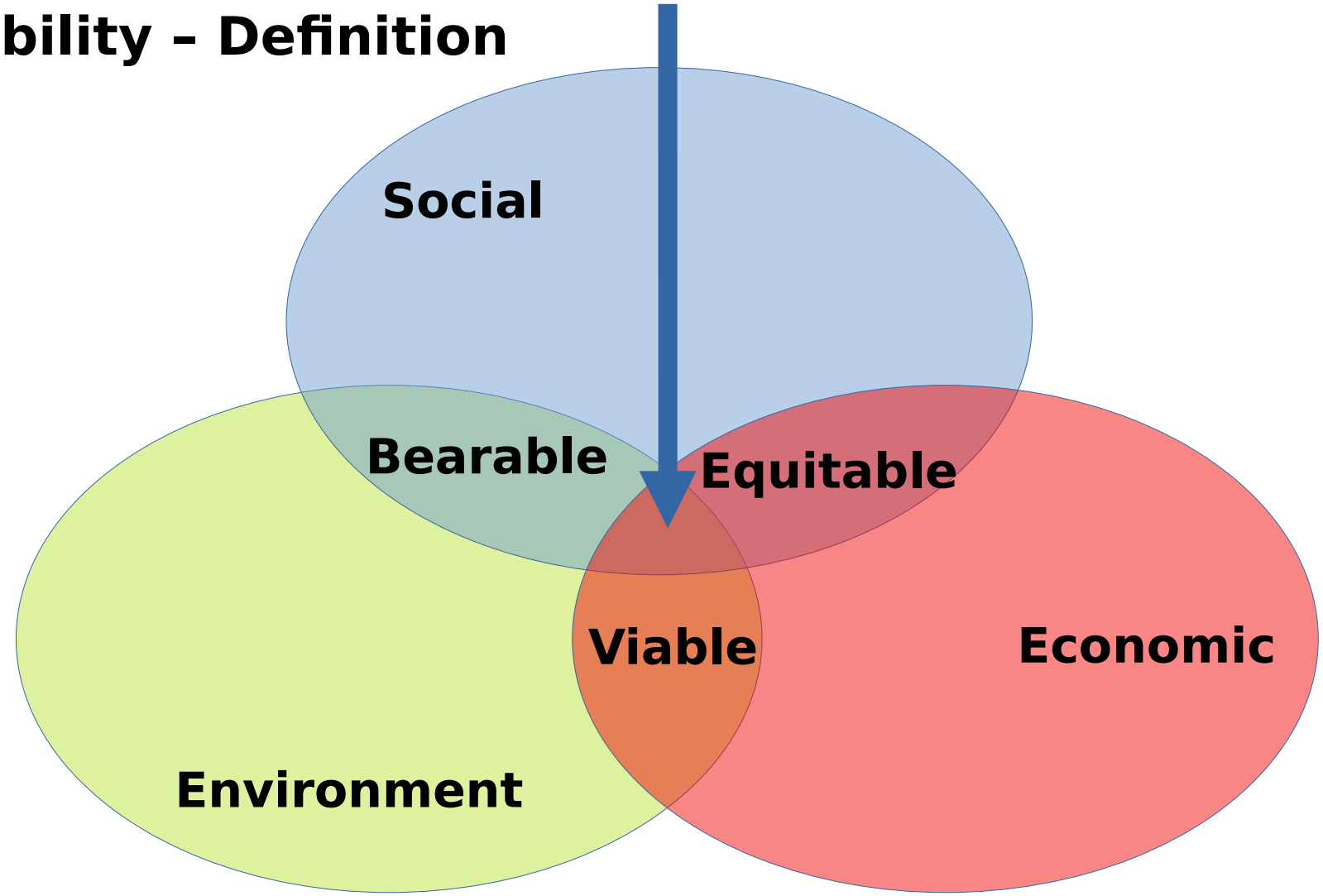

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Sustainability – Implications

Sustainability → Consume less

Report of the World Commission on Environment and Development: Our Common Future (1987) – http://www.un-documents.net/our-common-future.pdf

Circular Economy – Characteristics

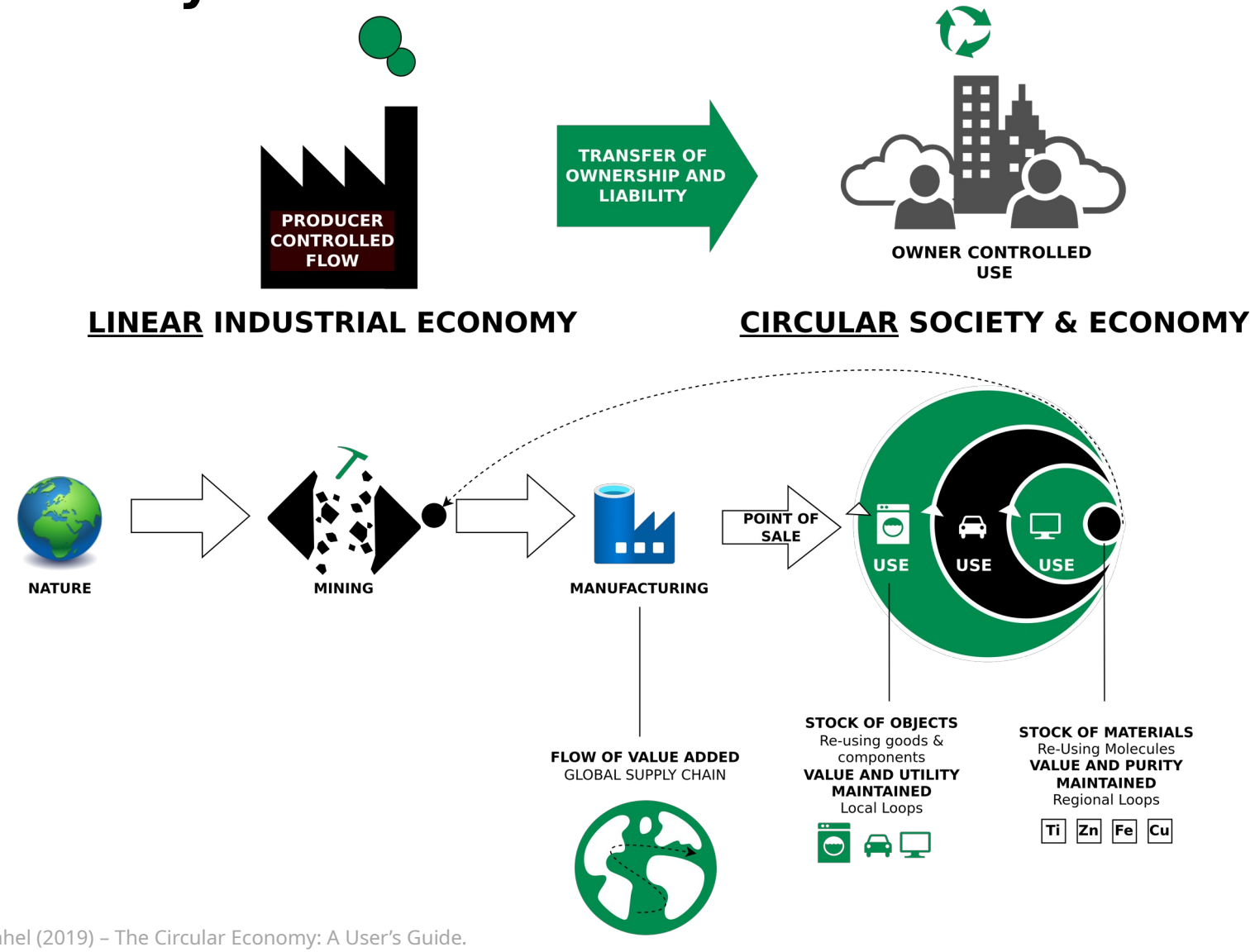


Image adapted from: Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

The Era of R

Techno-commercial strategies to keep goods and components at highest value level through:

- **R**euse
- **R**epair
- **R**emarket
- **R**emanufacture
- **R**e-refine
- **R**eprogramme goods

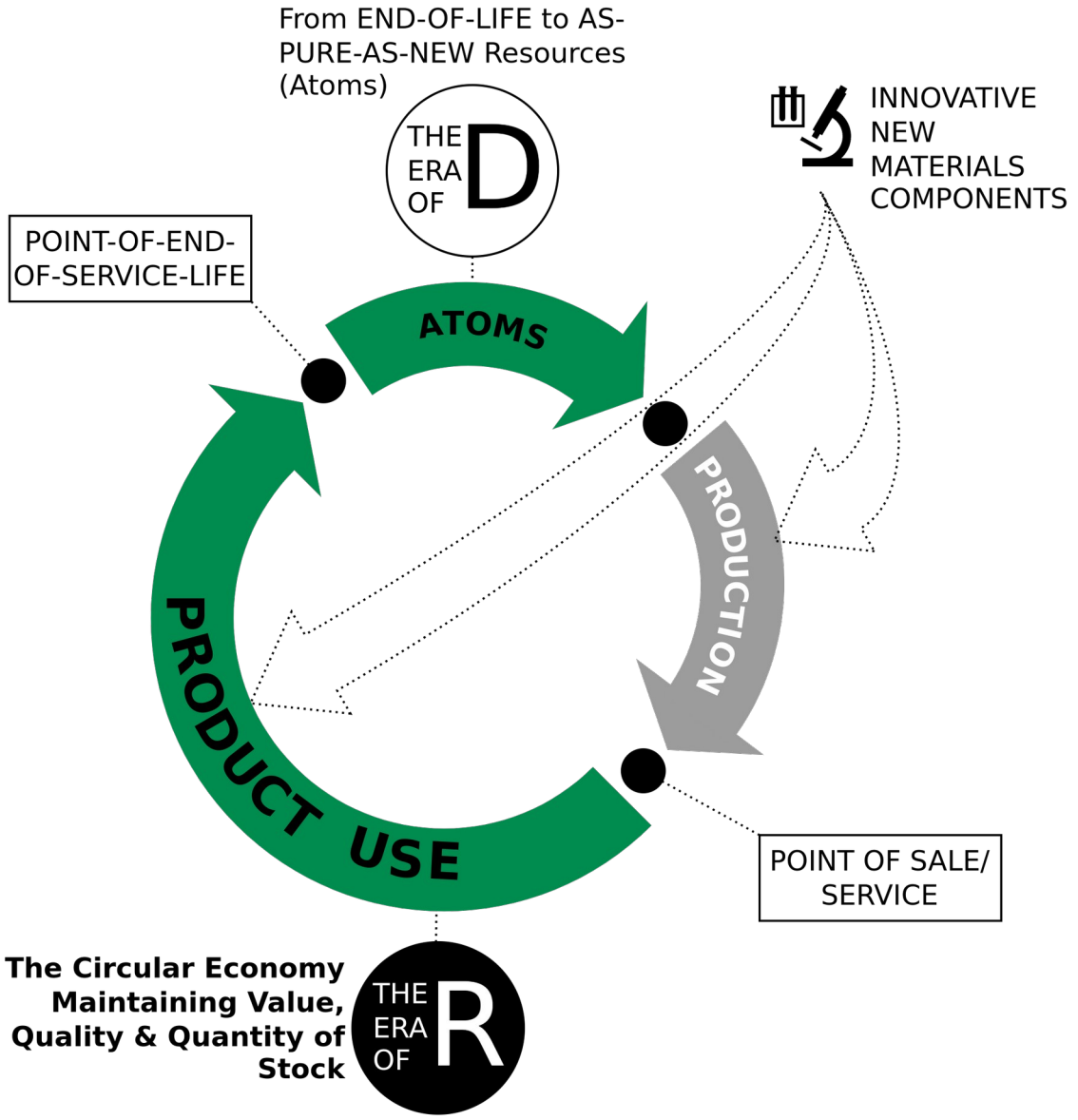


Image adapted from Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

The Era of D

Technologies and actions to recover atoms and molecules at highest quality (purity and value) level as pure as virgin:

- **D**e-polymerise
- **D**e-alloy
- **D**e-laminate
- **D**e-vulcanise
- **D**e-coat materials
- **D**e-construct high-rise buildings and major infrastructure

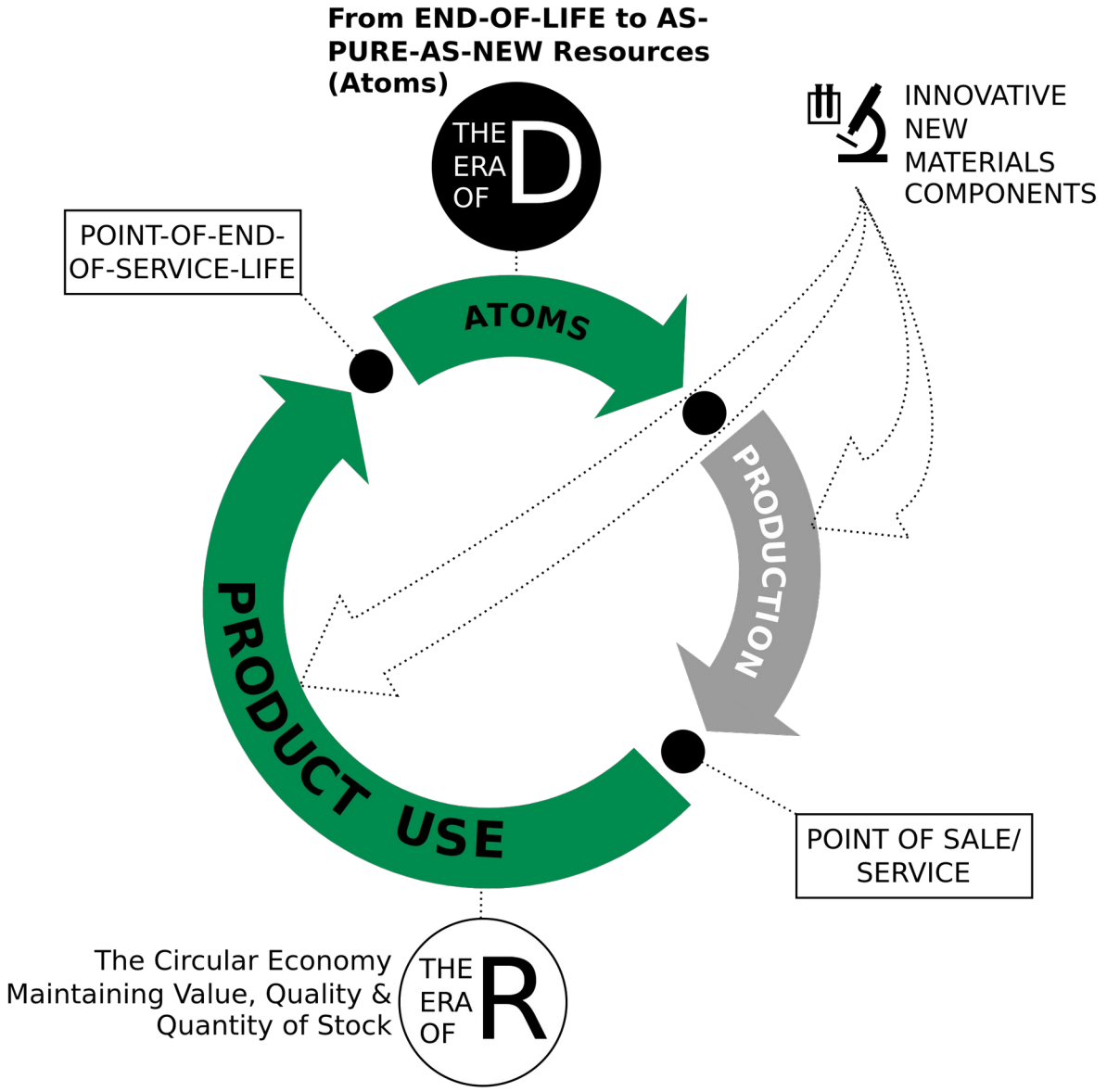


Image adapted from Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

End-of-service-life business opportunities for value preservation: Reuse or Recycle?

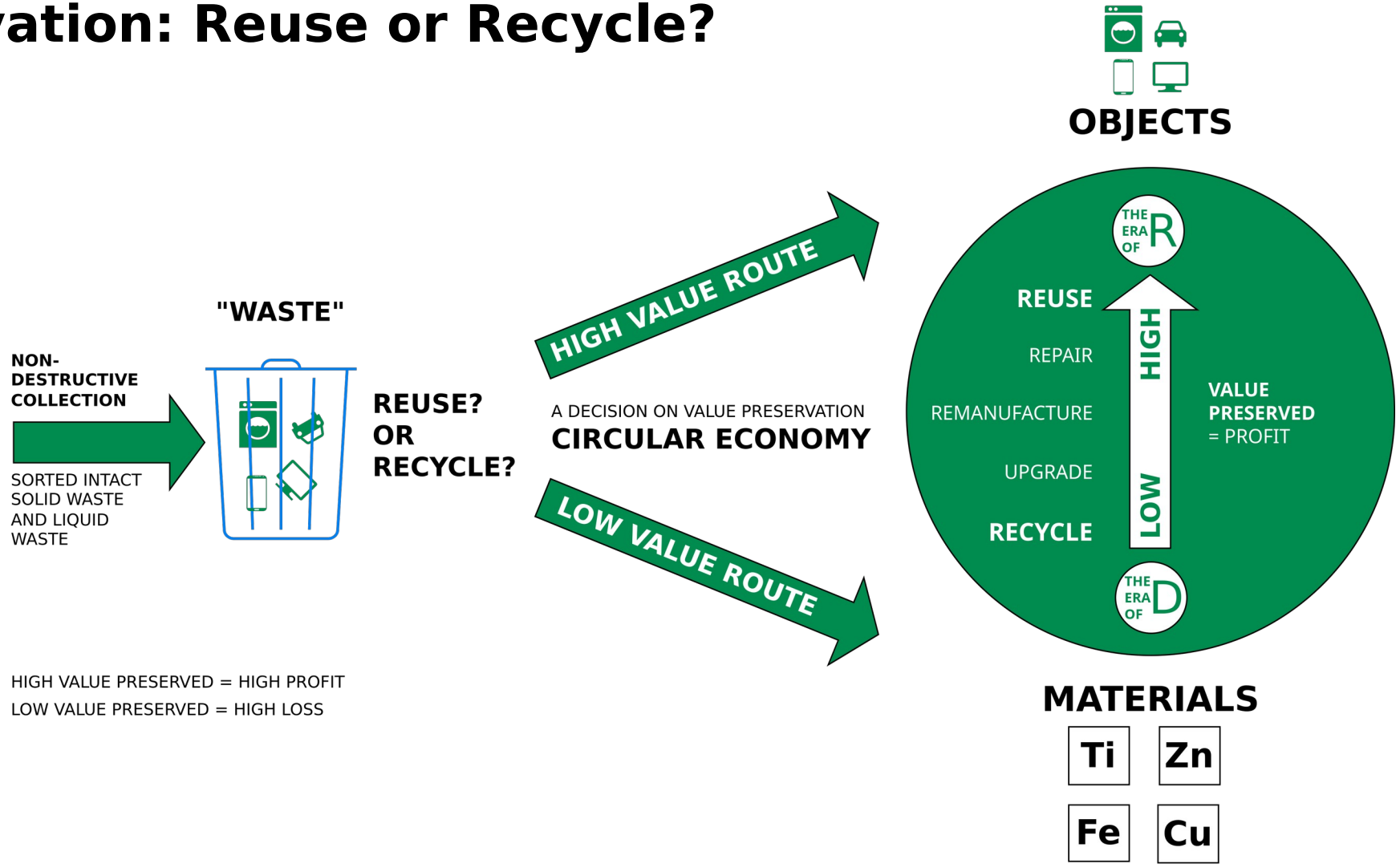
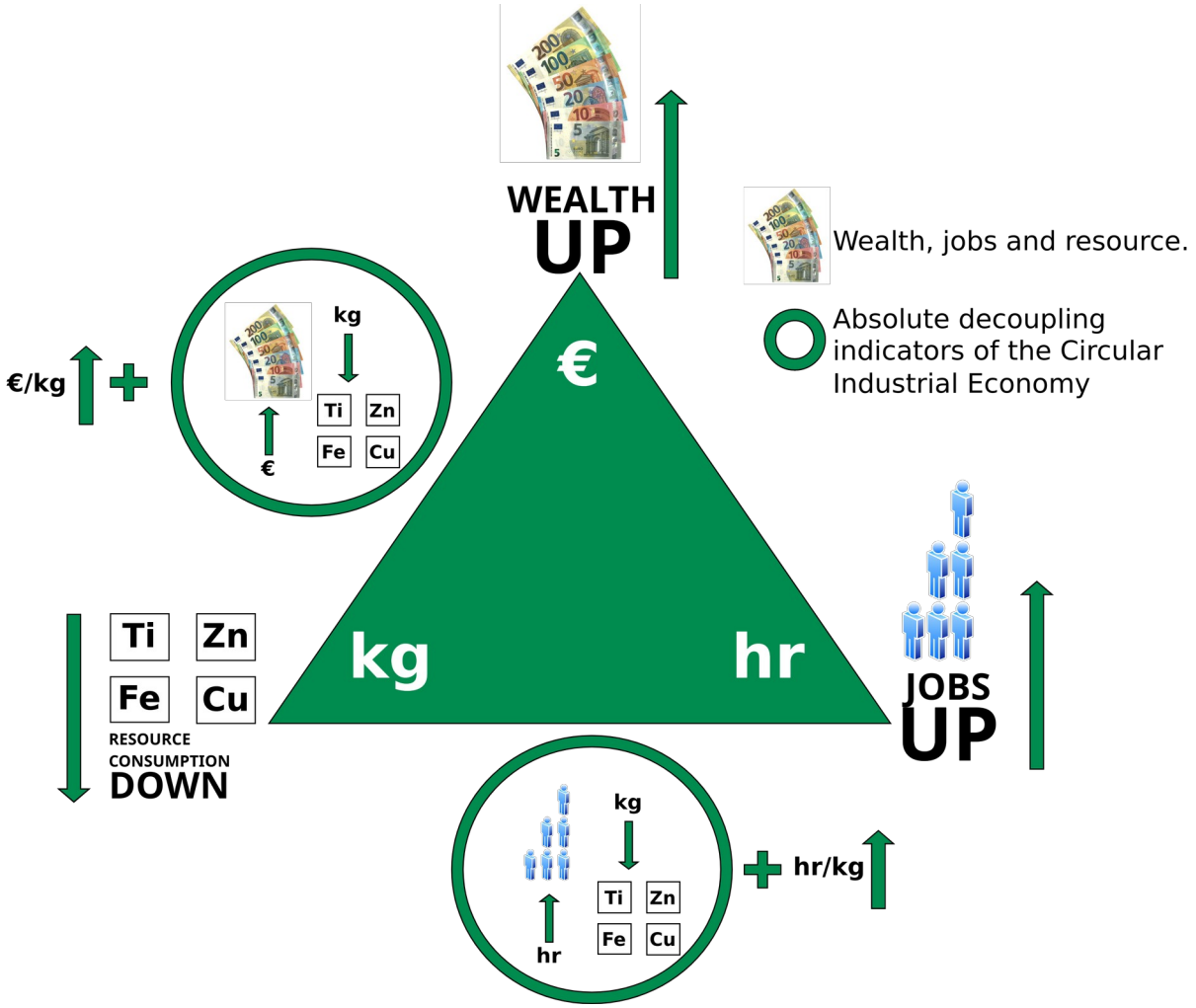


Image adapted from Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

The two absolute decoupling indicators of the CIE monitoring more wealth and jobs from less resource consumption

- **Linear Economy:** Low hr/kg (labor input per weight) ratios, coherent with mass production in highly mechanized processes, and low to medium €/kg (value per weight) ratios, in a range from basic materials like cement to smart goods like USB memory sticks



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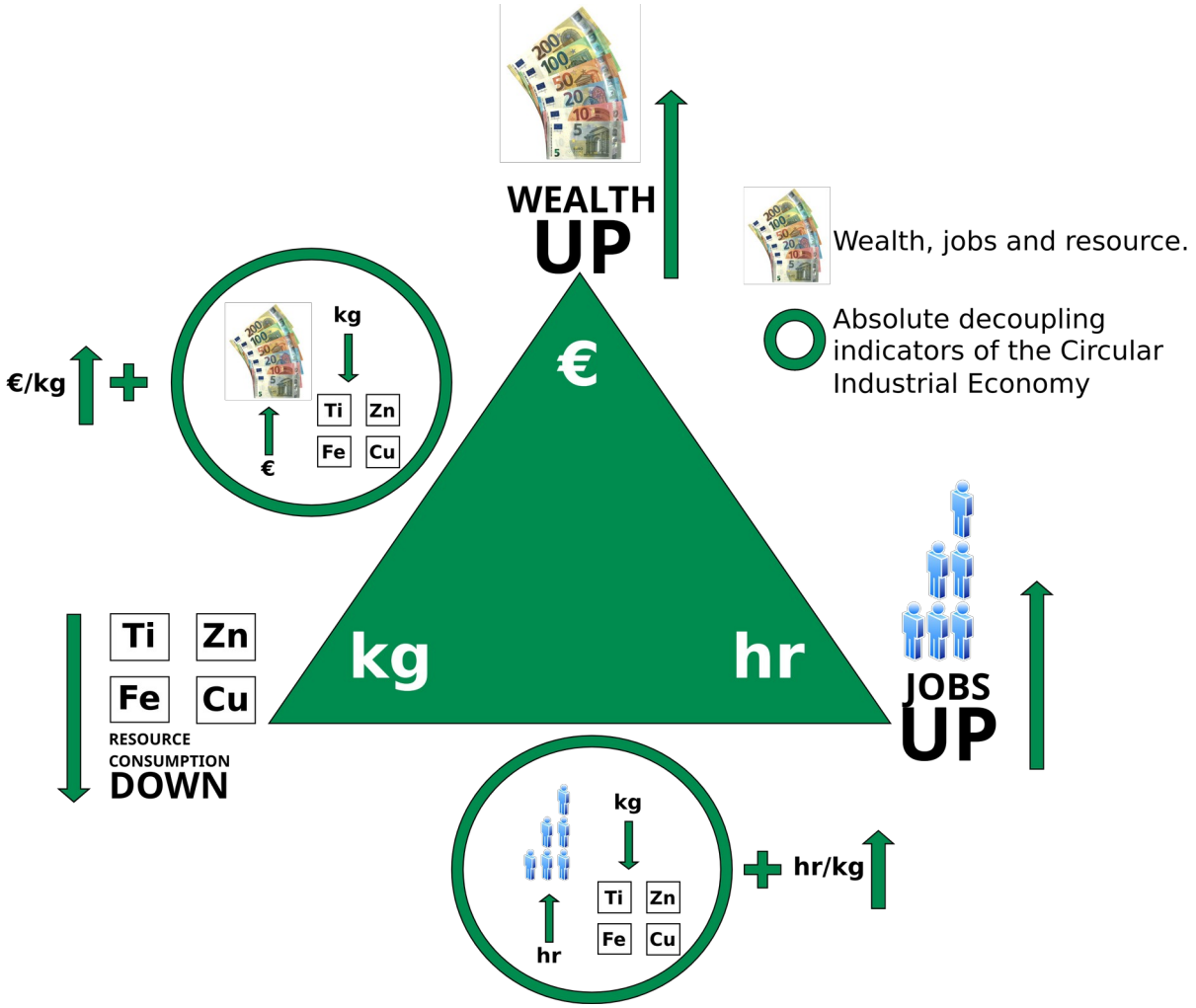
- **Circular Economy:** Higher hr/kg and €/kg ratios for reuse, remanufacture and selling performance (goods as a service), in a group with new technologies, such as life sciences and nanotechnologies, which by nature produce dematerialized objects.



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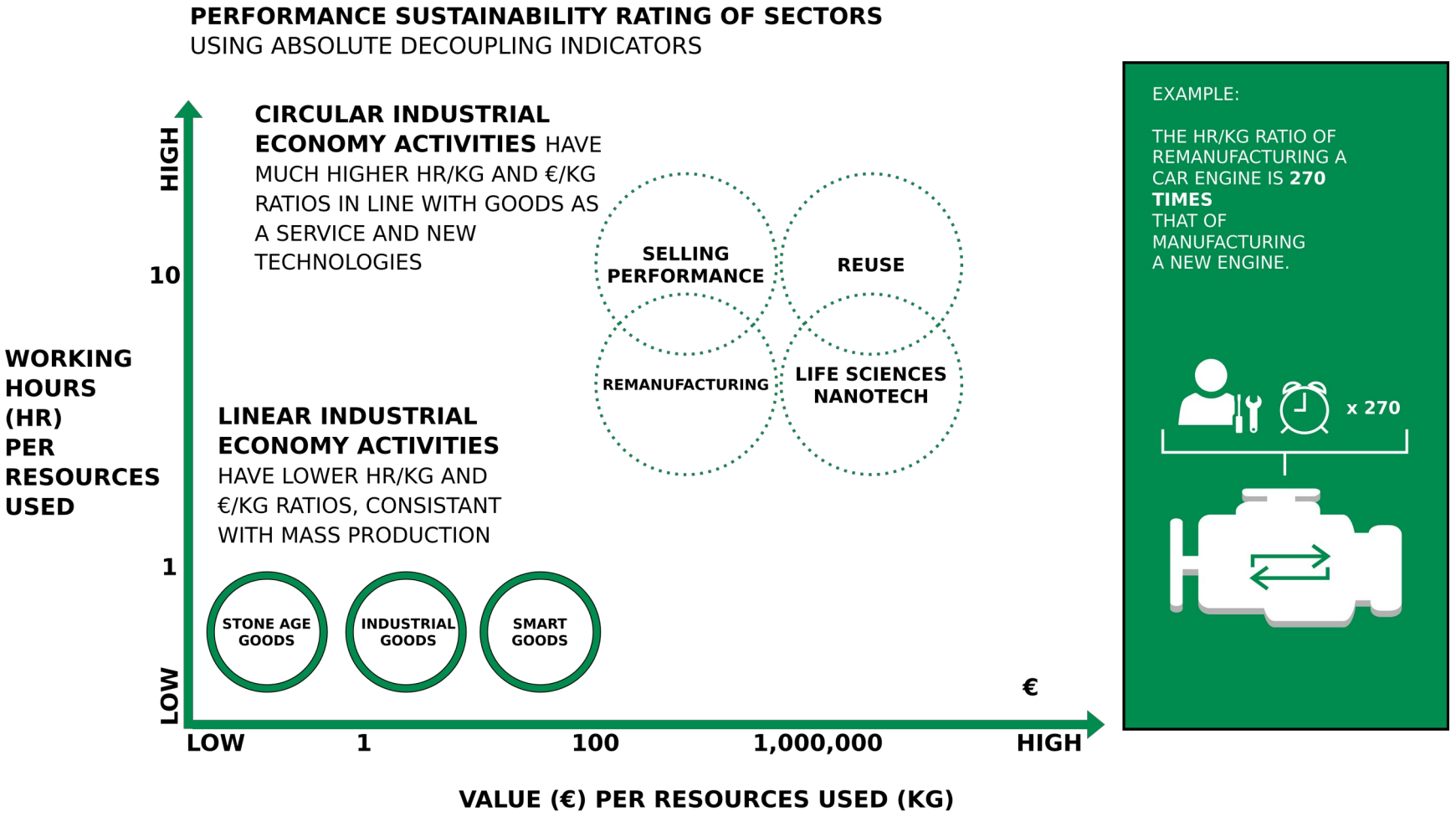
Absolute decoupling indicators make the difference between the LIE and the CIE visible



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PERFORMANCE ECONOMY

Performance Economy

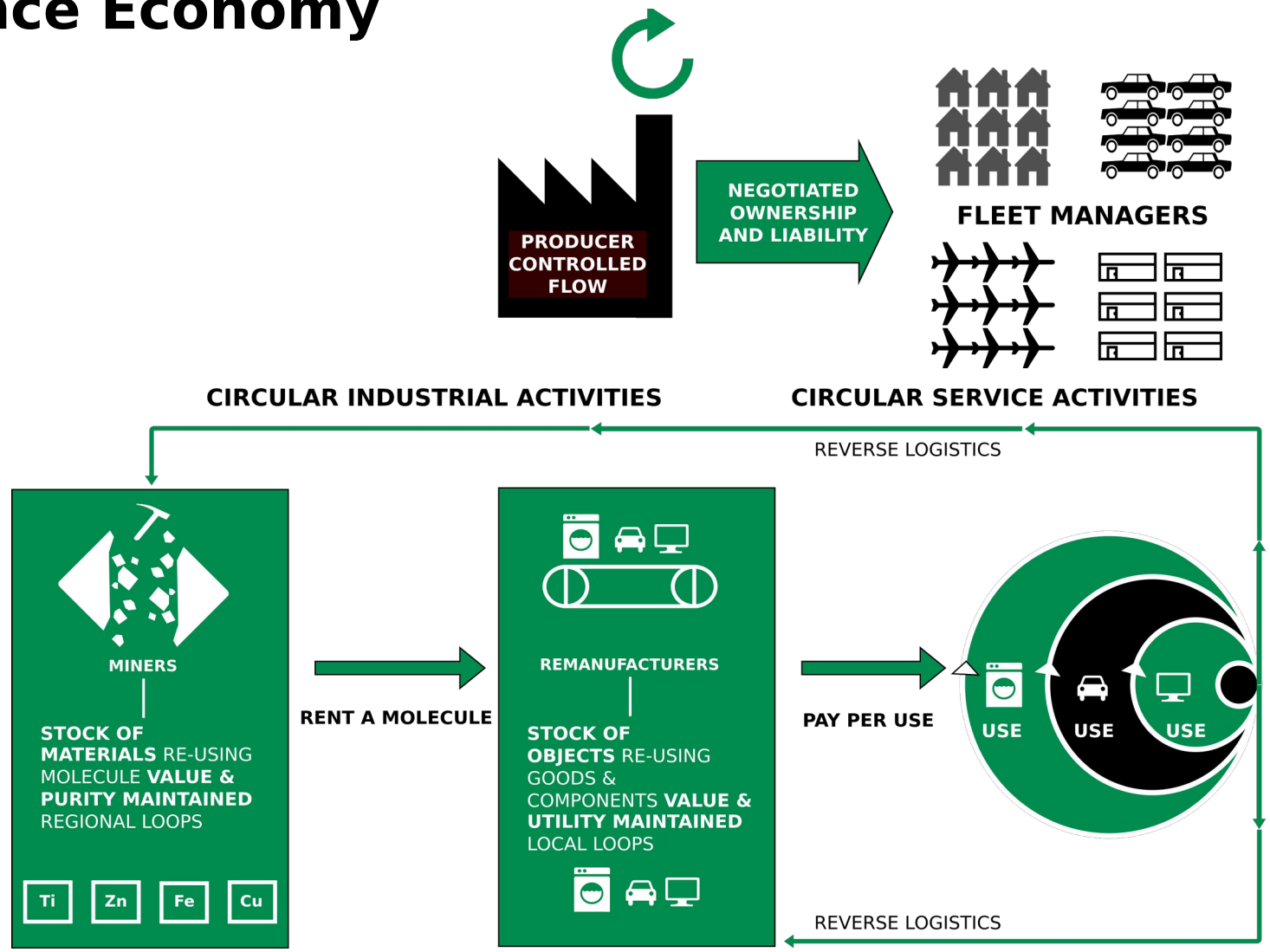

Image adapted from Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

Performance Economy – Definition

„The Performance Economy sells results instead of objects. Its economic actors may be manufacturers of durable objects or fleet managers operating them. In both cases, they sell the use of these objects as a service over the longest possible period of time and maximize their profits by exploiting both efficiency and sufficiency solutions. “

Walter R. Stahel (2019) – The Circular Economy: A User’s Guide.

Performance Economy – Most sustainable CE business model?

- Stahel argues:
  - “The Performance Economy of selling goods and molecules as a service, function guarantees or results and performance, is the most sustainable business model of the circular industrial economy because by internalising the costs of product liability, of risk and waste, it offers manufacturers a strong financial incentive to prevent losses and waste.”

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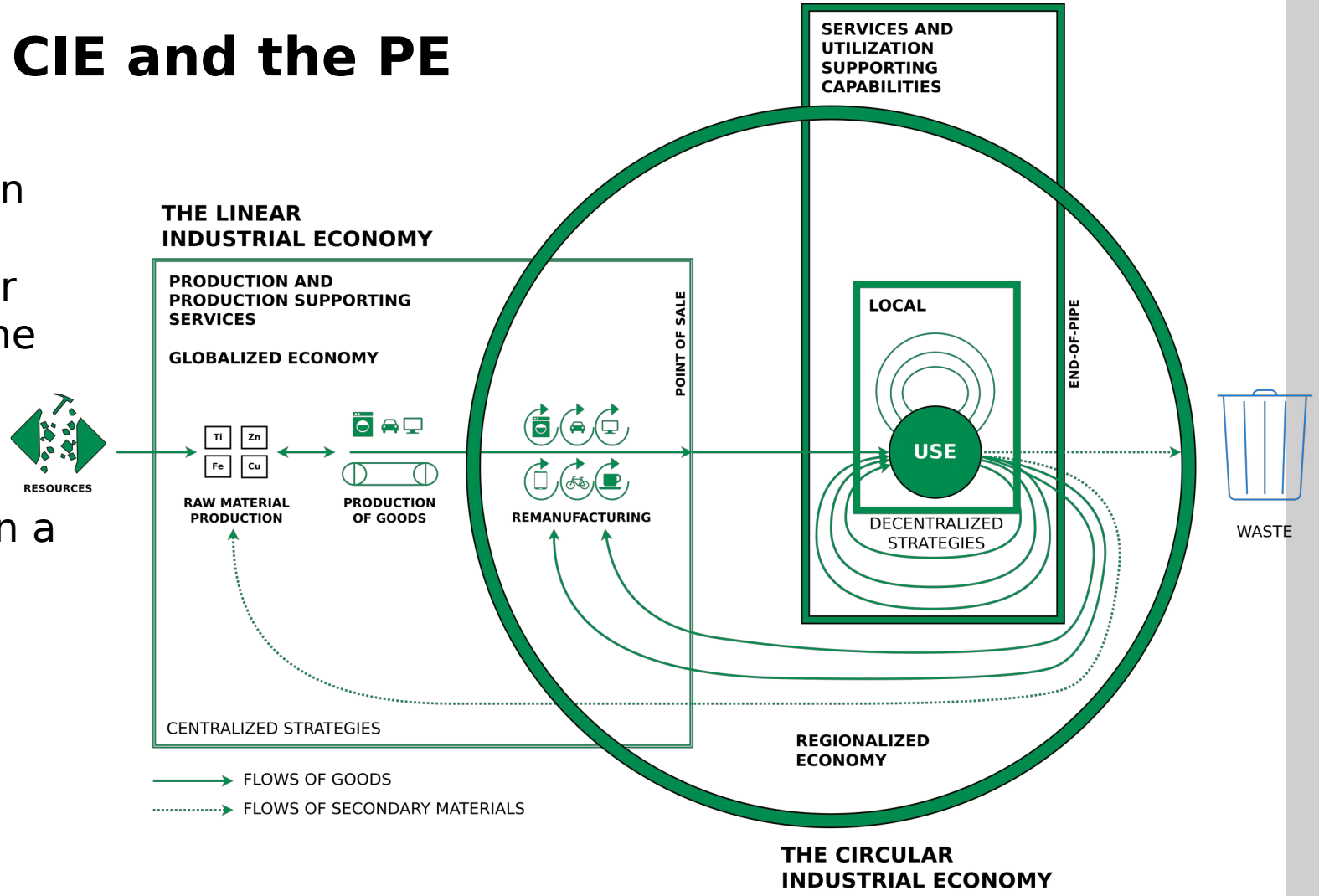
  - "It maximises the profit potential by exploiting sufficiency, efficiency and systems solutions."
  - "In addition, by maintaining the ownership of objects and embodied resources, it creates long-term corporate and national resource security at low cost."

Walter R. Stahel (2019) – The Circular Economy: A User's Guide.

Situating the LIE, the CIE and the PE

- **Circle:** Managing the utilisation or use phase of stocks of manufactured objects and their components, by maintaining the value and quality of infrastructure, buildings, investment goods, equipment and durable consumer goods in a local or regional economy



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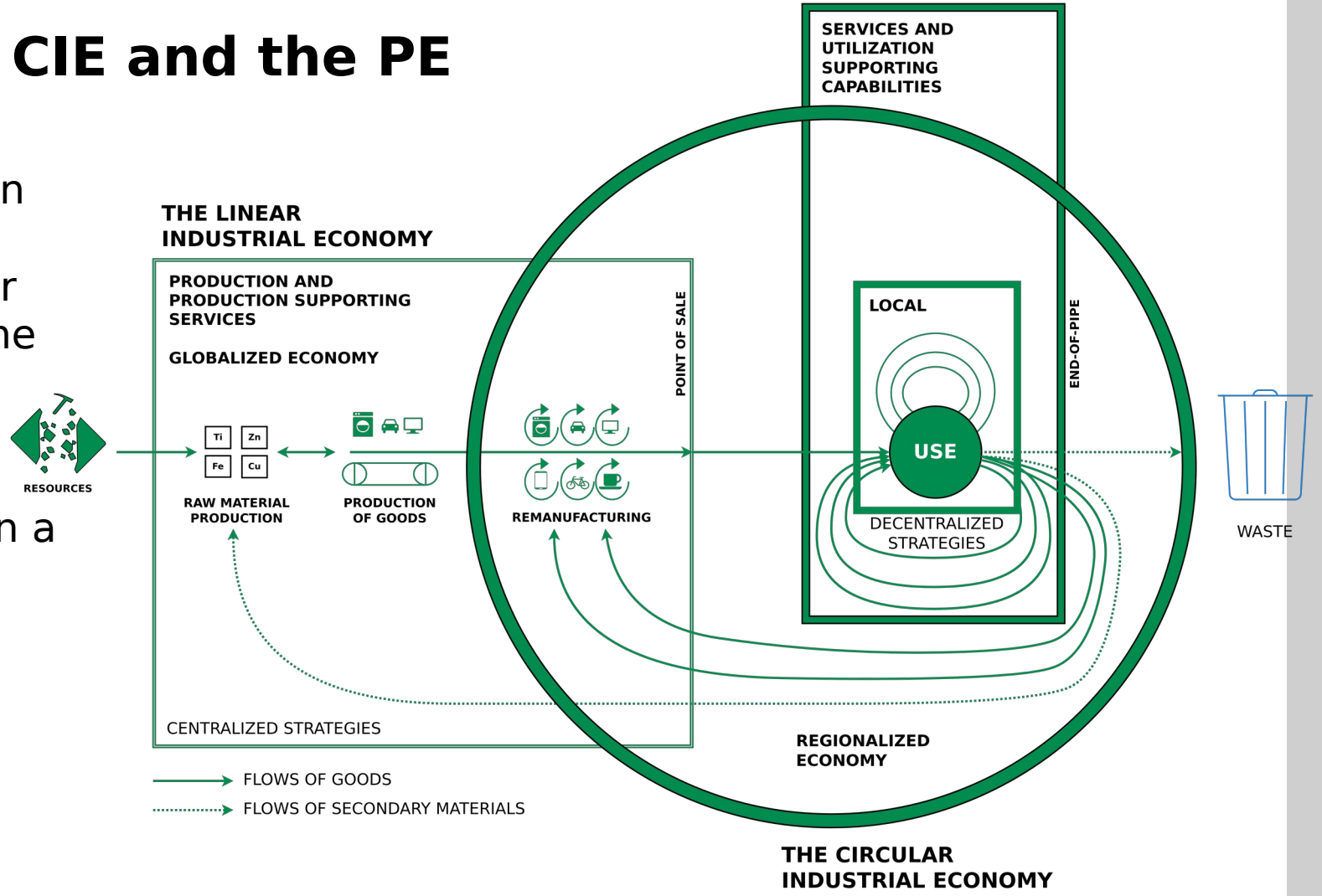
- **Small square:** Local use-focused PE



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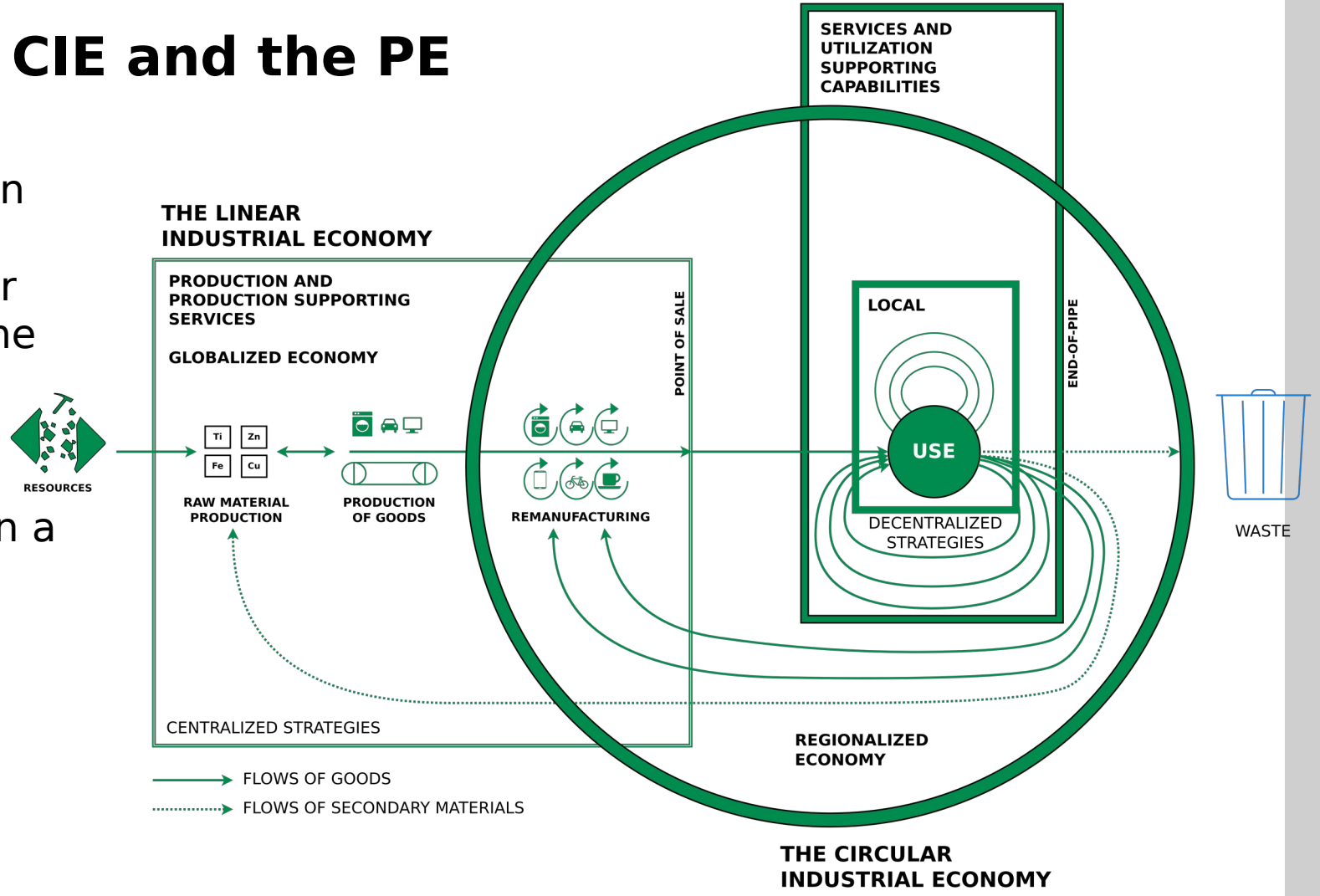
Situating the LIE, the CIE and the PE

- **Circle:** Managing the utilisation or use phase of stocks of manufactured objects and their components, by maintaining the value and quality of infrastructure, buildings, investment goods, equipment and durable consumer goods in a local or regional economy
- **Small square:** Local use-focused PE
- **Big square:** Flows of used materials returning to the raw material producer to recover molecules and atoms in a globalised economy



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EXAMPLE 1 – FOODSHARING

The Problem

Food Waste – Overview (2015)

- 1.3 billion tons of the world's food ends up in the trash every year.

1.) BMEL (2021) – Lebensmittelabfälle in Deutschland: Aktelle Studie über Höhe der Lebensmittelabfälle nach Sektoren – https://www.bmel.de/DE/themen/ernaehrung/lebensmittelverschwendung/studie-lebensmittelabfaelle-deutschland.html
2.) Lebensmittelabfälle in Deutschland – Baseline 2015 (2019) – https://www.thuenen.de/media/publikationen/thuenen-report/Thuenen_Report_71.pdf

Question 1

- What percentage of the food you purchase is ending up in your trash bin?
  - A: 0% – 10%
  - B: 10% – 25%
  - C: 25% – 40%
  - D: 40% – 50%

The Problem

Food Waste – Overview (2015)

- 1.3 billion tons of the world's food ends up in the trash every year.
- In Germany alone, 12 million tons of food are wasted every year → per capita: 75kg/year
  - Private households → 6.7 million tons (52%)
  - Processing → 2.2 million tons (18%)
  - Out-of-home-consumption → 1.7 million tons (14%)
  - Primary production → 1.4 million tons (12%)
  - Retail → 0.5 million tons (4%)

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The Problem

Food Waste – Retail in more detail (2015)

- Total food waste → **696,484 tons**
  - Fruit and vegetables → 328,245 tons
  - Bread and baked goods → 206,399 tons
  - Dairy products → 60,255 tons
  - Meat-like/based products → 53,307 tons
  - Others → 48,279 tons

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Where is the difference between the 0.5 million tons on the previous slide and the 696,484 tons on this slide coming from?

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Where is the difference between the 0.5 million tons on the previous slide and the 696,484 tons on this slide coming from? → donated food (Tafel Deutschland e.V.)

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Solution?

General

- Make it illegal to throw food away → In February 2016, France adopted a law on fighting food waste that meant supermarkets were forbidden to destroy unsold food products and were compelled to donate it instead.
  - Has been later adopted in the gastronomy and related sectors

Alternative Solutions?

Foodsharing Platform

- Click Me
- Platform launched in 2012
  - Decentralized and self-organized
  - 450,000 registered user (all volunteers)
  - Cooperates with more than 11,000 businesses
  - More than 65 million tons of food saved

https://foodsharing.de/

Alternative Solutions?

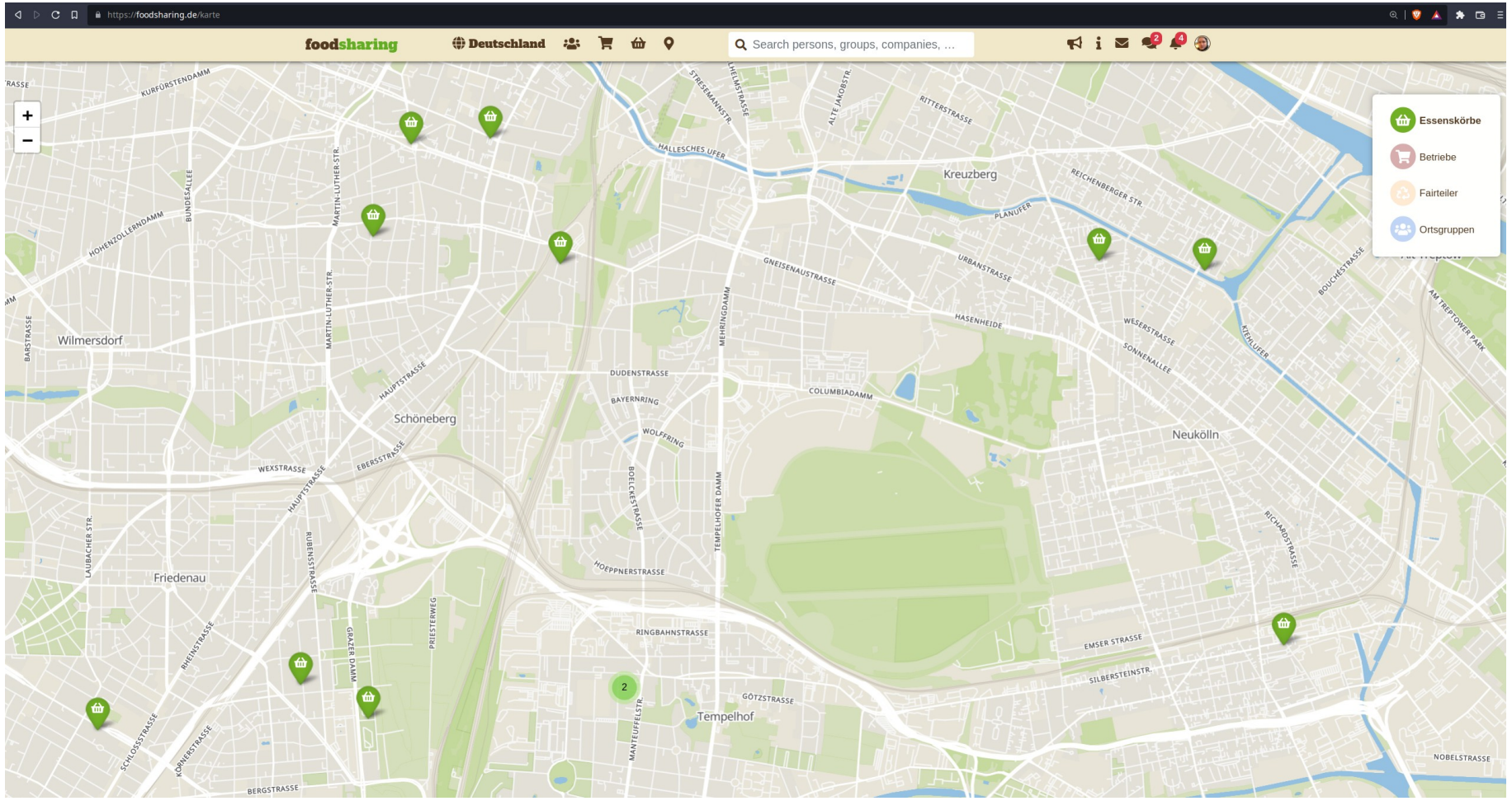
Foodsharing Platform – How does it work?

- Register (free – no charges, no subscriptions)
- Types of users:
  - 1. User
    - Share your own leftovers or collect food from others (offers visible on the Foodsharing map)
  - 2. Foodsavers
    - Pass a quiz (quite some effort) and become a Foodsaver.
    - Allowed to collect (“save”) leftovers from businesses that cooperate with Foodsharing
    - Redistribute saved food among friends and within the Foodsharing community
  - 3. Operations manager (Betriebsverantwortlicher = abbr. “BV”)
    - Manage cooperation with business, manage your team of Foodsavers and organize a collection schedule

https://foodsharing.de/

Alternative Solutions?

Foodsharing Platform – How does it work?



https://foodsharing.de/

Alternative Solutions?

Foodsharing Platform – How does it work?

- Just keep/take what you can consume, redistribute everything else
- Most businesses don’t want to be publicly mentioned
  - Bad image if you throw away huge amounts of food every day
  - People are supposed to buy their food at your place instead of picking it up for free ;)

- Strict:
  - Food collection schedule (pre-defined time slots, each foodsaver only once every week or every two weeks, etc.)
  - Hygiene rules
  - Pre-defined procedures for collection of food

https://foodsharing.de/

Alternative Solutions?

Foodsharing Platform – How much food is saved every day?

https://foodsharing.de/

Further Resources

- Baccini et al. (2012) – Metabolism of the Anthroposphere: Analysis, Evaluation, Design
- Deutscher Bundestag (1994): Bericht der Enquete-Kommission „Schutz des Menschen und der Umwelt − Bewertungskriterien und Perspektiven für umweltverträgliche Stoffkreisläufe in der Industriegesellschaft“ (Link)
- Meadows (1972) – The Limits to Growth
- Meadows, Randers und Meadows (2004) – Limits to Growth – The 30-Year Update
- Polestar (2020) – Life Cycle Assessment – Carbon Footprint of Polestar 2 (Link)
- Walter R. Stahel (2019) – The Circular Economy: A User's Guide
- Website of the Ellen MacArthur Foundation – Link

Questions?