

# The Limits to Growth: Sustainability and the Circular Economy

## Lecture 3: Introduction III - Resources and Environmental Pollution

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M.Sc. Anant Sujatanagarjuna

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- Updated versions of these slides will be available in our [Github repository](#).

## Updated BBB Links

- We have to update the BBB links → please check your emails, the course website or the slides on Github before the next lecture.

# Course Organization

- Course website – [Link](#)
- News and updates:
  - CLZ students + DigiTec: StudIP ([Link](#))
  - Everyone else: Mailing list ([Link](#))
- Slides will be uploaded to StudIP ([Link](#)) and to Github ([Link](#))
  - Please report bugs ;)
- Lecture recordings will be available on StudIP and on Github
- Questions? Write us an email: [etce-ltg@tu-clausthal.de](mailto:etce-ltg@tu-clausthal.de) ← **We will only respond to emails written to this specific email address!**

# Bonus Task

## Project Registration

- Bonus task:
  - Form groups of 2 or more people
  - Come up with a great idea that revolves around sustainability in general
  - Push the idea as far as possible throughout the semester
  - Record a 60s video explaining your idea and what you did throughout the semester
  - Selection of the 5 best ideas → bonus points for the exam (e.g., better grade – instead of 2.0 → 1.7 or something similar)

# Bonus Task

## Project Registration

Project registration deadline: 15.05.2022

- How do I register?
  - Form groups of 2 or more people
  - Come up with a great idea that revolves around sustainability in general
  - Write us an email (**etce-itg@tu-clausthal.de**) that contains:
    - Team name
    - Short description (2-5 sentences) of your idea
    - Team members

## Updates

### Earth Overshoot Day 2022 (Germany)

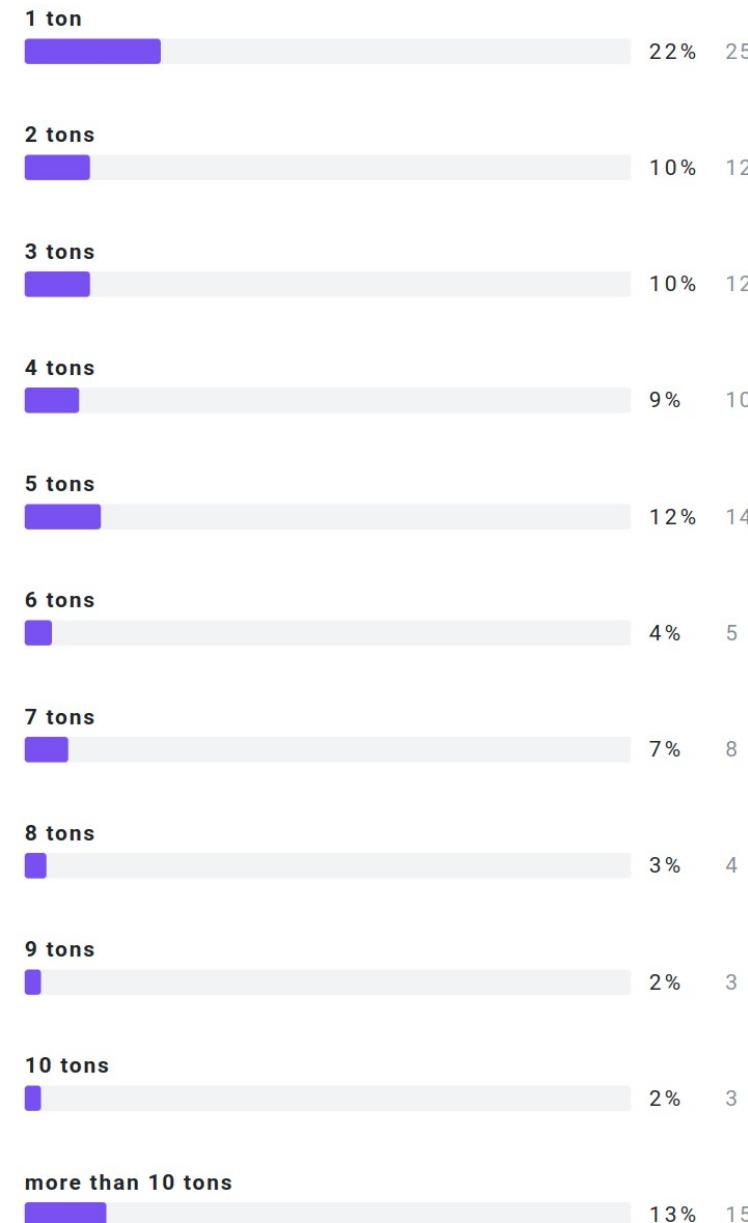
04.05.2022

- Assuming that everyone on Earth lives according to our (German) standard of living → How many Earths do we need?

# E01 - YOUR PERSONAL CARBON FOOTPRINT

# Your Personal Carbon Footprint

## Results E01



# Your Personal Carbon Footprint

Problem already solved?

**So we just reduce our CO<sub>2</sub> footprint and we are good?**

## Your Personal Carbon Footprint

**Microsoft will be Carbon Negative by 2030**

“By 2030 Microsoft will be carbon negative, and by 2050 Microsoft will remove from the environment all the carbon the company has emitted either directly or by electrical consumption since it was founded in 1975.”

## Your Personal Carbon Footprint

Apple will be Carbon Neutral by 2030

July 2020

“Apple today unveiled its plan to become carbon neutral across its entire business, manufacturing supply chain, and product life cycle by 2030. The company is already carbon neutral today for its global corporate operations, and this new commitment means that by 2030, every Apple device sold will have net zero climate impact.”

# Your Personal Carbon Footprint

## Polestar - 2030 Climate-neutral Car

“...we’re embarking on our greatest journey so far: challenging ourselves to create a climate-neutral car by 2030, by reducing emissions throughout supply chain and production.”

# Your Personal Carbon Footprint

## Polestar - 2030 Climate-neutral Car

“...we’re embarking on our greatest journey so far: challenging ourselves to create a climate-neutral car by 2030, by reducing emissions throughout supply chain and production.”

“Relying on the current trend of offsetting by planting trees is not sustainable in the long run. It would mean using too much land, and the long-term carbon-storage capacity of forests and soils is not well known. Offsetting by planting trees also risks contributing to monocultures and loss of biodiversity. Additionally, there can be no guarantee that a forest won’t later be logged, devastated by a forest fire or altered by climate change.”

# Your Personal Carbon Footprint

Problem already solved?

**It is not only about CO<sub>2</sub>...**

# Your Personal Carbon Footprint

## Greenwashing?

<b>Apple iPad Pro 11" 2018</b>	<ul style="list-style-type: none"><li>• Gobs of adhesive hold most everything in place, making all repairs more difficult.</li><li>• The battery is secured with both easier-to-remove stretch-release tabs and conventional, non-removable adhesive.</li><li>• The USB-C port is modular and can be independently replaced.</li></ul>
<b>Microsoft Surface Pro 6 2018</b>	<ul style="list-style-type: none"><li>• All repairs require first removing the display assembly—which is stubbornly glued in place, expensive, and prone to shattering.</li><li>• The battery is firmly glued in place, with its connector pinned under the motherboard—requiring near-total disassembly for service.</li><li>• Once upon a time, Surface Pro storage was removable—but not in this version.</li></ul>
<b>Apple iPad Air 3 2019</b>	<ul style="list-style-type: none"><li>• Battery replacement is possible, but still unnecessarily difficult.</li><li>• Gobs of adhesive hold many parts and cables in place, complicating all repairs.</li><li>• Many components are modular and can be replaced independently, but the Lightning port is soldered to the logic board.</li></ul>
<b>Apple iPad 7 2019</b>	<ul style="list-style-type: none"><li>• As with all iPads, a solid barrier of very strong adhesive hinders all repairs.</li><li>• The Lightning port, a common point of failure, is soldered to the logic board.</li><li>• More adhesive holds nearly everything else in place. Battery and logic board replacements are particularly obnoxious.</li></ul>
<b>Apple iPad Mini 5 2019</b>	<ul style="list-style-type: none"><li>• Battery replacement is possible, but still unnecessarily difficult.</li><li>• Gobs of adhesive hold many parts and cables in place, complicating all repairs.</li><li>• Removing the home button is tough, and will be required for display replacement if you want to keep Touch ID functionality.</li></ul>

# SUSTAINABILITY

# Ecological Footprint

## Definition

*„The ecological footprint for a particular population is defined as the total area of productive land and water ecosystems required to produce sufficient resources and assimilate wastes“*

- 1.) W.E. Rees (1992) – Ecological footprint and appropriated carrying capacity: what urban economics leaves out. Environmental Urbanization.
- 2.) W.E. Rees, M. Wackernagel (1994) – Ecological footprints and appropriated carrying capacity: measuring the natural capital requirements of the human economy.
- 3.) D. Yue, J. Guo, C. Hui (2013) – Scale dependency of biocapacity and the fallacy of unsustainable development – <https://doi.org/10.1016/j.jenvman.2013.04.022>

# Biocapacity

## Definition

*Is „the locally available carrying capacity of the ecosystem for generating resources and absorbing wastes“*



# Sustainability

## Definition

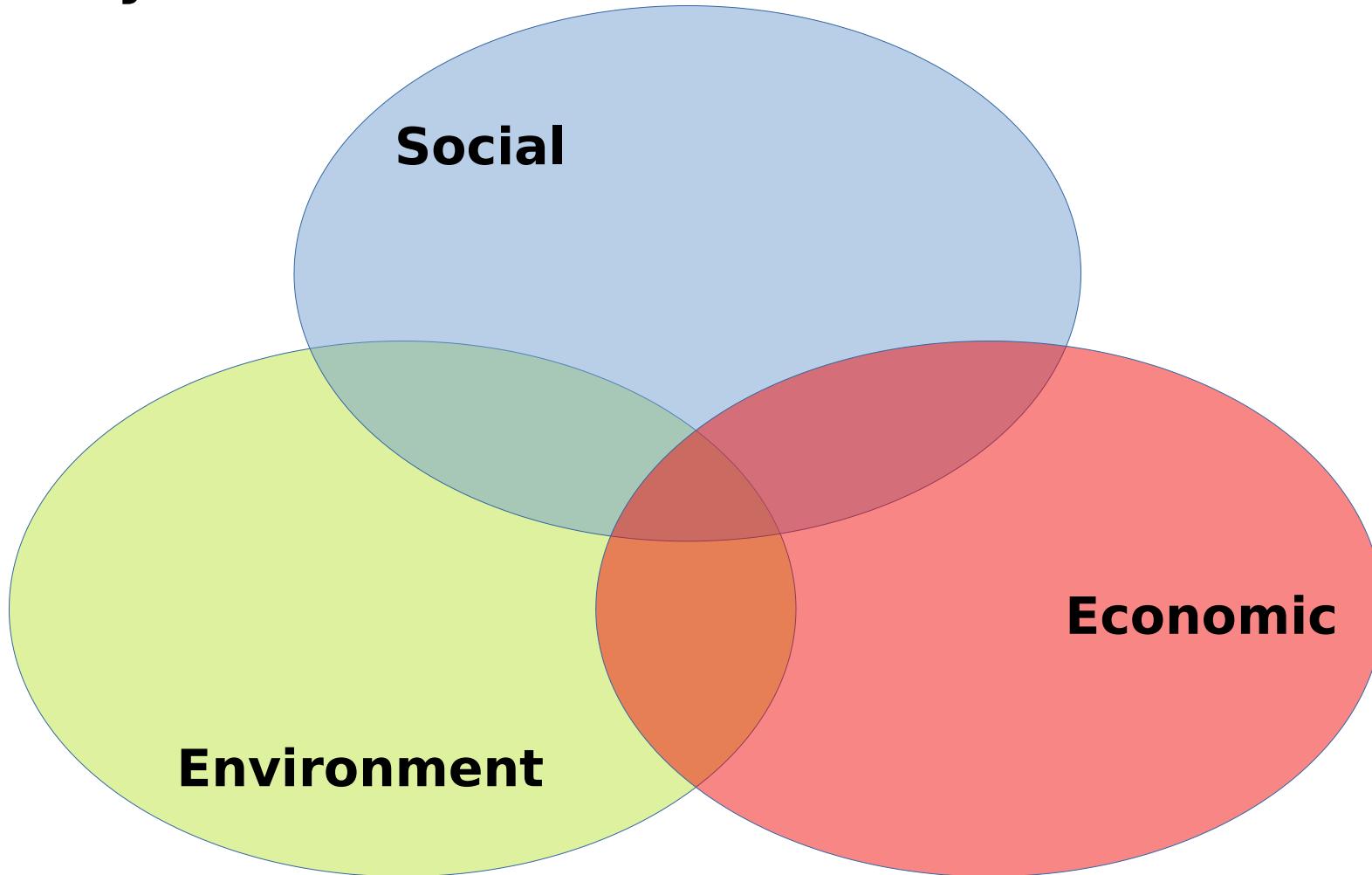
# Sustainability

## Definition

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

# Sustainability

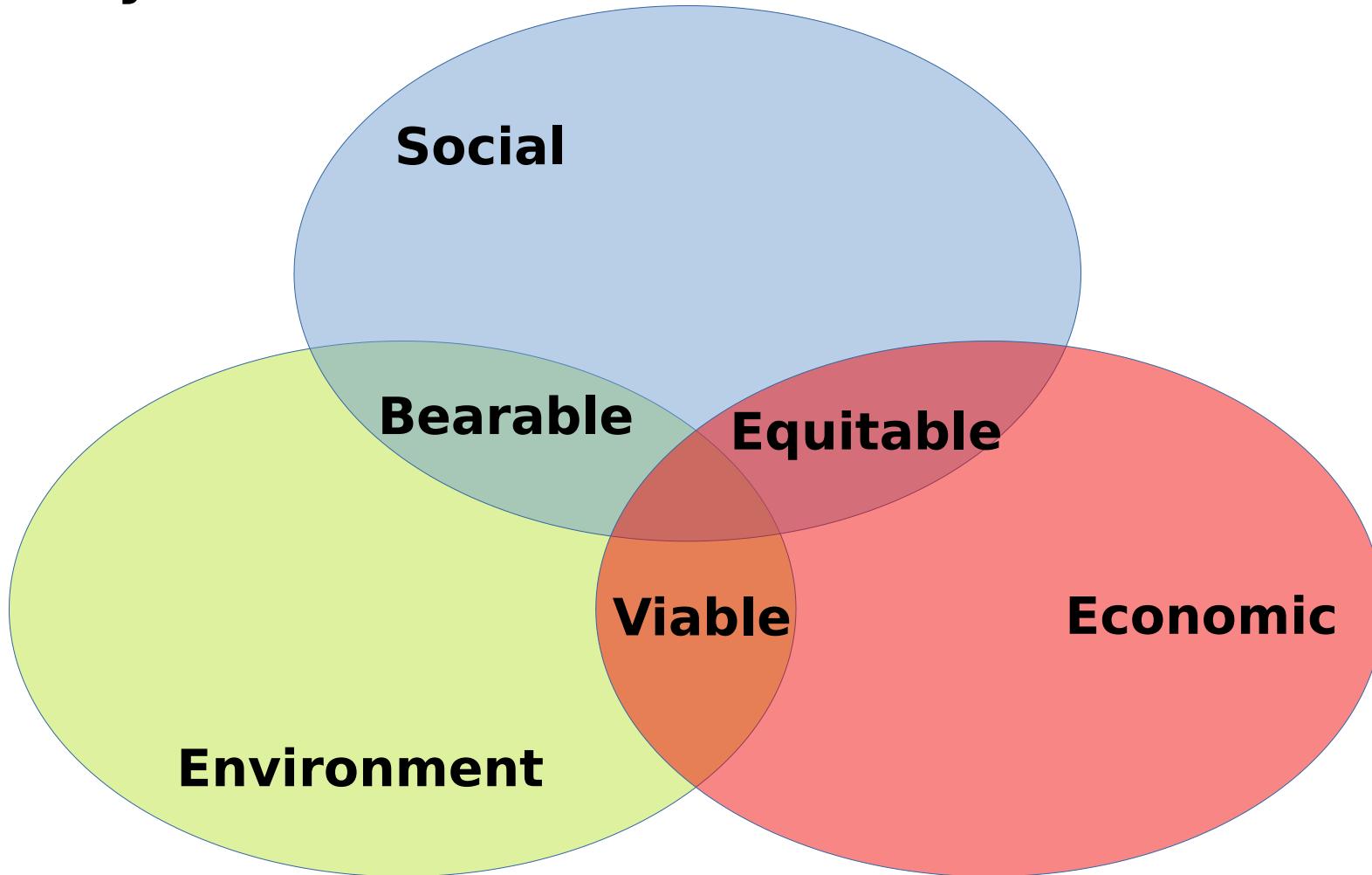
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Based on: Thomsen C. (2013) Sustainability (World Commission on Environment and Development Definition). In: Idowu S.O., Capaldi N., Zu L., Gupta A.D. (eds) Encyclopedia of Corporate Social Responsibility. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-642-28036-8\\_531](https://doi.org/10.1007/9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

# Sustainability

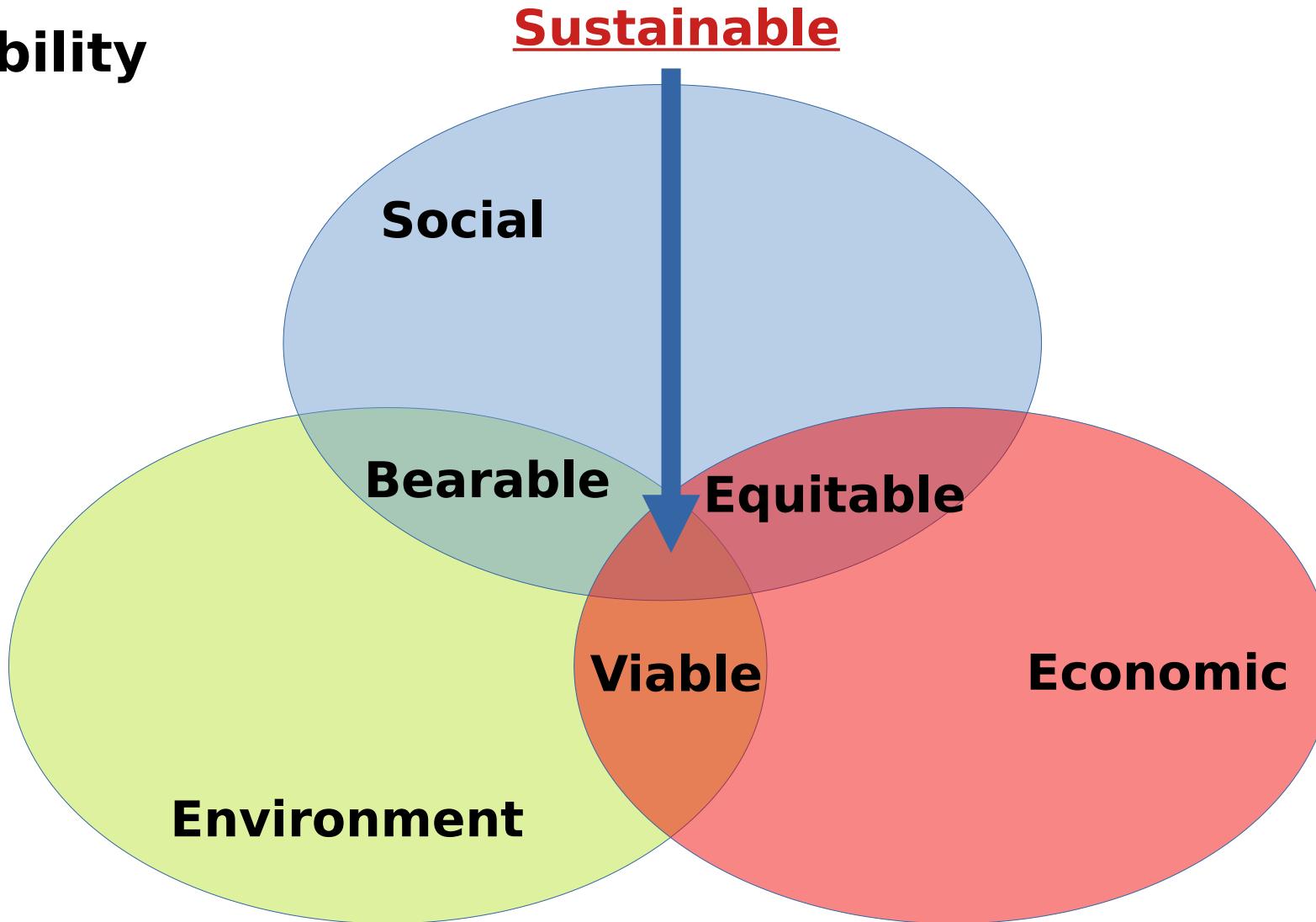
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# Sustainability Implications

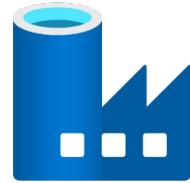
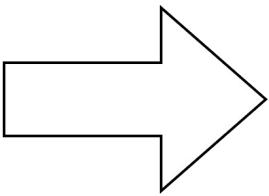
**Sustainability → Consume less**

# Sustainability

## The Linear (Industrial) Economy



### RESOURCES



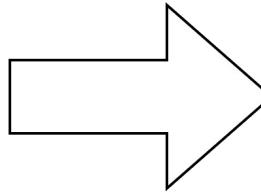
### MANUFACTURING

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).



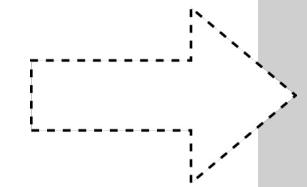
### DISTRIBUTION



### POINT OF SALE

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)...



# A LACK OF RESOURCES

# We only have one planet

## Resources



*"I am afraid of losing my child  
to a resource war because of a  
climate collapse"*

→ “Our parents will die of old  
age, our children will die of  
climate change”

# We only have one Planet

## Resource Wars

*“Resource wars are violent conflicts that are largely driven by competition for control over vital or valuable natural materials, such as oil, water, land, timber, animals (or animal products), gold, silver, gems, and other key minerals.”*

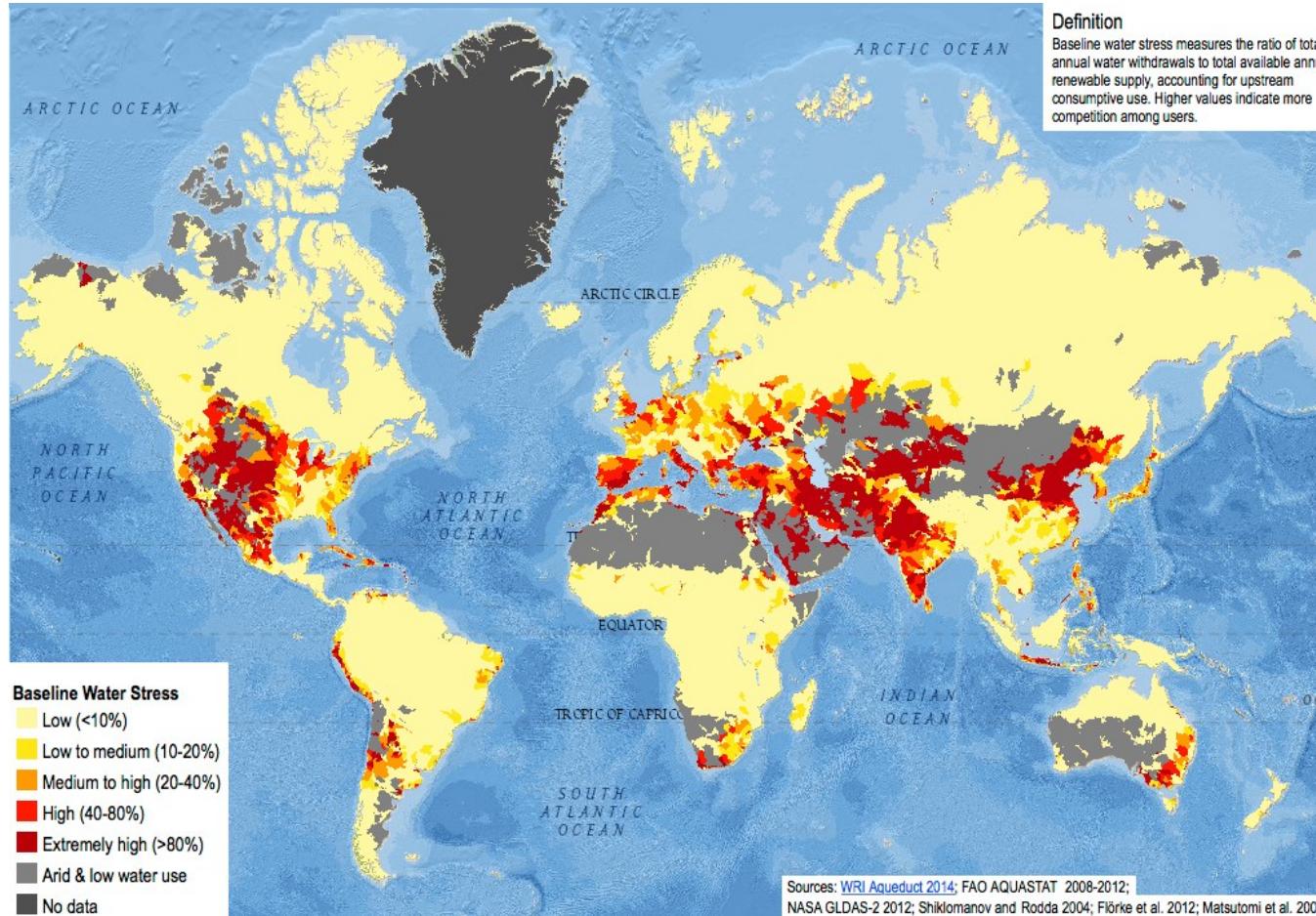
# We only have one Planet

## Resource Wars – Oil, etc.



# We only have one Planet

## Resource Wars – Water



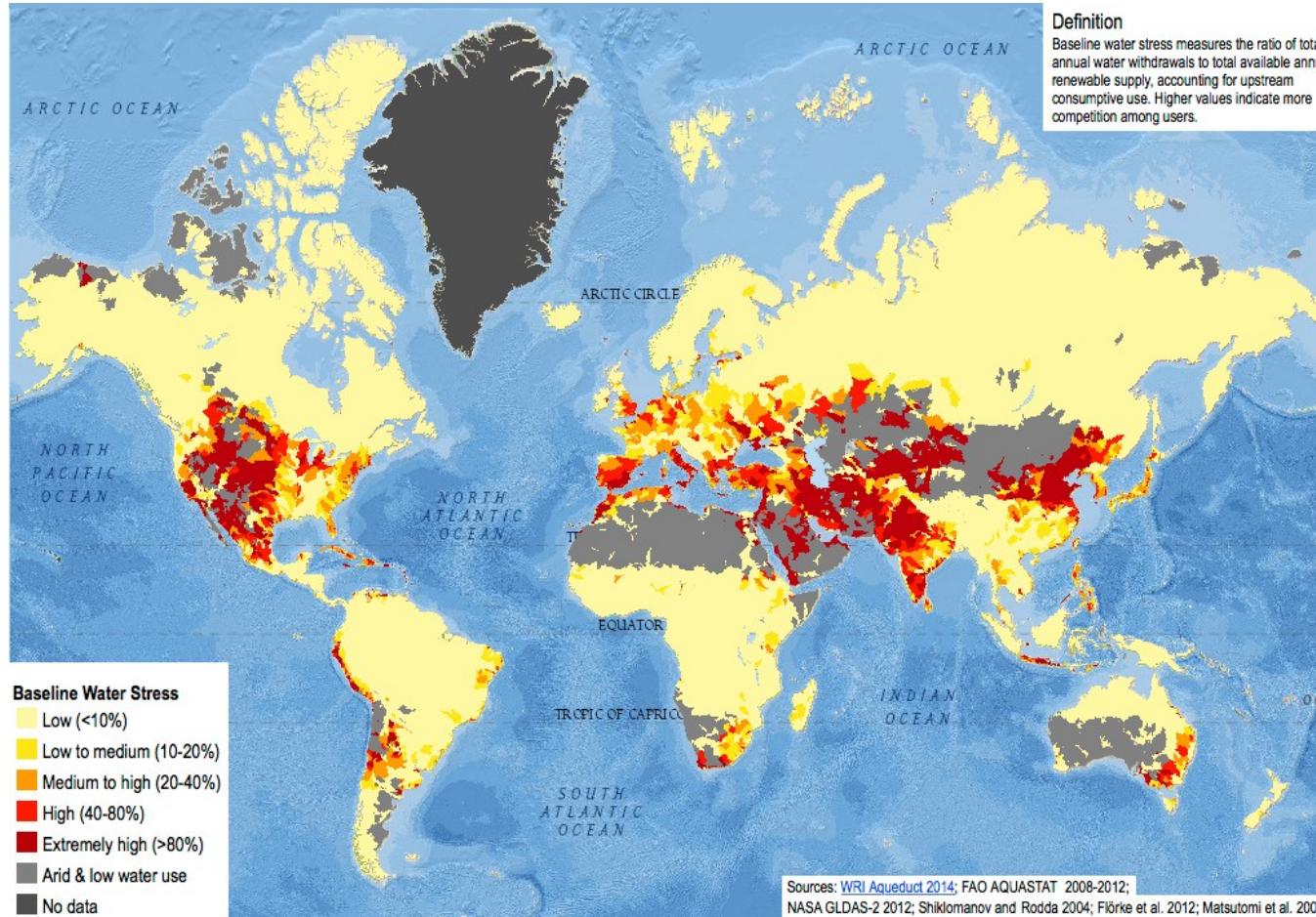
1. Sampa – [https://commons.wikimedia.org/wiki/File:Baseline\\_water\\_stress.jpg](https://commons.wikimedia.org/wiki/File:Baseline_water_stress.jpg) – CC BY-SA 4.0

2. Kgbo – [https://commons.wikimedia.org/wiki/File:Closed\\_Wivenhoe\\_Dam\\_and\\_spillway,\\_August\\_2020.jpg](https://commons.wikimedia.org/wiki/File:Closed_Wivenhoe_Dam_and_spillway,_August_2020.jpg) – CC BY-SA 4.0

3. Arian Zwegers – <https://www.flickr.com/photos/azwegers/6226842732> – CC BY 2.0

# We only have one Planet

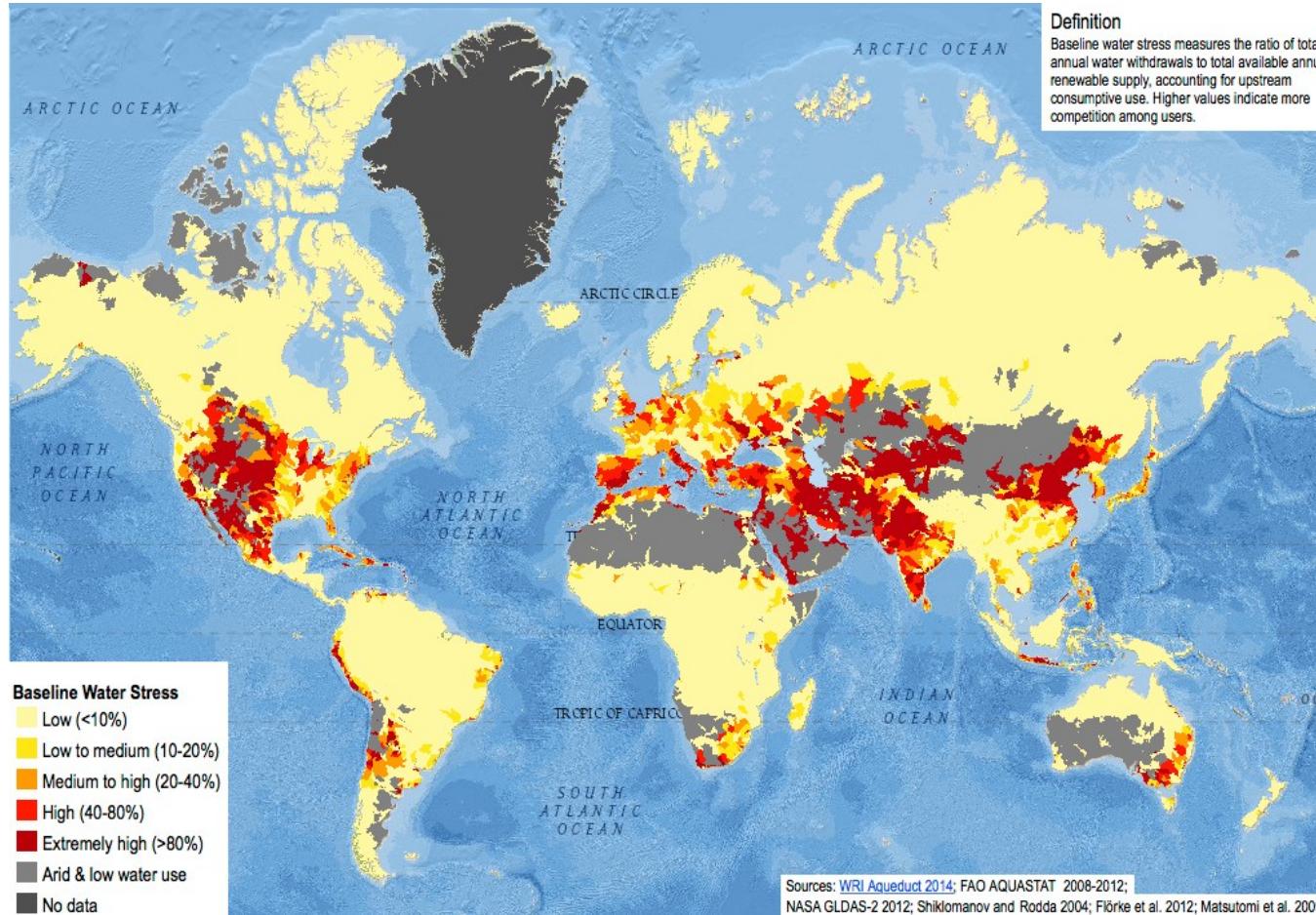
## Resource Wars – Water



1. Sampa – [https://commons.wikimedia.org/wiki/File:Baseline\\_water\\_stress.jpg](https://commons.wikimedia.org/wiki/File:Baseline_water_stress.jpg) – CC BY-SA 4.0
2. Kgbo – [https://commons.wikimedia.org/wiki/File:Closed\\_Wivenhoe\\_Dam\\_and\\_spillway,\\_August\\_2020.jpg](https://commons.wikimedia.org/wiki/File:Closed_Wivenhoe_Dam_and_spillway,_August_2020.jpg) – CC BY-SA 4.0
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# We only have one Planet

## Resource Wars – Water



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# ENVIRONMENTAL POLLUTION

# Environmental Pollution

## Definition

**„Pollution**, also called **environmental pollution**, the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

*The major kinds of pollution, usually classified by environment, are air pollution, water pollution, and land pollution.”*

# Environmental Pollution

## Waste



1. "Landfill at Upernivik" by ulalume – <https://www.flickr.com/photos/96649248@N00/43867280734> – CC BY-NC-ND 2.0

2. Christian Hüper – <https://flic.kr/p/aKXw2F> – CC BY-SA 2.0

# Environmental Pollution

## Fossil Fuels

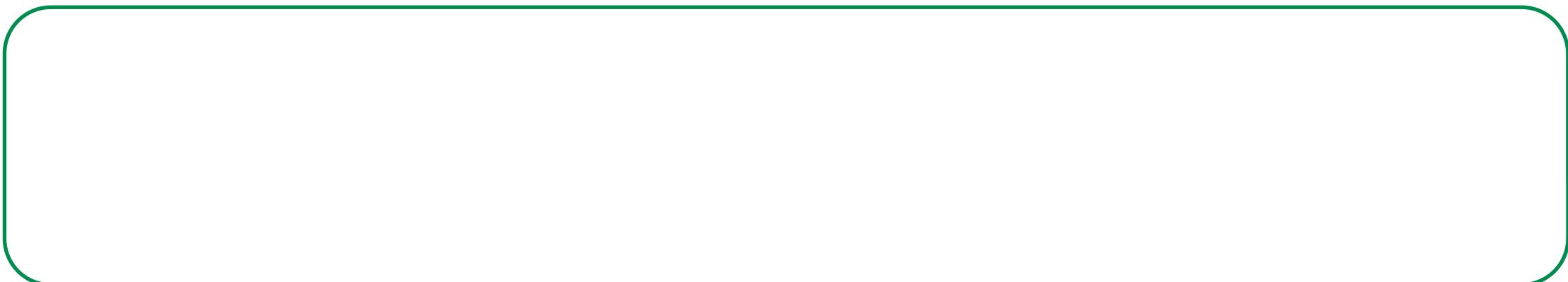
- 3 of the 10 dirtiest European coal plants are located in Poland
- In which country/countries are the other 7 dirtiest coal plants located?
  - 7 of the 10 dirtiest European coal plants are located in **GERMANY**



1. <https://ember-climate.org/insights/research/top-10-emitters-in-the-eu-ets-2021/>  
2. John Englart – <https://www.flickr.com/photos/takver/11308053925/> – CC BY-SA 2.0  
3. John Englart – <https://www.flickr.com/photos/takver/51658831095/> – CC BY-SA 2.0

# Environmental Pollution

## Linear Economy - Definition



# Environmental Pollution

## Linear Economy - Definition

“Take – Make – Dispose”

# Environmental Pollution

## Horrible Waste Management - Example 1



# Environmental Pollution

## Horrible Waste Management - Example 1



# Environmental Pollution

## Horrible Waste Management - Example 1

→ 2 generations profited from cheap nuclear energy

# Environmental Pollution

## Horrible Waste Management - Example 1

- 2 generations profited from cheap nuclear energy
- 40,000 generation will have to live with the waste

# Environmental Pollution

## Horrible Waste Management - Example 2



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# Environmental Pollution

## Horrible Waste Management - Example 2

- We are consuming about 2000 tiny pieces of plastic every week.



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Wijnand de Wit and Nathan Bigaud for the WWF (2019) – No Plastic in Nature: Assessing Plastic Ingestion from Nature to People.

# Environmental Pollution

## Horrible Waste Management - Example 2

- We are consuming about 2000 tiny pieces of plastic every week.
- That is a credit card every week!
- That's approximately 21 grams a month, or just over 250 grams a year.



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# Environmental Pollution

## Global Flows of Plastic Packaging Materials in 2013

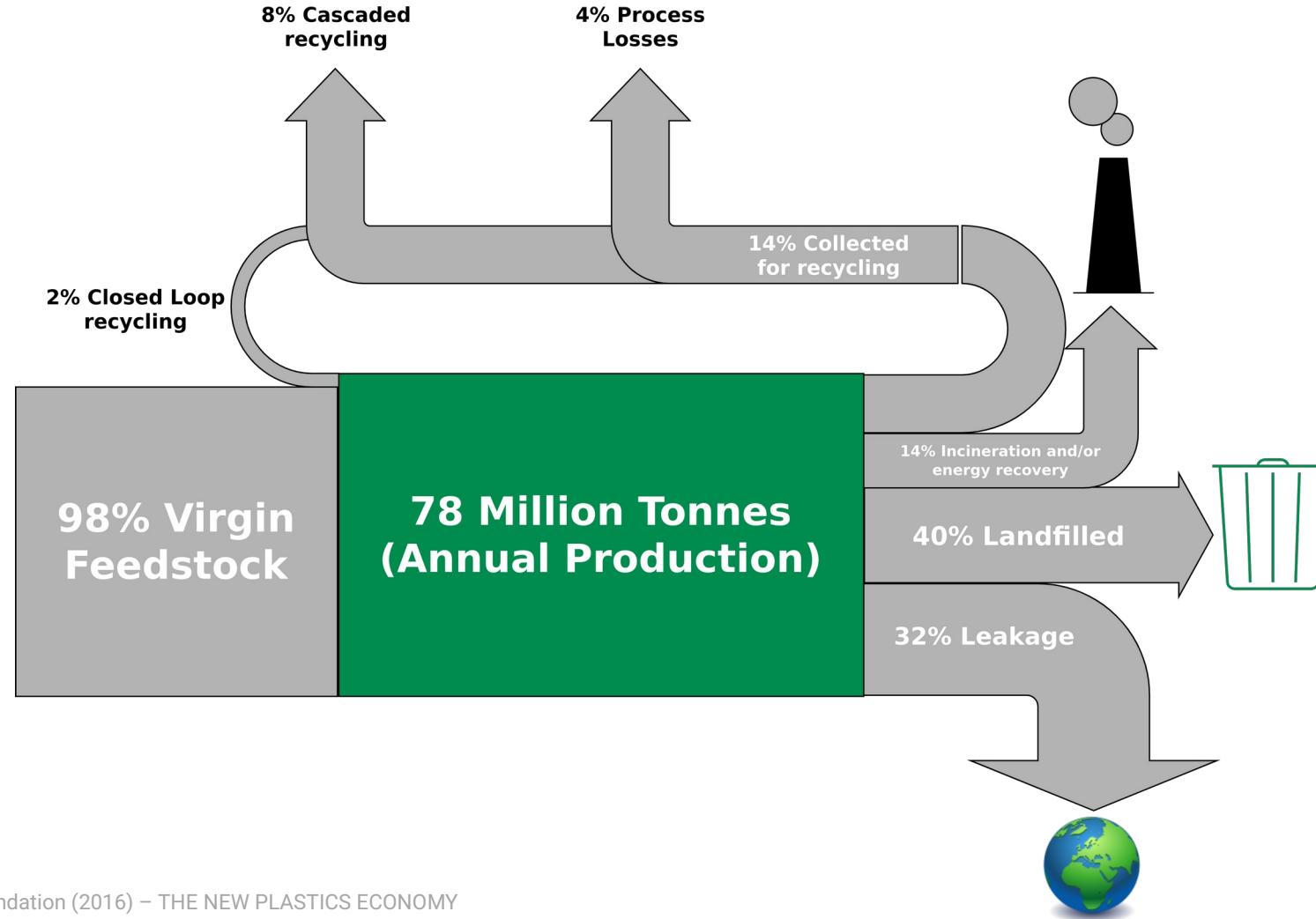


Figure adapted from: Ellen MacArthur Foundation (2016) – THE NEW PLASTICS ECONOMY

# Environmental Pollution

## Global Flows of Plastic Packaging Materials in 2013

- In 2050, there will be more plastic than fish in the ocean (by weight)

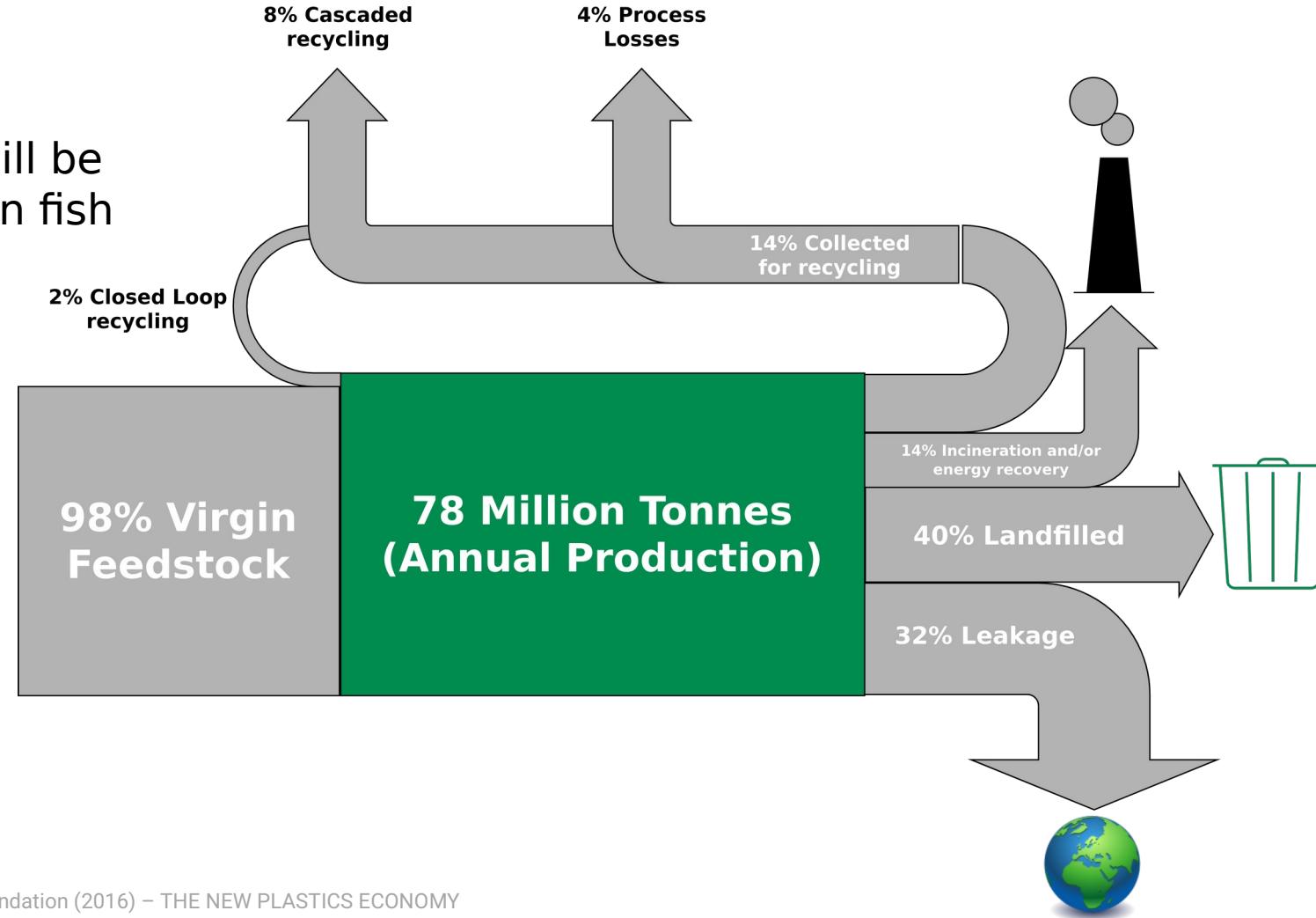


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# Environmental Pollution

## The Limits to Recycling

- Recycling often requires a lot of energy
- Some materials cannot be recycled at all (yet)
- Impurities are challenging
- Often requires a lot of manual labor
- Recycled material often with lower quality than input material
- False sense of safety!

# Environmental Pollution

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**I am not saying you should stop recycling!**

# Environmental Pollution

## The Limits to Recycling

- Recycling often requires a lot of energy
- Some materials cannot be recycled at all (yet)
- Impurities are challenging
- Often requires a lot of manual labor
- Recycled material often with lower quality than input material
- False sense of safety!

**I am not saying you should stop recycling!**

→ Recycling is great but it is better to make sure that we do not have to recycle anything.  
→ Buying less (e.g., only the essentials) is way more effective.

*"We buy things we don't need, to impress people we don't like." -  
Tyler Durden / Chuck Palahniuk*

# CONCLUSION

## Conclusion

- Personal carbon footprint and greenwashing
- Basic concepts and definitions related to sustainability, resources, environmental pollution
- The limits to recycling
- Exercise E02
- Q&A teaser → Case study on avoiding food waste



## EXERCISE E02

## Exercise E02

### Household Waste

- Get the largest jar that you can find (either at your own place, or ask your friends).
- Collect all the trash that you are producing in the upcoming week (except for bio-waste that is supposed to go into the green trash bin) – starting on Tuesday (10.05.2022 – 00:01) until Sunday (15.05.2022 – 23:59).
- How many days of trash can you fit into your jar?
- Submit your result according to the submission guidelines posted in the exercise sheet → E02.

## Additional Resources

- Baccini et al. (2012) – Metabolism of the Anthroposphere: Analysis, Evaluation, Design
- Podcast *How to Save a Planet* – “Sacrifice Zones: ProPublica Takes Us Inside America’s Toxic Hotspots (2022) – Link

# Questions?

## CASE STUDY: FOODSHARING.DE

## 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%)

1.) BMEL (2021) – Lebensmittelabfälle in Deutschland: Aktuelle Studie über Höhe der Lebensmittelabfälle nach Sektoren – <https://www.bmel.de/DE/themen/ernaehrung/lebensmittelverschwendungen/studie-lebensmittelabfaelle-deutschland.html>

2.) Lebensmittelabfälle in Deutschland – Baseline 2015 (2019) – [https://www.thuenen.de/media/publikationen/thuenen-report/Thuenen\\_Report\\_71.pdf](https://www.thuenen.de/media/publikationen/thuenen-report/Thuenen_Report_71.pdf)

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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

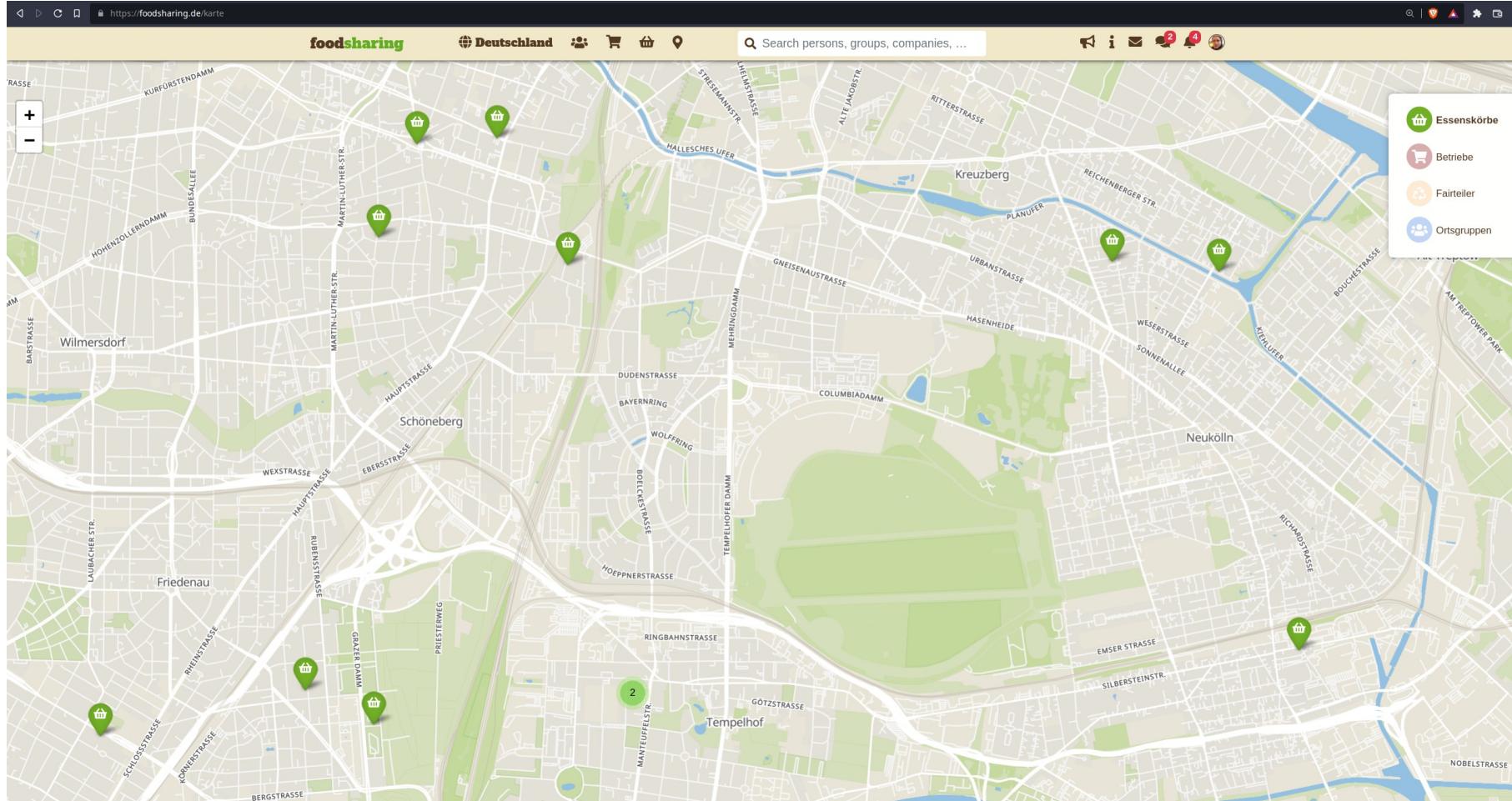
## Alternative Solutions?

### 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

# 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

# Alternative Solutions?

## Foodsharing Platform - How much food is saved every day?



The screenshot shows a user profile for 'Benjamin' on the foodsharing platform. At the top, there's a navigation bar with 'foodsharing' and 'Deutschland' (Germany) selected. A search bar says 'Search persons, groups, companies, ...'. Below the bar, a message says 'Neues Update | FAQ zu Corona und foodsharing'. The main profile area has a photo of Benjamin and a status bubble saying 'Benjamin is online.' To the right, there's a summary of his activity: 3 Posts, 3 Food baskets, 30 x picked up, and 550 kg saved. Below this, it says 'Benjamin is a foodsaver in: Deutschland, Braunschweig, Niedersachsen, Europa' and 'home district of Benjamin: Braunschweig'.



<https://foodsharing.de/>

# Questions?