



# **ENV 370 (GR A332 – GRB001)**

## **Environmental system analysis and assessment – Evaluation et analyse environnementale systémique**

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Claudia R. Binder / [claudia.binder@epfl.ch](mailto:claudia.binder@epfl.ch)

**EPFL - Spring 2025**

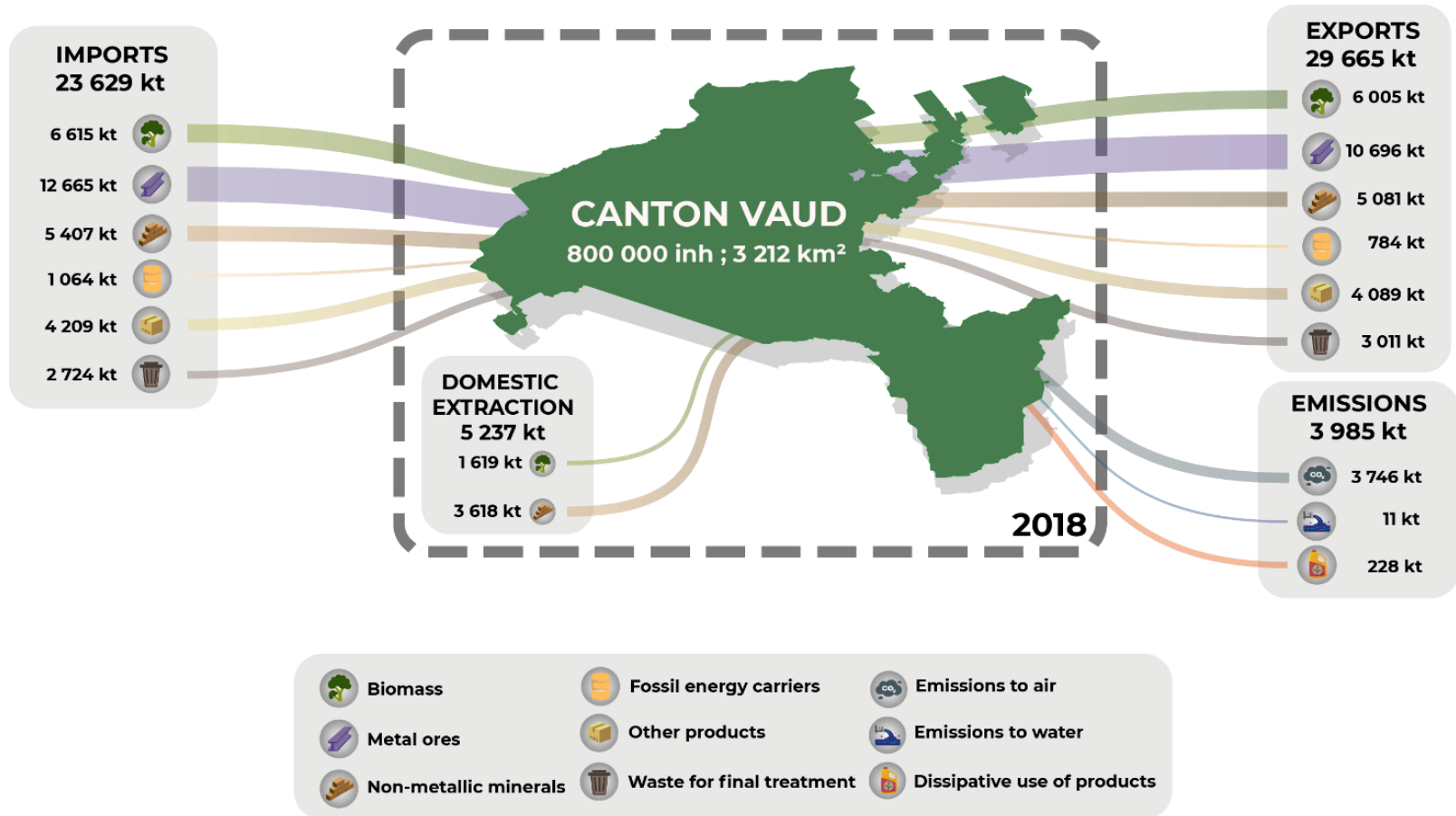


# Welcome to the course



# Aim of the course

Enable you to carry out environmental system analyses and assessments  
(through using different assessment methods for different scales)



# Dr. Aristide Athanassiadis



- **Current:** **Lecturer:** EPFL, Université Libre de Bruxelles, SciencesPo Paris  
**Researcher and Co-Founder:** Metabolism of Cities (online tools, podcast)  
**Focus:** Urban Metabolism, Circular Economy, Material Flow Analysis, Material stocks
- **Positions held:** Collaborateur Scientif HERUS, EPFL, 2020-2023  
**Chair of Circular Economy and Circular Economy, 2018-2020**  
**Postdoc Université Libre de Bruxelles, 2016-2018**  
Research stays in Université Paris 1 Panthéon - Sorbonne; Université de Montréal, Ecole Polytechnique Fédérale de Lausanne
- **PhD:** **Université Libre de Bruxelles - The University of Melbourne, 2016**  
“Towards more comprehensive urban environmental assessment. Exploring the complex relationship between urban and metabolic profiles.”

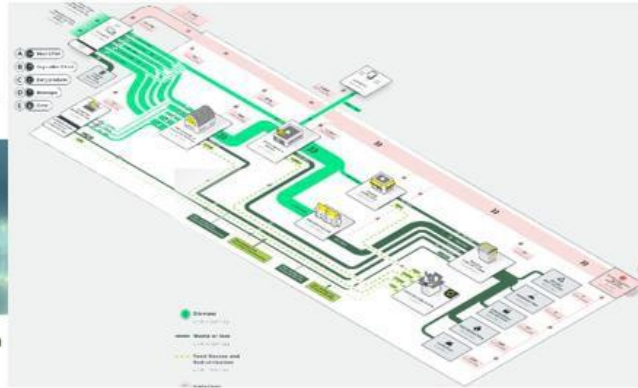


# MFA in reality

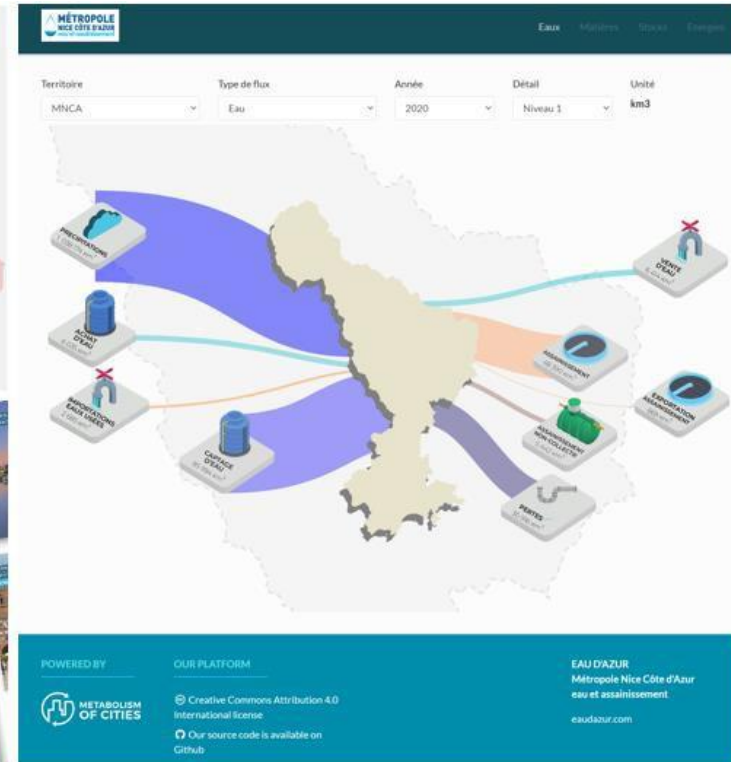


Métabolisme de la Région de Bruxelles-Capitale : identification des flux, acteurs et activités économiques sur le territoire et pistes de réflexion pour l'optimisation des ressources

Rapport final juillet 2015



10 SECTOR-WIDE  
CIRCULARITY  
ASSESSMENTS



# MFA in policy

## What Works for Brussels?

Towards a common understanding of the intersection between spatial and economic planning

September 2018



chair  
circular  
metabolism

## École d'été internationale 2020

"Ville, territoire, économie circulaire"

14 - 28 juin



Université  
Gustave Eiffel

Université  
de Montréal

UNIVERSITÉ  
DE GENÈVE

GEDT

Futurs  
Urbains  
Urban  
Futures

Evaluation du Programme  
Régionale en Economie  
Circulaire de la Région de  
Bruxelles-Capitale

Un regard académique sur le  
programme initial et les  
réalisations (2016-2018)

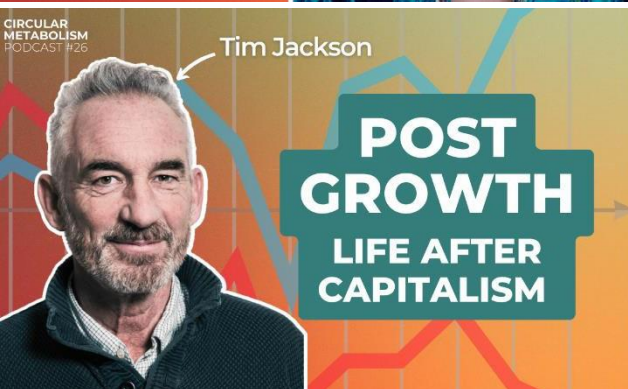
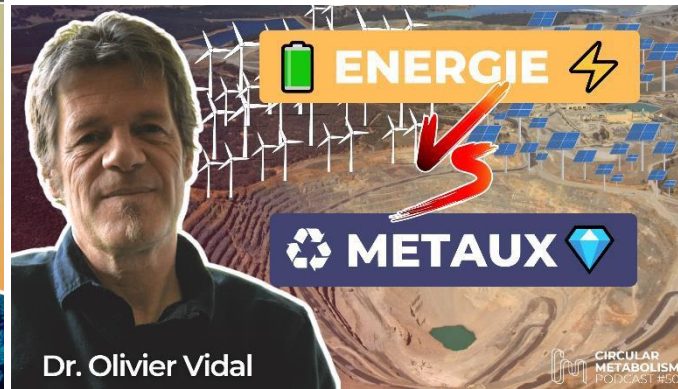
Octobre 2018



chair  
circular  
metabolism

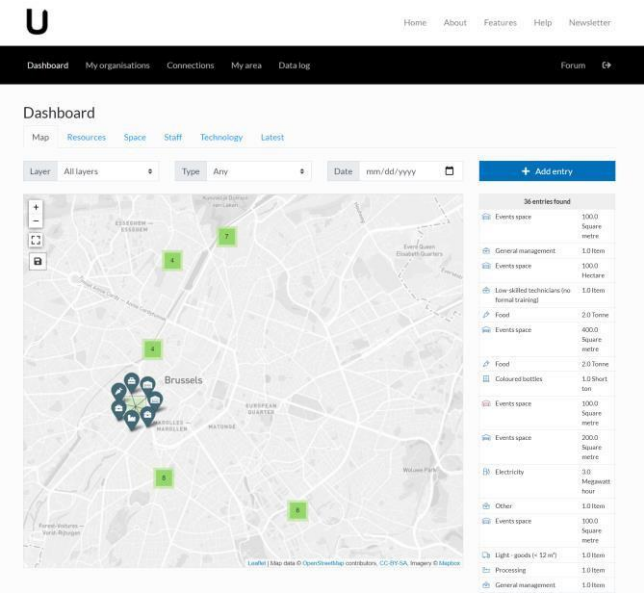
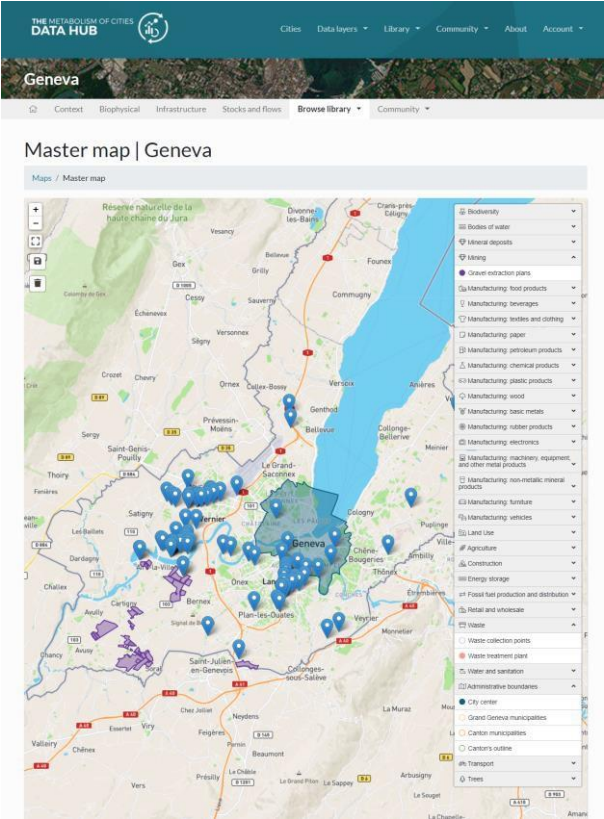
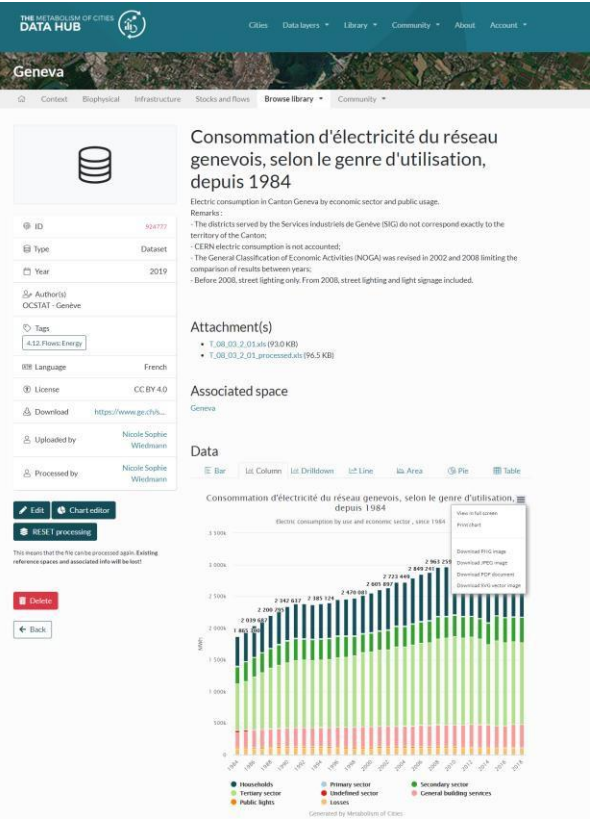


# MFA in public – Circular Metabolism Podcast





# MFA and tools



[WWW.METABOLISMOFCITIES.ORG](http://WWW.METABOLISMOFCITIES.ORG)

**Welcome to the course – who are you/where are you from?**

**Welcome to the course –  
what is your dream job after the BSc or MSc?**



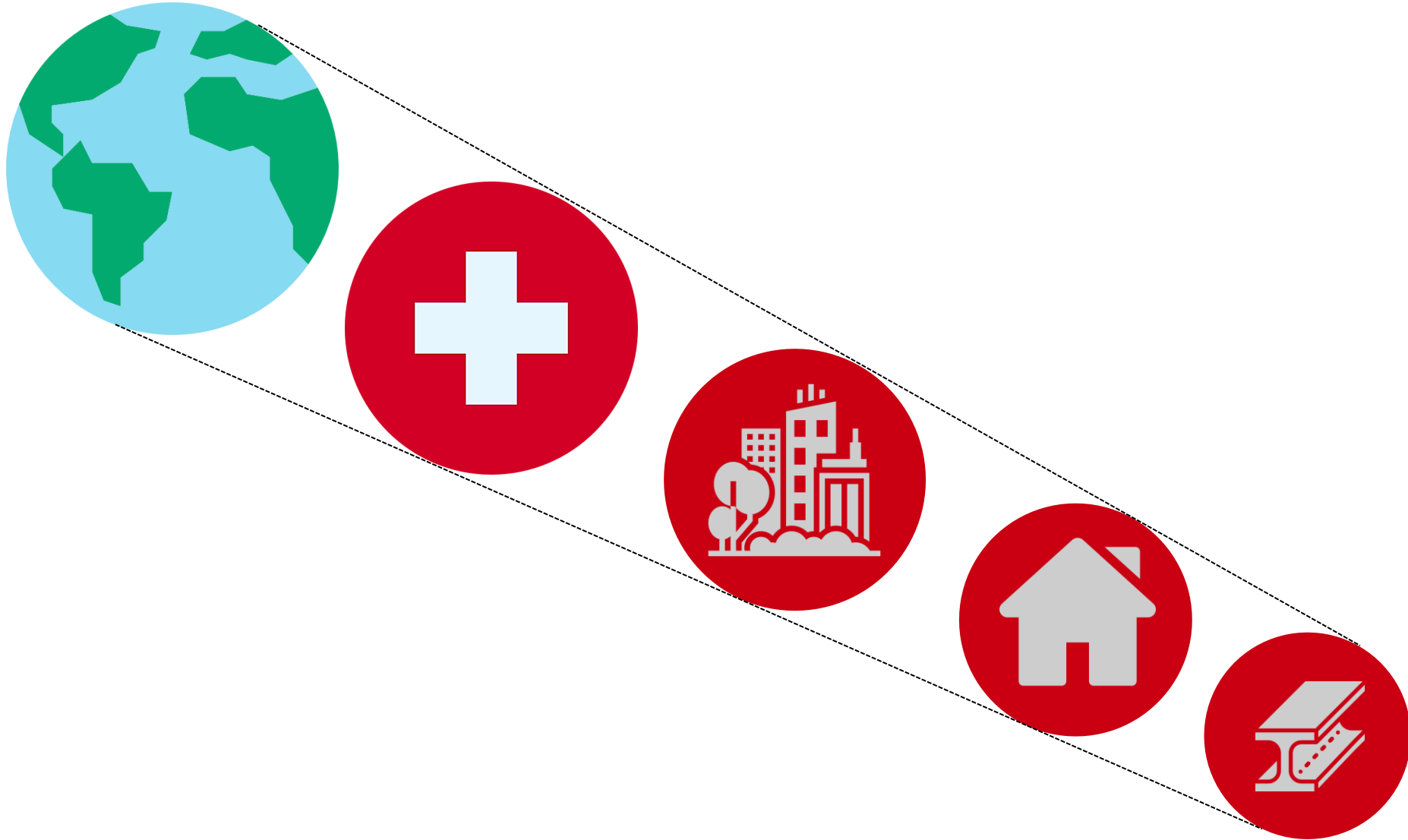
# Welcome to the course – Have you ever been to a climate strike?



# Welcome to the course – What is the science needed?



# Link from Planet to Product





# A 20th century odyssey of the Anthroposphere

50<sup>th</sup> ANNIVERSARY EDITION

**CLINT EASTWOOD**



## **THE GOOD THE BAD and THE UGLY**

co-starring  
**LEE VAN CLEEF**

also starring  
**ELI WALLACH**  
in the role of TUCO

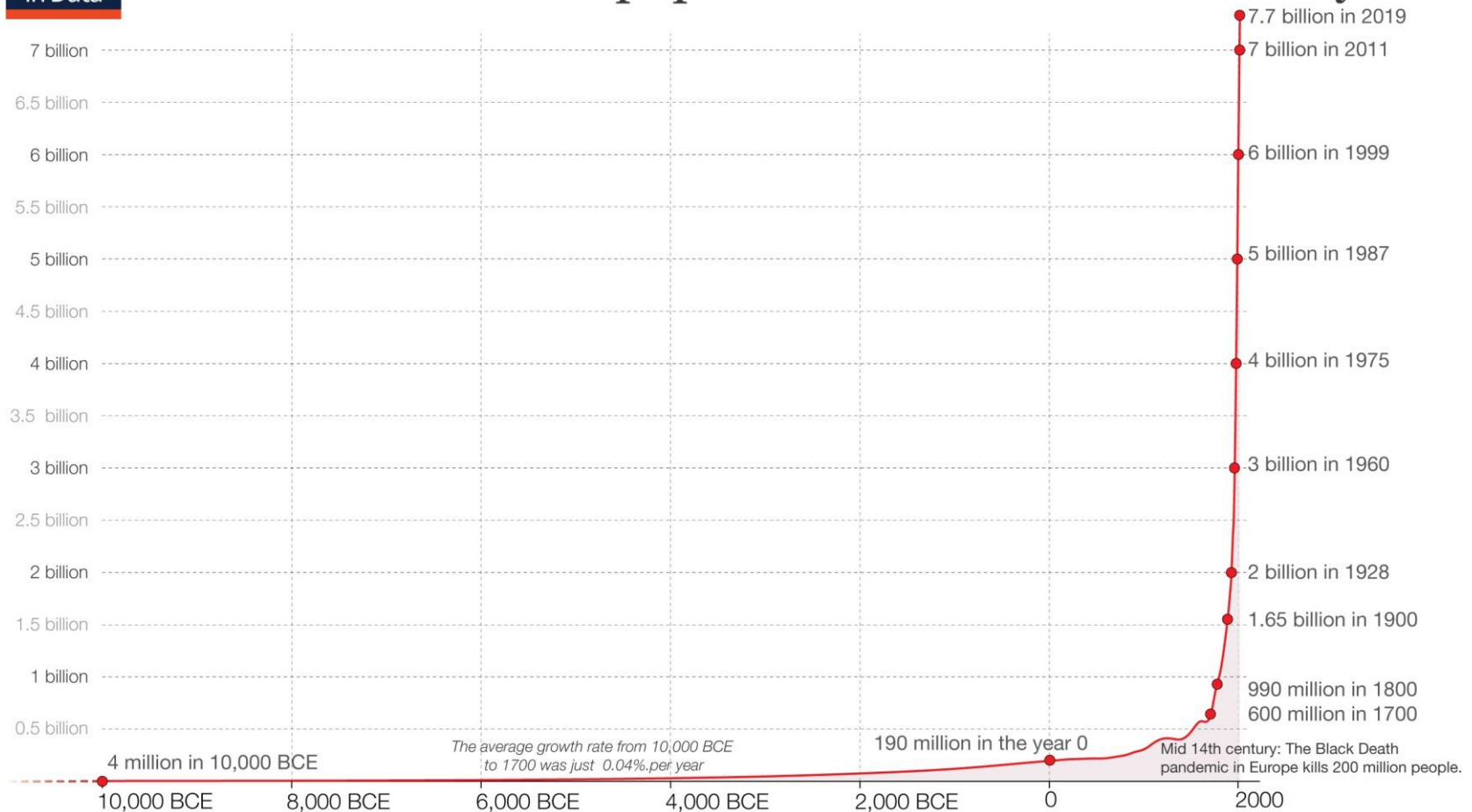
directed by  
**SERGIO LEONE**



# A global development overview - population

Our World  
in Data

## The size of the world population over the last 12.000 years



Based on estimates by the *History Database of the Global Environment* (HYDE) and the United Nations. On [OurWorldinData.org](https://ourworldindata.org) you can download the annual data.

This is a visualization from [OurWorldinData.org](https://ourworldindata.org), where you find data and research on how the world is changing.

Licensed under CC-BY-SA by the author Max Roser.

Source: <https://ourworldindata.org/world-population-growth>



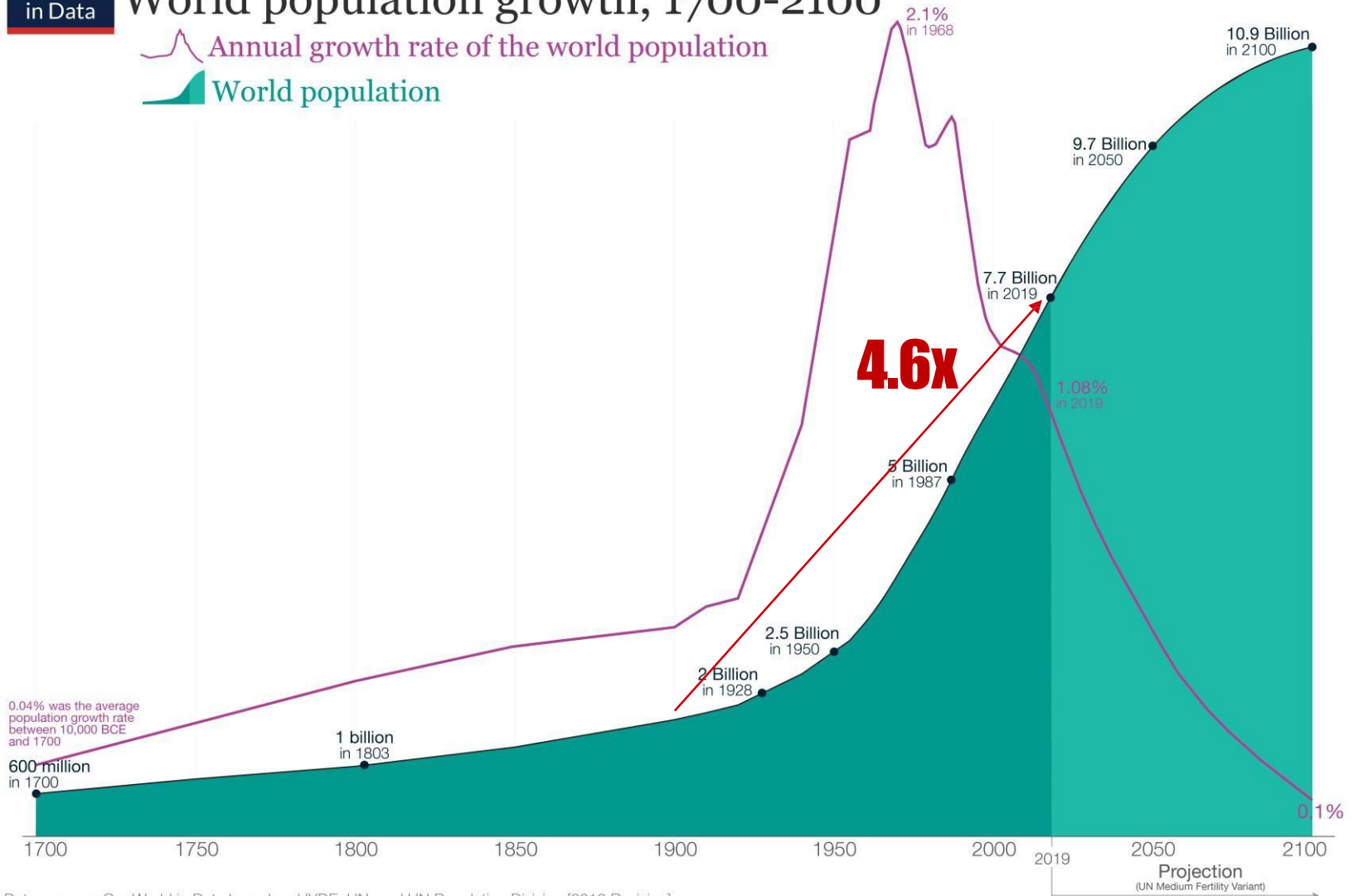
# A global development overview - population

Our World  
in Data

## World population growth, 1700-2100

Annual growth rate of the world population

World population



Data sources: Our World in Data based on HYDE, UN, and UN Population Division [2019 Revision]  
This is a visualization from [OurWorldinData.org](https://ourworldindata.org), where you find data and research on how the world is changing.

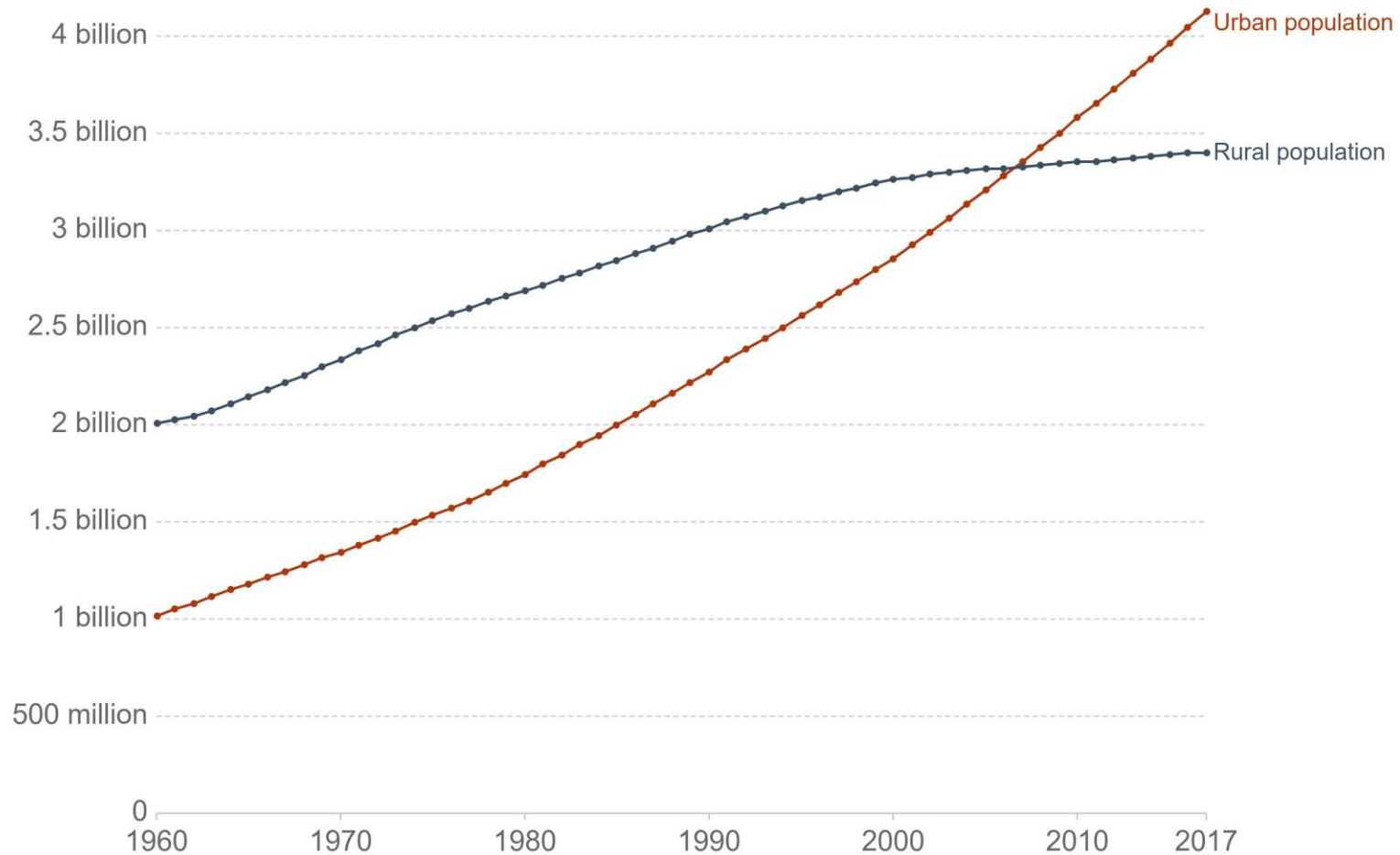
Licensed under CC-BY by the author Max Roser.

Source: <https://ourworldindata.org/world-population-growth>

# A global development overview - (urban) population

Number of people living in urban and rural areas, World, 1960 to 2017

Our World  
in Data



Source: UN World Urbanization Prospects (2018)

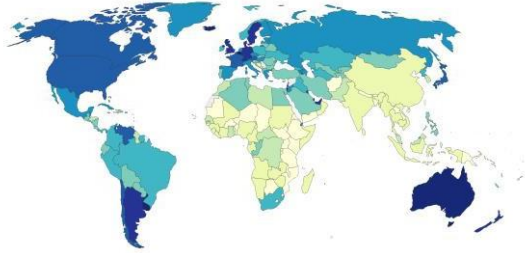
OurWorldInData.org/urbanization • CC BY

Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

Source: <https://ourworldindata.org/urbanization>

# A global development overview - (urban) population

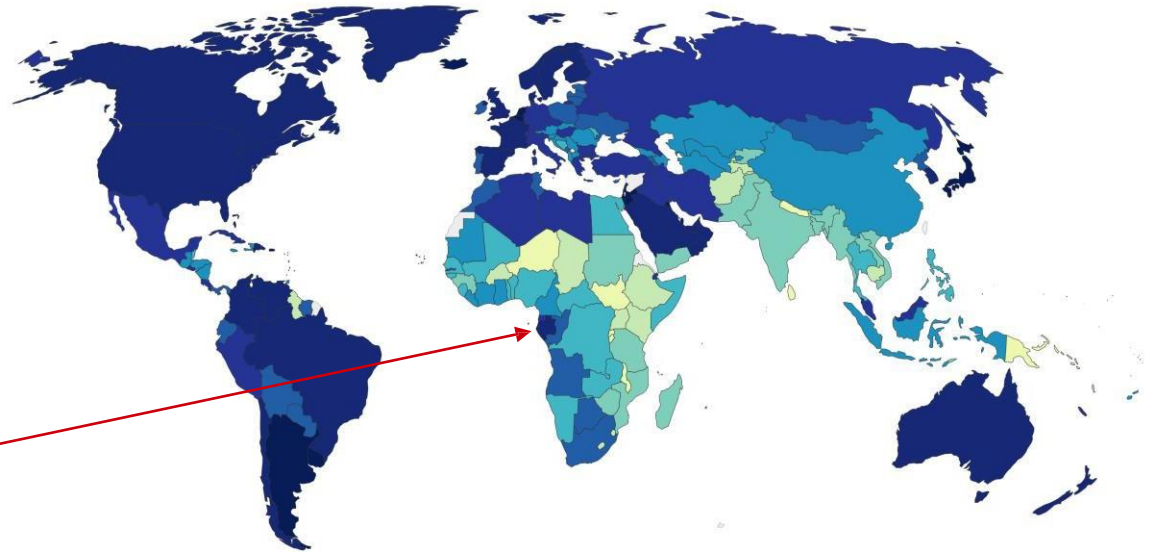
Share of people living in urban areas, 1960



No data 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Source: UN World Urbanization Prospects (2018)  
Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

Share of people living in urban areas, 2017



Look at Gabon

No data 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Source: UN World Urbanization Prospects (2018)

Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

OurWorldInData.org/urbanization • CC BY

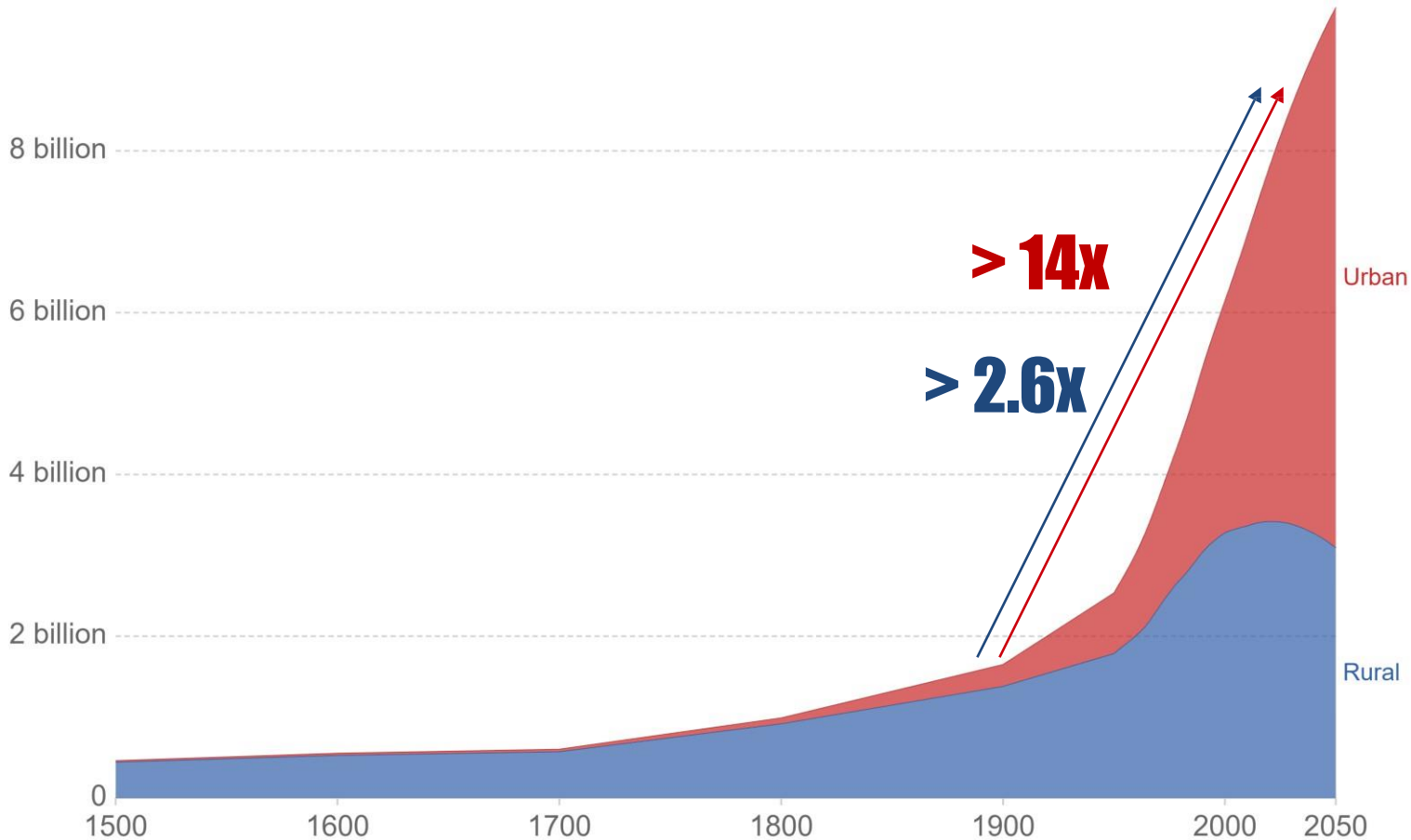
Source: <https://ourworldindata.org/urbanization>

# A global development overview - (urban) population

## Urban and rural population projected to 2050, World, 1500 to 2050

Total urban and rural population, given as estimates to 2016, and UN projections to 2050. Projections are based on the UN World Urbanization Prospects and its median fertility scenario.

Our World  
in Data



Source: OWID based on UN World Urbanization Prospects 2018 and historical sources (see Sources)

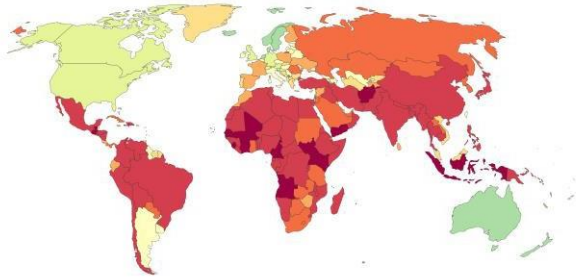
CC BY

Source: <https://ourworldindata.org/urbanization>

# A global development overview - life expectancy

Life expectancy, 1940

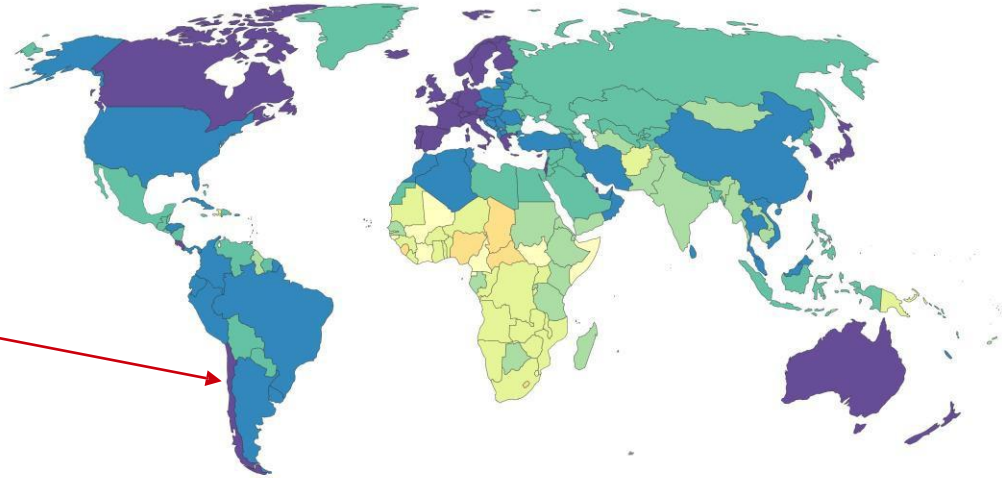
Our World  
in Data



Source: Riley (2005), Clio Infra (2015), and UN Population Division (2019)  
Note: Shown is period life expectancy at birth, the average number of years a newborn would live if the pattern of mortality in the given year were to stay the same throughout its life.

Life expectancy, 2018

Our World  
in Data



Source: Riley (2005), Clio Infra (2015), and UN Population Division (2019)  
Note: Shown is period life expectancy at birth, the average number of years a newborn would live if the pattern of mortality in the given year were to stay the same throughout its life.

OurWorldInData.org/life-expectancy • CC BY



Look at Chile



Source: <https://ourworldindata.org/life-expectancy>

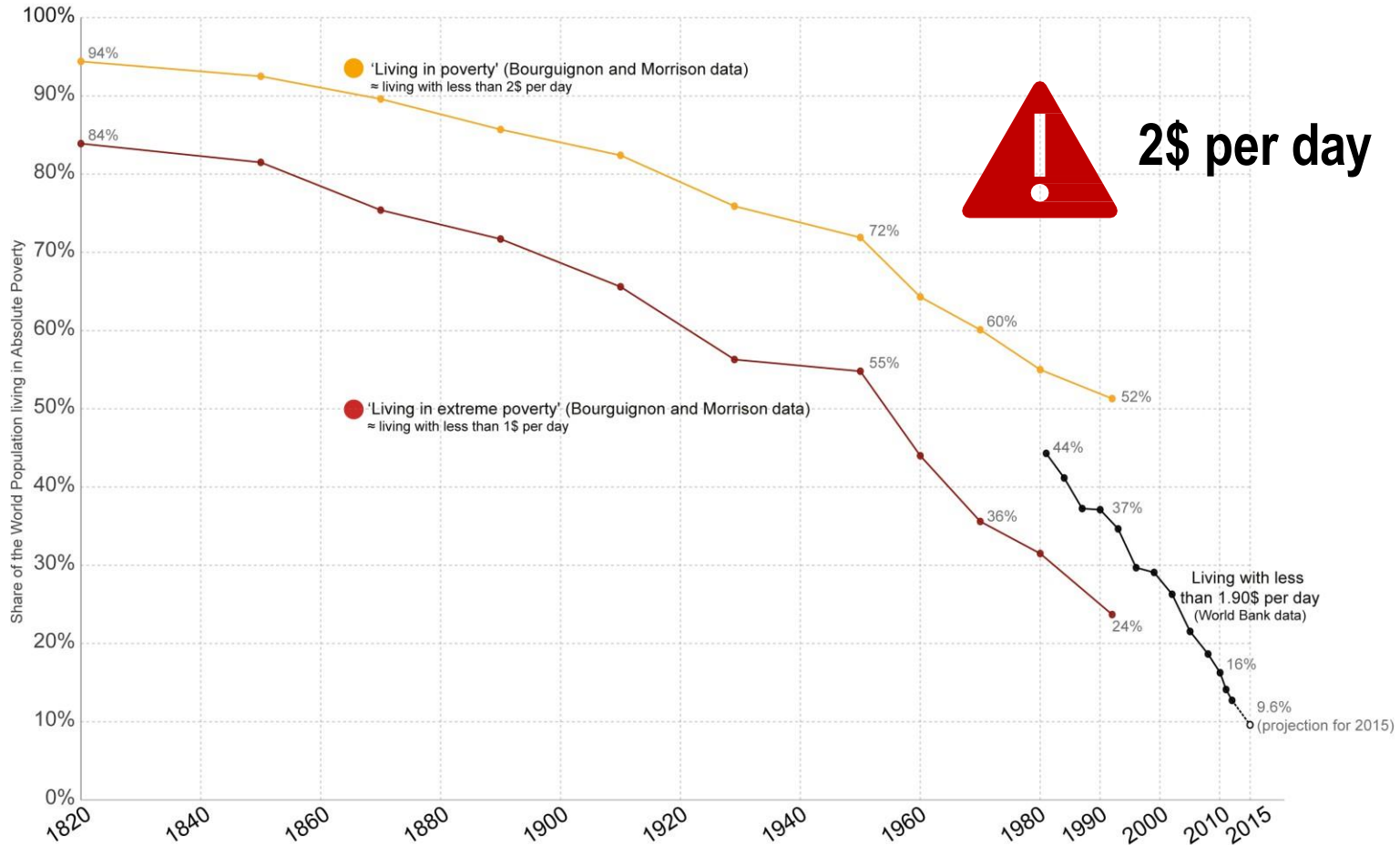


# A global development overview - poverty

OurWorld  
in Data

## Share of the World Population living in Absolute Poverty, 1820-2015

All data are adjusted for inflation over time and for price differences between countries (PPP adjustment).



Data sources: 1820-1992 Bourguignon and Morrison (2002) - Inequality among World Citizens, In The American Economic Review; 1981-2015 World Bank (PovcalNet)

The interactive data visualisation is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualisations on this topic.

Licensed under CC-BY-SA by the author Max Roser.

Source: <https://ourworldindata.org/extreme-poverty>

# A global development overview - Human Development Index

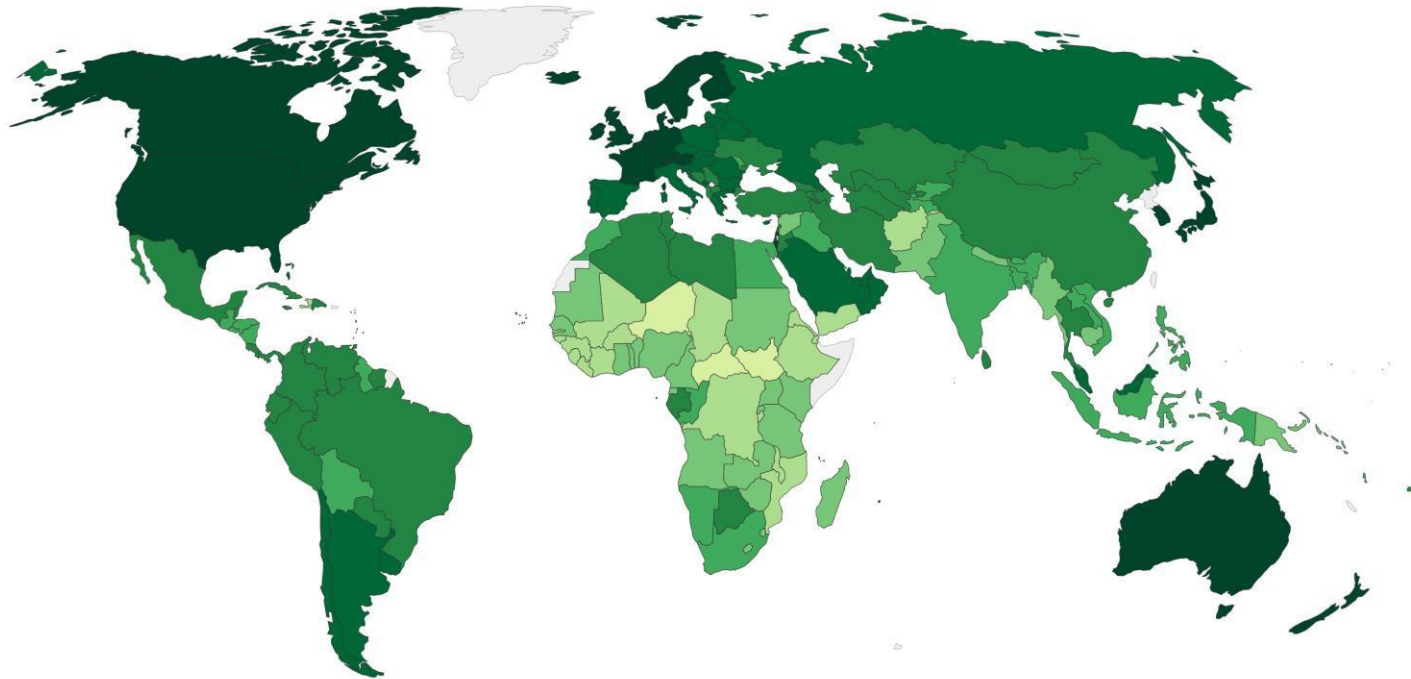
The Human Development Index (HDI) is an index that measures key dimensions of human development. The three key dimensions are:

- **A long and healthy life** – measured by *life expectancy*.
- **Access to education** – measured by *expected years of schooling* of children at school-entry age and *mean years of schooling* of the adult population.
- **And a decent standard of living** – measured by *Gross National Income per capita* adjusted for the price level of the country.

# A global development overview - Human Development Index

## Human Development Index, 2017

The Human Development Index (HDI) is a summary measure of key dimensions of human development: a long and healthy life, a good education, and having a decent standard of living.



Source: UNDP (2018)

OurWorldInData.org/human-development-index/ • CC BY

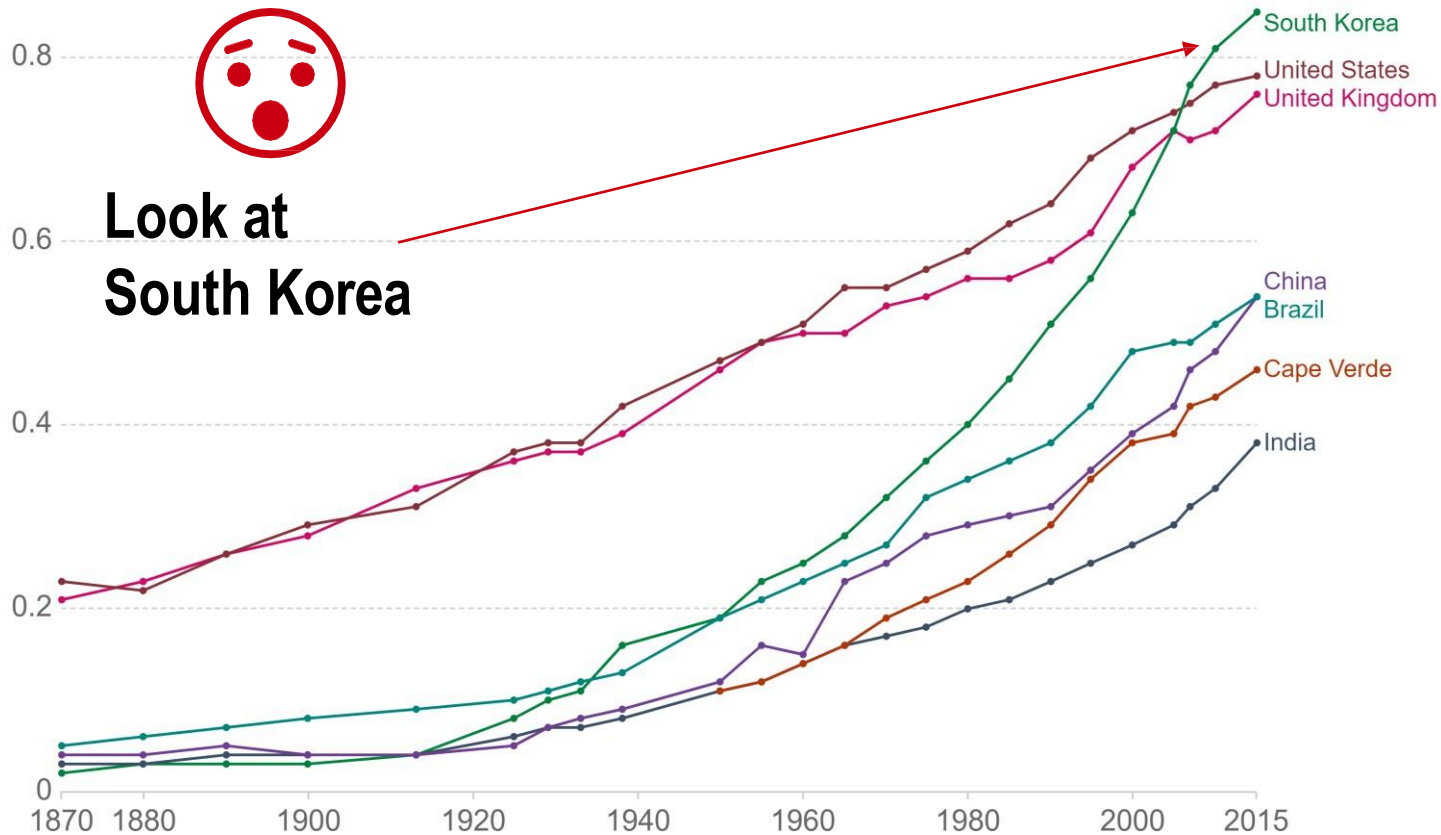
Source: <https://ourworldindata.org/human-development-index>

# A global development overview - Human Development Index

## Historical Index of Human Development, 1870 to 2015

The Historical Index of Human Development (HIHD) is a summary measure of average achievement in three key dimensions of human development: a long and healthy life, being knowledgeable and having a decent standard of living.

Our World  
in Data




Source: Prados de la Escosura (2018)

OurWorldInData.org/human-development-index • CC BY

Source: <https://ourworldindata.org/human-development-index>



A young boy with a joyful expression is sitting on a low, rustic stone wall. He is wearing a grey and blue patterned hoodie, white shorts, and white sneakers. The background shows a dirt path, a stone wall, and a blurred village scene with trees and buildings under warm, golden-hour lighting.

**The world is healthier &  
more prosperous  
than ever**



**BUT...**



**EPFL**

**50<sup>th</sup> ANNIVERSARY EDITION**

**CLINT EASTWOOD**



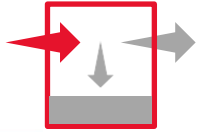
**THE GOOD THE BAD and THE UGLY**

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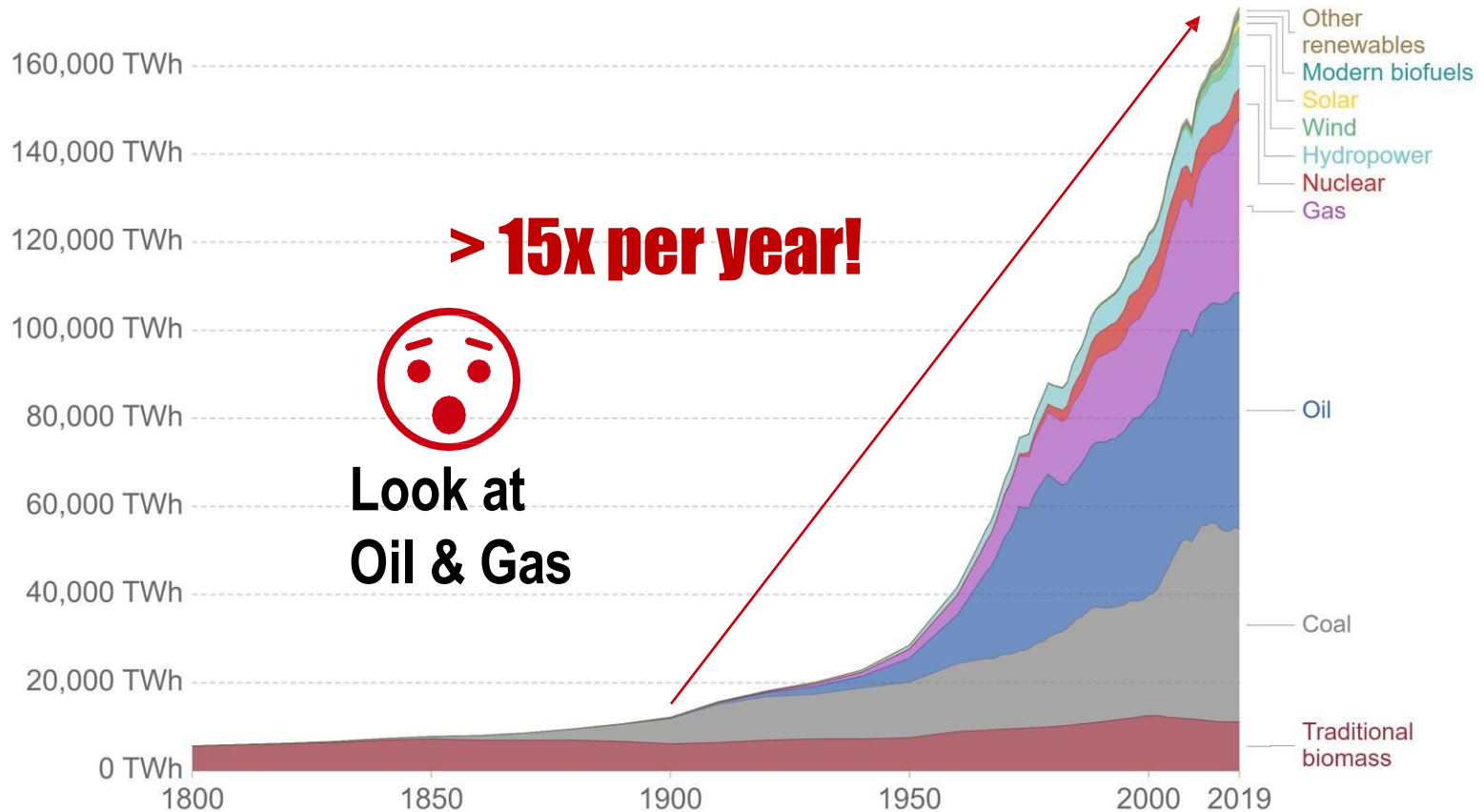
# A global development overview –energy



Our World  
in Data

## Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

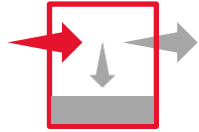


Source: <https://ourworldindata.org/energy>

Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

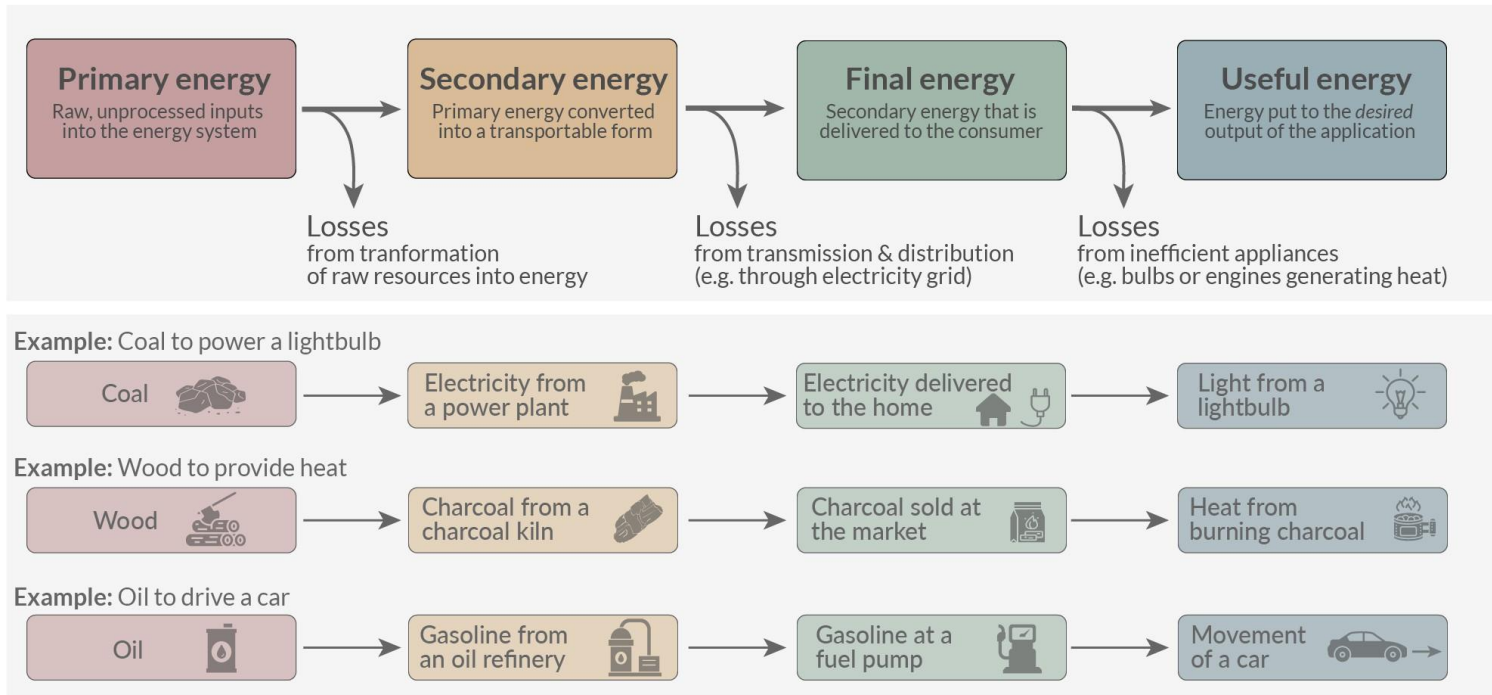
OurWorldInData.org/energy • CC BY

# A global development overview – wasteful energy ?



## The four ways of measuring energy

Our World  
in Data



Icon source: Noun Project.  
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Hannah Ritchie.

Source: <https://ourworldindata.org/energy>

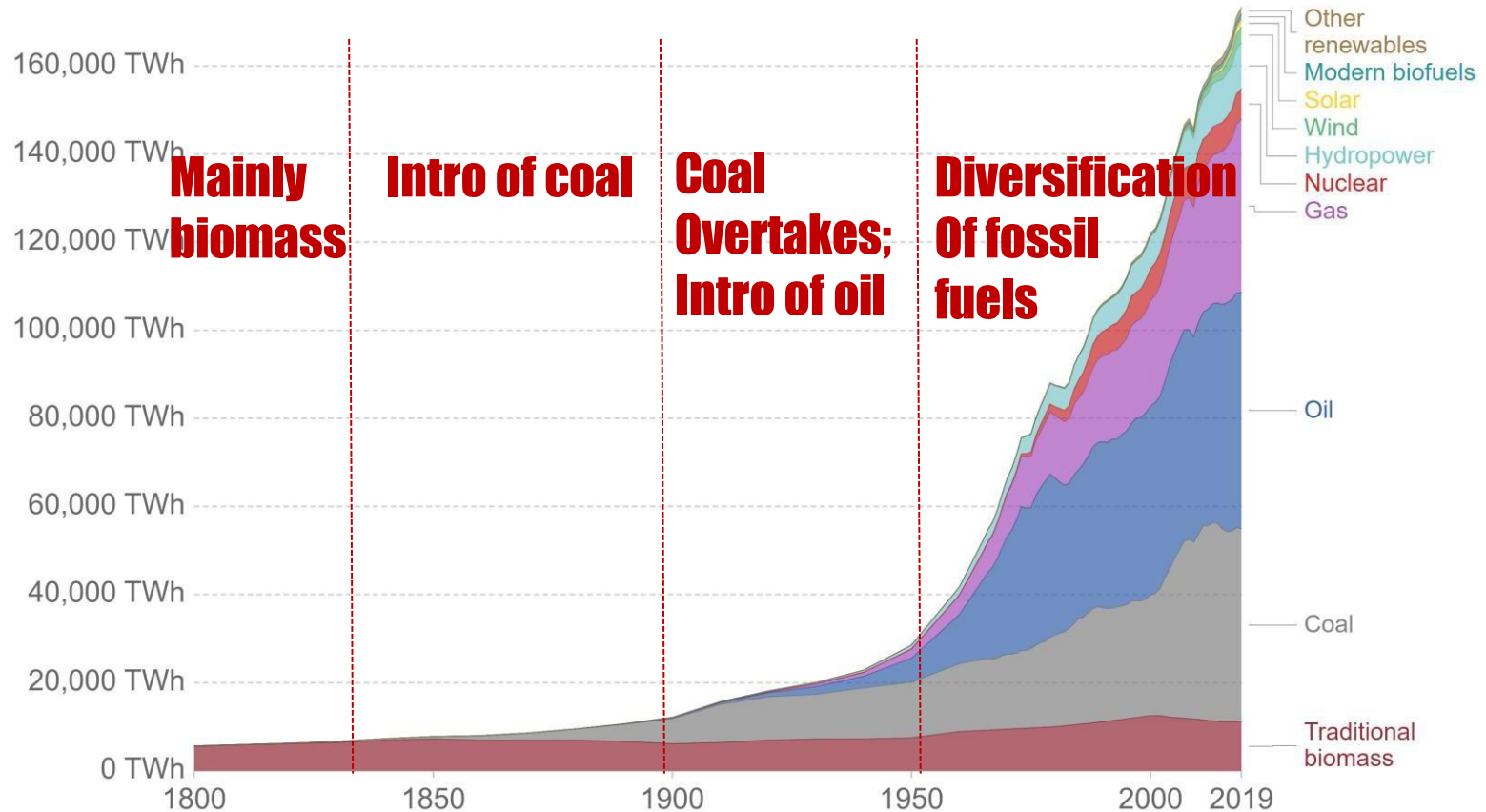
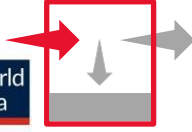


# A global development overview – energy transition or accumulation ?

## Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

Our World  
in Data

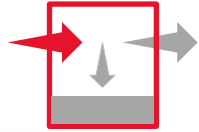


Source: <https://ourworldindata.org/energy>

Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

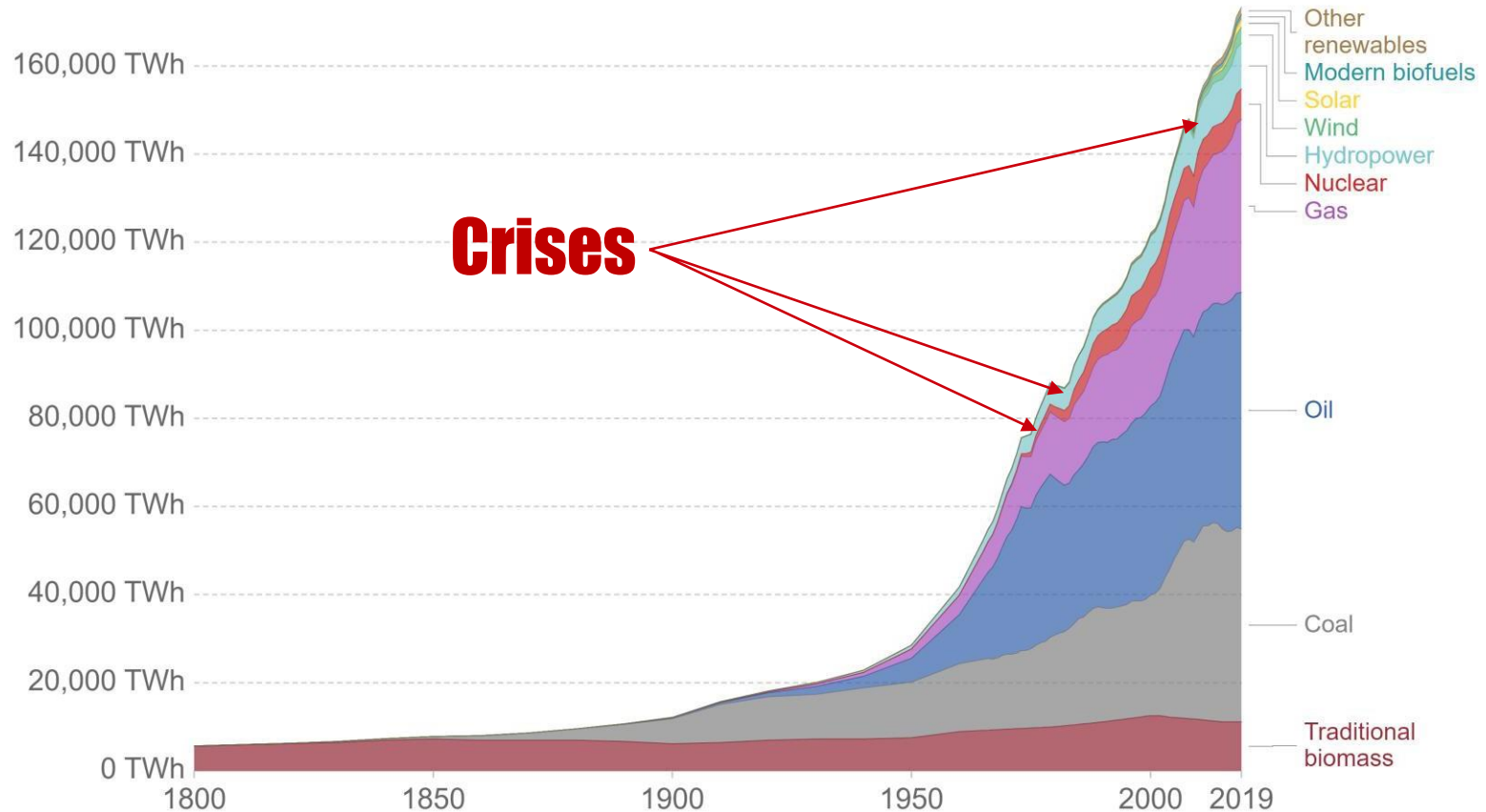
# A global development overview – energy



Our World  
in Data

## Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.



Source: <https://ourworldindata.org/energy>

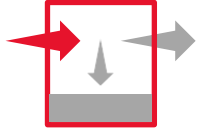
Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

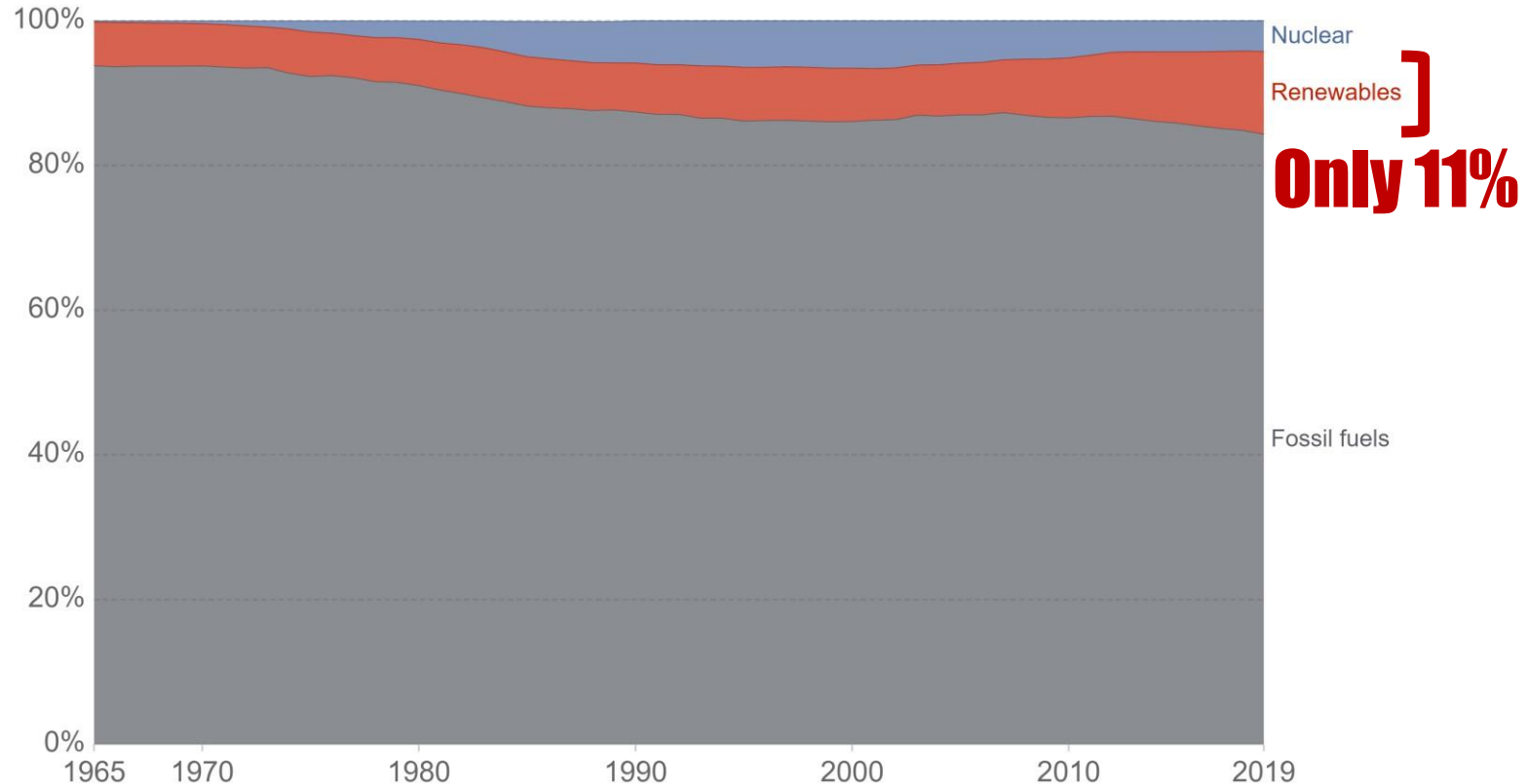
# A global development overview – what about renewable energy ?

Primary energy consumption from fossil fuels, nuclear and renewables, World

Our World  
in Data



The breakdown of primary energy is shown based on the 'substitution' method which takes account of inefficiencies in energy production from fossil fuels.



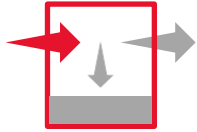
Source: Our World in Data based on BP Statistical Review of World Energy (2020)

OurWorldInData.org/energy • CC BY

Note: Renewables includes hydropower, solar, wind, geothermal, wave and tidal and bioenergy. It does not include traditional biofuels.

Source: <https://ourworldindata.org/energy>

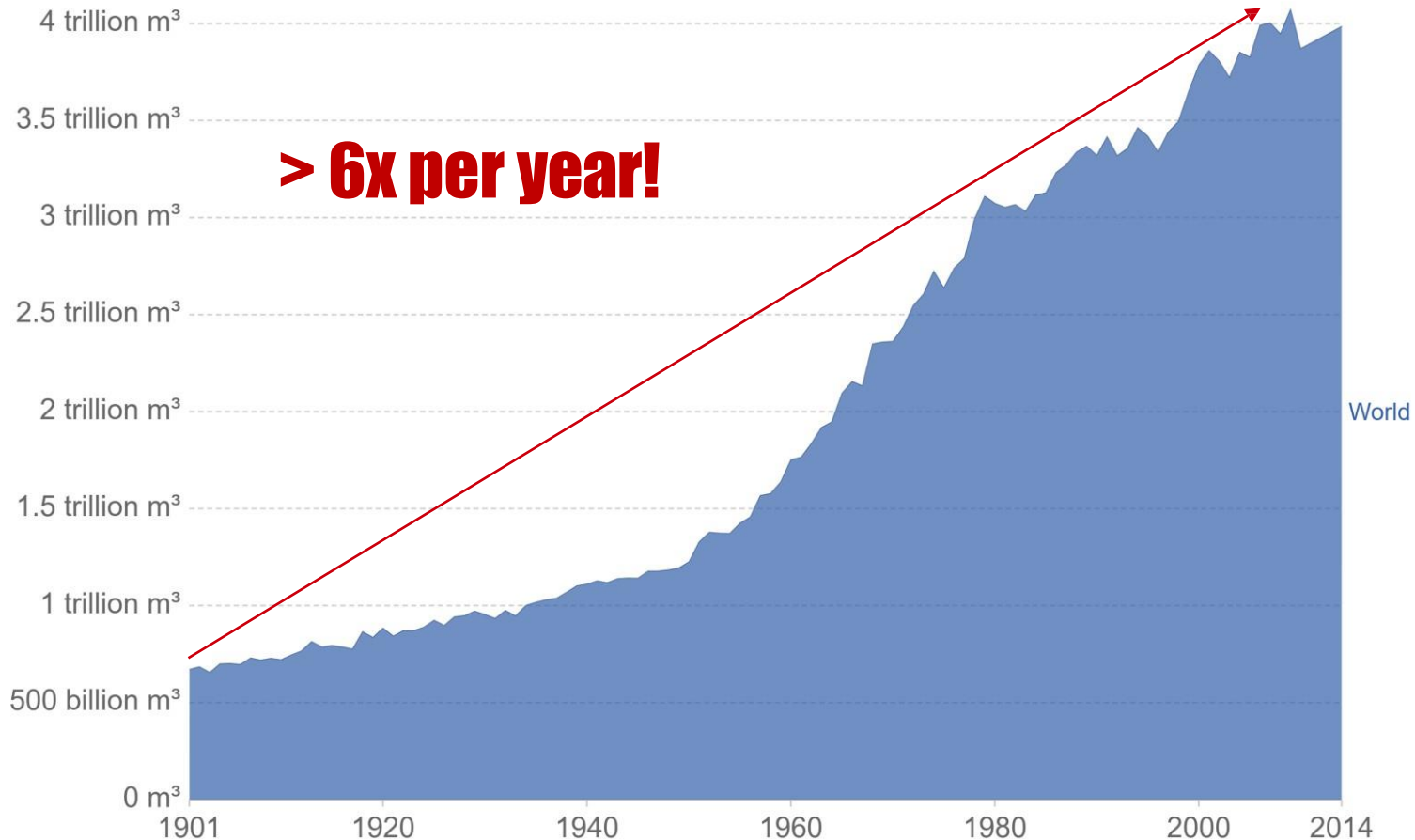
# A global development overview – water



Our World  
in Data

## Global freshwater use over the long-run

Global freshwater withdrawals for agriculture, industry and domestic uses since 1900, measured in cubic metres ( $\text{m}^3$ ) per year.



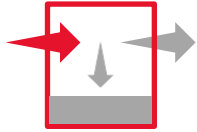
Source: Global International Geosphere-Biosphere Programme (IGB)

OurWorldInData.org/water-access-resources-sanitation/ • CC BY

Source: <https://ourworldindata.org/water-use-stress>



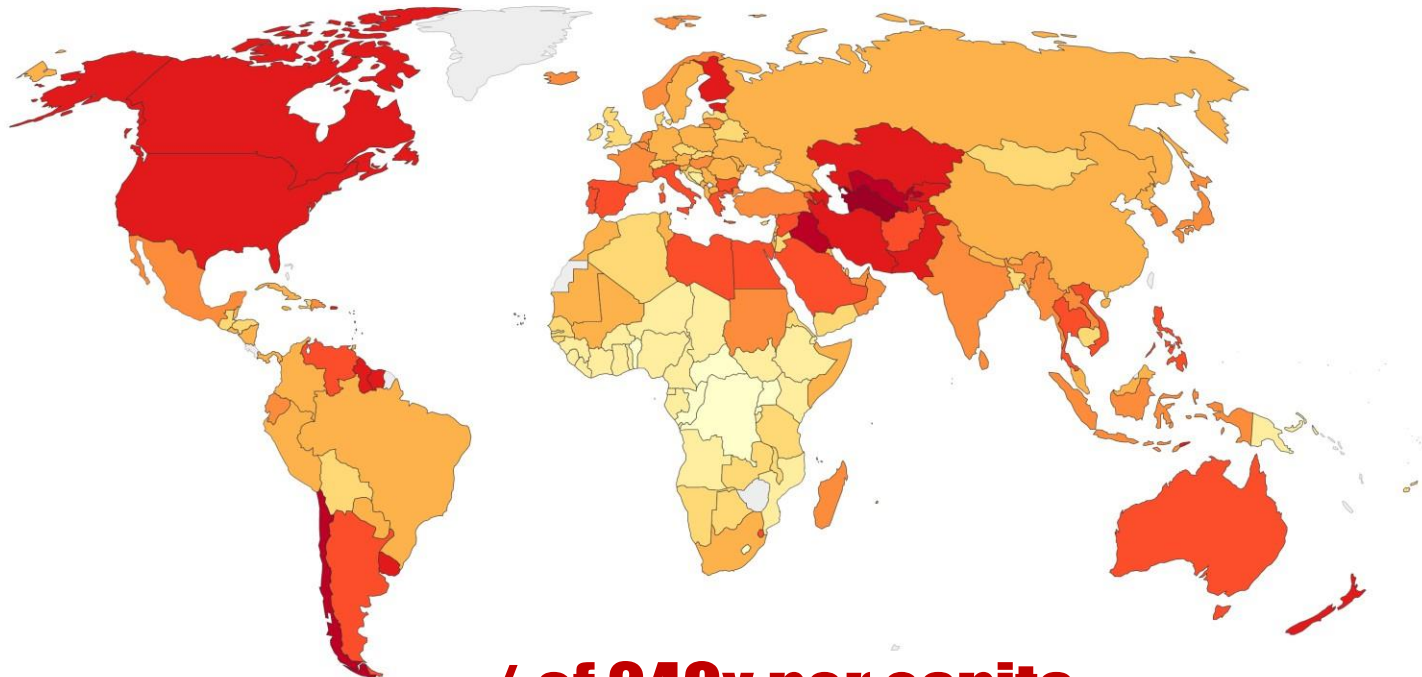
# A global development overview – water



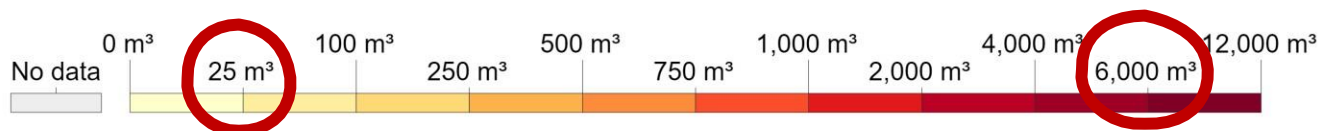
## Water withdrawals per capita, 2005

Total water withdrawals from agricultural, industrial and municipal purposes per capita, measured in cubic metres (m<sup>3</sup>) per year.

Our World  
in Data



**≠ of 240x per capita**

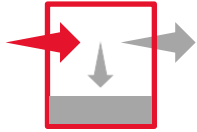


Source: UN Food and Agricultural Organization (FAO) AQUASTAT

OurWorldInData.org/water-access-resources-sanitation/ • CC BY

Source: <https://ourworldindata.org/water-use-stress>

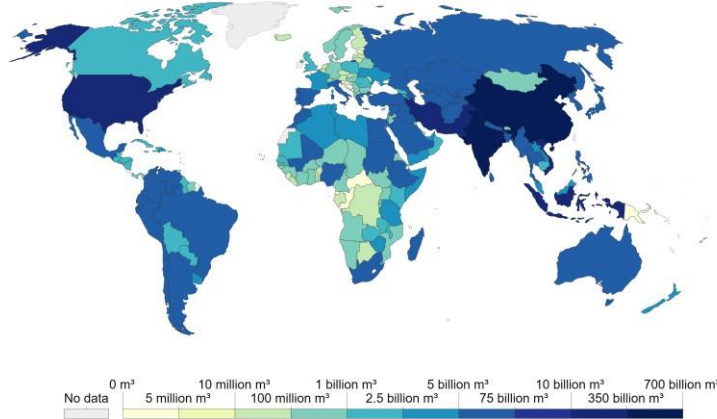
# A global development overview – water main uses



## Agricultural water withdrawals, 2005

Total agricultural withdrawals, measured in m<sup>3</sup> per year. Agricultural water is defined as the annual quantity of self-supplied water withdrawn for irrigation, livestock and aquaculture purposes.

Our World in Data



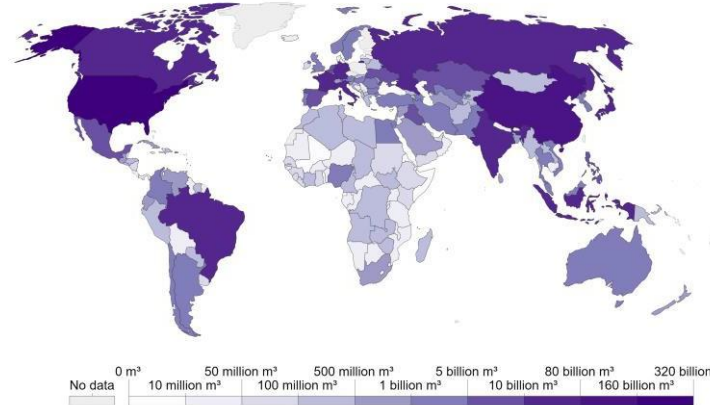
Source: UN Food and Agricultural Organization (FAO) AQUASTAT

OurWorldInData.org/water-access-resources-sanitation/ • CC BY

## Industrial water withdrawal, 2005

This measures the annual quantity of self-supplied water withdrawn for industrial uses, in cubic metres (m<sup>3</sup>) per year. It includes water for the cooling of thermoelectric and nuclear power plants, but it does not include hydropower. Water withdrawn by industries that are connected to the public supply network is generally included in municipal water withdrawal.

Our World in Data



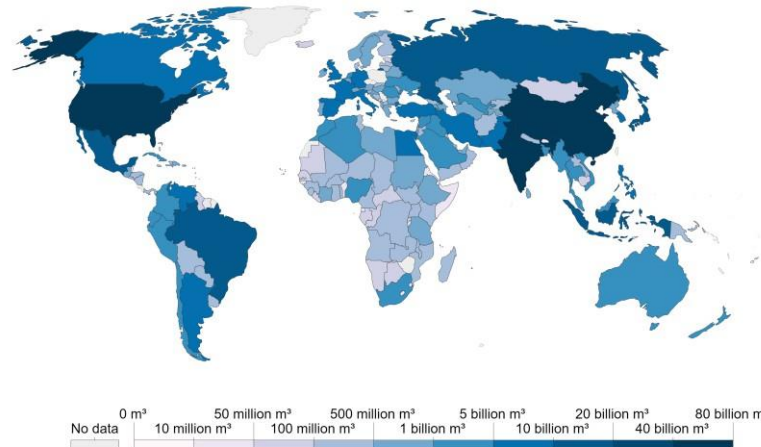
Source: UN Food and Agricultural Organization (FAO) AQUASTAT

OurWorldInData.org/water-access-resources-sanitation/ • CC BY

## Municipal water withdrawal, 2005

Total water withdrawal for municipal (domestic) purposes, measured in cubic metres (m<sup>3</sup>) per year. Municipal water is the annual quantity of water withdrawn primarily for the direct use by the population.

Our World in Data



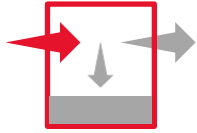
Source: UN Food and Agricultural Organization (FAO) AQUASTAT

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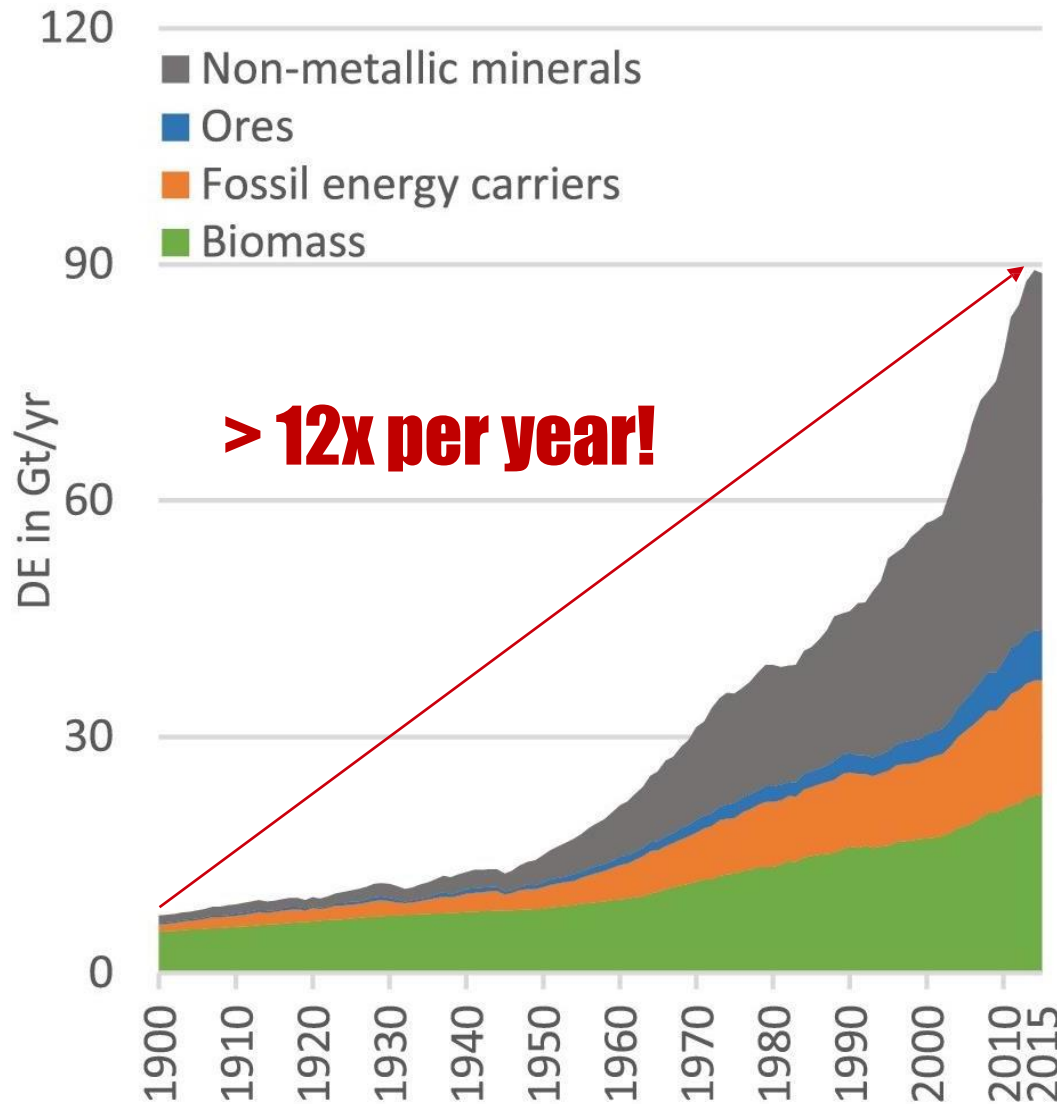
**Agriculture >> Industrial**  
**Industrial >> Households**

Source: <https://ourworldindata.org/water-use-stress>

# A global development overview – material extraction



Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131–140.

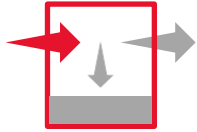


From 1900 to 2015, 3400 billion tons of materials were extracted, half of these materials were extracted since 1988

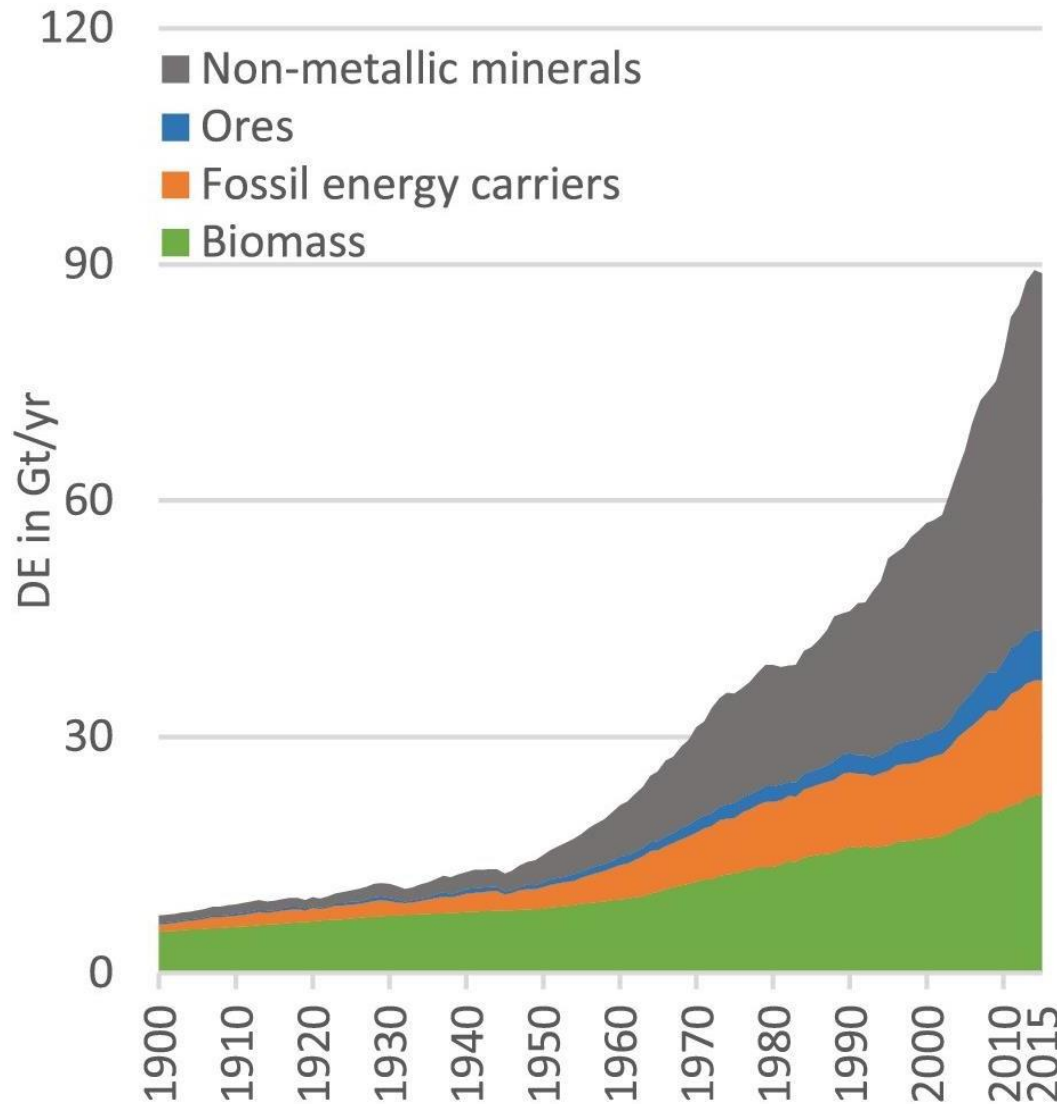
From 1900 to 2015, the amount of materials which was extracted globally went from 7.2 Gt/yr to 82 Gt/yr (an increase of **12 times**) while global population increased by 4.5 times.

**Today 100Gt/yr**

# A global development overview - material extraction



Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131–140.



From 1900 to 2015, the amount of biomass which was extracted globally went from 5.5 Gt/yr to 22.7 Gt/yr (**an increase of 4.3 times**) while global population increased by 4.5 times.

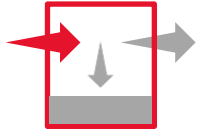
the amount of fossil energy carriers which was extracted globally went from 1 Gt/yr to 14.5 Gt/yr (an increase of **14.5 times**)

the amount of ores which was extracted globally went from 0.2 Gt/yr to 6.5 Gt/yr (an increase of **33 times**)

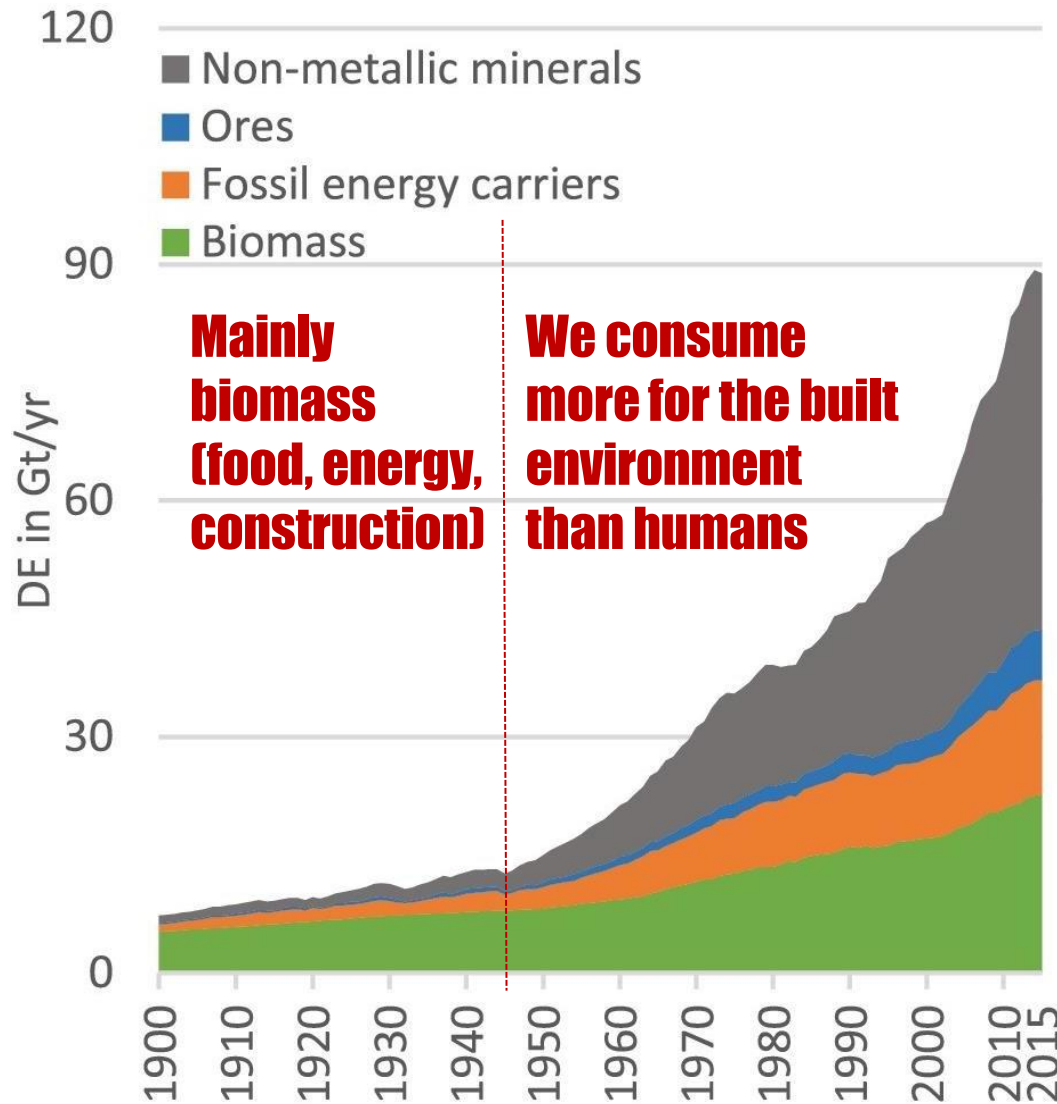
the amount of non-metallic minerals which was extracted globally went from 0.9 Gt/yr to 45.3 Gt/yr (an increase of **50 times**).



# A global development overview - material extraction



Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131–140.



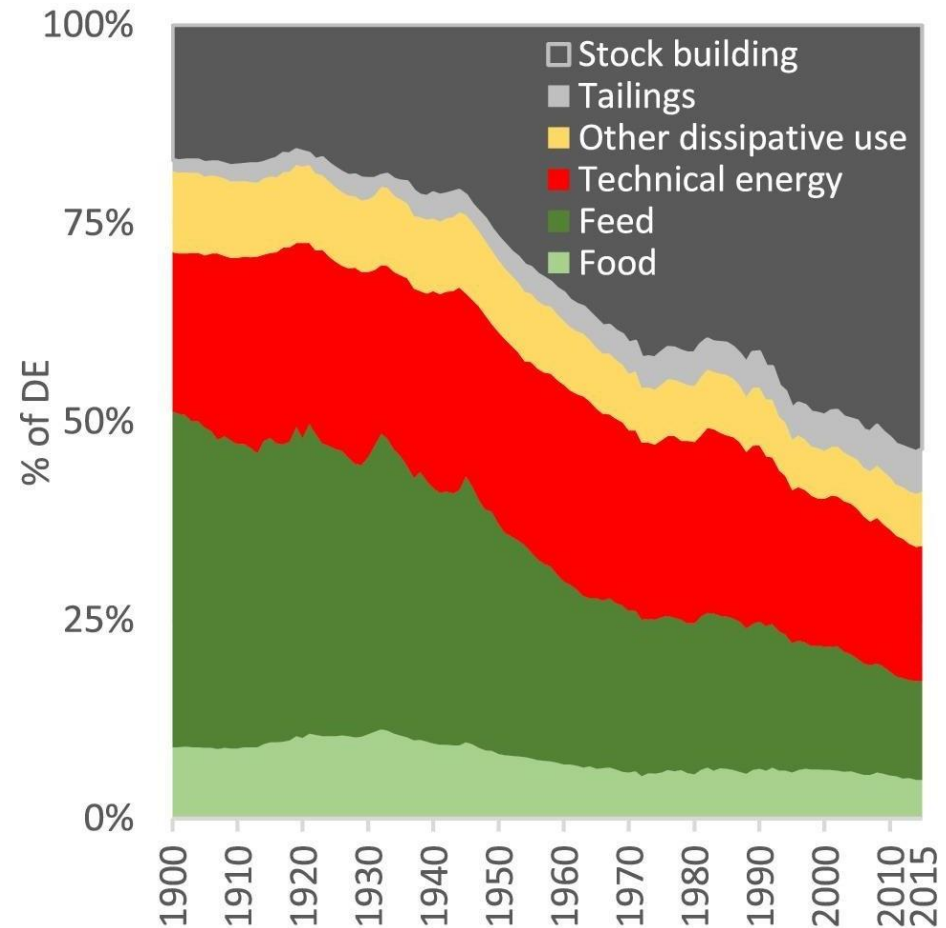
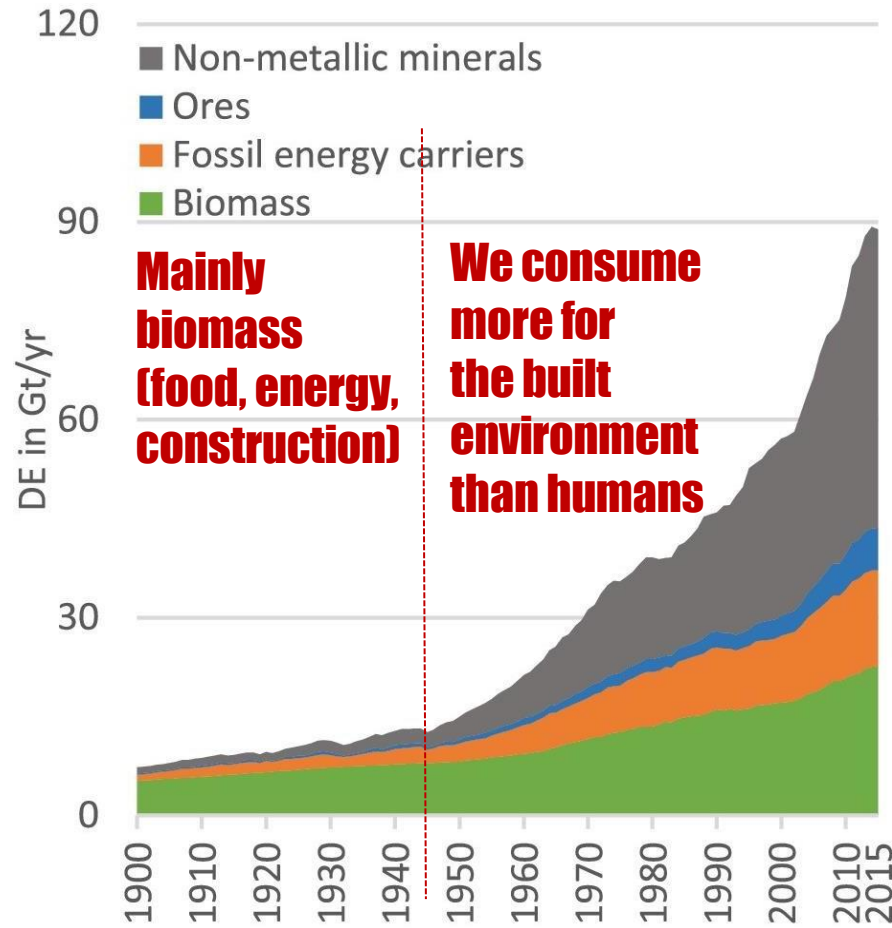
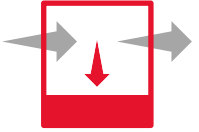
**From 1900 to 2015,**  
the amount of biomass which was extracted globally went from 5.5 Gt/yr to 22.7 Gt/yr (**an increase of 4.3 times**) while global population increased by 4.5 times.

the amount of fossil energy carriers which was extracted globally went from 1 Gt/yr to 14.5 Gt/yr (an increase of **14.5 times**)

the amount of ores which was extracted globally went from 0.2 Gt/yr to 6.5 Gt/yr (an increase of **33 times**)

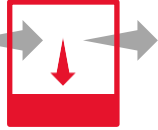
the amount of non-metallic minerals which was extracted globally went from 0.9 Gt/yr to 45.3 Gt/yr (an increase of **50 times**).

# A global development overview - material extraction

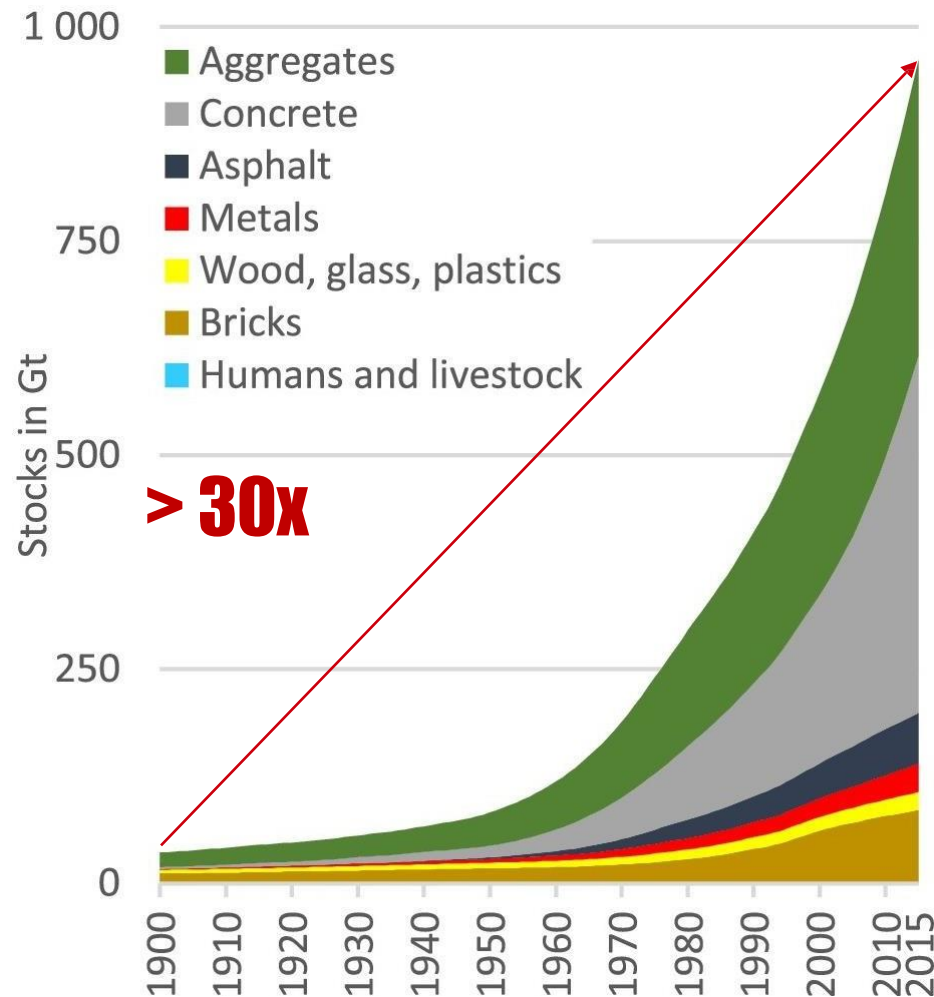


Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131–140.

# A global development overview - material extraction

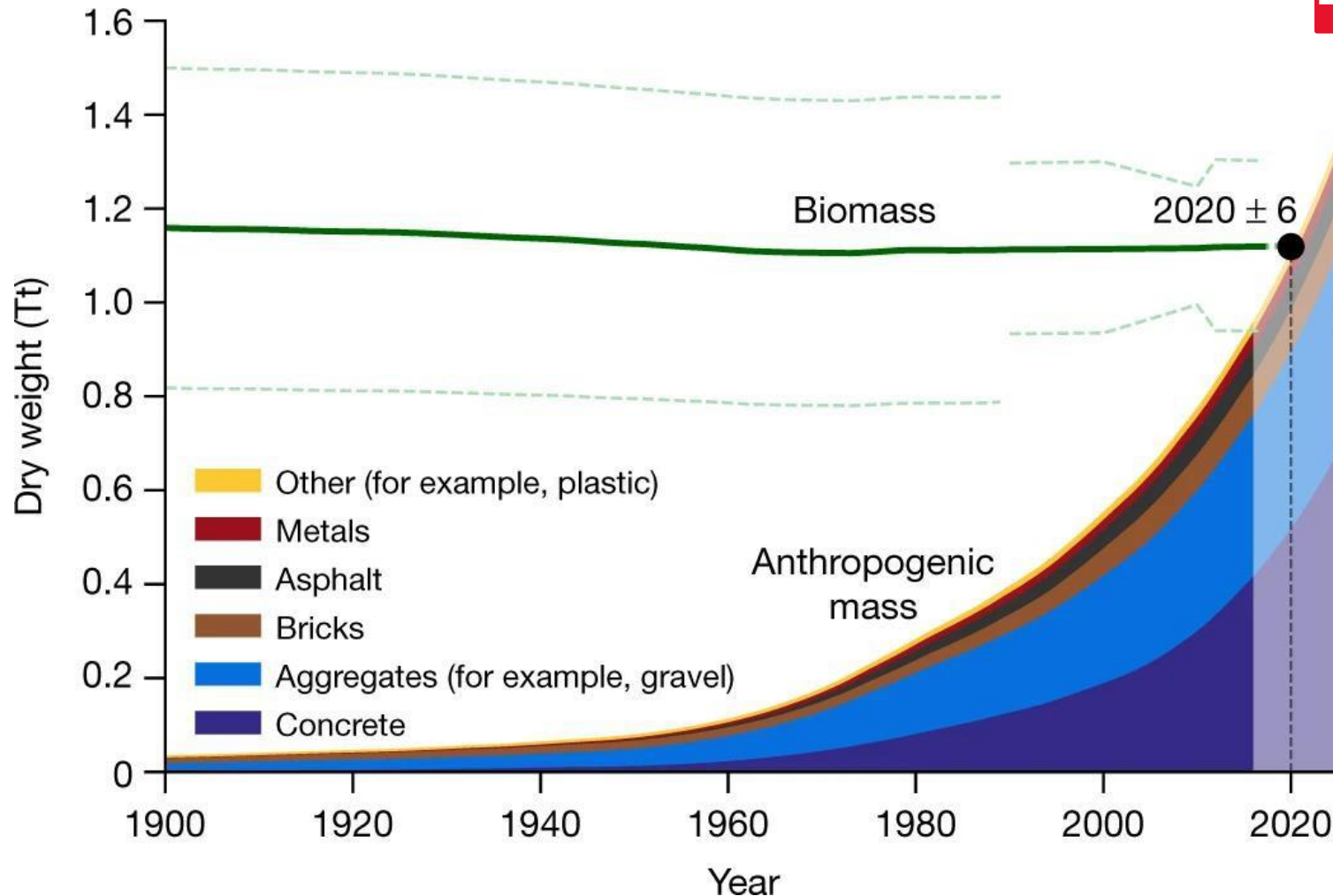
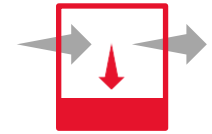


**STOCK = 1000 GT**  
**EXTRACTION = 100 GT/YR**



Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131-140.

# A global development overview - material stocks

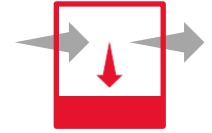


Elhacham, E., Ben-Uri, L., Grozovski, J., Bar-On, Y. M., & Milo, R. (2020). Global human-made mass exceeds all living biomass. *Nature*, 588(7838), 442-444.

Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131-140.



# A global development overview - material stocks



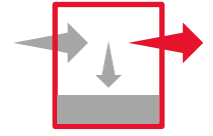
Living biomass

Human-made mass

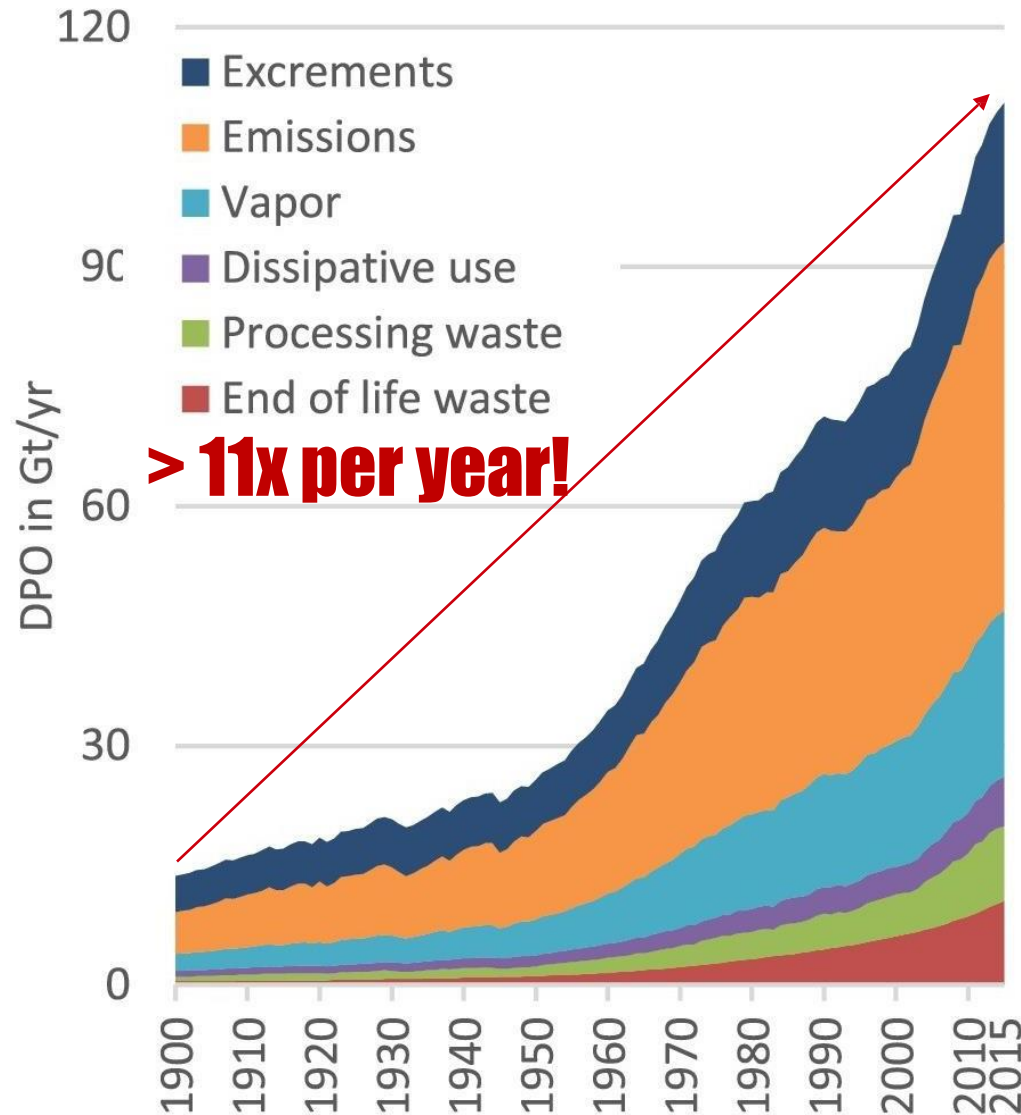
Elhacham, E., Ben-Uri, L., Grozovski, J., Bar-On, Y. M., & Milo, R. (2020). Global human-made mass exceeds all living biomass. *Nature*, 588(7838), 442-444.

Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131-140.

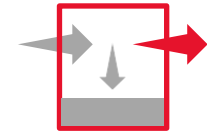
# A global development overview – outflows/waste



Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, 52, 131–140.



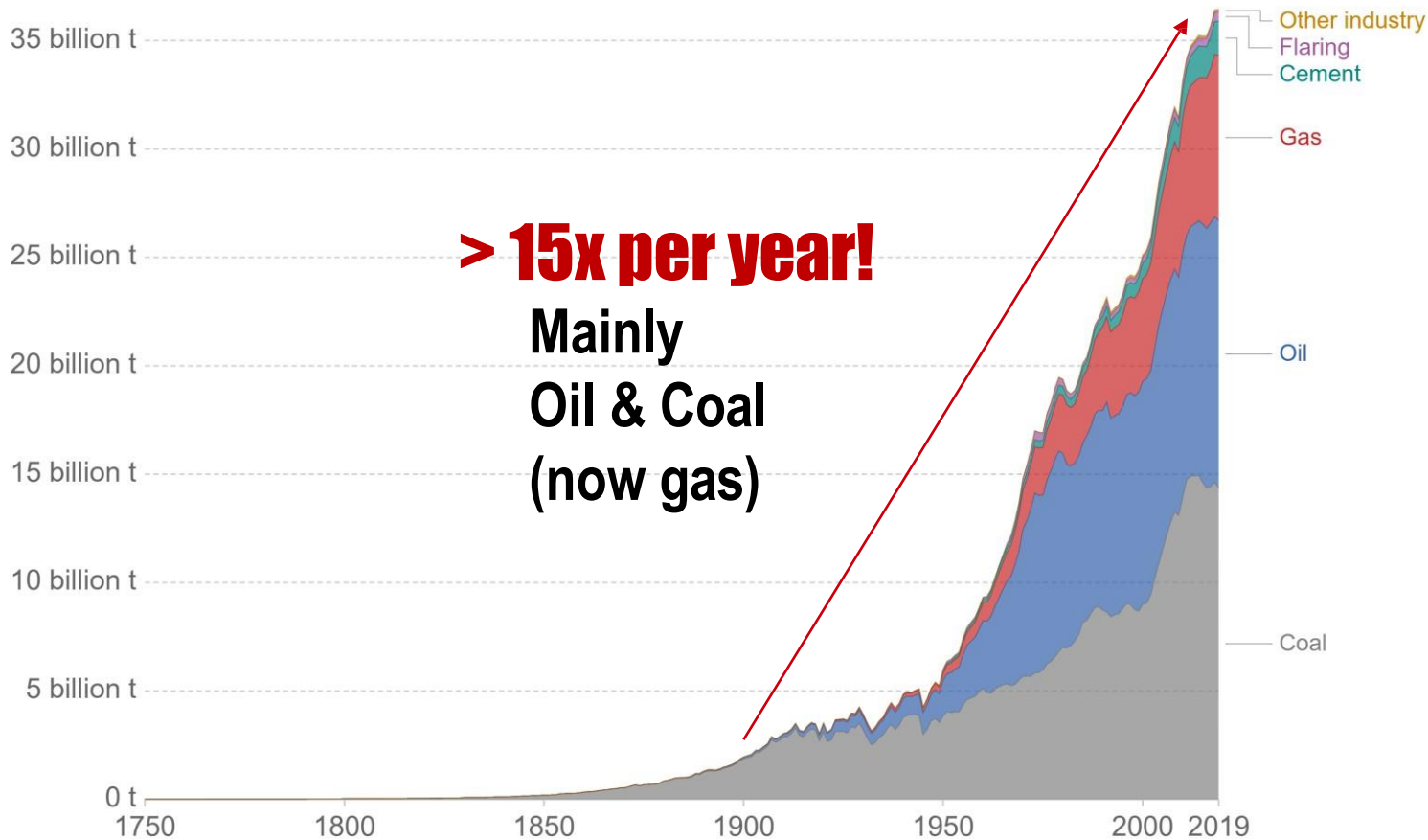
# A global development overview – CO<sub>2</sub> emissions



## CO<sub>2</sub> emissions by fuel type, World

Annual carbon dioxide (CO<sub>2</sub>) emissions from different fuel types, measured in tonnes per year.

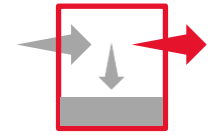
Our World  
in Data



Source: Global Carbon Project

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

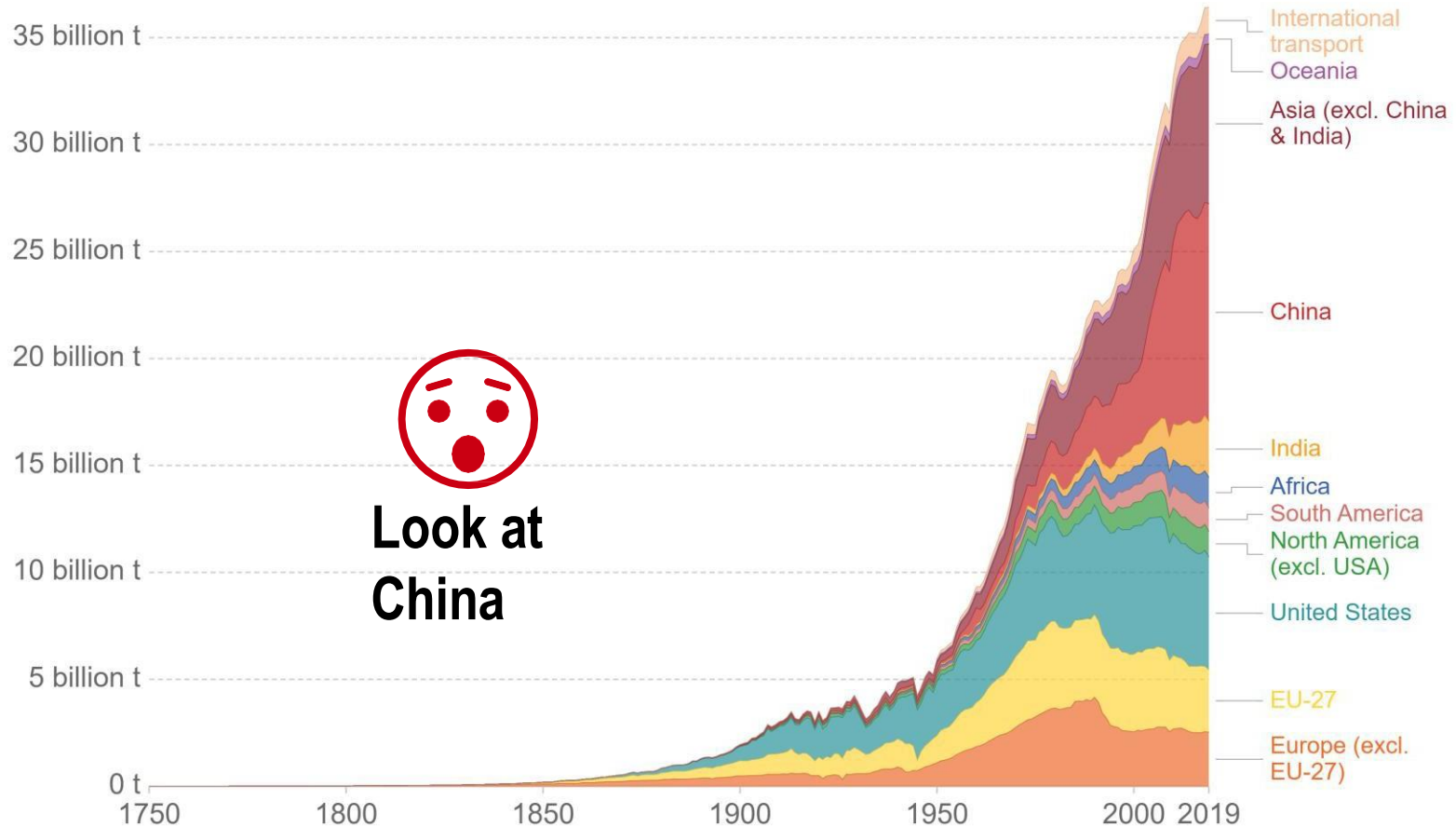
# A global development overview – CO<sub>2</sub> emissions



Our World  
in Data

## Annual total CO<sub>2</sub> emissions, by world region

This measures CO<sub>2</sub> emissions from fossil fuels and cement production only – land use change is not included.



Source: Our World in Data based on the Global Carbon Project

Note: 'Statistical differences' included in the GCP dataset is not included here.

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY



# Recap – what number surprised you the most?

From 1900-2015

- Population: 4.6x
- Rural Population: 2.6x
- **Urban Population: 14x**
- Global primary energy consumption: 15x/year
- Global freshwater use: 6x/year
- Global material extraction: 12x/year
- Material stocks: 30x
- Waste/Outflows: 11x/year
- CO<sub>2</sub> emissions: 15x/year
- Global GDP: 30x

# **So what? Why should we care?**

What is the most preoccupying figure? Report back to the group

# The impact(s) of global growth - Welcome to the Anthropocene



50<sup>th</sup> ANNIVERSARY EDITION

**CLINT EASTWOOD**



## THE GOOD THE BAD and THE UGLY

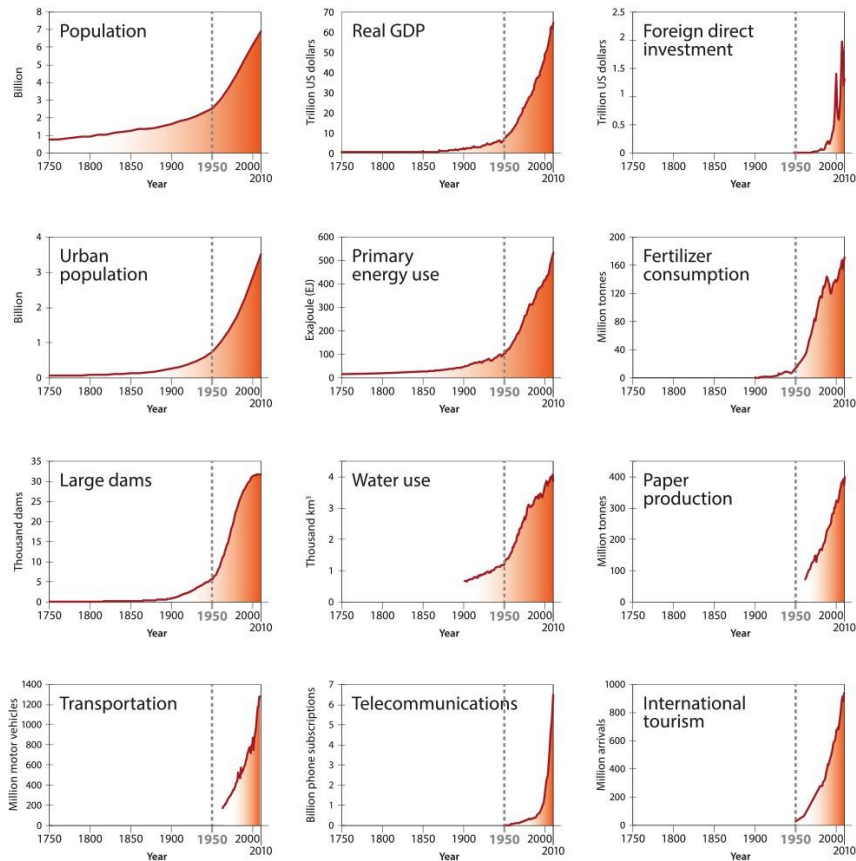
co-starring  
**LEE VAN CLEEF**

also starring  
**ELI WALLACH**  
in the role of TUCO

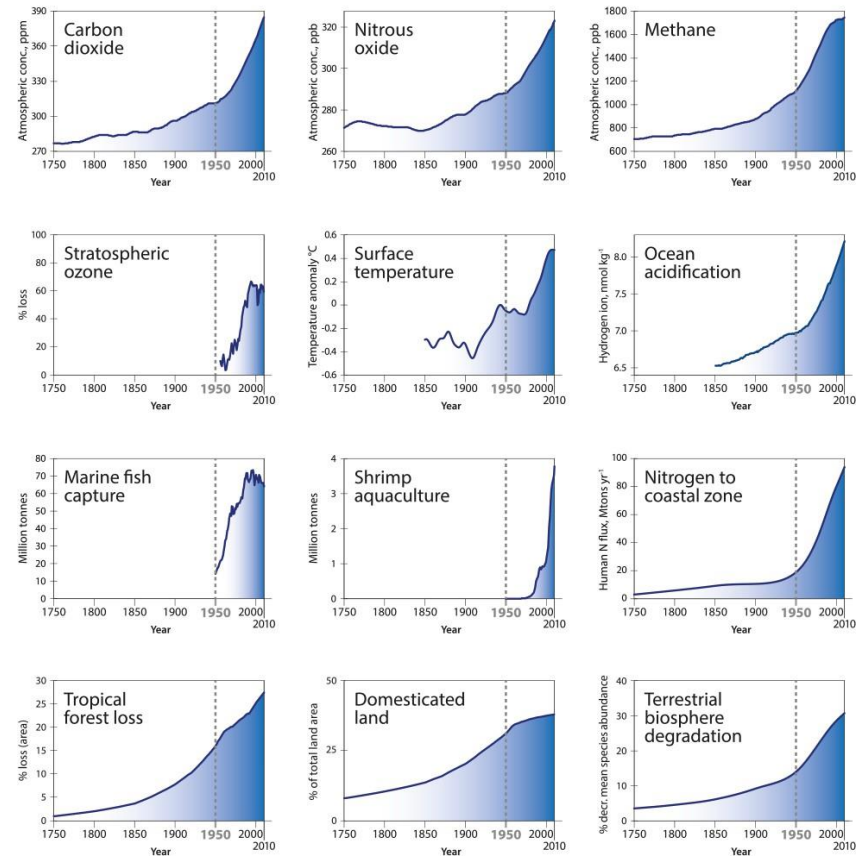
directed by  
**SERGIO LEONE**

# The Great Acceleration – to recap

## Socio-economic trends



## Earth system trends



Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review*, 2(1), 81-98.

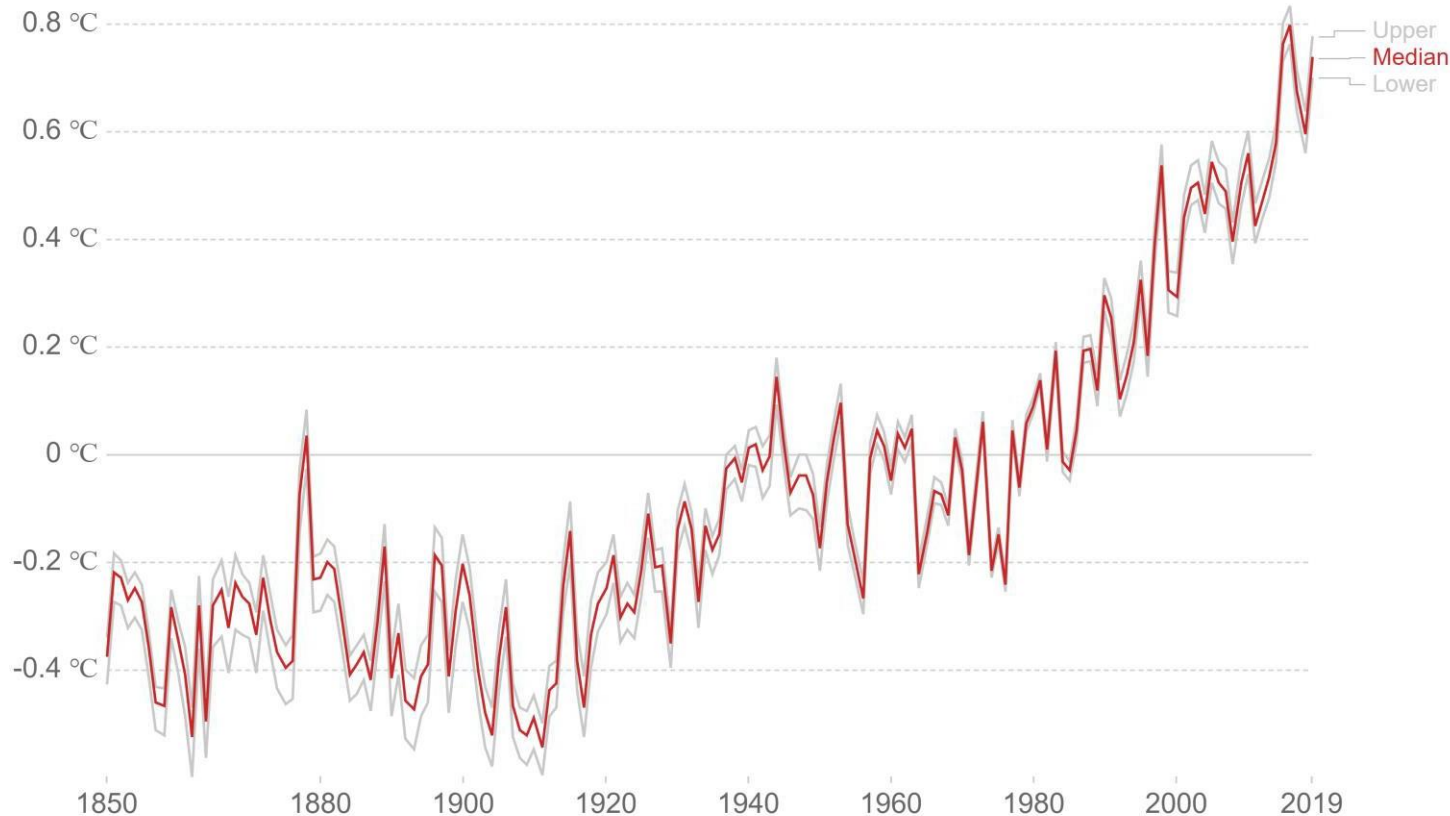


# Impacts of global development – global warming

## Average temperature anomaly, Global

Global average land-sea temperature anomaly relative to the 1961-1990 average temperature.

Our World  
in Data



Source: Hadley Centre (HadCRUT4)

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: The red line represents the median average temperature change, and grey lines represent the upper and lower 95% confidence intervals.

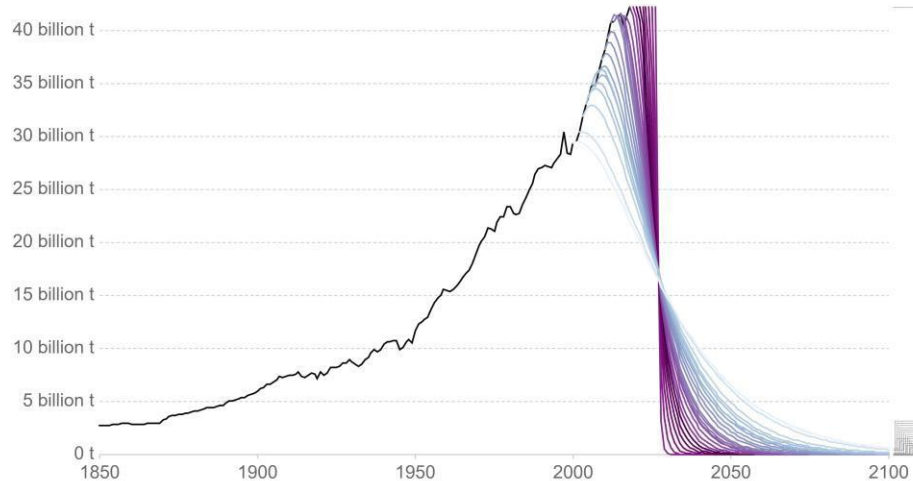
We see that over the last few decades, global temperatures have risen sharply — to approximately 0.7°C higher than our 1961-1990 baseline. When extended back to 1850, we see that temperatures then were a further 0.4°C colder than they were in our baseline. Overall, this would amount to an average temperature rise of 1.1°C.

# Impacts of global development – global warming

## CO<sub>2</sub> reductions needed to keep global temperature rise below 1.5°C

Annual emissions of carbon dioxide under various mitigation scenarios to keep global average temperature rise below 1.5°C. Scenarios are based on the CO<sub>2</sub> reductions necessary if mitigation had started – with global emissions peaking and quickly reducing – in the given year.

Our World  
in Data

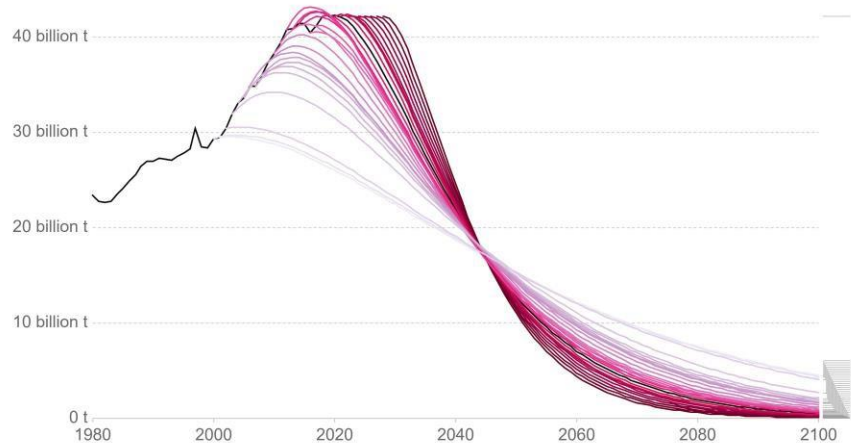


Source: Robbie Andrews (2019); based on Global Carbon Project & IPCC SR15  
Note: Carbon budgets are based on a >66% chance of staying below 1.5°C from the IPCC's SR15 Report.  
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

## CO<sub>2</sub> reductions needed to keep global temperature rise below 2°C

Annual emissions of carbon dioxide under various mitigation scenarios to keep global average temperature rise below 2°C. Scenarios are based on the CO<sub>2</sub> reductions necessary if mitigation had started – with global emissions peaking and quickly reducing – in the given year.

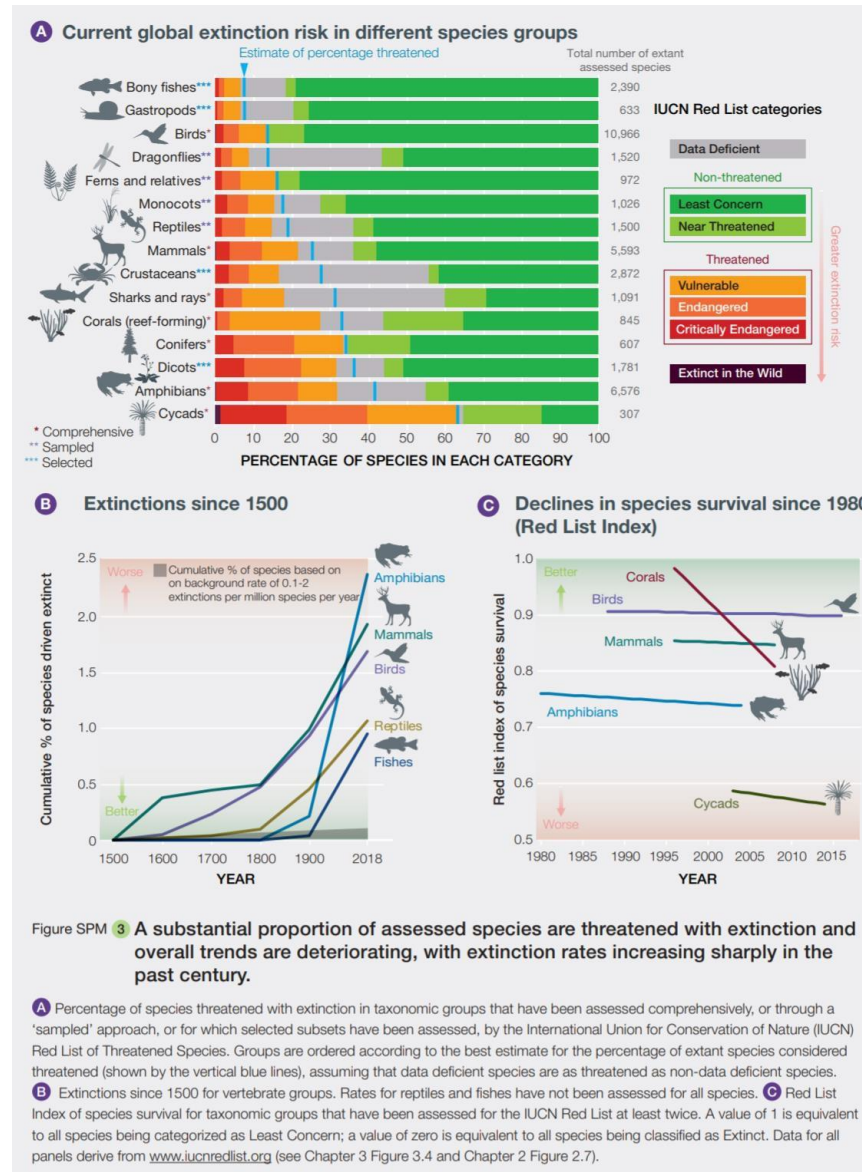
Our World  
in Data



Source: Robbie Andrews (2019); based on Global Carbon Project & IPCC SR15  
Note: Carbon budgets are based on a >66% chance of staying below 2°C from the IPCC's SR15 Report.  
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Source: <https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>

# Impacts of global development – biodiversity loss





# A global development overview – global inequalities



Source: [http://www.astro4dev.org/wp-content/uploads/2020/08/South-Africa-drone\\_inequality.png](http://www.astro4dev.org/wp-content/uploads/2020/08/South-Africa-drone_inequality.png)



# Global inequalities

What we do

Take action

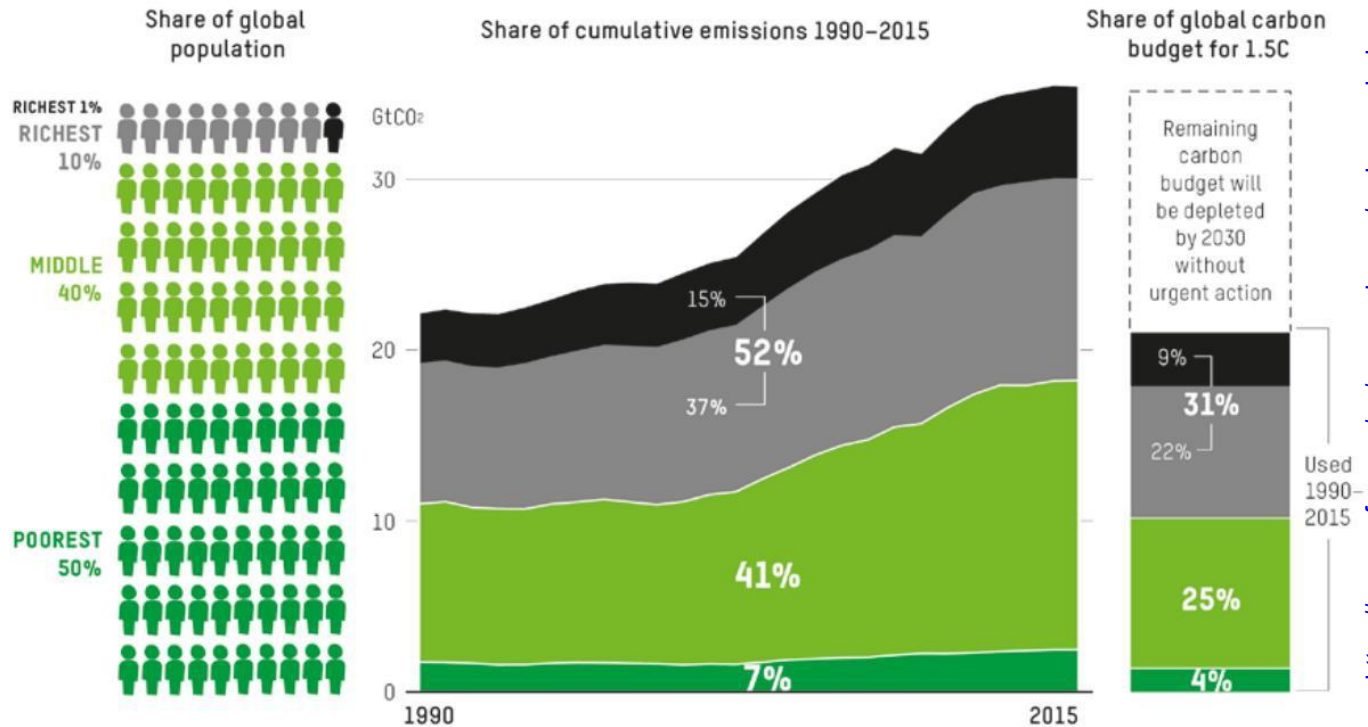
Donate

Press releases

Carbon emissions of richest 1 percent more than double the emissions of the poorest half of humanity

Published: 21st September 2020

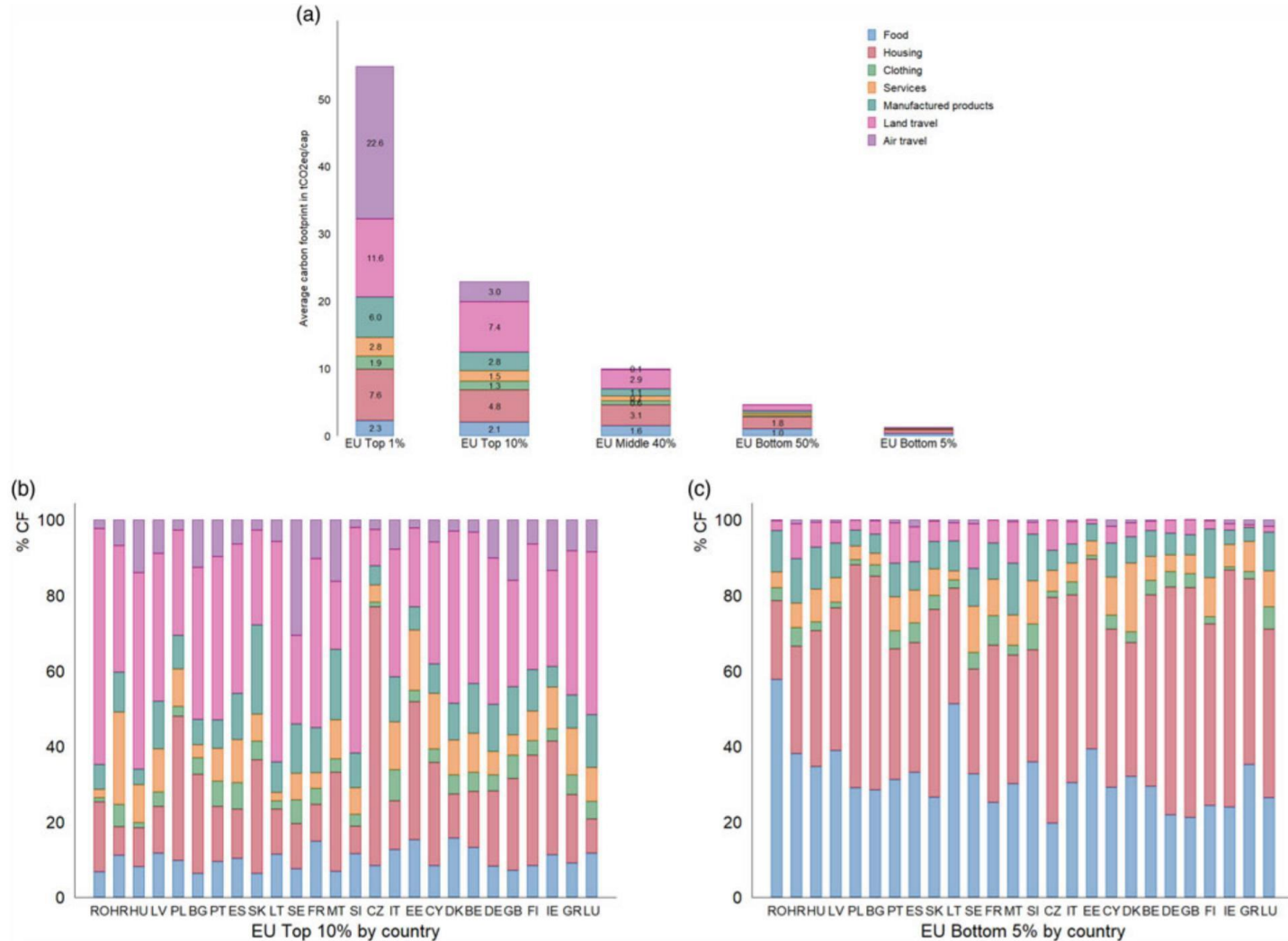
**Figure 1: Share of cumulative emissions from 1990 to 2015 and use of the global carbon budget for 1.5C linked to consumption by different global income groups**



Per capita income threshold (\$PPP2011) of richest 1%: \$109k; richest 10%: \$38k; middle 40%: \$6k; and bottom 50%: less than \$6k. Global carbon budget from 1990 for 33% risk of exceeding 1.5C: 1,205Gt.

<https://www.oxfam.org/en/press-releases/carbon-emissions-richest-1-percent-more-double-emissions-poorest-half-humanity>

# Global inequalities over use



**Fig. 3.** Average carbon footprint (CF) distribution by consumption category in the European Union (EU) (top). The bottom graph depicts the average CF shares by consumption category and countries of EU top 10% emitters on the left (with CF >15 tCO<sub>2</sub>eq/cap) and EU bottom 5% of emitters on the right (with CF <2.5 tCO<sub>2</sub>eq/cap). See SI4 for country averages. EU household weights applied. See Section 2 for country codes.

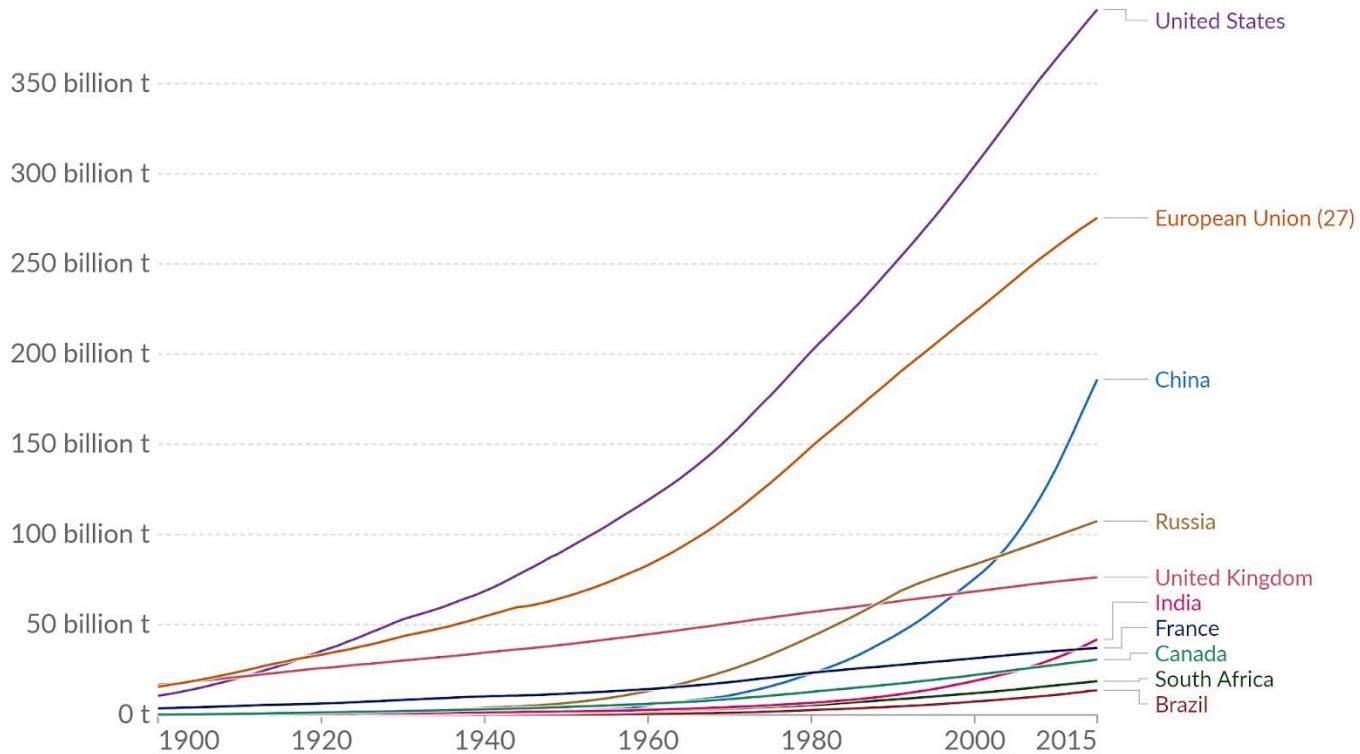
Source: Ivanova D, Wüstenhagen R (2020). The unequal distribution of household carbon footprints in Europe and its link to sustainability. Global Sustainability 3, e18, 1–12. <https://doi.org/10.1017/sus.2020.12>

# Global inequalities over time

## Cumulative CO<sub>2</sub> emissions

Cumulative emissions are the running sum of CO<sub>2</sub> emissions produced from fossil fuels and industry<sup>1</sup> since 1750. Land use change is not included.

Our World  
in Data



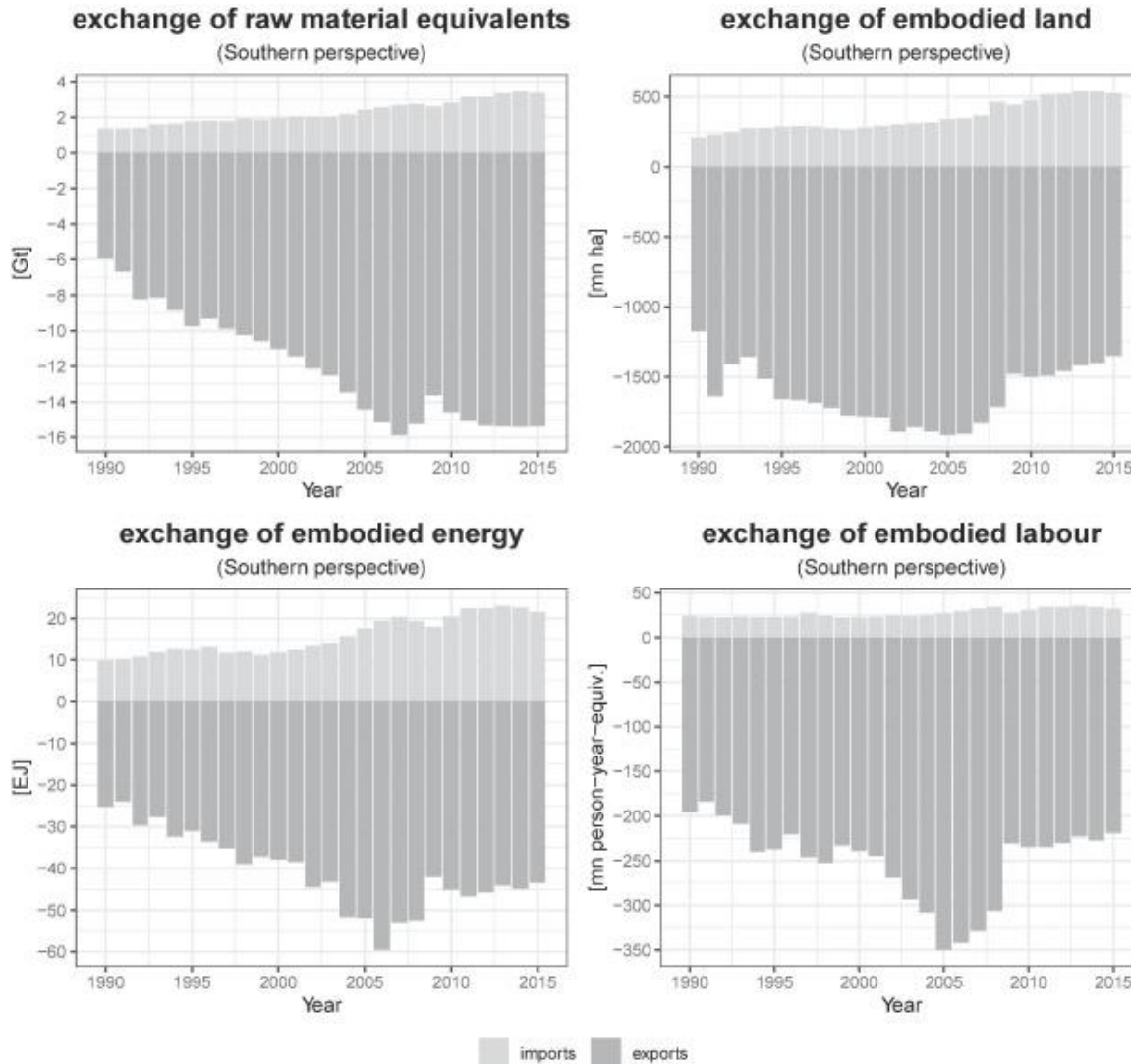
Source: Global Carbon Budget (2022)

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY

**1. Fossil emissions:** Fossil emissions measure the quantity of carbon dioxide (CO<sub>2</sub>) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO<sub>2</sub> includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

<https://ourworldindata.org/co2-emissions#cumulative-co2-emissions>

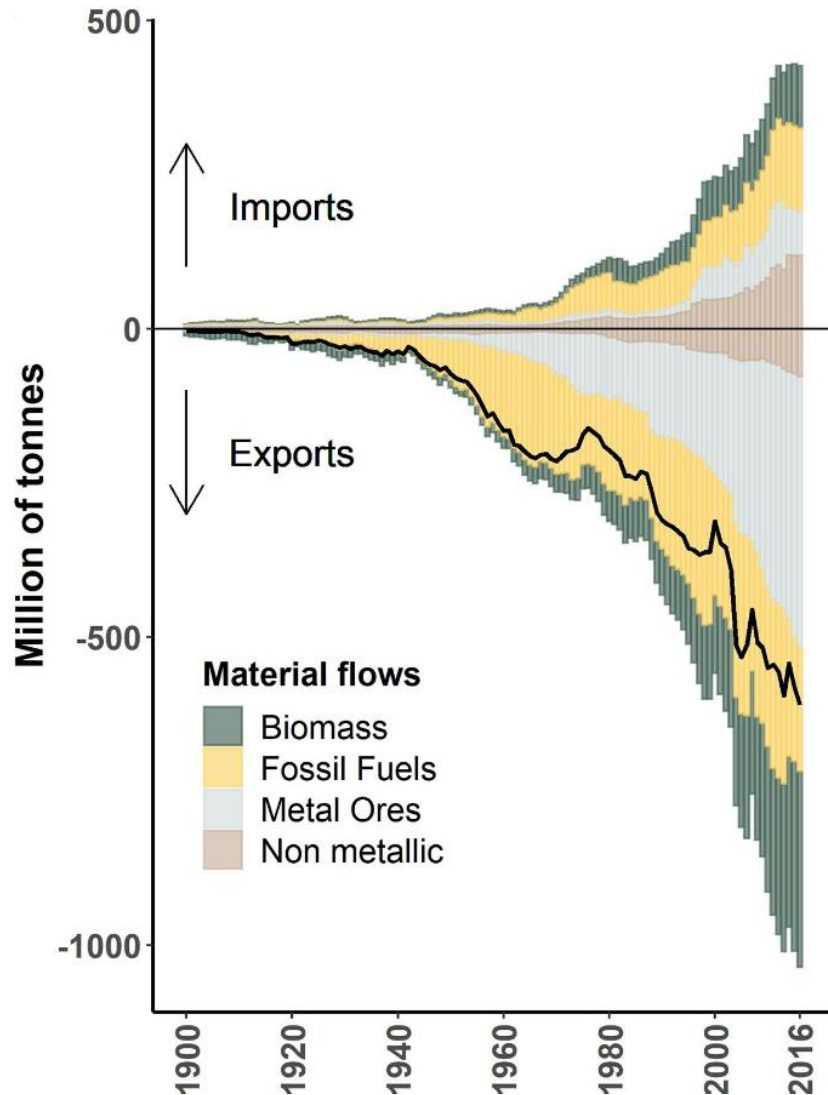
# Impacts of Global Development – Resource Drain



Hickel, J., Dorninger, C., Wieland, H., & Suwandi, I. (2022). Imperialist appropriation in the world economy: Drain from the global South through unequal exchange, 1990–2015. *Global Environmental Change*, 73, 102467.

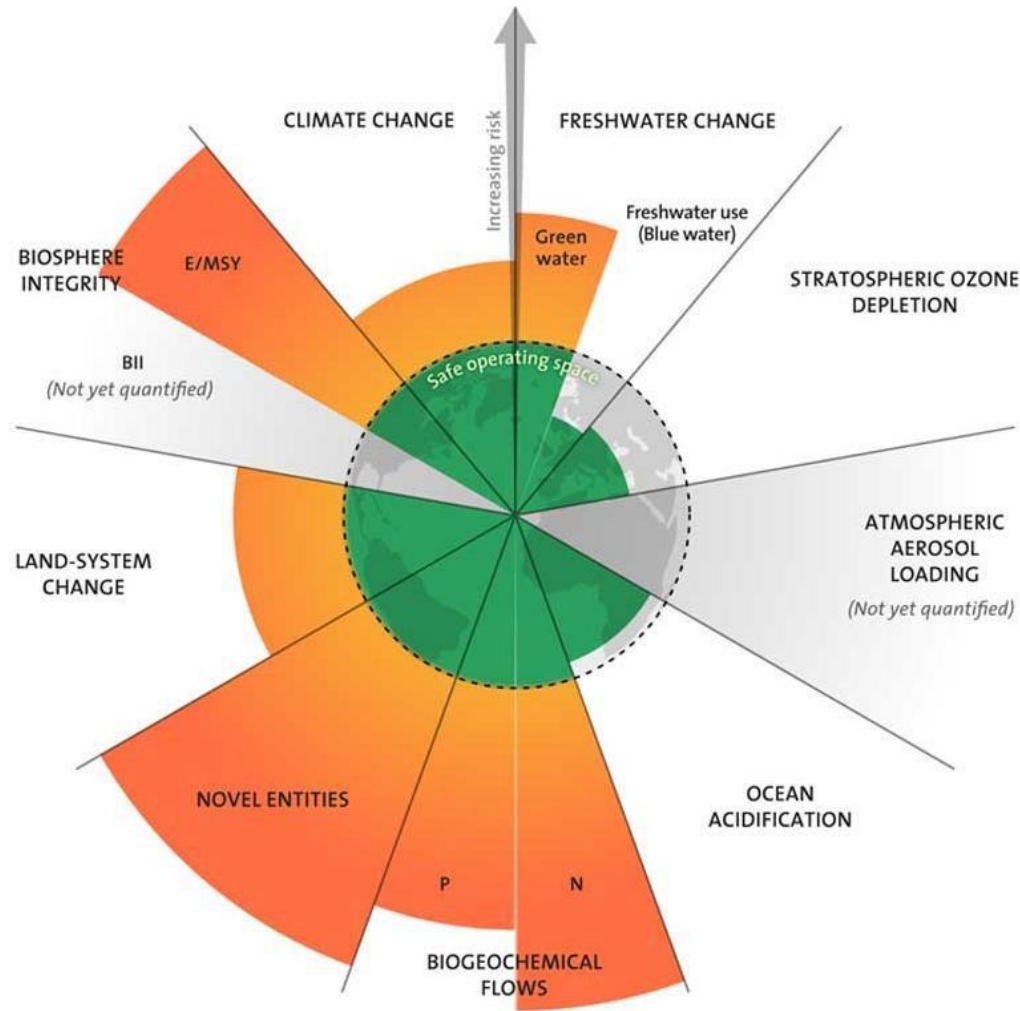


# Impacts of Global Development – Resource Drain



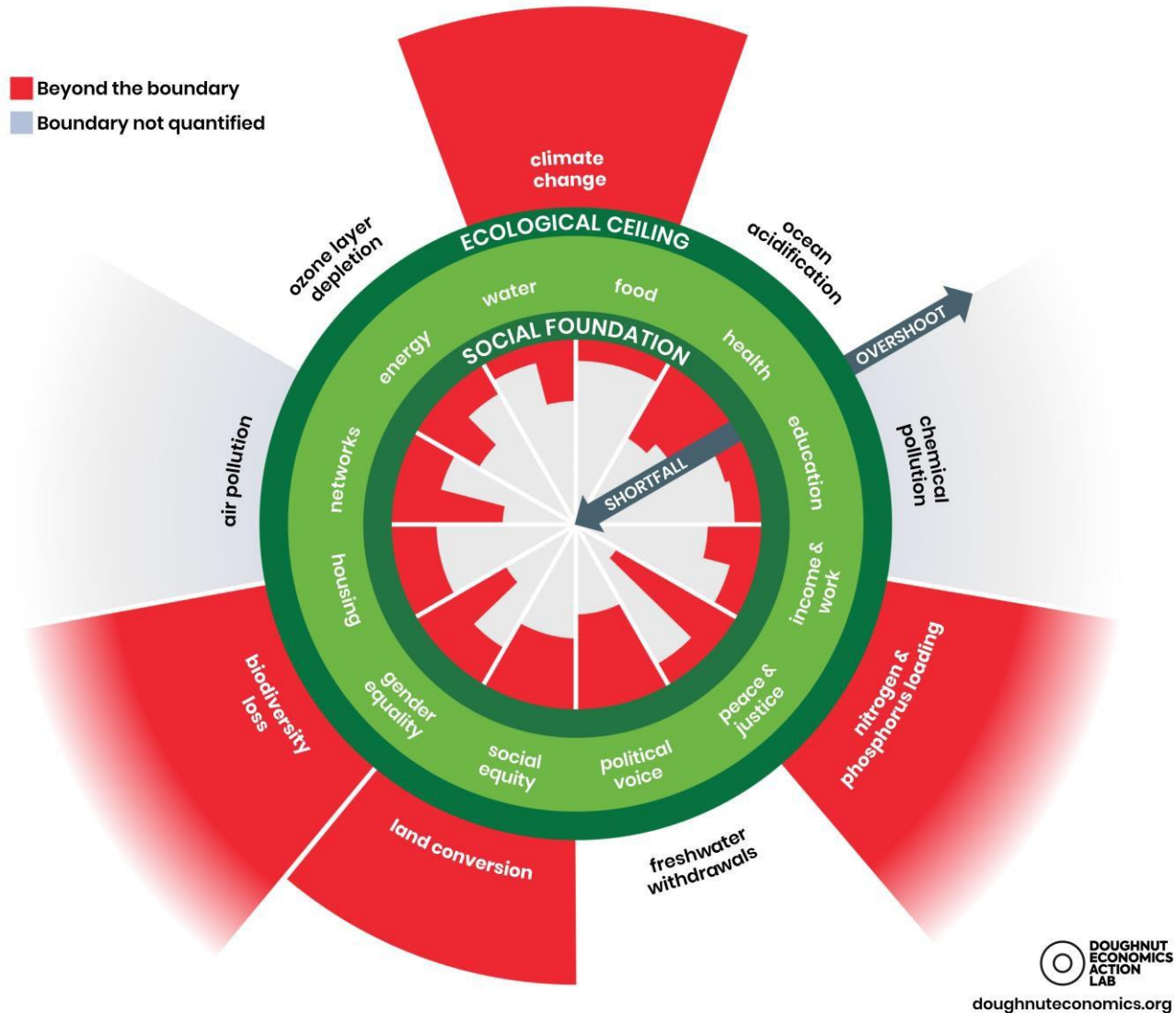
Infante-Amate, J., Urrego-Mesa, A., Pinero, P., & Tello, E. (2022). The open veins of Latin America: Long-term physical trade flows (1900–2016). *Global Environmental Change*, 76, 102579.

# Planetary boundaries



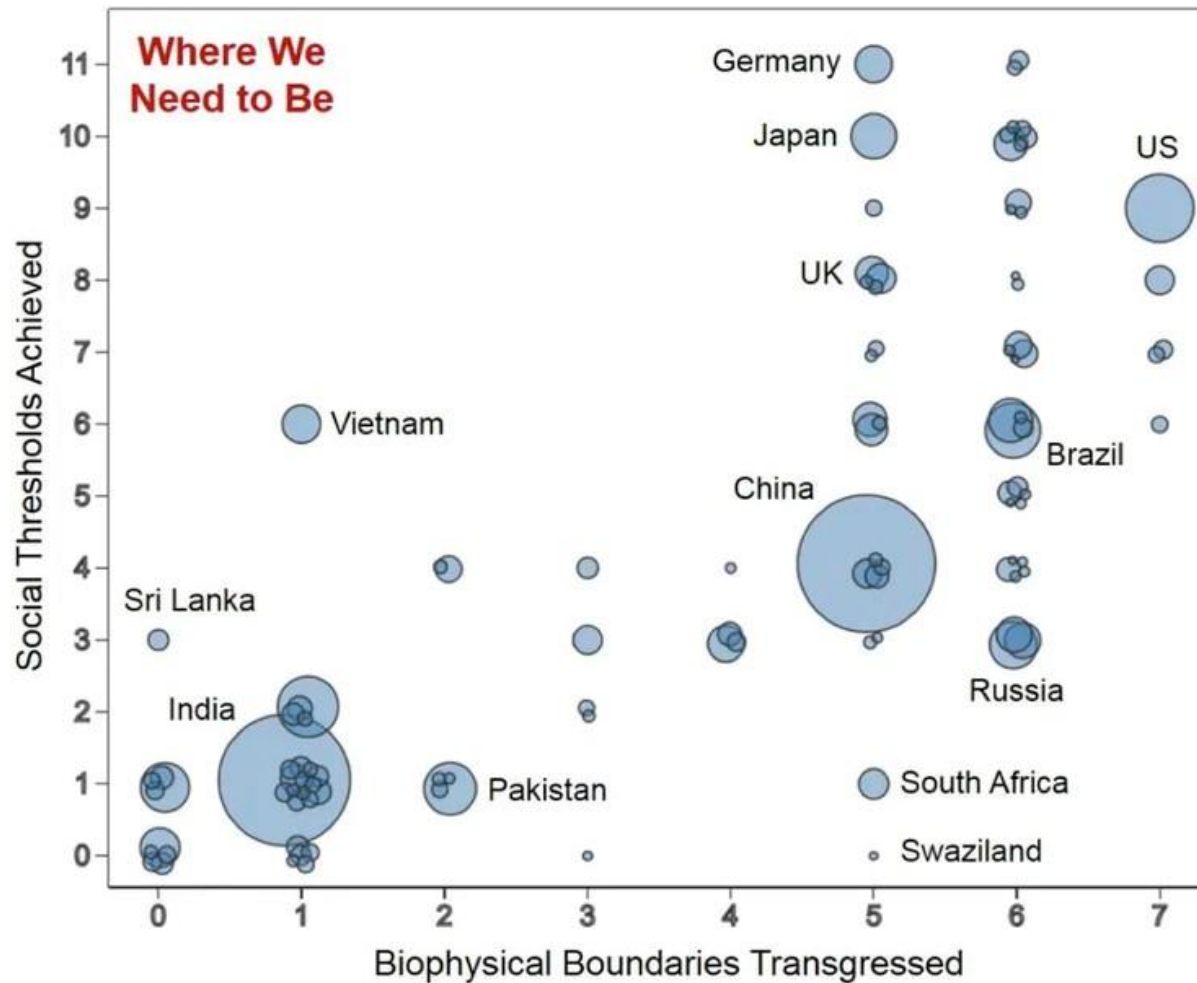
Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., ... & Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and society*, 14(2).

# Doughnut Economics



<https://doughnuteconomics.org/>

# A Good Life For All Within Planetary Boundaries



Measures of a 'good life' vs overuse of resources for different countries (scaled by population). Ideally, countries would be located in the top-left corner.  
O'Neill et al. Author provided

<https://theconversation.com/is-it-possible-for-everyone-to-live-a-good-life-within-our-planets-limits-91421>

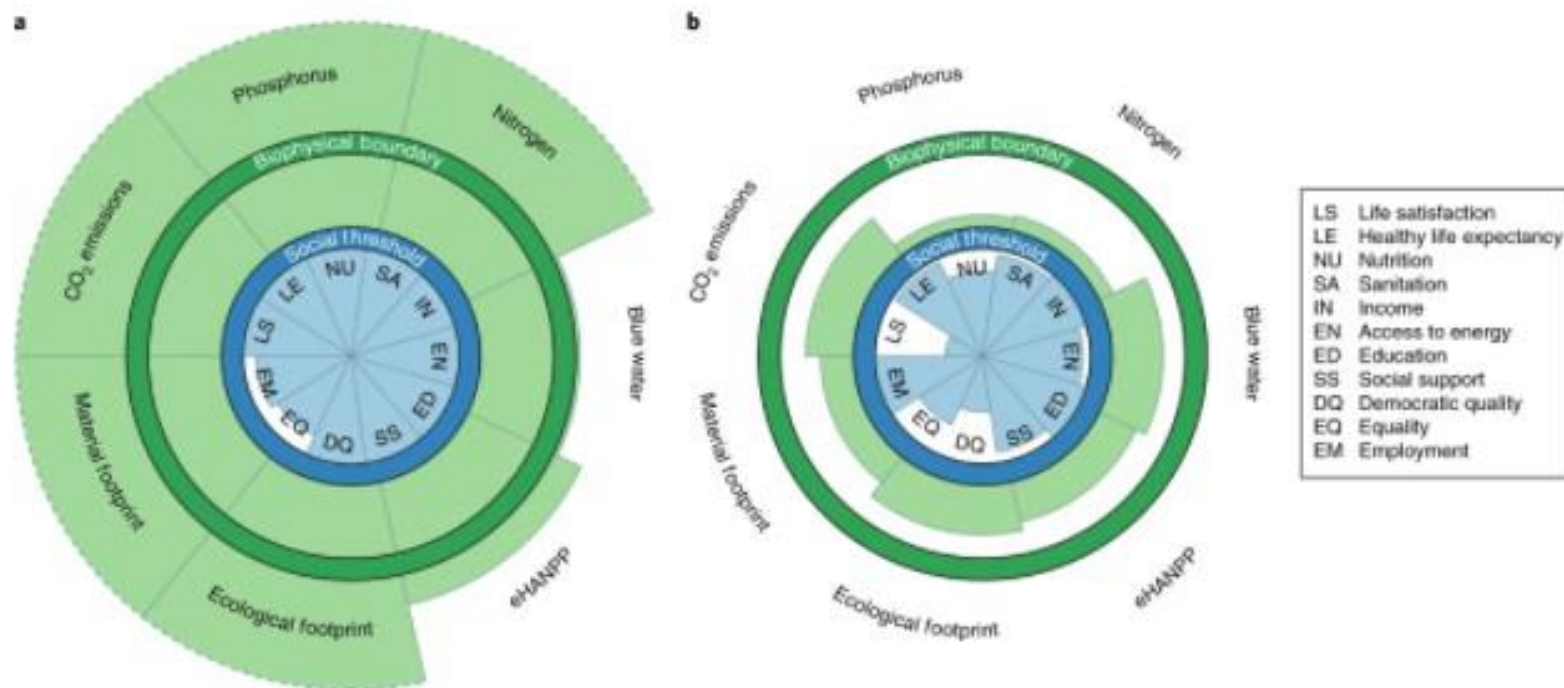
O'Neill, D.W., Fanning, A.L., Lamb, W.F. et al. A good life for all within planetary boundaries. *Nat Sustain* 1, 88–95 (2018).  
<https://doi.org/10.1038/s41893-018-0021-4>



# A Good Life For All Within Planetary Boundaries

**Fig. 3: National performance relative to a 'safe and just space' for two countries.**

From: A good life for all within planetary boundaries



**a**, The United States. **b**, Sri Lanka. Blue wedges show social performance relative to the social threshold (blue circle), whereas green wedges show resource use relative to the biophysical boundary (green circle). The blue wedges start at the centre of the plot (which represents the worst score achieved by any country), whereas the green wedges start at the outer edge of the blue circle (which represents zero resource use). Both the social thresholds and biophysical boundaries incorporate a range of uncertainties, and should be interpreted as fuzzy lines. Wedges with a dashed edge extend beyond the chart area. Ideally, a country would have blue wedges that reach the social threshold and green wedges within the biophysical boundary. See [Supplementary Data](#) for data for all countries and <https://goodlife.leeds.ac.uk> for an interactive website that produces plots for all countries.

O'Neill, D.W., Fanning, A.L., Lamb, W.F. et al. A good life for all within planetary boundaries. *Nat Sustain* 1, 88–95 (2018). <https://doi.org/10.1038/s41893-018-0021-4>



A photograph of a person with blonde hair, seen from behind, walking away on a gravel path that splits into two directions. The person is wearing a dark blue coat and carrying a large, bright yellow bag. The path is surrounded by green grass and trees, suggesting a park or campus setting. The text "Where to now?" is overlaid in white on the left side of the image.

**Where to now?**

# What about Energy Transition ?

National 4+ categories  
material flows

National 13+  
categories material  
flows

National material  
totals and ratios

Filter countries

Clear filter

World x

Filter categories

Clear filter

Fossil fuels x

Metal ores x

Filter flow types

Clear filter

DE (Domestic Extraction,... x

Country ^	Category ^	Flow ^	2020 ^	2021 ^	2022 ^	2023 ^	2024 ^
World	Fossil fuels	DE	362,033,658	15,823,307,613	15,915,740,174	15,998,218,386	16,102,490,158
World	Metal ores	DE	405,077,100	9,830,519,158	10,070,051,181	10,321,586,529	10,619,770,397

<https://www.resourcepanel.org/global-material-flows-database>



# What about Energy Transition ?



## All the Metals We Mined IN ONE CHART

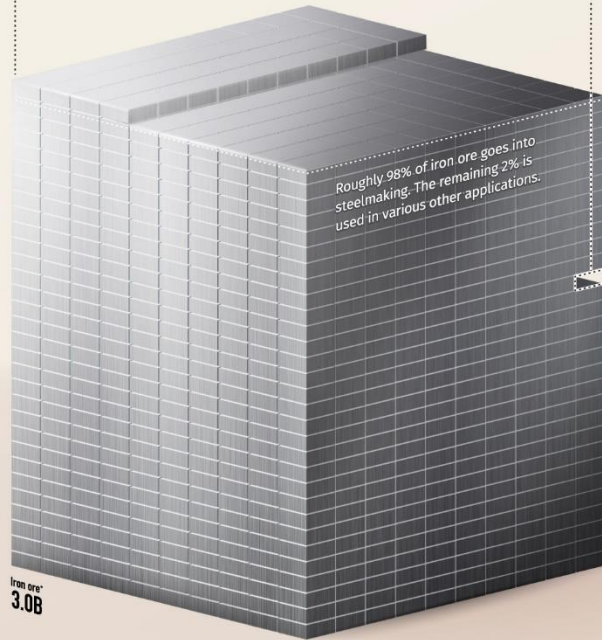
**Iron ore\***  
3,040,000,000 tonnes



Iron ore made up roughly 94% of the 3.2 billion tonnes of metals mined in 2019.



= 1,000,000 tonnes



### Industrial metals 207,478,486 tonnes



**Aluminum** is the world's second-most used metal after iron, found in everything from electronic devices to aircraft parts.



**Manganese** is mainly used in iron and steel manufacturing and is a key ingredient in lithium-ion batteries.



**Copper** production is one-third that of aluminum, though it has several uses ranging from wiring to construction.



**Chromium** enhances the hardenability and corrosion resistance of stainless steel.



**Total Metals** 3,248,814,334 tonnes

Metals are the building blocks of the global economy. From iron ore to rare earths, here are all the metals we mined in 2019.



### Metals vs. Ores

**Ores** are naturally occurring rocks that contain metals or metal compounds.

**Metals** are the valuable parts of ores that can be extracted and sold.

### Tech and precious metals 1,335,848 tonnes



**Niobium** is a rare metal used in superalloys for jet and rocket engines.



**Lithium and cobalt** are critical ingredients of lithium-ion batteries for electric vehicles.



**Indium** is used to make indium tin oxide, an important part of touch screens, TVs, and solar panels.

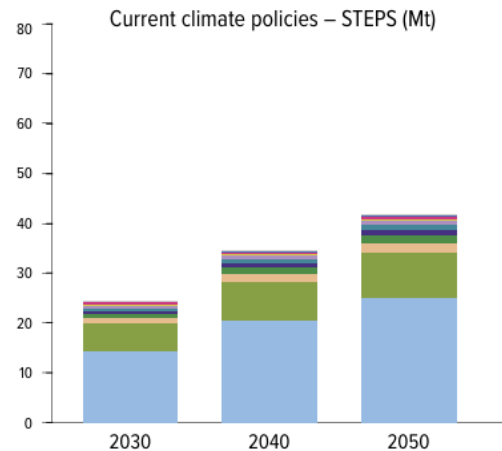


<https://www.visualcapitalist.com/all-the-metals-we-mined-in-one-visualization/>

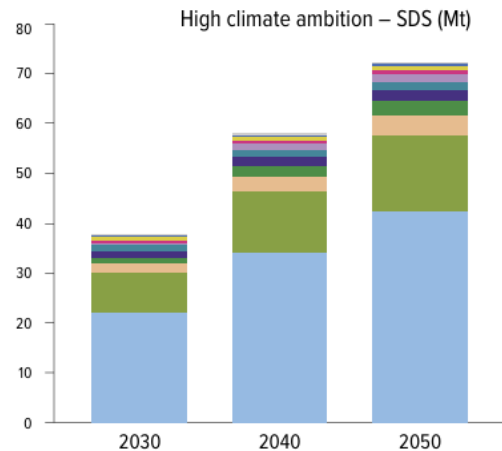


# What about Energy Transition ? Metal needs

Global metal demand by commodity for clean energy technologies in a STEPS and SDS scenario respectively (Mt\*)



2050 Metals demand  
Current climate policy | **45Mt**



2050 Metals demand  
Ambitious climate policy | **75Mt**

\*Mt = million tonnes, annual (including lithium expressed as metal equivalent)

% metal required in 2050 for clean energy technologies vs. 2020 overall use (Global SDS ambitious climate scenario).\*\* †

Lithium	2,109%	Silicon	62%
Dysprosium	433%	Terbium	62%
Cobalt	403%	Copper	51%
Tellurium	277%	Aluminium	43%
Scandium	204%	Tin	28%
Nickel	168%	Germanium	24%
Praseodymium	110%	Molybdenum	22%
Gallium	77%	Lead	22%
Neodymium	66%	Indium	17%
Platinum	64%	Zinc	14%
Iridium	63%	Silver	10%

<https://www.eurometaux.eu/media/hr2ftbp3/2022-policymaker-summary-report-final-13-5-22.pdf>

# What about Energy Transition ? (Lithium need in EU x35)

**World Mine Production and Reserves:** Reserves for Argentina, Australia, Brazil, China, the United States, and “Other countries” were revised based on company and Government reports.

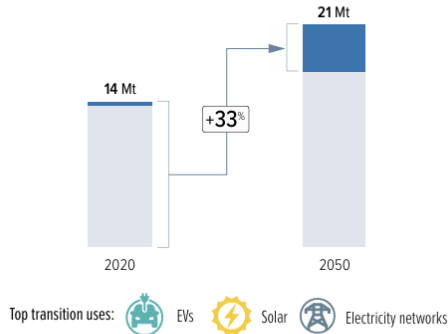
	Mine production		Reserves <sup>4</sup>
	<u>2022</u>	<u>2023<sup>e</sup></u>	
United States	W	W	1,100,000
Argentina	6,590	9,600	3,600,000
Australia	74,700	86,000	<sup>5</sup> 6,200,000
Brazil	<sup>e</sup> 2,630	4,900	390,000
Canada	<sup>e</sup> 520	3,400	930,000
Chile	38,000	44,000	9,300,000
China	<sup>e</sup> 22,600	33,000	3,000,000
Portugal	<sup>e</sup> 380	380	60,000
Zimbabwe	<sup>e</sup> 1,030	3,400	310,000
Other countries <sup>6</sup>	—	—	<u>2,800,000</u>
World total (rounded)	<u><sup>7</sup>146,000</u>	<u><sup>7</sup>180,000</u>	28,000,000

<https://www.usgs.gov/centers/national-minerals-information-center/lithium-statistics-and-information>

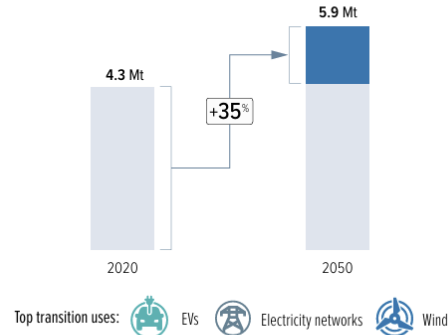
# What about Energy Transition ? In Eu ? Opening of new Mines ?

● Energy transition uses ● Other uses

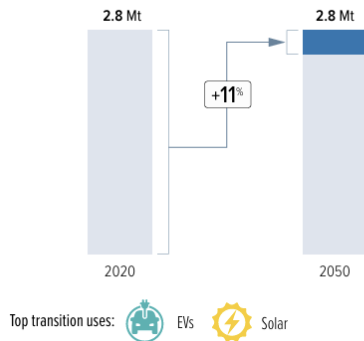
Aluminium (Mt)



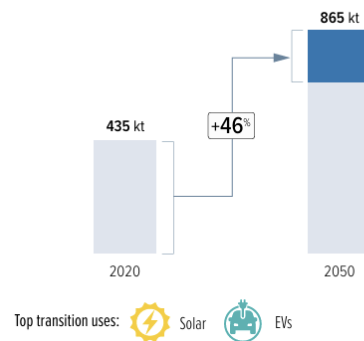
Copper (Mt)



Zinc (Mt)



Silicon (kt)



## BATTERY METALS

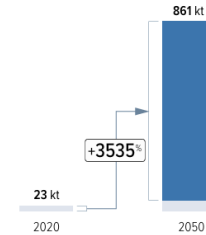
Europe will require significant new supplies of nickel, lithium, and cobalt for its domestic battery cathode manufacturing plans. Of these metals, Europe only has a significant existing market for nickel, which is mainly used in stainless steel.

By 2050, batteries will be Europe's major use for lithium, nickel, and cobalt under all the study's scenarios, with new demand

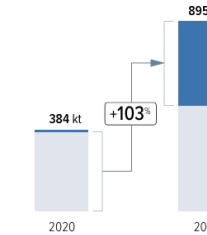
reaching up to 3500% of Europe's lithium consumption today, 330% of cobalt, and more than 100% of nickel.

Uncertain technology developments after 2030 will likely impact these long-term projections. Regular attention is required to the battery market and potential breakthrough technologies.

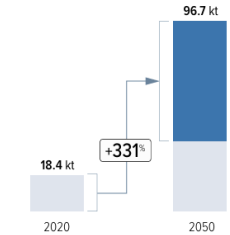
Lithium (kt, LCE)



Nickel (kt)



Cobalt (kt)



Top transition uses (all battery metals): EVs, Battery storage

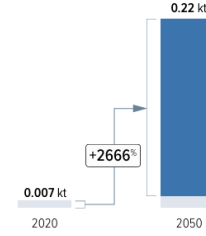
## RARE EARTH METALS

Significant volumes of rare earth elements in permanent magnets will be required in Europe's electric vehicles and wind turbines.

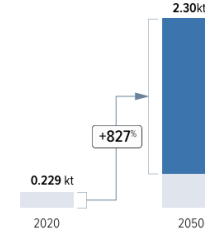
But Europe will only require new supplies of rare earth metals if it is successful in building up domestic permanent magnets production – competing against China's near monopoly of the rare earths/permanent magnets market.

Even a moderate level of European domestic magnets production would transform the European rare earths market, requiring between 600% and 2700% extra compared with Europe's consumption today.

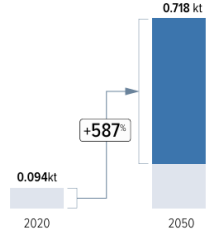
Dysprosium (kt)



Neodymium (kt)



Praseodymium (kt)



Top transition uses (rare earth elements): EVs, Wind

<https://www.eurometaux.eu/media/hr2ftbp3/2022-policymaker-summary-report-final-13-5-22.pdf>

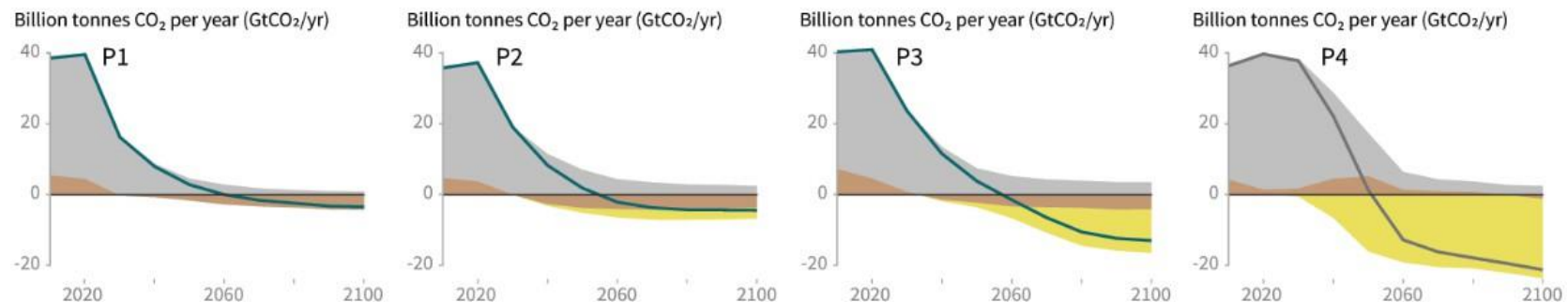
# IPCC Pathways that stay under 1,5 C

## Characteristics of four illustrative model pathways

Different mitigation strategies can achieve the net emissions reductions that would be required to follow a pathway that limits global warming to 1.5°C with no or limited overshoot. All pathways use Carbon Dioxide Removal (CDR), but the amount varies across pathways, as do the relative contributions of Bioenergy with Carbon Capture and Storage (BECCS) and removals in the Agriculture, Forestry and Other Land Use (AFOLU) sector. This has implications for emissions and several other pathway characteristics.

## Breakdown of contributions to global net CO<sub>2</sub> emissions in four illustrative model pathways

● Fossil fuel and industry ● AFOLU ● BECCS



**P1:** A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

**P2:** A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

**P3:** A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

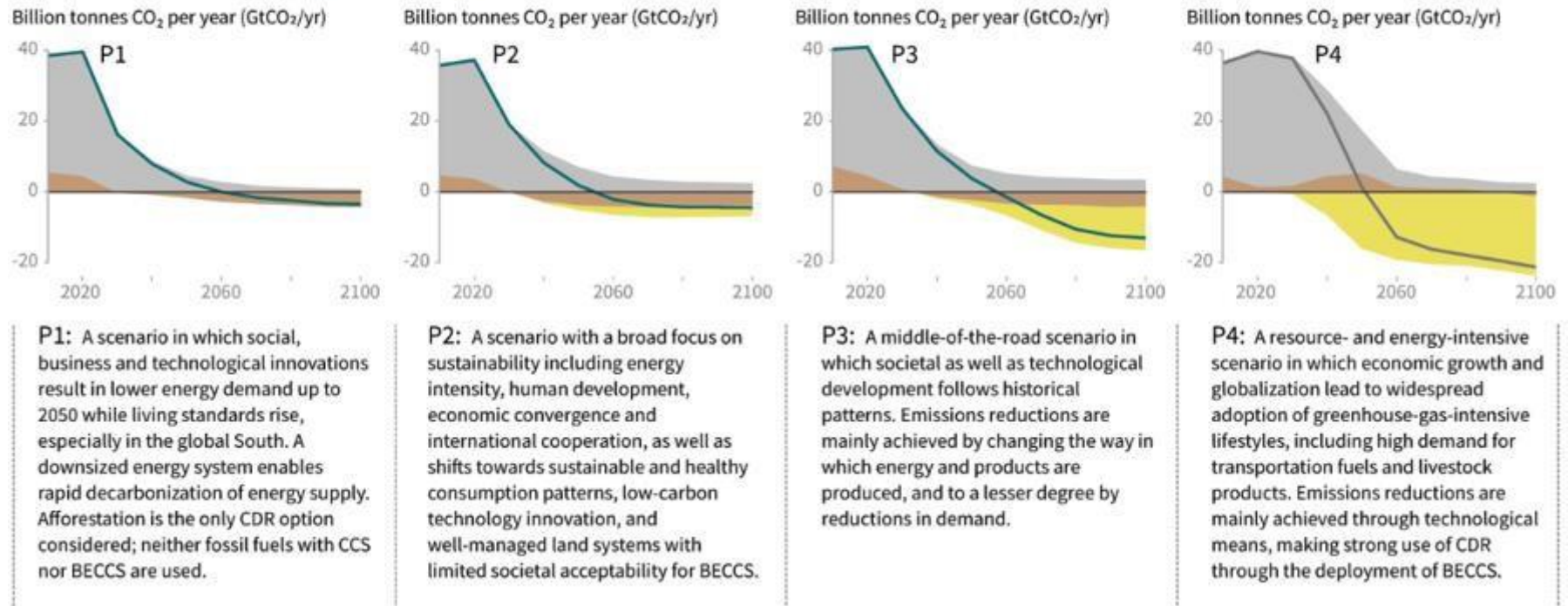
**P4:** A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Source: IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24, doi:[10.1017/9781009157940.001](https://doi.org/10.1017/9781009157940.001).



# What Scenario is most desirable ?

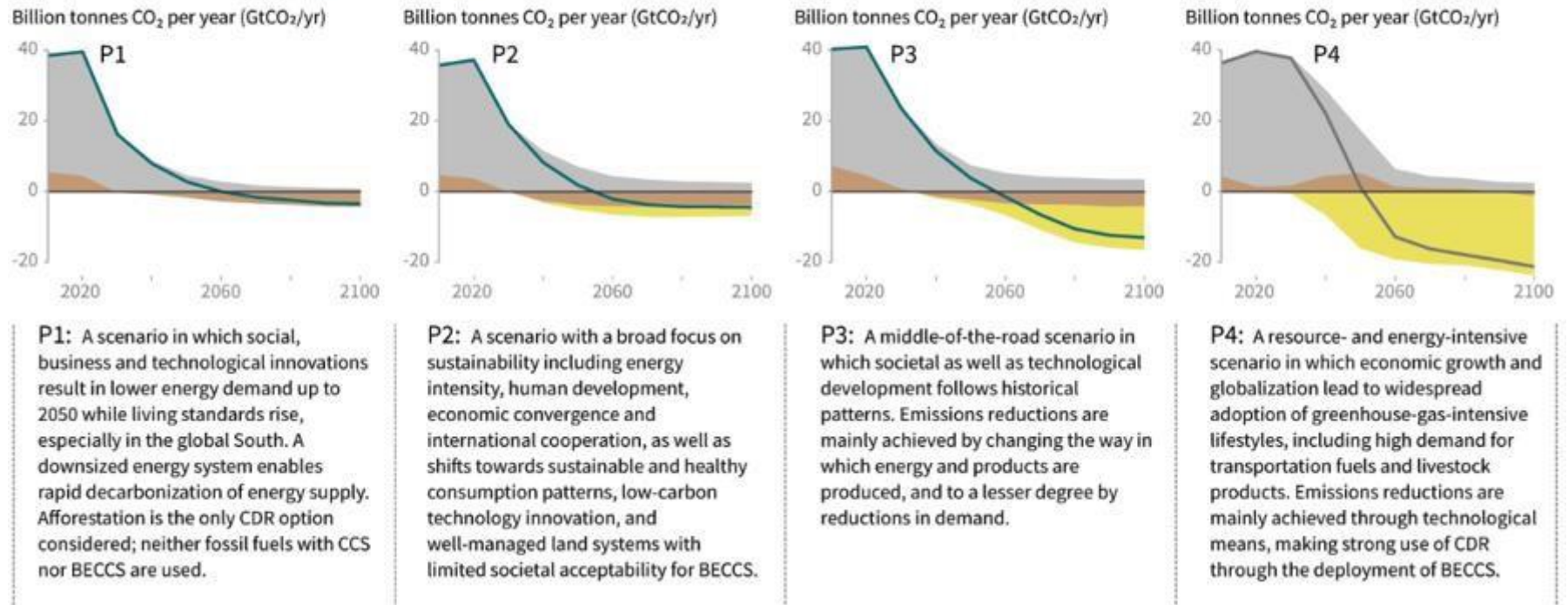
● Fossil fuel and industry ● AFOLU ● BECCS



Source: IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24, doi:[10.1017/9781009157940.001](https://doi.org/10.1017/9781009157940.001).

# What Scenario is most likely ?

● Fossil fuel and industry ● AFOLU ● BECCS

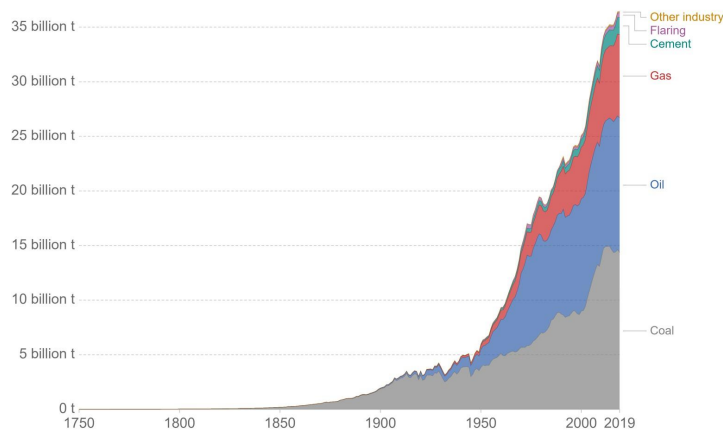


Source: IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24, doi:[10.1017/9781009157940.001](https://doi.org/10.1017/9781009157940.001).

# What solutions do we have ? Technologies

## CO<sub>2</sub> emissions by fuel type, World

Annual carbon dioxide (CO<sub>2</sub>) emissions from different fuel types, measured in tonnes per year.



Source: Global Carbon Project

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.

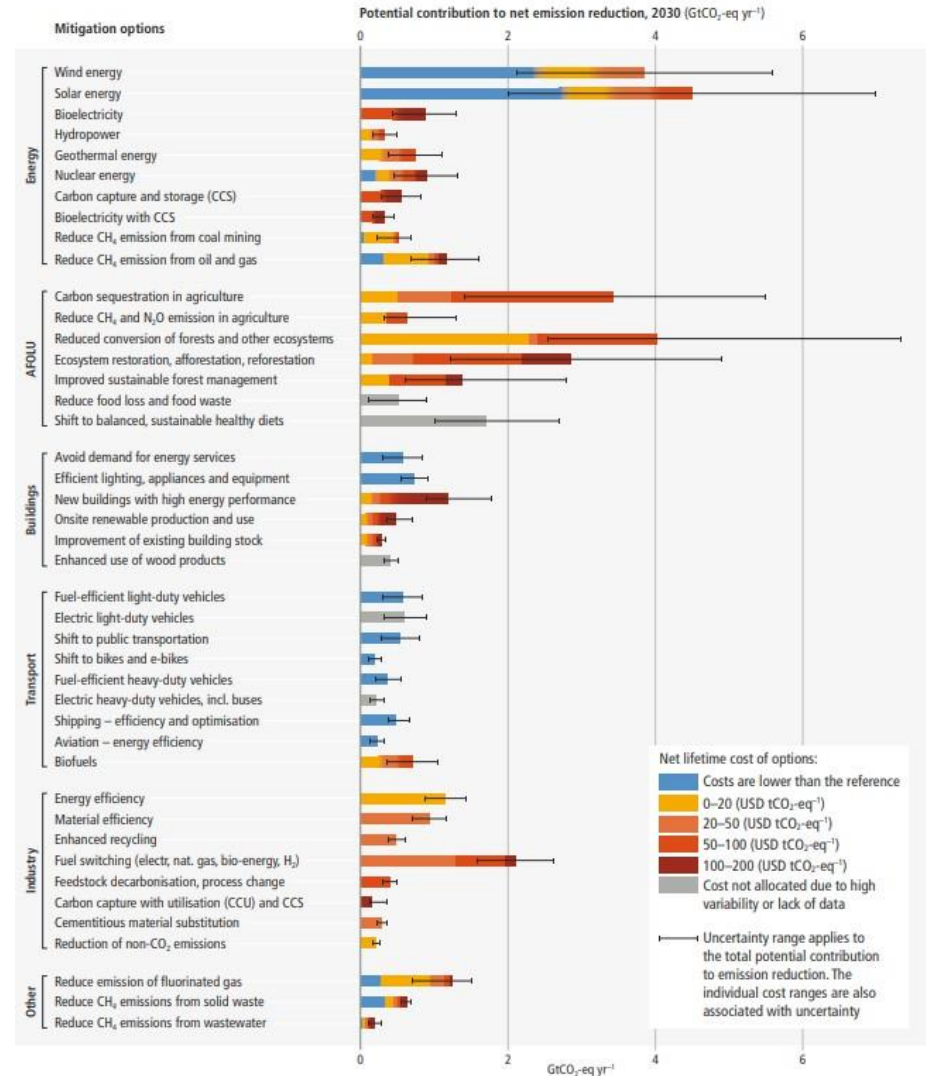


Figure SPM.7 | Overview of mitigation options and their estimated ranges of costs and potentials in 2030.

Source: IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.

# What solutions do we have ? - Sufficiency

Sufficiency policies are a set of measures and daily practices that avoid demand for energy, materials, land and water while delivering human well-being for all within planetary boundaries.



Global Environmental Change  
Volume 65, November 2020, 102168



## Providing decent living with minimum energy: A global scenario

Joel Millward-Hopkins<sup>a</sup>, Julia K. Steinberger<sup>a,b</sup>, Narasimha D. Rao<sup>c,d</sup>, Yannick Oswald<sup>a</sup>

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### Highlights

- Providing Decent Living with Minimum Energy: A Global Scenario.
- As ecological breakdown looms, the basic material needs of billions remain unmet.
- We estimate the minimal energy for providing decent living globally & universally.
- Despite population growth, 2050 global energy use could be reduced to 1960 levels.
- This requires advanced technologies & reductions in demand to sufficiency levels.
- But 'sufficiency' is far more materially generous than many opponents often assume.

Table 1. . Inventory of the prerequisites for Decent Living Standards (DLS) (Rao and Min, 2018a) broken-down into key material requirements and services. The final column indicates where we implement regional variations in the model, and gives a brief explanation; the Supplementary Materials give full details.

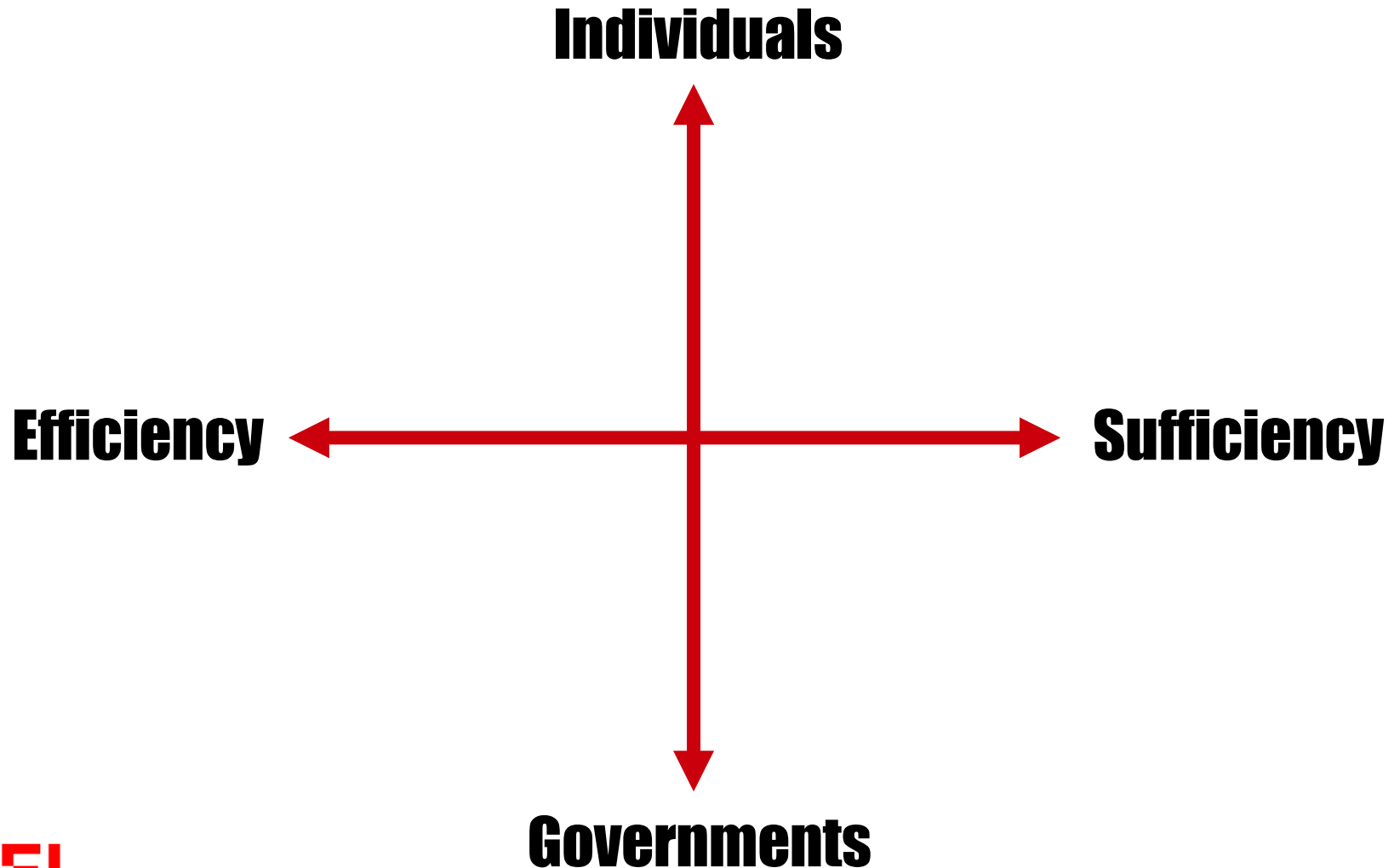
DLS dimension	Material requirements and services	Regional variation
Nutrition	Food	Consumption varies with countries' age structures
	Cooking appliances	None implemented
	Cold Storage	None implemented
Shelter and living conditions	Sufficient housing space	None implemented
	Thermal comfort	Requirements vary with regional HDDs and CDDs
	Illumination	None implemented
Hygiene	Water supply	Intensity varies with water scarcity (higher scarcity→higher intensities)
	Water heating	Intensity varies with countries' average temperatures
	Waste management	None implemented
Clothing	Clothes	None implemented
	Washing facilities	None implemented
Healthcare	Hospitals	None implemented
Education	Schools	Requirements vary with age structures (more young people→more schools)
Comms' and information	Phones	Requirements vary with age structures (more children <10yo→less phones)
	Computers	None implemented
	Networks+data centres	None implemented
Mobility	Vehicle production	Activity levels and mode shares vary with countries' adjusted ('lived') population densities (higher densities→lower activity levels)
	Vehicle's propulsion	
	Transport infrastructure	



**Who has to do something about it ?**

**How to do it ?**

**Give me some solutions ?**



# What is happening ? Paris agreement (2015)



# SDGs (2030)



# Green New Deal





# EU Green New Deal



# Examples at a city level (Lausanne climat)

 Ville de Lausanne



Plan climat

0% carbone

100% solidaire



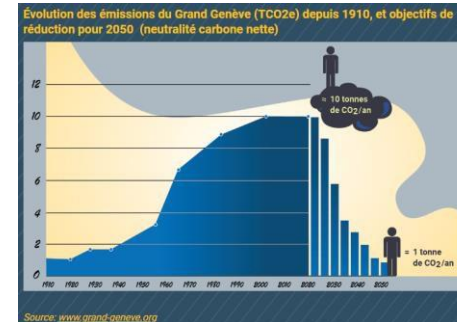
## PLAN CLIMAT CANTONAL 2030

2<sup>e</sup> GÉNÉRATION



**PARTIE I:** Objectifs et stratégie

**PARTIE II:** Plan de mesures 2021-2023



Source: <https://www.ge.ch/teaser/plan-climat-cantonal-geneve-2030/plan-climat>

Source: <https://www.ge.ch/document/24973/telecharger>

# Examples at a city level (Transition Towns)



Select Language ▼



Search...

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Donate

Get involved

About the Movement

Transition Near me

Stories

Do Transition

News and blog

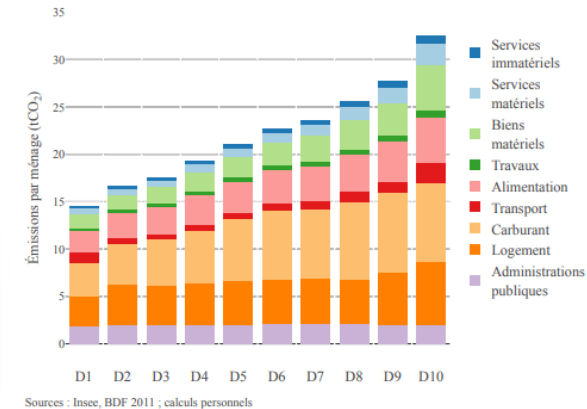
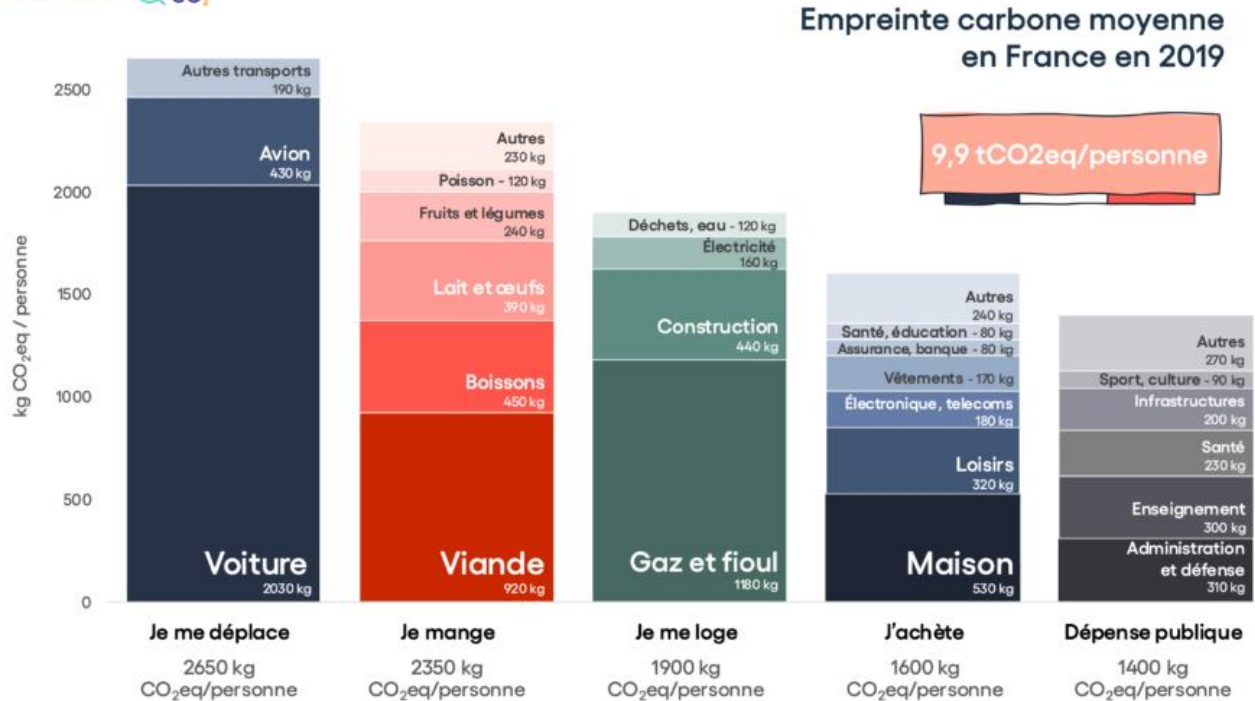
A movement of communities coming together to reimagine and rebuild our world



<https://transitionnetwork.org/>



# Everyday choices – what can you cut off?



Gaz inclus : CO<sub>2</sub> (hors UTCATF France), CH<sub>4</sub>, N<sub>2</sub>O, HFC, SF<sub>6</sub>, PFC, H<sub>2</sub>O (trainées de condensation).  
Source : MyCO<sub>2</sub> par Carbone 4 d'après le ministère de la Transition écologique, le Haut Conseil pour le Climat, le CITEPA, Agribalyse V3 et INCA 3.

Source: <https://bonpote.com/comment-calculer-son-empreinte-carbone/>

Source: Pottier, A., Combet, E., Cayla, J. M., de Lauretis, S., & Nadaud, F. (2020). Qui émet du CO<sub>2</sub>? Panorama critique des inégalités écologiques en France. *Revue de l'OFCE*, 169(5), 73-132.



# Where to now? Let's vote

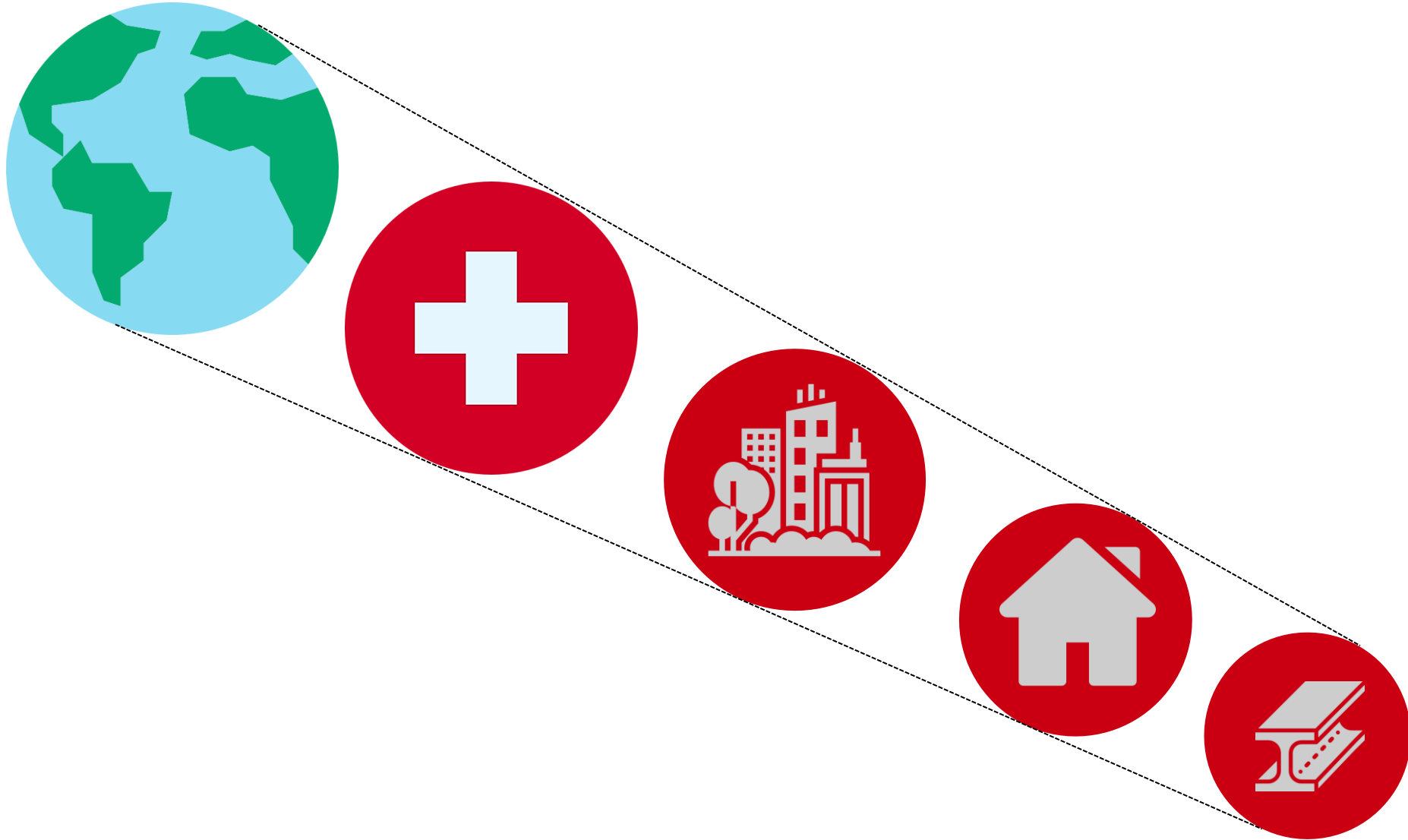


- Degrowth
- Technological fix
- Policy vs everyday choices

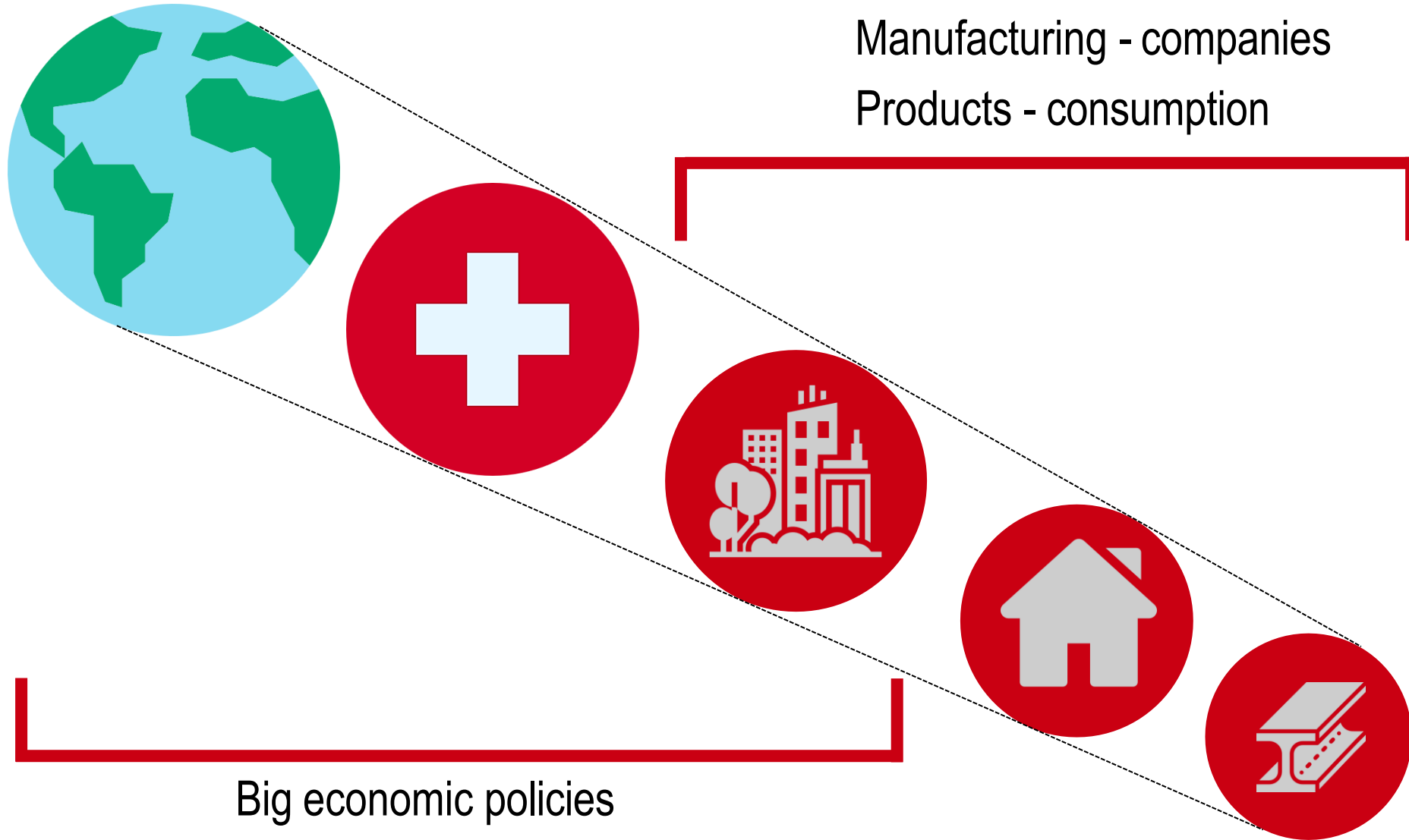
	Degrowth	Technofix
Individual	A	B
Policy	C	D



# Link from Planet to Product



# Link from Planet to Product – what systemic vantage point?



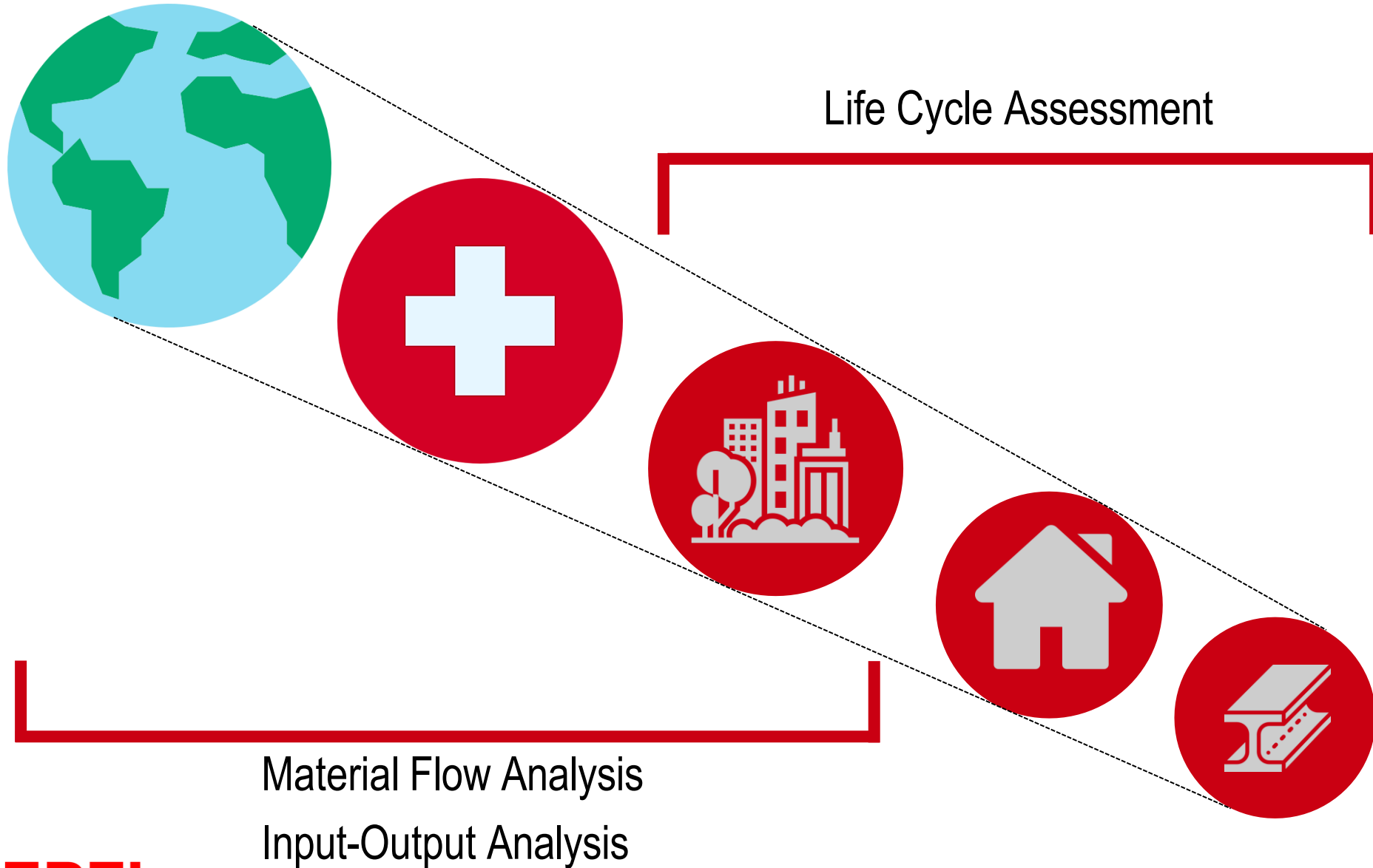
Manufacturing - companies

Products - consumption

Big economic policies

Global challenges

# Link from Planet to Product – accounting methods

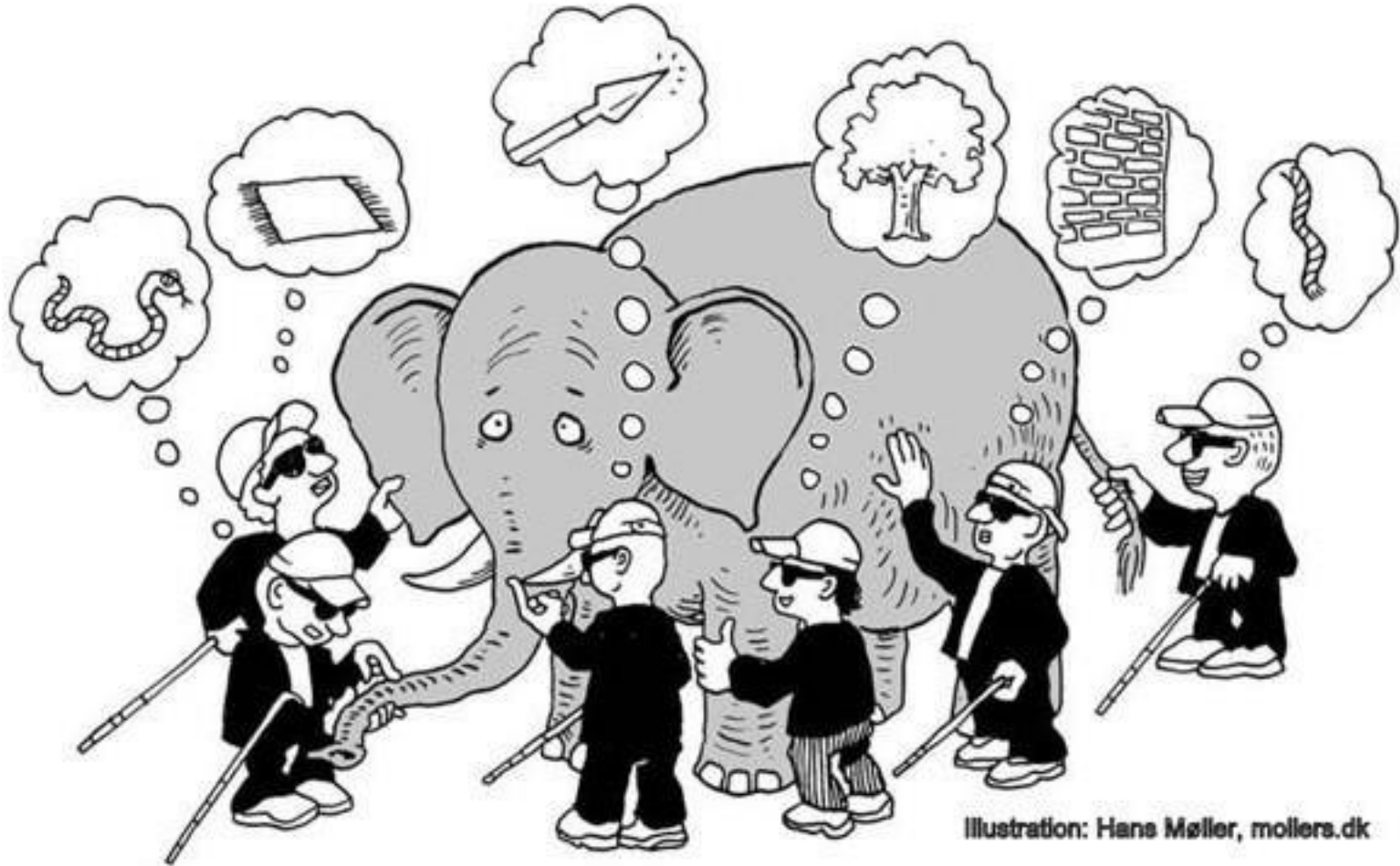




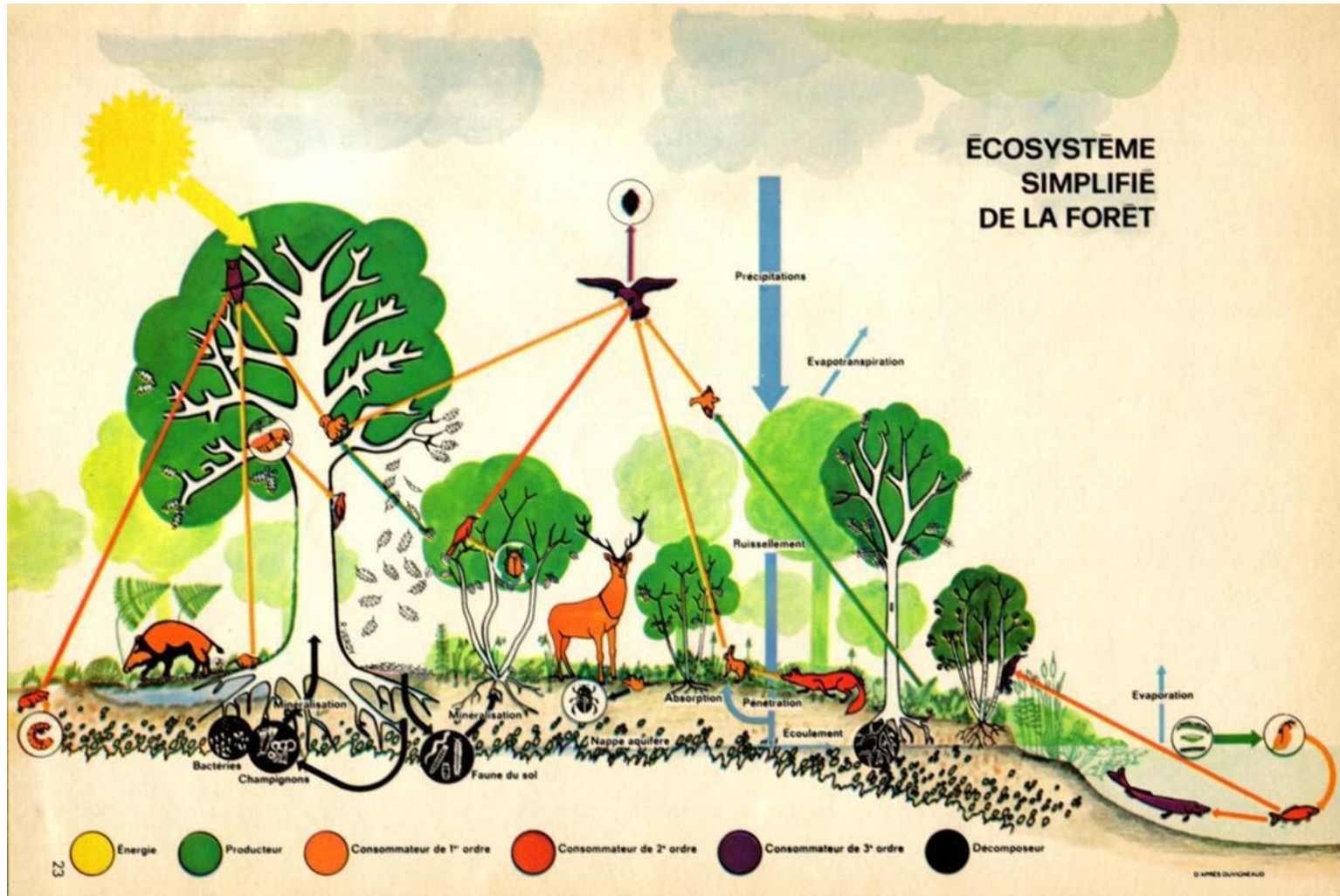
# Systems thinking

# What is a system?

# The elephant and the blind men – what is a system?



# What is a system?



Duvigneaud, P. (1974). A synthesis of ecology: populations, communities, ecosystems, biosphere and noosphere. Doin, éditeurs..

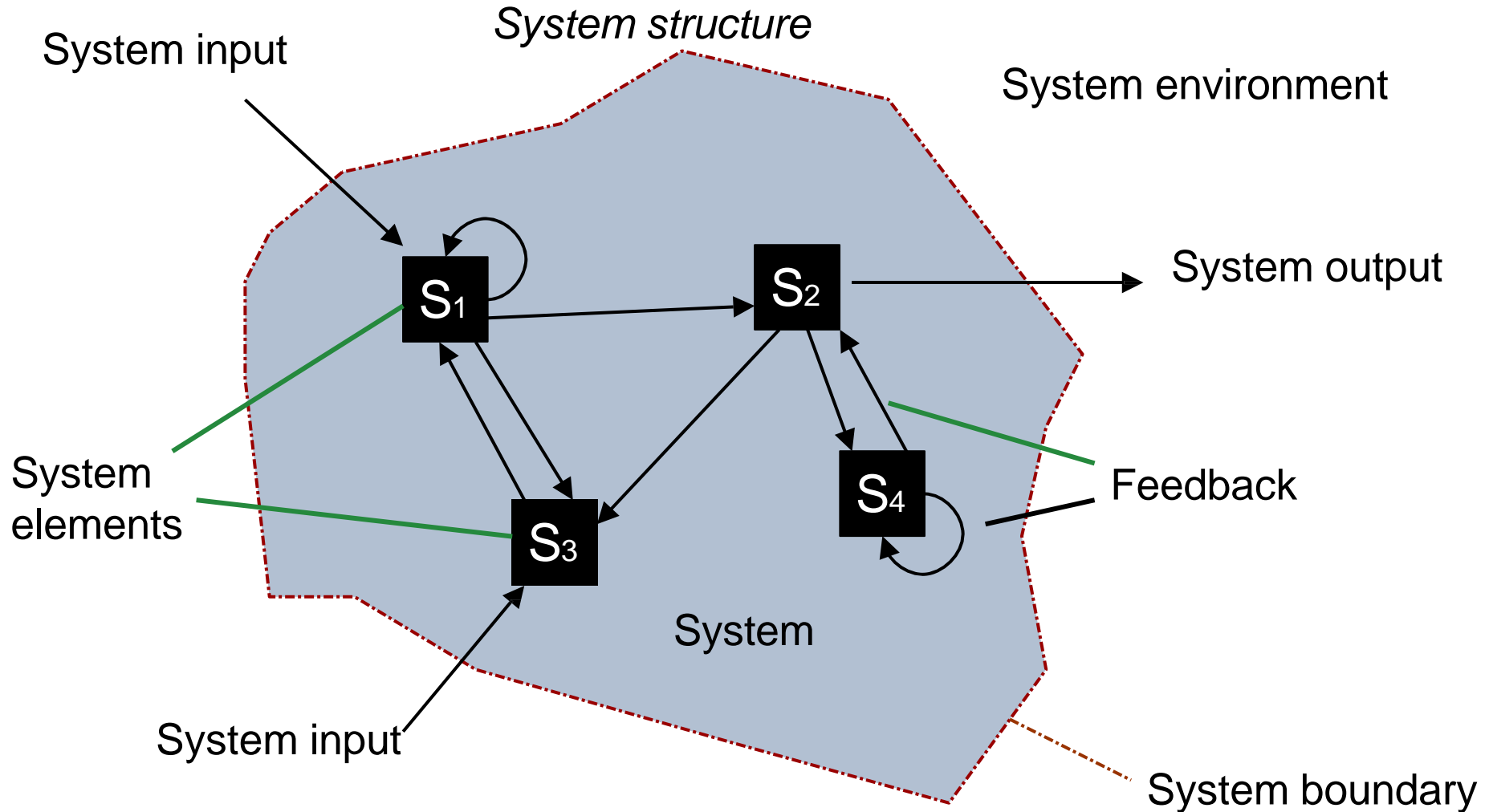


# What is a system?

A **system** is anything that is composed of system **elements** connected in a characteristic system **structure**. This configuration of system elements allows it to perform specific system **functions** in its system **environment**.

These functions can be interpreted as serving a distinct system **purpose**. The system **boundary** is permeable for **inputs** from and **outputs** to the environment. It defines the system's **identity** and **autonomy**. (Bossel, 1999)

# What is a system? Elements, interrelations, system boundaries



After Bossel, 2004; Mroczek, 2009

# What is a system? System boundary

- Defines what is inside of the system to be analysed and what belongs to the system context
- Defines inputs and outputs of the system
- Elements of a system boundary: space and time.

# What is a system? The role of system boundaries

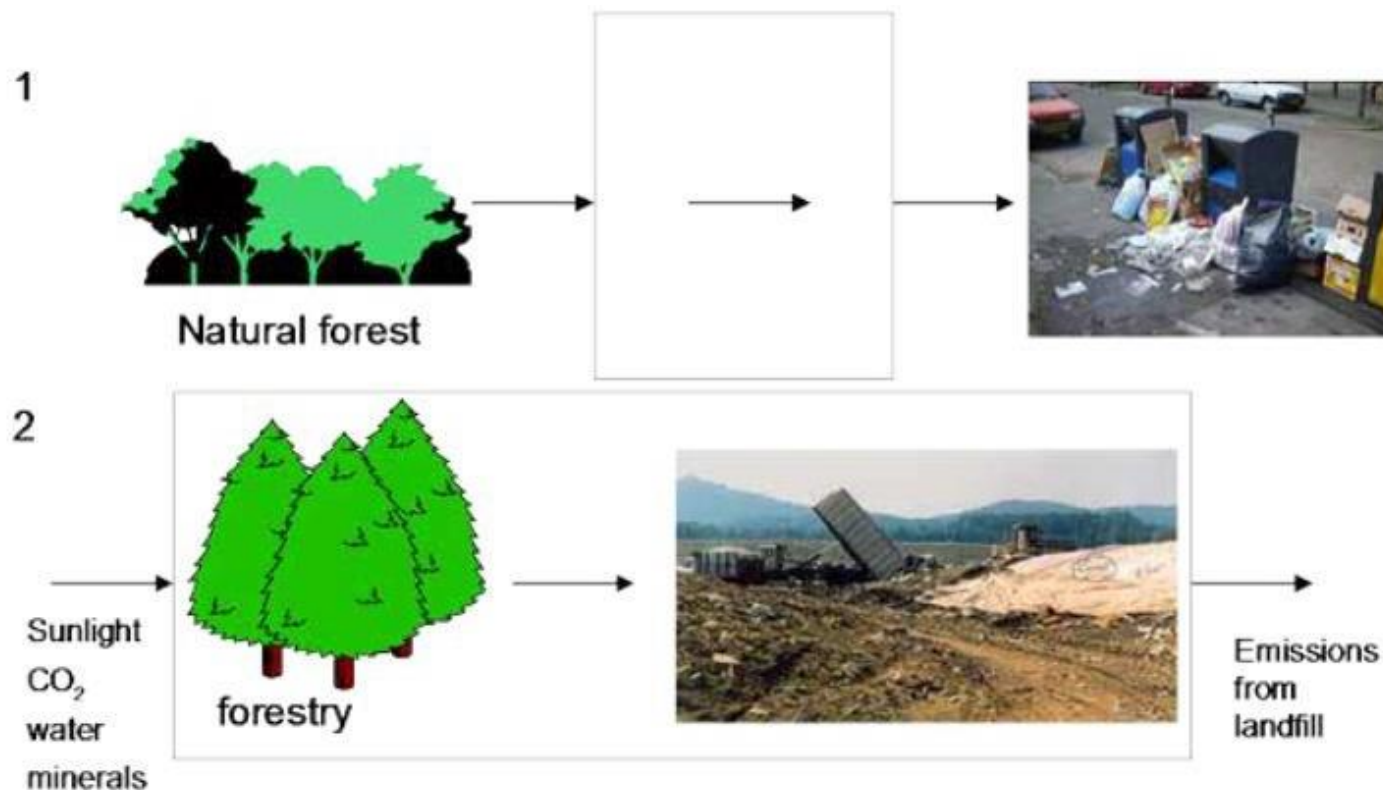


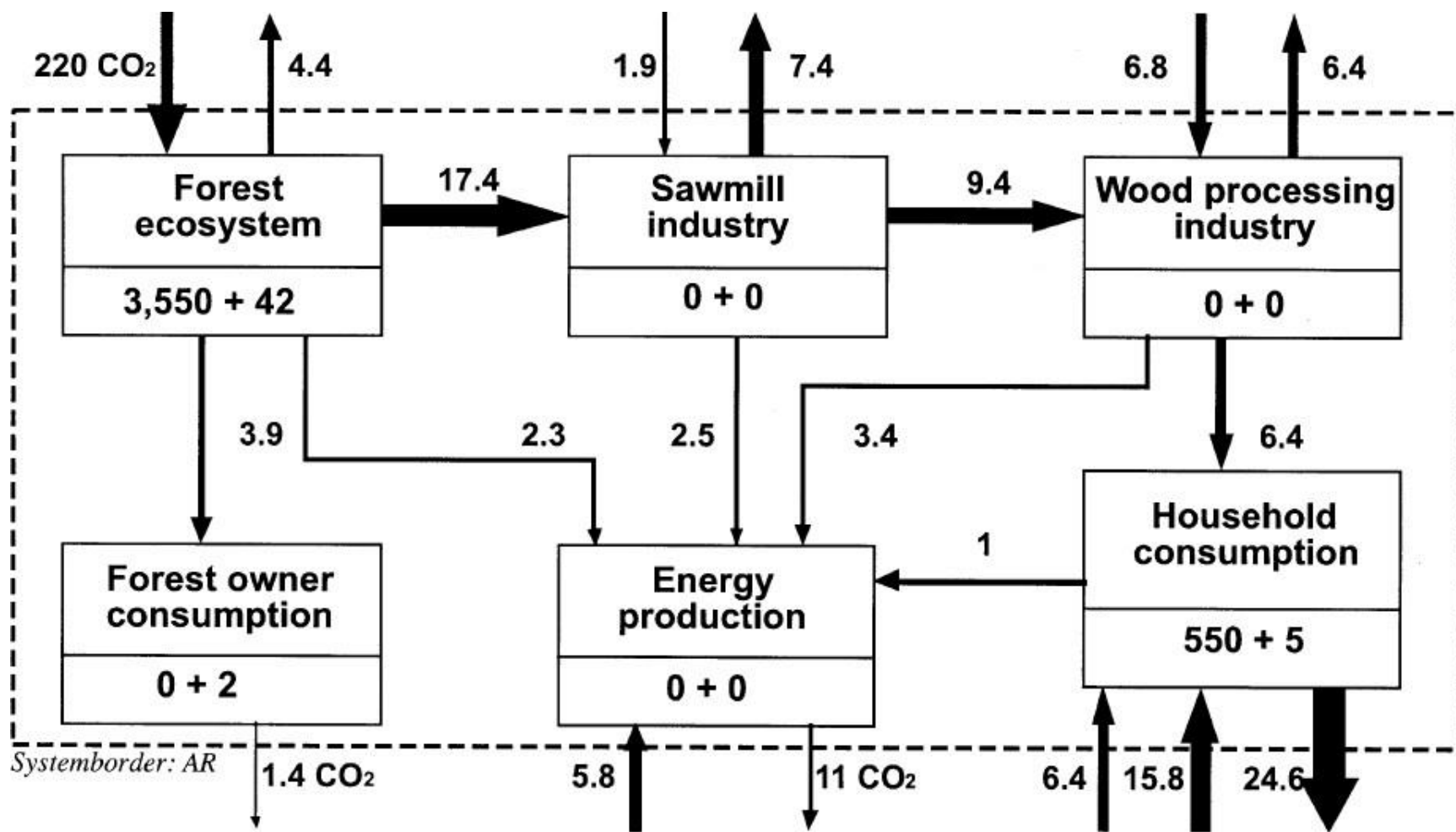
Figure 2 : Two ways of defining system boundaries between physical economy and environment in LCA; a) with narrow system boundaries, b) with extended boundaries.

Jeroen B. Guinée, 2001



# Example – The wood flow in Appenzell Ausserrhoden

Stock in 1000 m<sup>3</sup>; wood flow in 1000 m<sup>3</sup> wood/year; CO<sub>2</sub> flow in 1000 t CO<sub>2</sub>



# System purpose – Function of systems

What are some functions of systems ?

# System purpose – Function of systems

- Self-preservation (biological and social systems)
- Conservation of a stable state (body temperature)
- Reproduction and multiplication (biol. und social systems)
- Security and shelter (ABS, airbag)
- Production (brewery → beer)
- Provision of housing
- Provision of services (health, communication, transport, etc.)

# System structure – elements / interrelations

- **Structure:** Internal composition and interrelations within a system
  - subsystems and their hierarchy;
  - specific system elements and their characteristics (types, diversity, parsimony, sufficiency);
  - the relation or interaction between the system elements (connectivity, feedbacks).
- **Dynamics:** Development over time



The dynamics of a system are determined primarily by its (static) structure.

„Structure determines dynamics“

Examples: „arguing couple“, arms race



# System dynamics – Causal loops (i)

Conceptual representation by means of **Causal Loop Diagrams (CLD)**

- CLDs are used to depict **causal relations** in systems
- CLDs help **revealing feedback** in systems
- The CLD notation is a tool to **communicate** complex system structures.
- A CLD may be **drawn before model implementation** to get acquainted with the system.
- The CLD can be **derived from a Stock and Flow model** to reveal feedback not apparent from the Stock and Flow structure.

# System dynamics – Causal loops (ii)

- The arrows in a causal loop diagram are label + or – depending on whether the causal influence is positive or negative!
- Two variables change in the **same direction** – positive polarity

Number of Births  $\xrightarrow{+}$  Population

- Two variables change in the **opposite direction** – negative polarity

Number of fatalities  $\xrightarrow{-}$  Population

# System dynamics – Causal loops (iii)

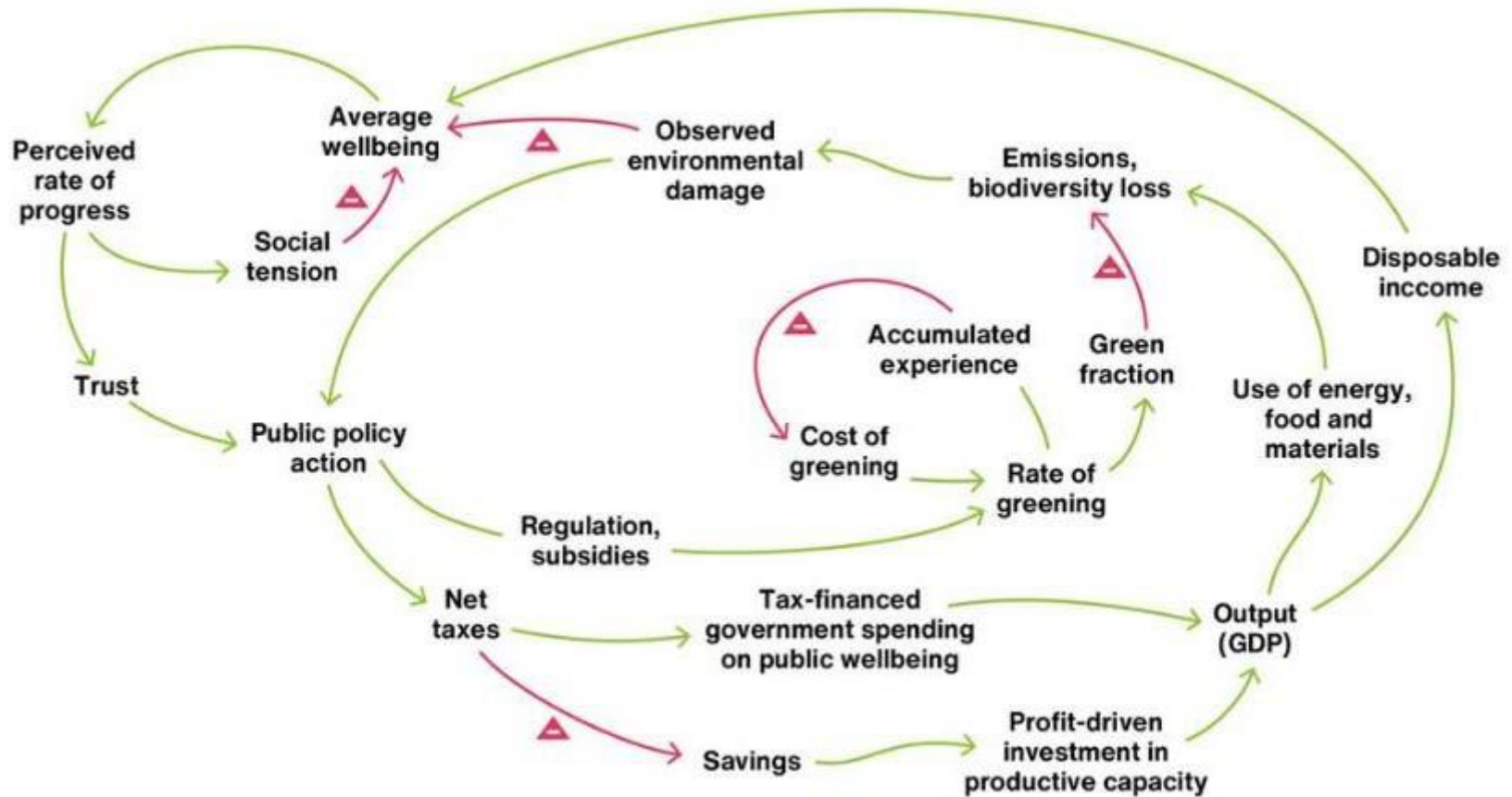
## **Positive Feedback** (enforcing feedback):

Feedback is positive, if a loop consists of causalities with positive polarity only or an even number of negative polarities

## **Negative Feedback** (balancing feedback):

Feedback is negative, if a loop consist of an uneven number of negative causal relations.

# System dynamics – Causal loops diagram example



SOURCE: Fayard et al., 2020

Source: <https://www.earth4all.life/the-science>

# **Systems science**



# Systems science

**System sciences** focus on interrelations and feedbacks within systems

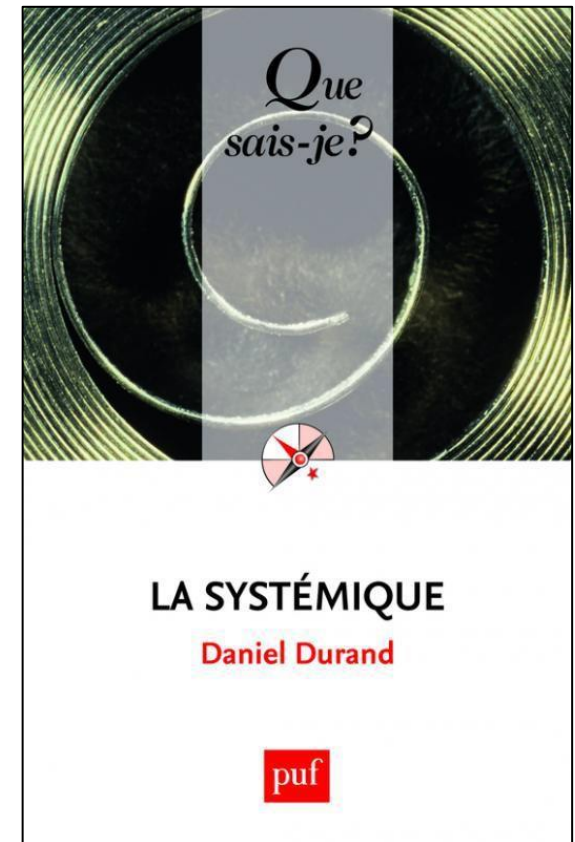
## Goals:

- Understanding the dynamics of systems
- Insights into future developments / simulations
- Management approaches

## Principle:

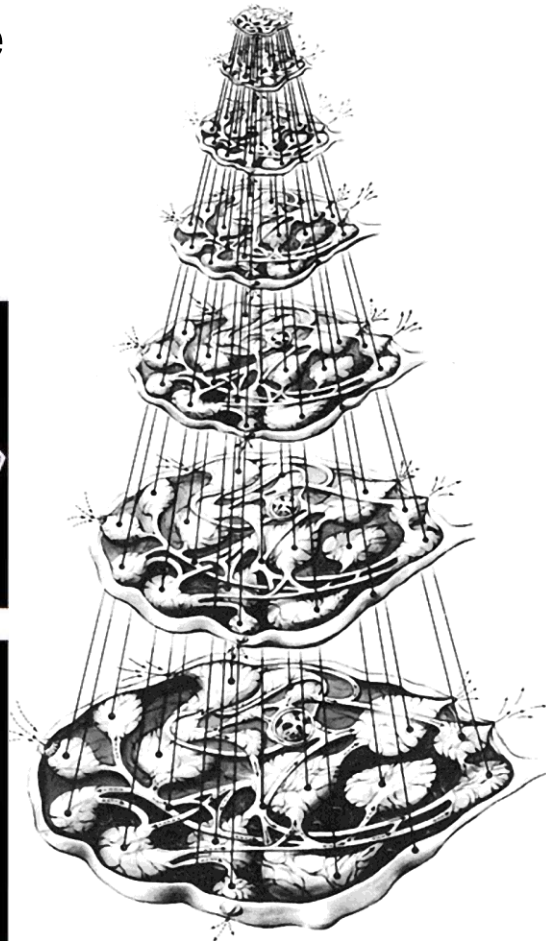
„The whole is more than the sum of its parts.“

Aristoteles (384-322 v. Chr.)



# Systems science : Emergence

In philosophy, systems theory, science, and art, **emergence** occurs when an entity is observed to have **properties its parts do not have on their own**, properties or behaviors which emerge only when the parts interact in a wider whole (Wikipedia, 2021).



Cell

Organ

Organism

Group

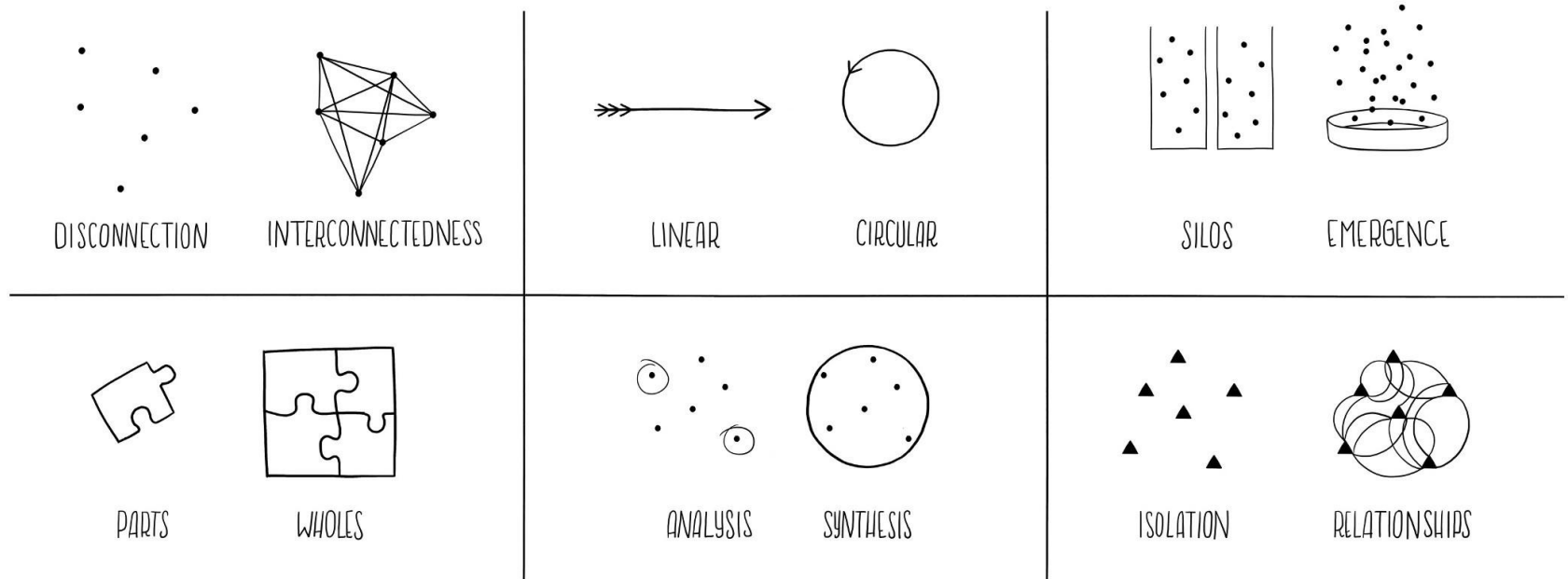
Society

Supranational

<https://en.wikipedia.org/wiki/Emergence#/media/File:SnowflakesWilsonBentley.jpg>

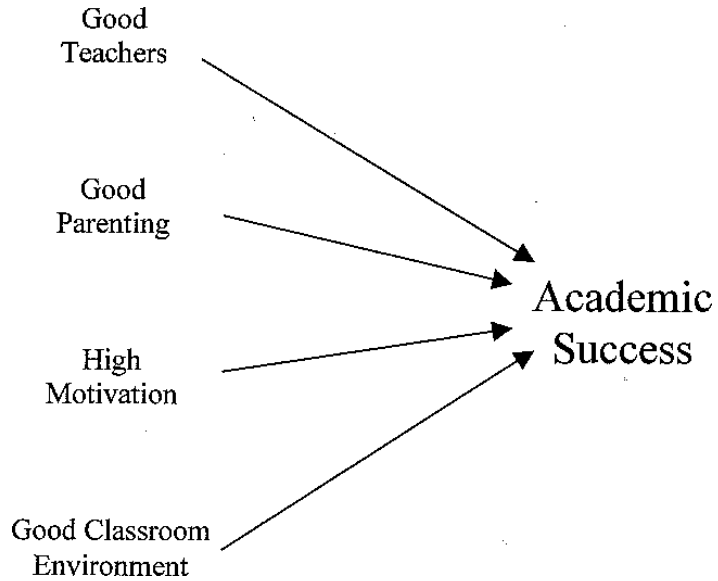
# Systems science: analytical vs systems thinking

## TOOLS OF A SYSTEM THINKER

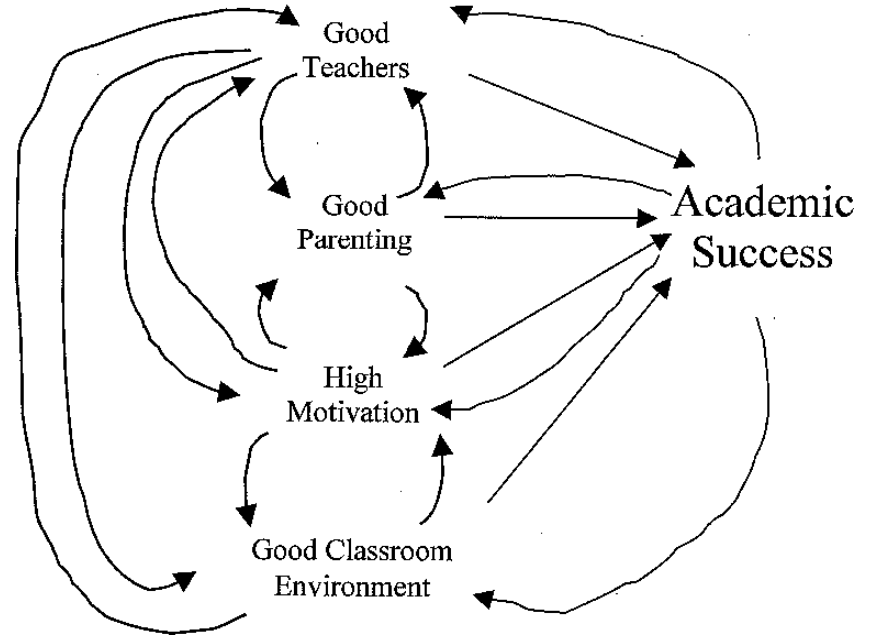


# **Why is systems view useful?**

# Systems thinking



Descriptive View

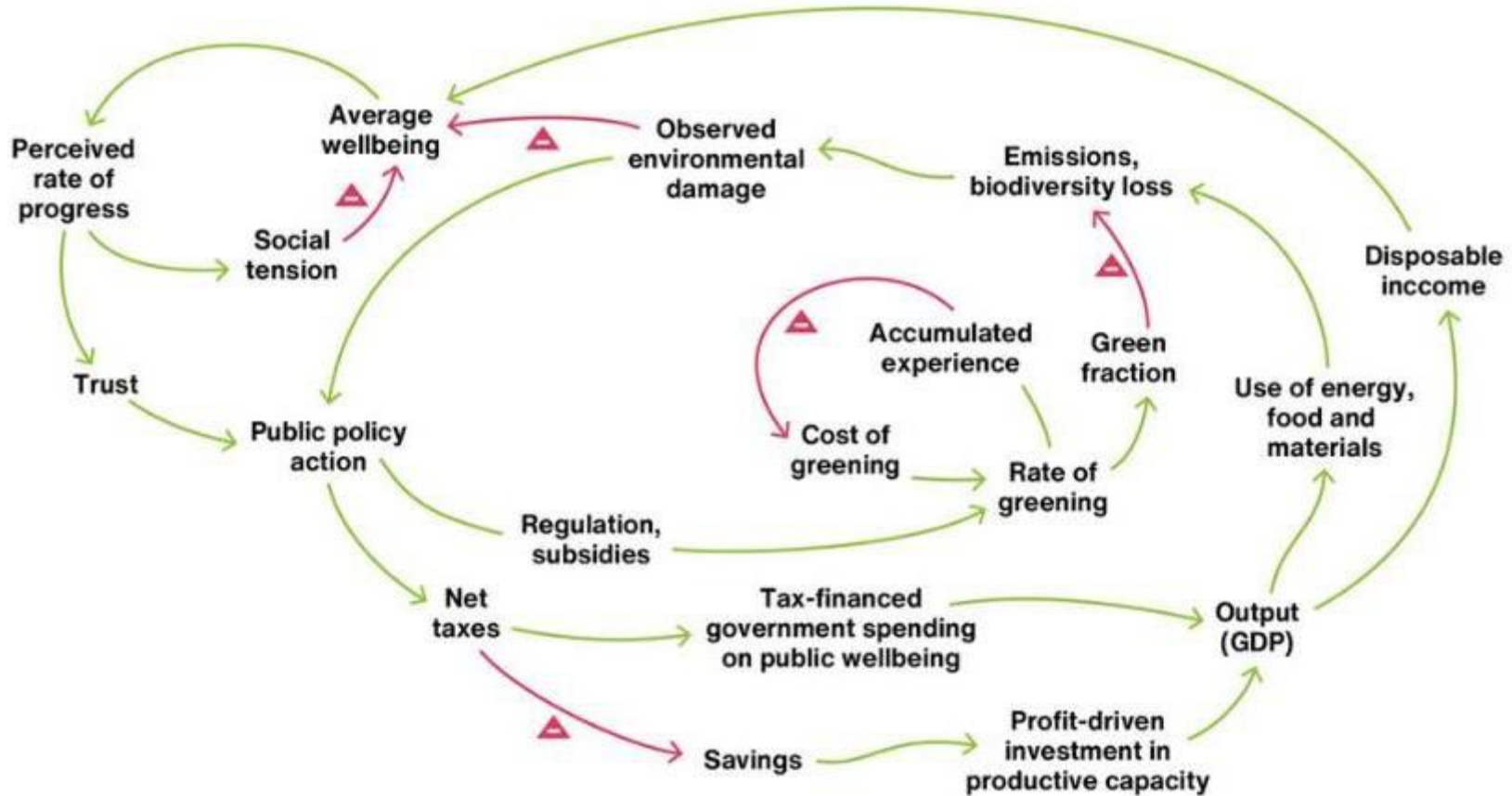


Explanatory System View

Source: Richmond, 2001



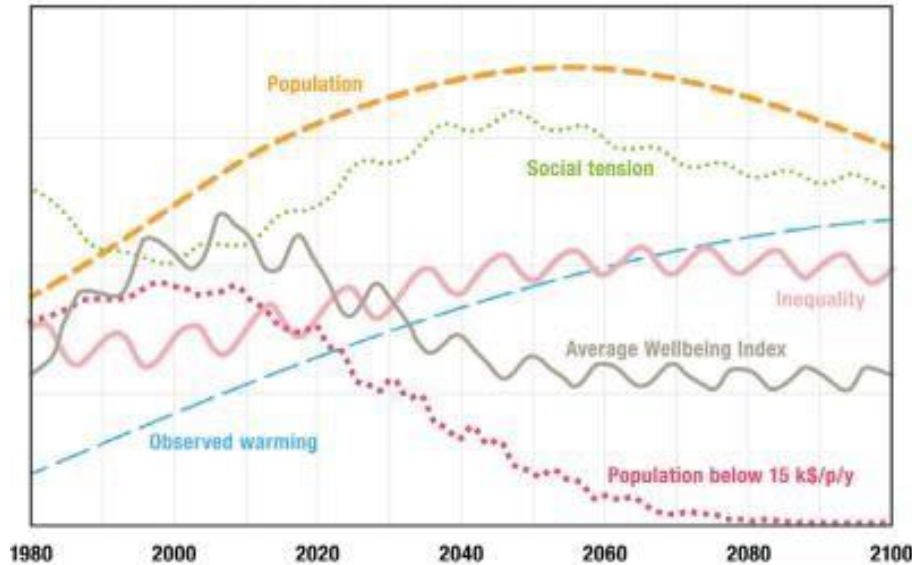
# From Causal Loop Diagram ...



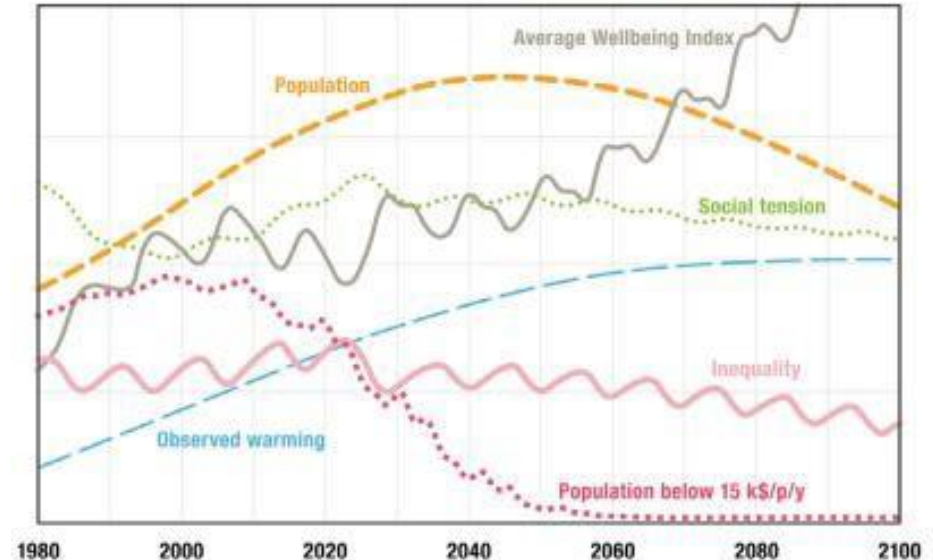
Source: <https://www.earth4all.life/the-science>

# ... to Scenario making

1. Main trends  
Too Little Too Late scenario



1. Main trends  
Giant Leap scenario



- **Too Little Too Late** – a scenario that explores what if economic policy continues in the same track it has for the last forty years.
- **Giant Leap** – a scenario that explores what if societies make extraordinary decisions and invest in building more resilient societies? What will valuing our collective future look like? Can societies enhance social cohesion and strengthen democracies to reduce vulnerability to shocks and provide wellbeing for the majority on a planet under enormous pressure?

# Course organisation

# Aim of the course (I)



- Analyser un produit ou un service avec l'ACV
- Calculer les impacts environnementaux d'un produit
- Anticiper les évolutions réglementaires en environnement
- Optimiser les performances environnementales des produits
- Critiquer une étude existante
- Elaborer des stratégies holistiques pour boucler les flux de matière
- Critiquer les stratégies et plans environnementaux des villes et pays
- Analyser les flux de ressources et de déchets

# Aim of the course (II)



- Planifier des actions et les mener à bien de façon à faire un usage optimal du temps et des ressources à disposition.
- Recevoir du feedback (une critique) et y répondre de manière appropriée.
- Ecrire un rapport scientifique ou technique.
- Utiliser les outils informatiques courants ainsi que ceux spécifiques à leur discipline.
- Etre responsable des impacts environnementaux de ses actions et décisions.



# Course evaluation



- Projet (examen écrit) – 60% de la note
  - System analysis : 1h
  - ACV : 1h – 15 à 18 questions rapides sur des points clés de l'ACV
- Evaluation projet ACV– 40% de la note

Projet à 2 ou 3 étudiants : Evaluation ACV d'un système photovoltaïque intégré à des bâtiments. Evaluation avec un rapport (15 pages maximum hors annexes) + Pitch 3 min

# Partie Analyse du Cycle de Vie

## Cours théorique et mise en application pratique

### ACV d'un système photovoltaïque intégré à des bâtiments (BIPV)

- Etudiants par groupe de 2 ou 3
- Choix d'un système photovoltaïque (libre)
- Collecte des données
- Réaliser l'ACV simplifiée de ce système
- Rapport d'ACV (15 pages maximum hors annexes) + 1pitch (3 minutes) présentant le produit BIPV, la méthode et les résultats obtenus
- Evaluation 40% note totale (moitié rapport et moitié pitch)

# Course references



- Analyse du cycle de vie - Comprendre et réaliser un écobilan  
O. Jolliet, M. Saadé, P. Crettaz, Presses Polytechniques et Universitaires Romandes, 2005
- Brunner P. H., Rechberger, H. 2016, Practical handbook of material flow analysis, Lewis Publishers
- Baccini, P. and P. H. Brunner 2012, Metabolism of the Anthroposphere: Analysis, Evaluation, Design, MIT Press
- Ferrão, P. and J. E. Fernández, 2013. Sustainable urban metabolism, Cambridge (MA): MIT Press.
- Circular Metabolism Podcast ([iTunes](#), [Youtube](#), [Spotify](#), [Stitcher](#))