# Some World Energy Insights

13 march 2023

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# Energy throuth the Human History

- Hundreds thousand years ago: first extrasomatic consumption of energy (fire – cooking and heating)

↓

- 10 thousand years: agriculture (principle of alteration and deliberate control of the environment). Energy from Human muscle. (*4 million inhabitants*)

↓

- 9 thousand years: domestication of animals and their use for work and transport.

↓

- Inanimate energy sources;

| | | |
|---|---|---|
| - 5000 years: first source: sails | - 2000 years: water mills | - 1000 years: wind mills |

# Energy throught the Human History

- Until 1600: thermal energy came from vegetable fuels, mechanical energy came from people and animals.

- After 1600: increasing use of fossil coal (England)

- 1700 first steam engines in coal mines (coal combustion)

- 1800: vegetable fuel represents 98% of heat and lighting production, people and animals 90% of mechanical energy.

- 1900: half mechanical energy: steam engines (coal), waterwheels and water turbines, windmills, steam turbines and internal combustion engines.

- In 1950: fossil fuels 3/4 primary energy, combustion engines represent 80% mechanical energy

*- 1800: 1 billion inhabitants - 0.05 GJ per capita*

*- 1900: 1.6 billion - 2.7 GJ per capita*

*- 2000: 6.1 billion - 28 GJ per capita, but USA 150 GJ, Japan 80 GJ, China 50GJ)*

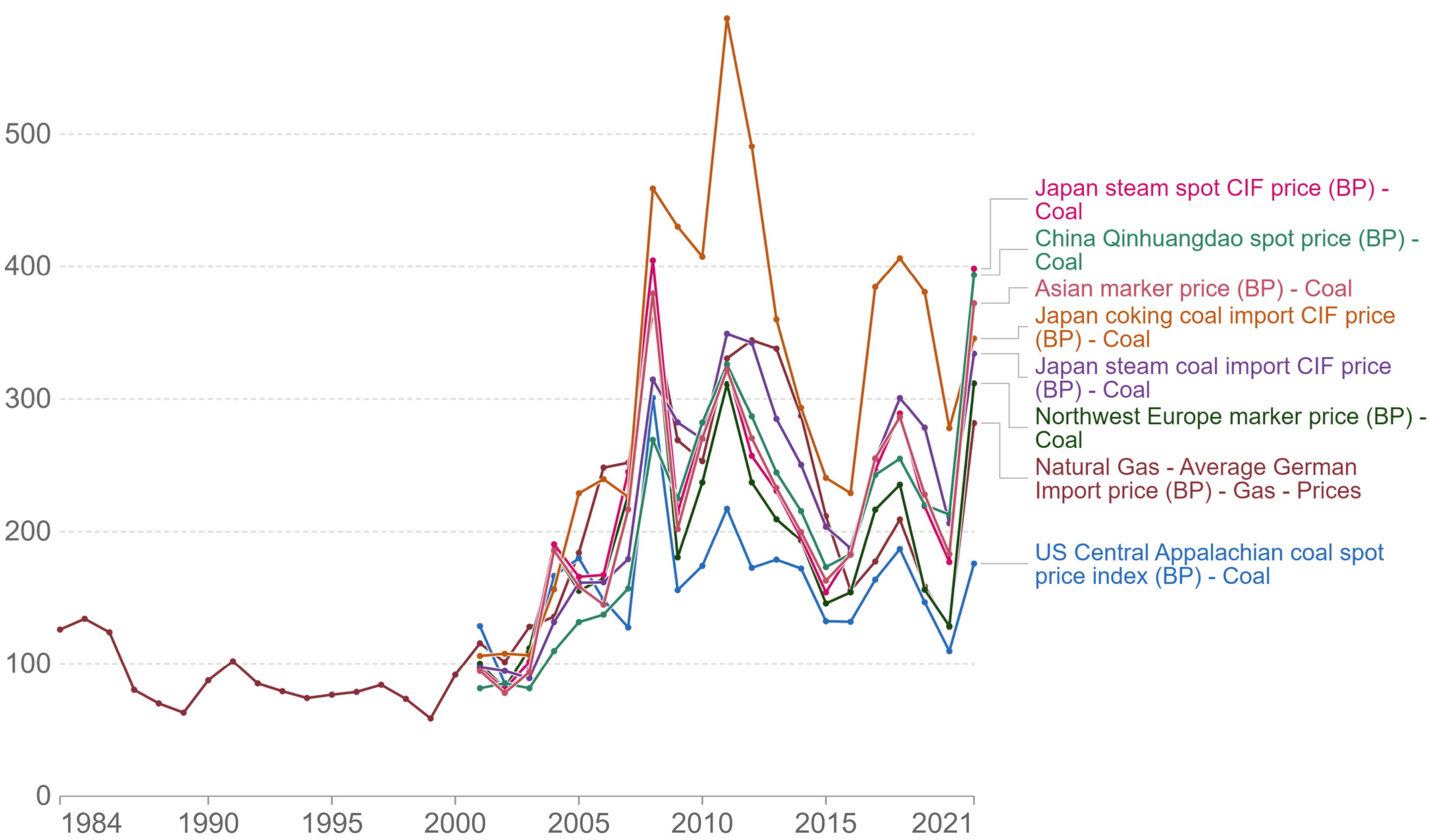
# Energy

Allways present in our life (food production, transport, lighting, communication, internet, thermal comfort,ventilation, entertainment, etc)

- Production Factor (cost, supply availability)
- Strategic Resource (National, European energy dependency, limited resources)
- Environmental impact (pollution, CO2 emissions, global heating, climate change)

# Fossil fuel price index, 1984 to 2021

Average global prices of oil, natural gas and coal, measured as an energy index where prices in 2001=100.

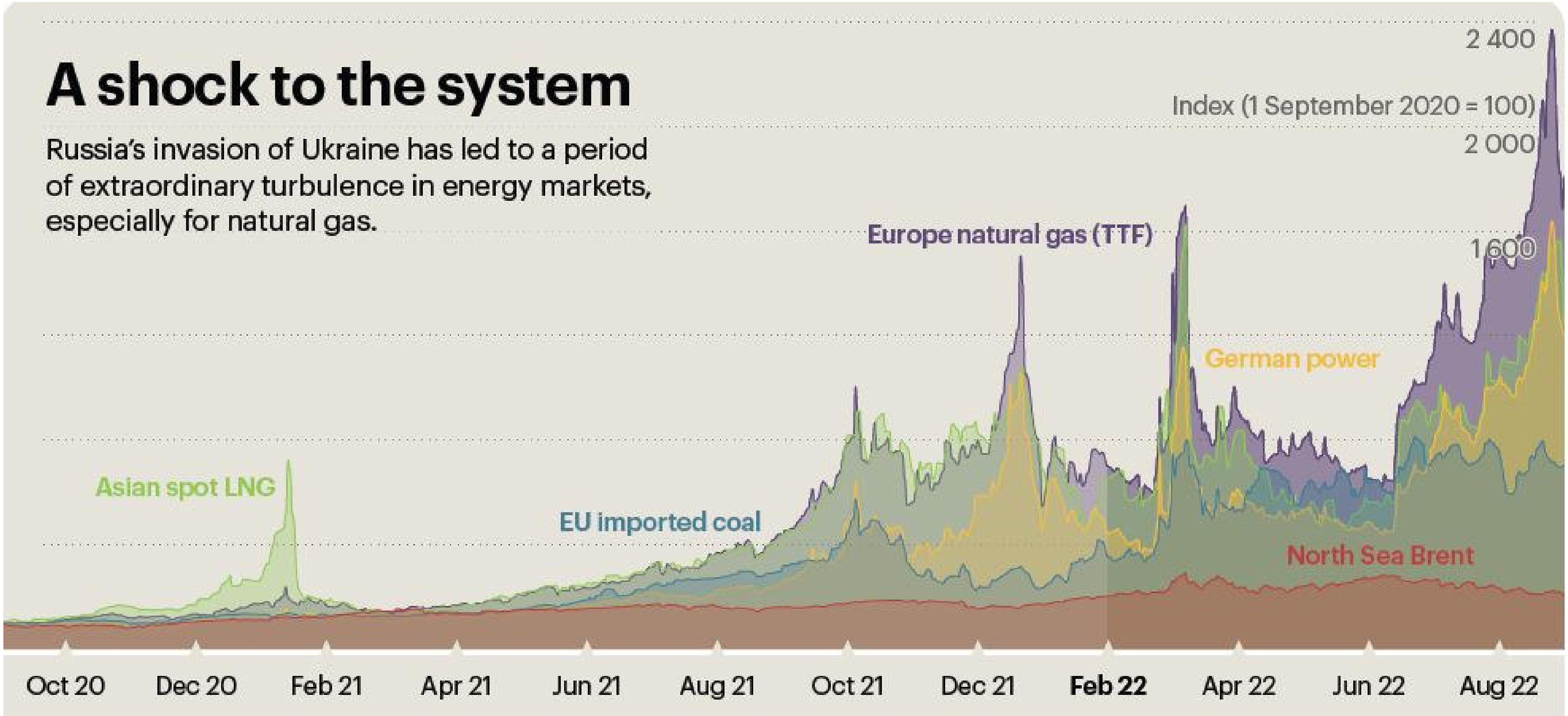



Source: BP Statistical Review of World Energy

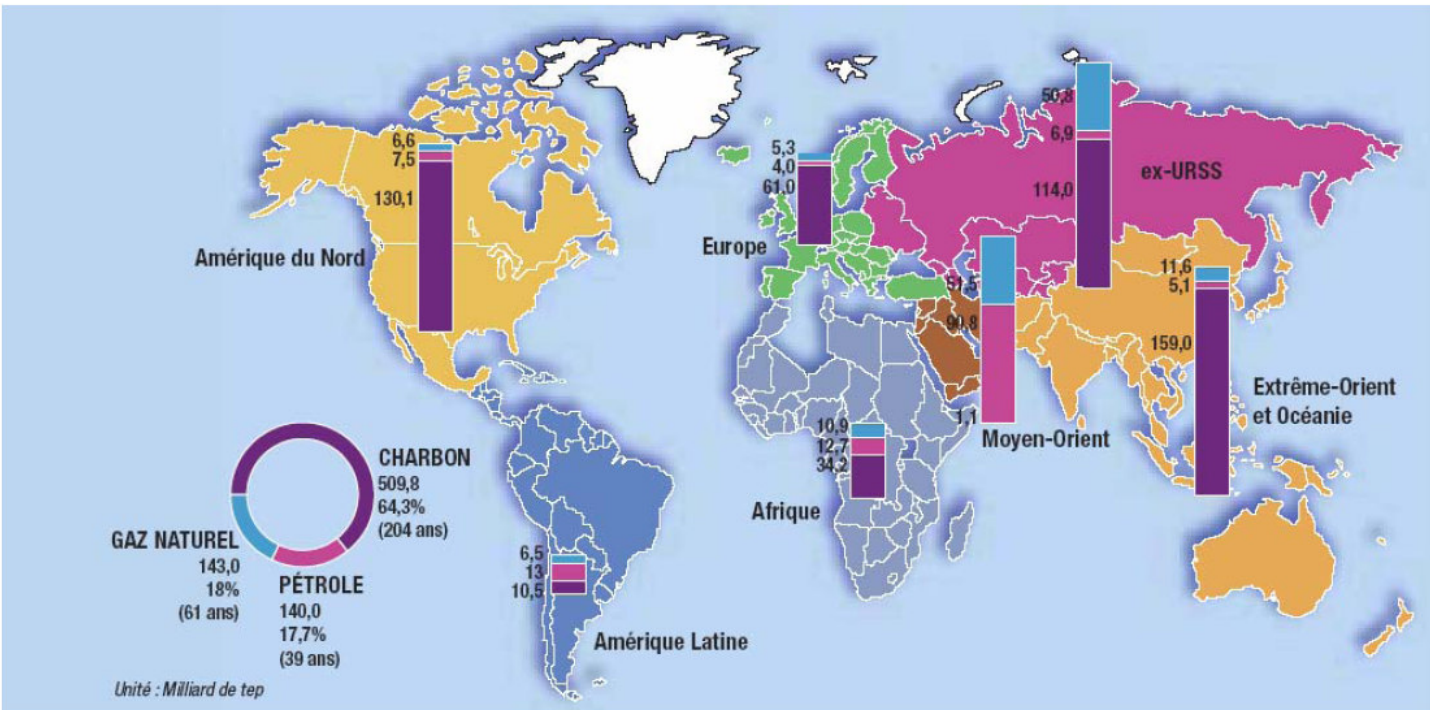
OurWorldInData.org/fossil-fuels • CC BY

# A shock to the system

Russia's invasion of Ukraine has led to a period of extraordinary turbulence in energy markets, especially for natural gas.

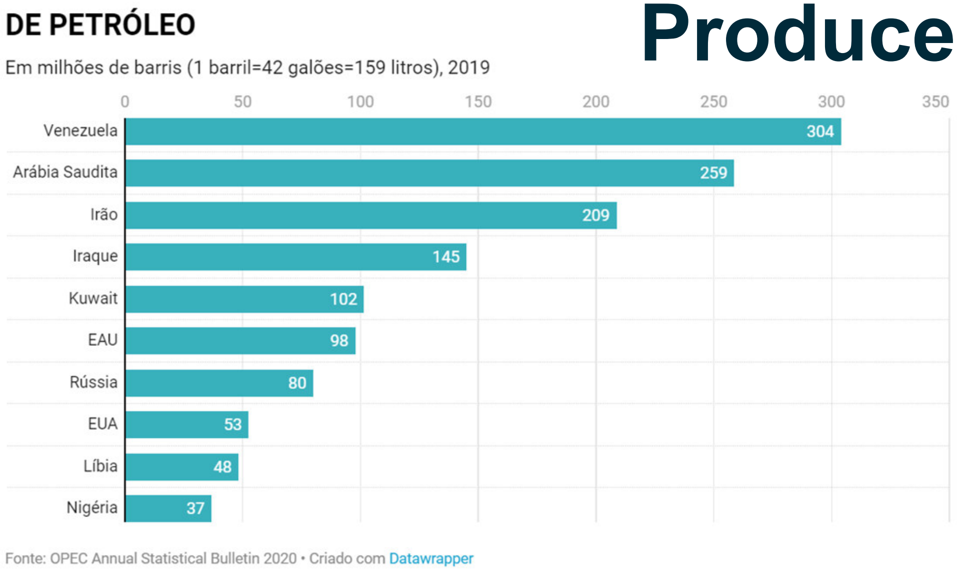


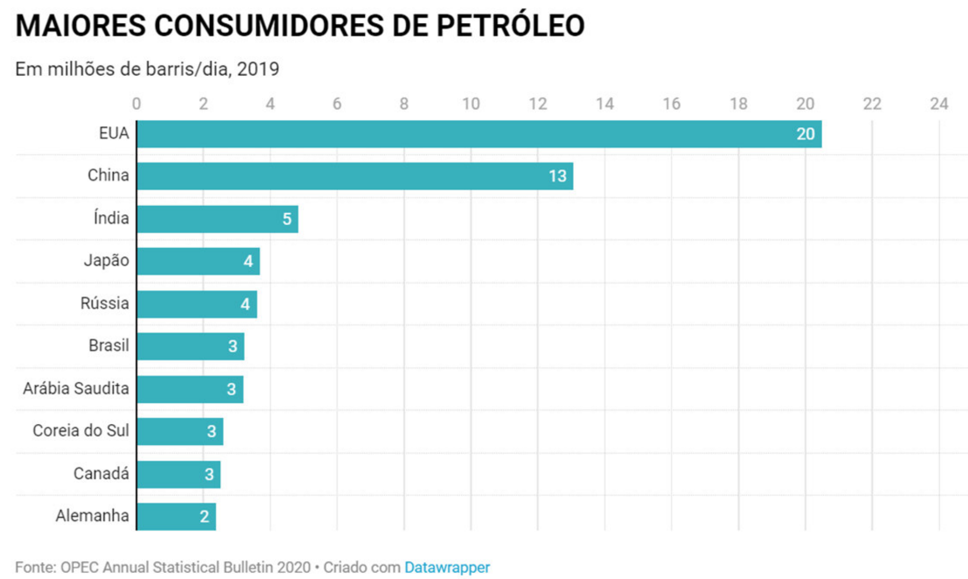
# world fossil energy reserves

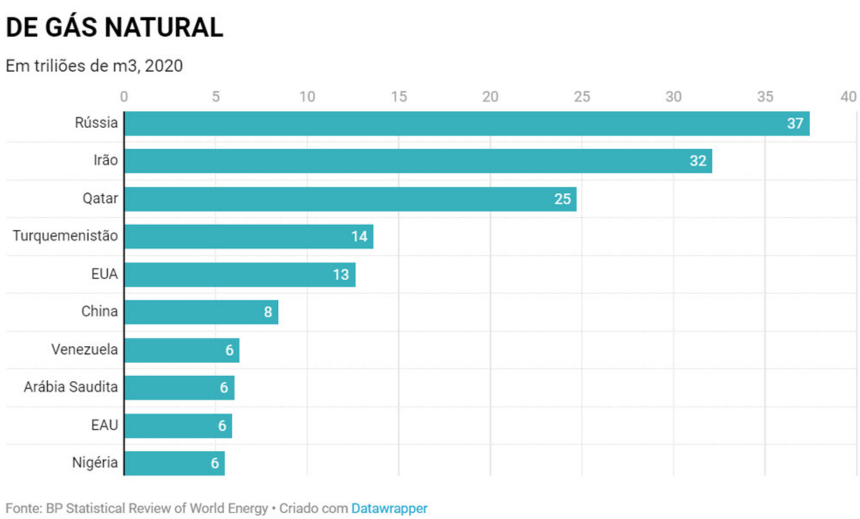



*Sources : Conseil Mondial de l'Energie, BP et Ministère de l'Économie et des Finances (DGEMP).*

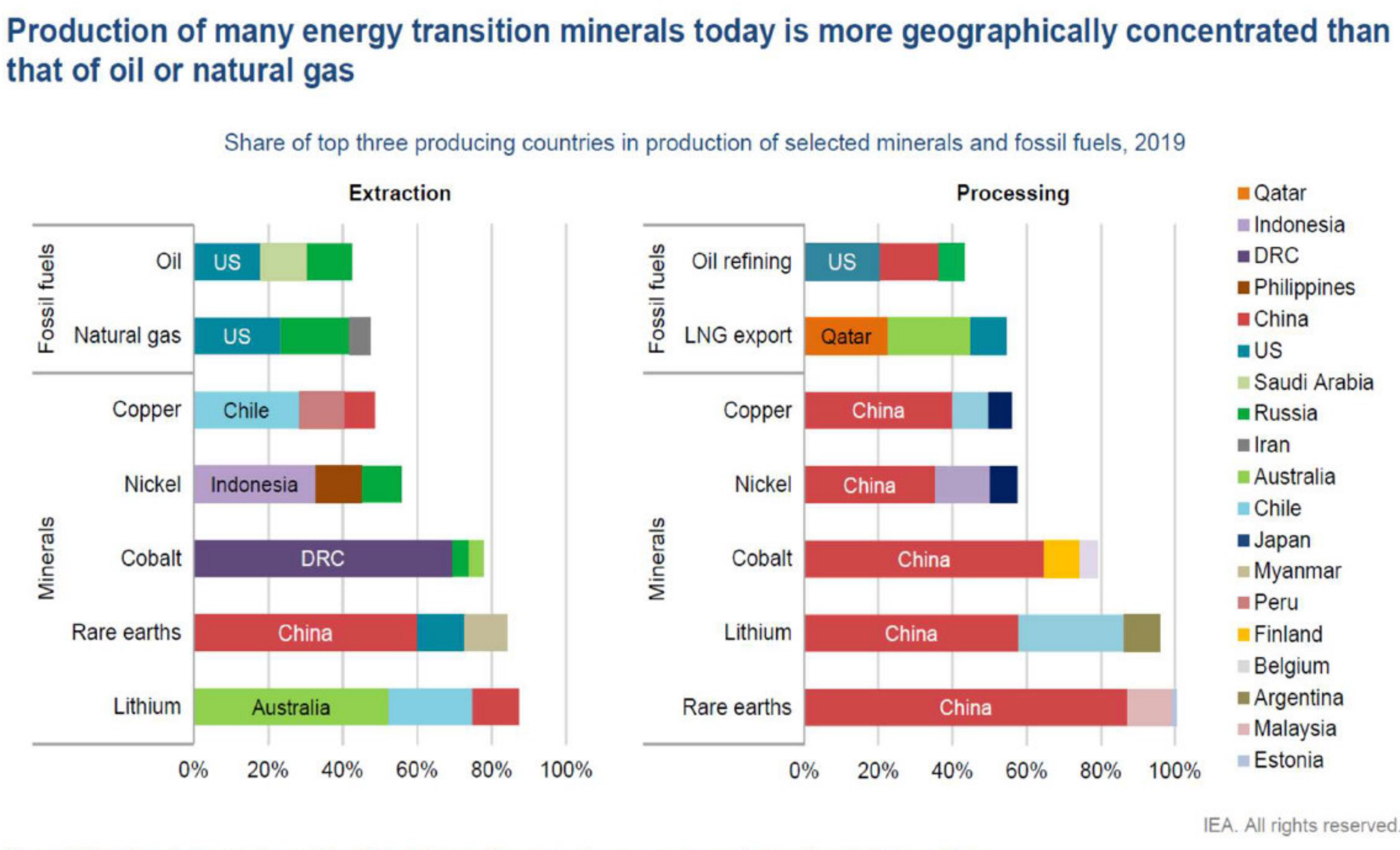
# Producers and Consumers



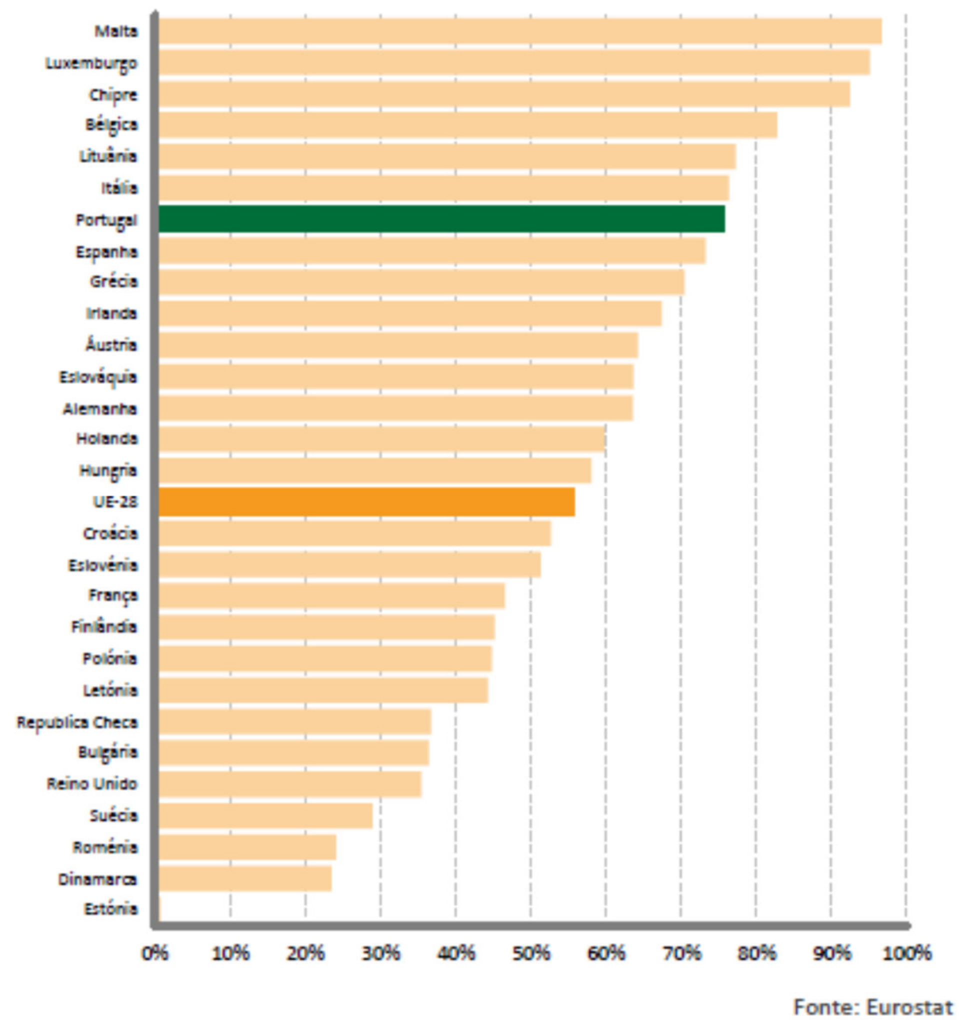



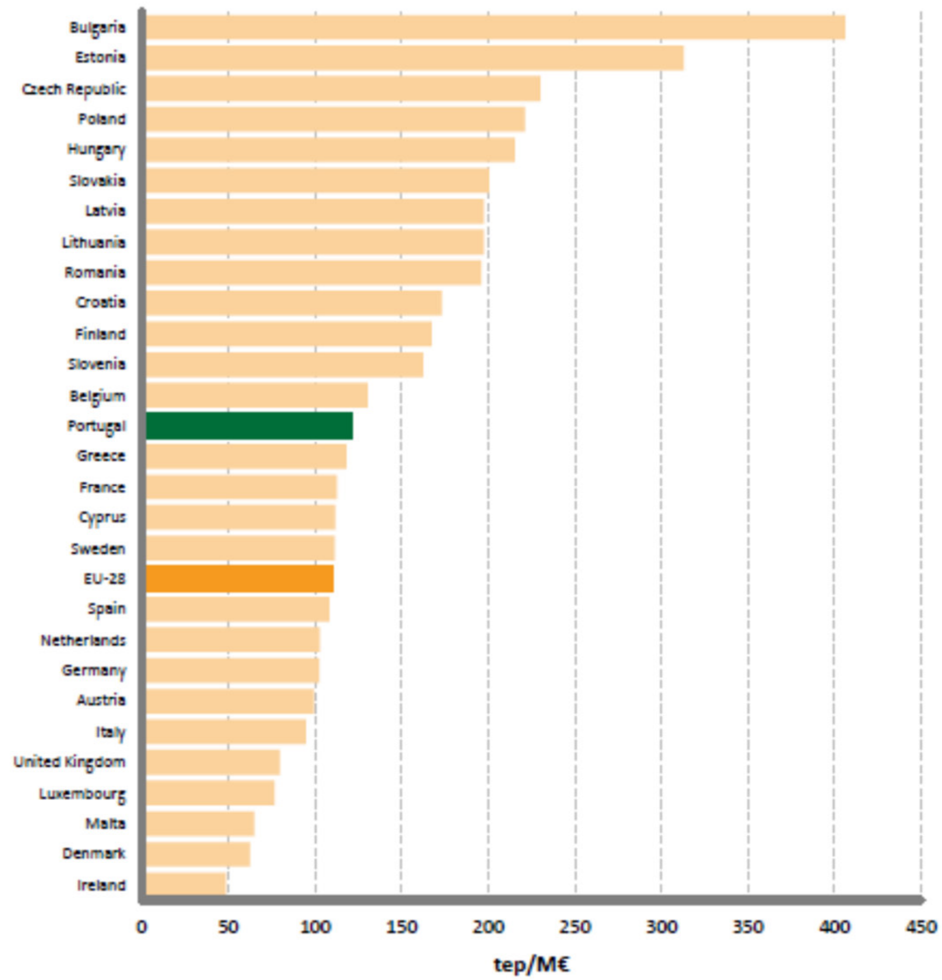
# Energy Transition – Eletrification - dangers



# Energy Dependency Comparison

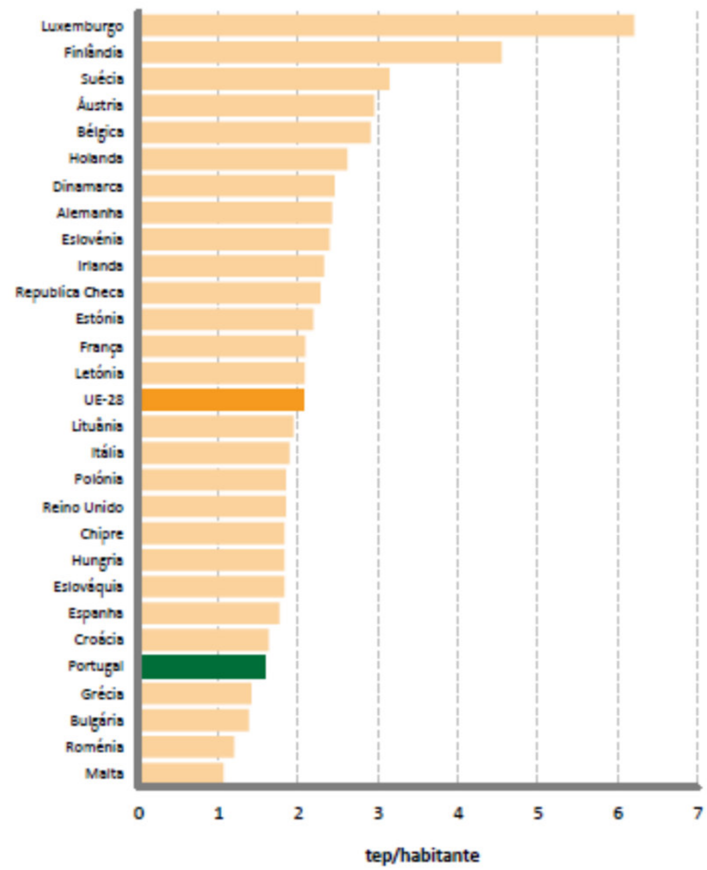


Economic energy intensity comparison(2018) toe/1000€



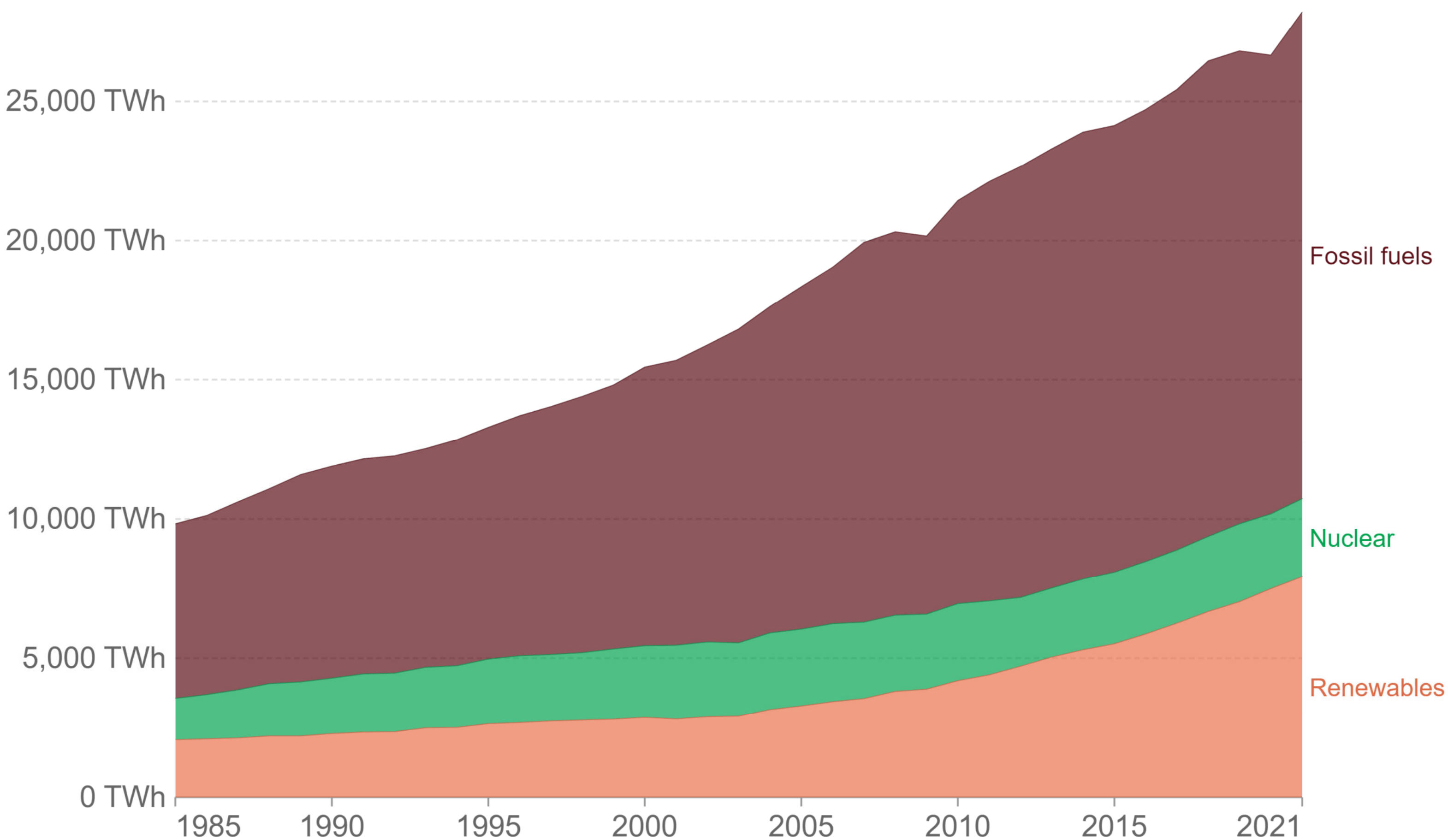
Final Energy consumption comparison (2018)

toe/inhabitant




Fonte: Eurostat

# Electricity production from fossil fuels, nuclear and renewables, World




Source: Our World in Data based on BP Statistical Review of World Energy (2022); Our World in Data based on Ember's Global Electricity Review (2022); Our World in Data based on Ember's European Electricity Review (2022)

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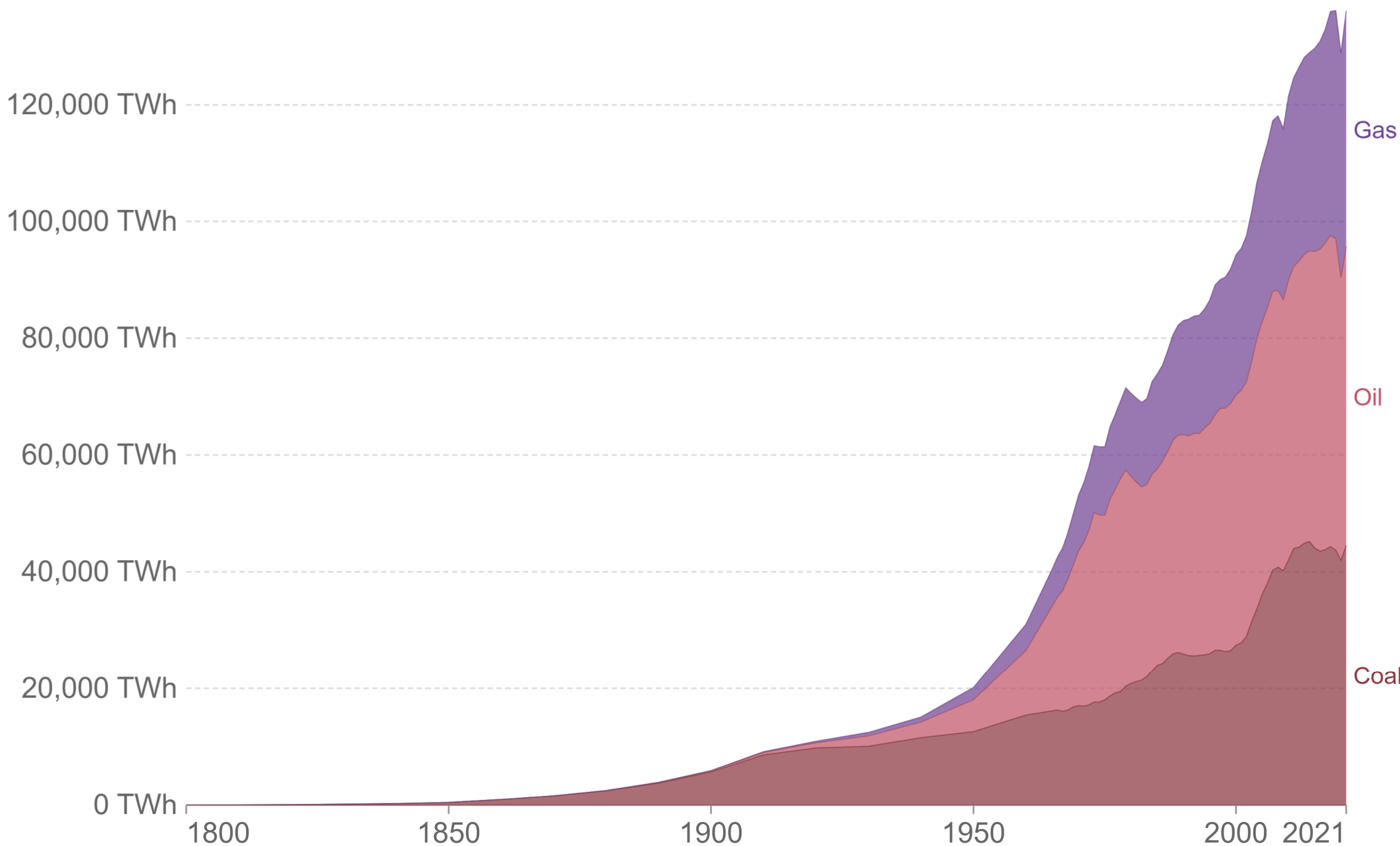
# Global fossil fuel consumption

Global primary energy consumption by fossil fuel source, measured in terawatt-hours (TWh).

Our World in Data




Source: Our World in Data based on Vaclav Smil (2017) and BP Statistical Review of World Energy

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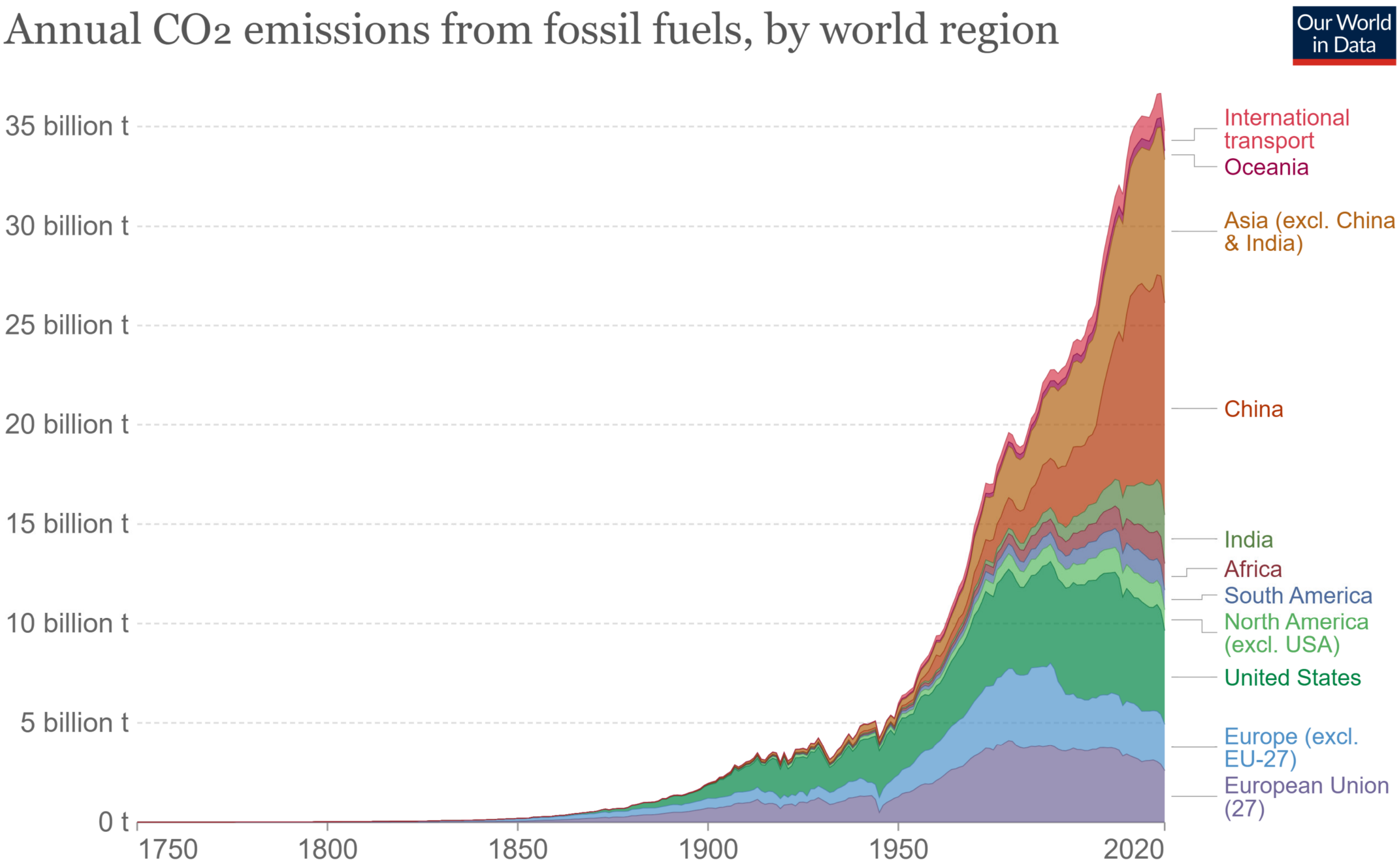
# Annual $CO_2$ emissions from fossil fuels, by world region



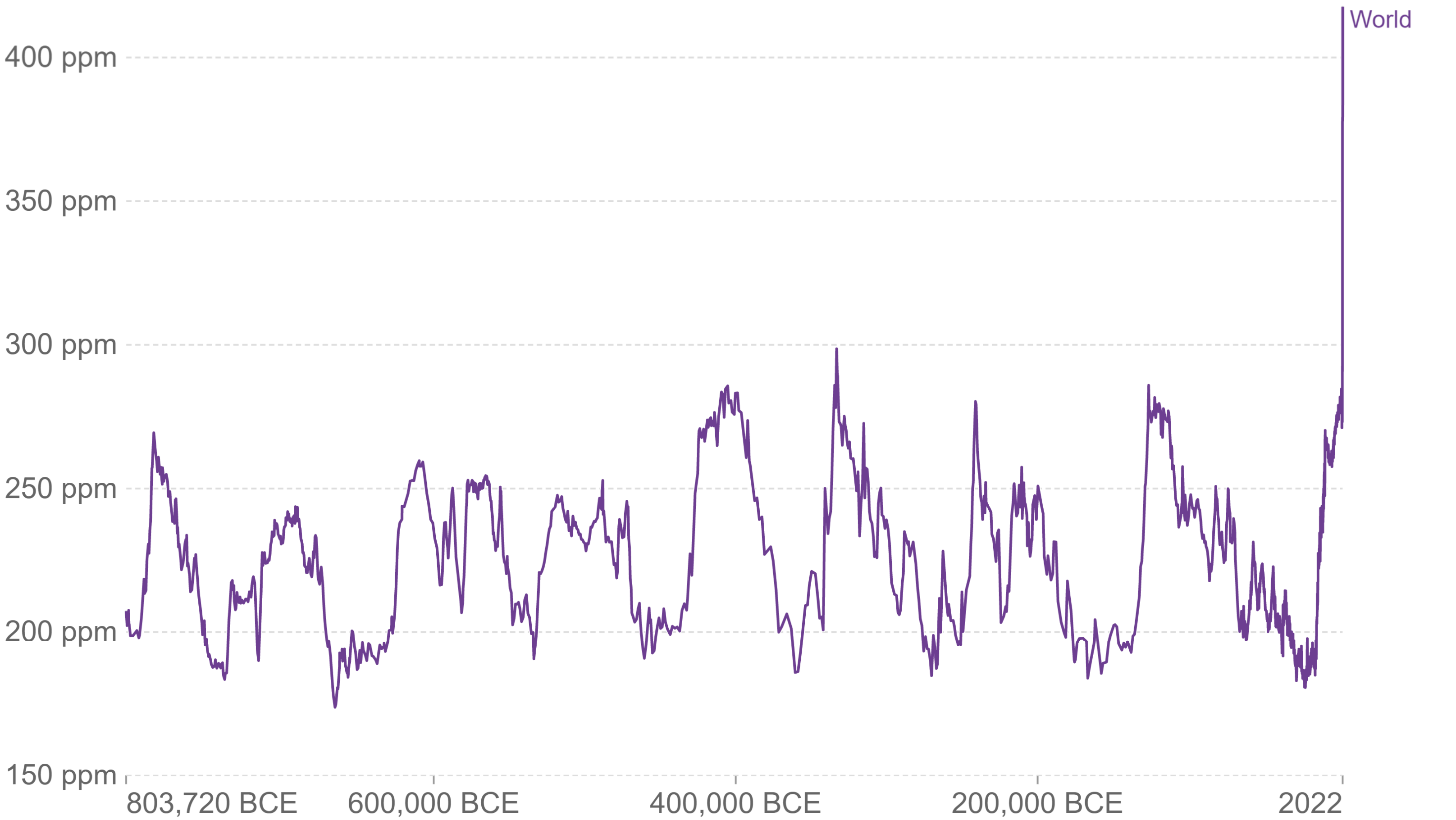

Source: Global Carbon Project

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

Note: This measures $CO_2$ emissions from fossil fuels and cement production only – land use change is not included. 'Statistical differences' (included in the GCP dataset) are not included here.

# Global atmospheric $CO_2$ concentration

Atmospheric carbon dioxide ($CO_2$) concentration is measured in parts per million (ppm). Long-term trends in $CO_2$ concentrations can be measured at high-resolution using preserved air samples from ice cores.




Source: National Oceanic and Atmospheric Administration (NOAA)

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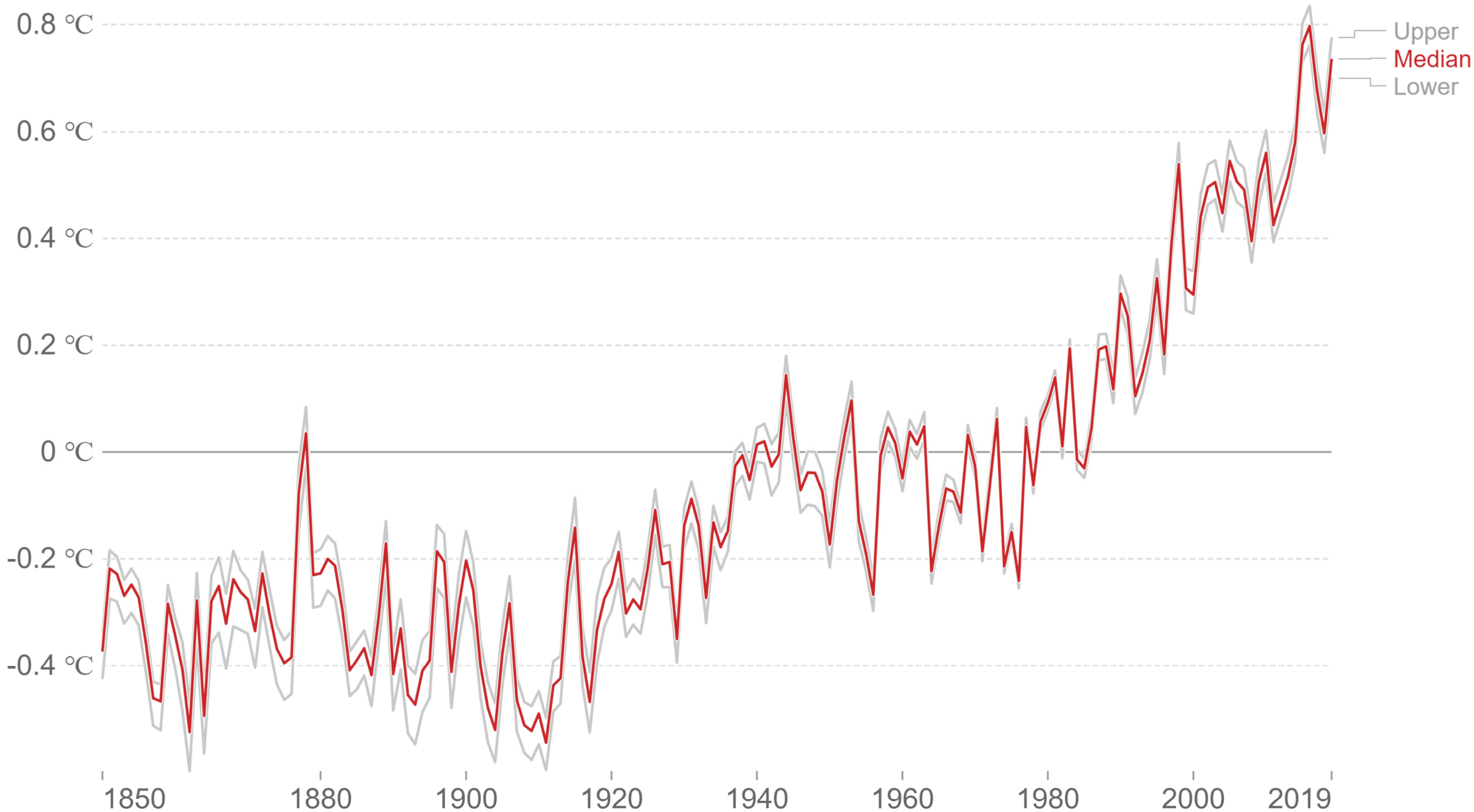
# Average temperature anomaly, Global

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




Source: Hadley Centre (HadCRUT4)

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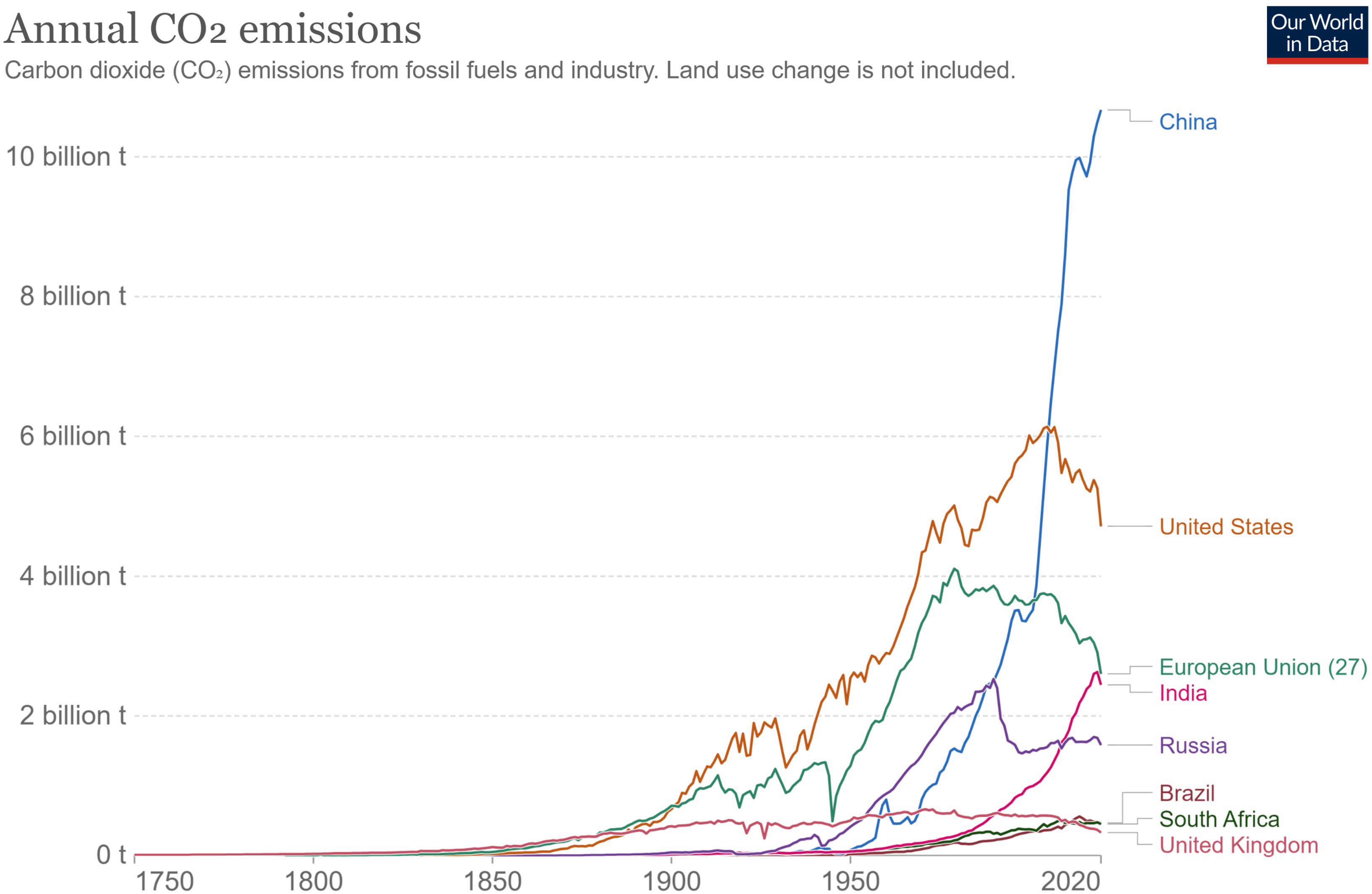
Note: The red line represents the median average temperature change, and grey lines represent the upper and lower 95% confidence intervals.

# Annual $CO_2$ emissions

Carbon dioxide ($CO_2$) emissions from fossil fuels and industry. Land use change is not included.




Source: Global Carbon Project

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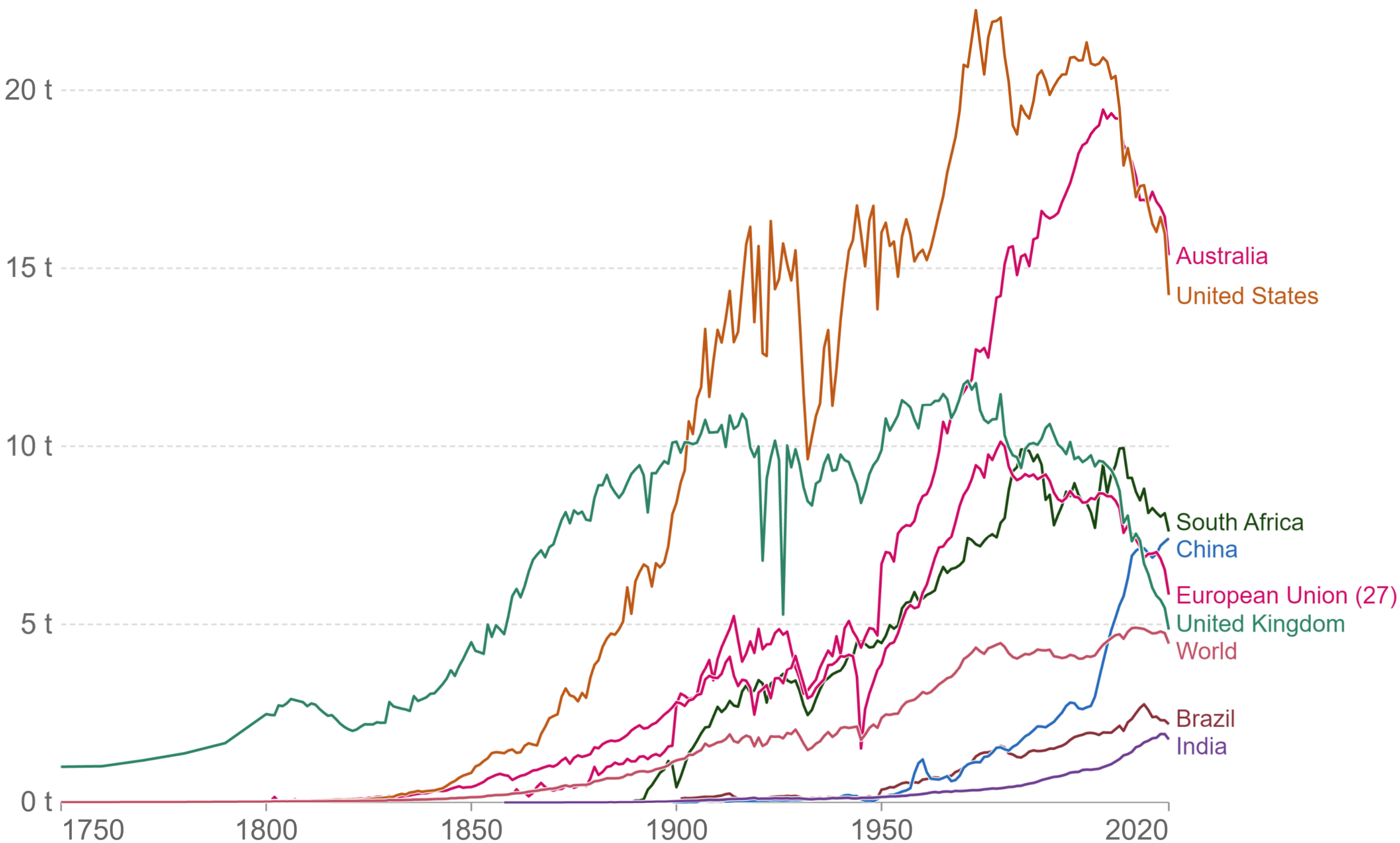
# Per capita CO2 emissions

Carbon dioxide ($CO_2$) emissions from fossil fuels and industry. Land use change is not included.




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

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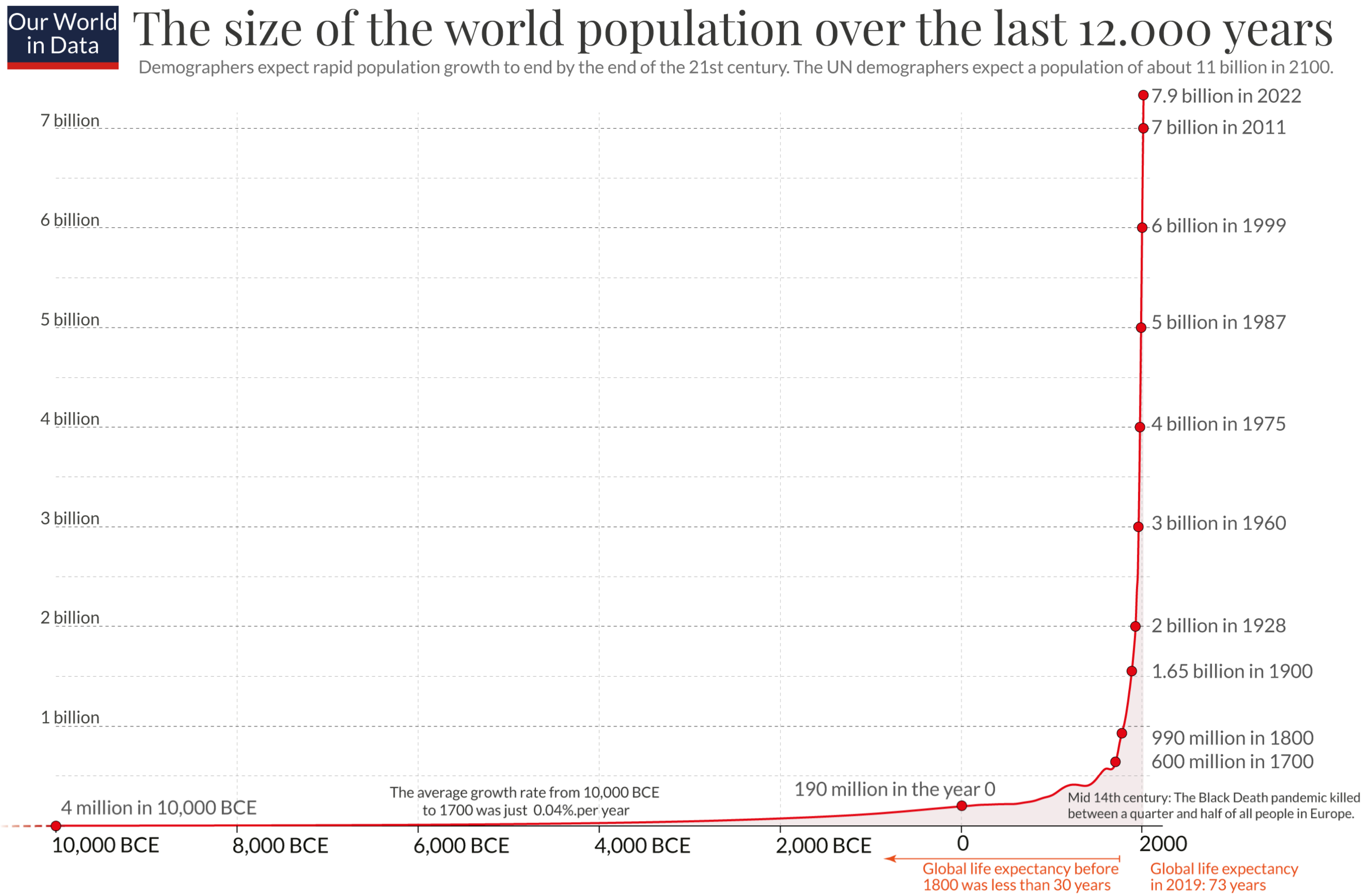
# The size of the world population over the last 12.000 years

Demographers expect rapid population growth to end by the end of the 21st century. The UN demographers expect a population of about 11 billion in 2100.




Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org.

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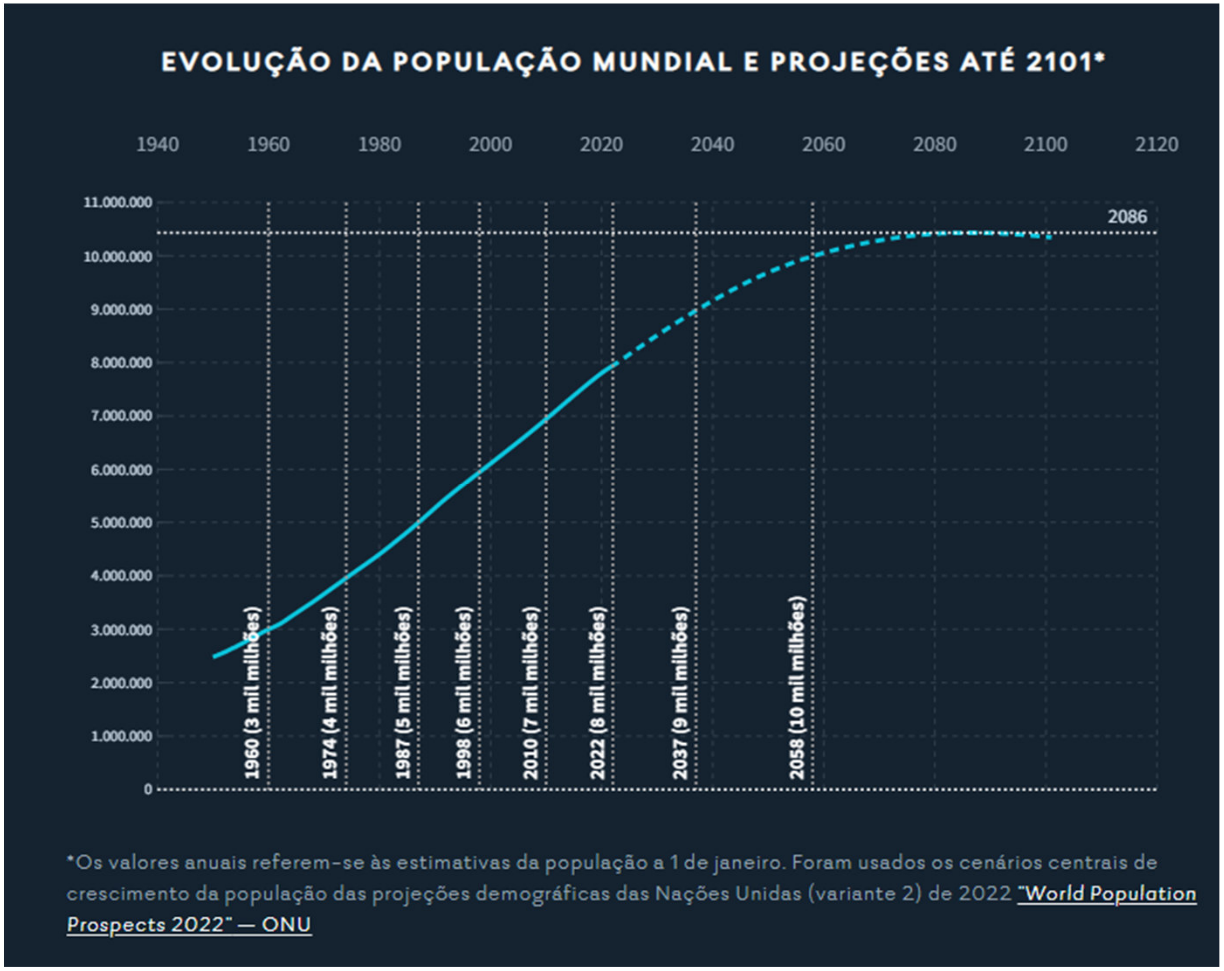
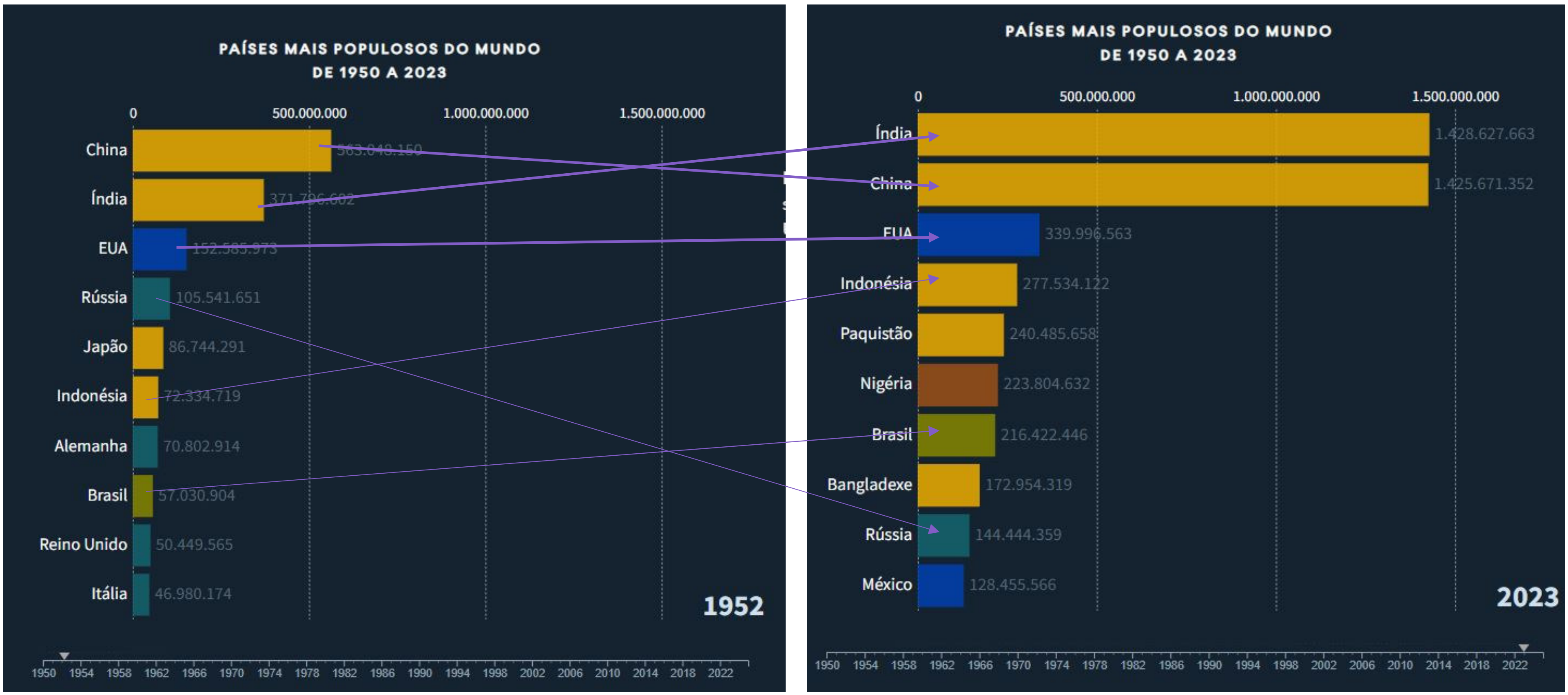
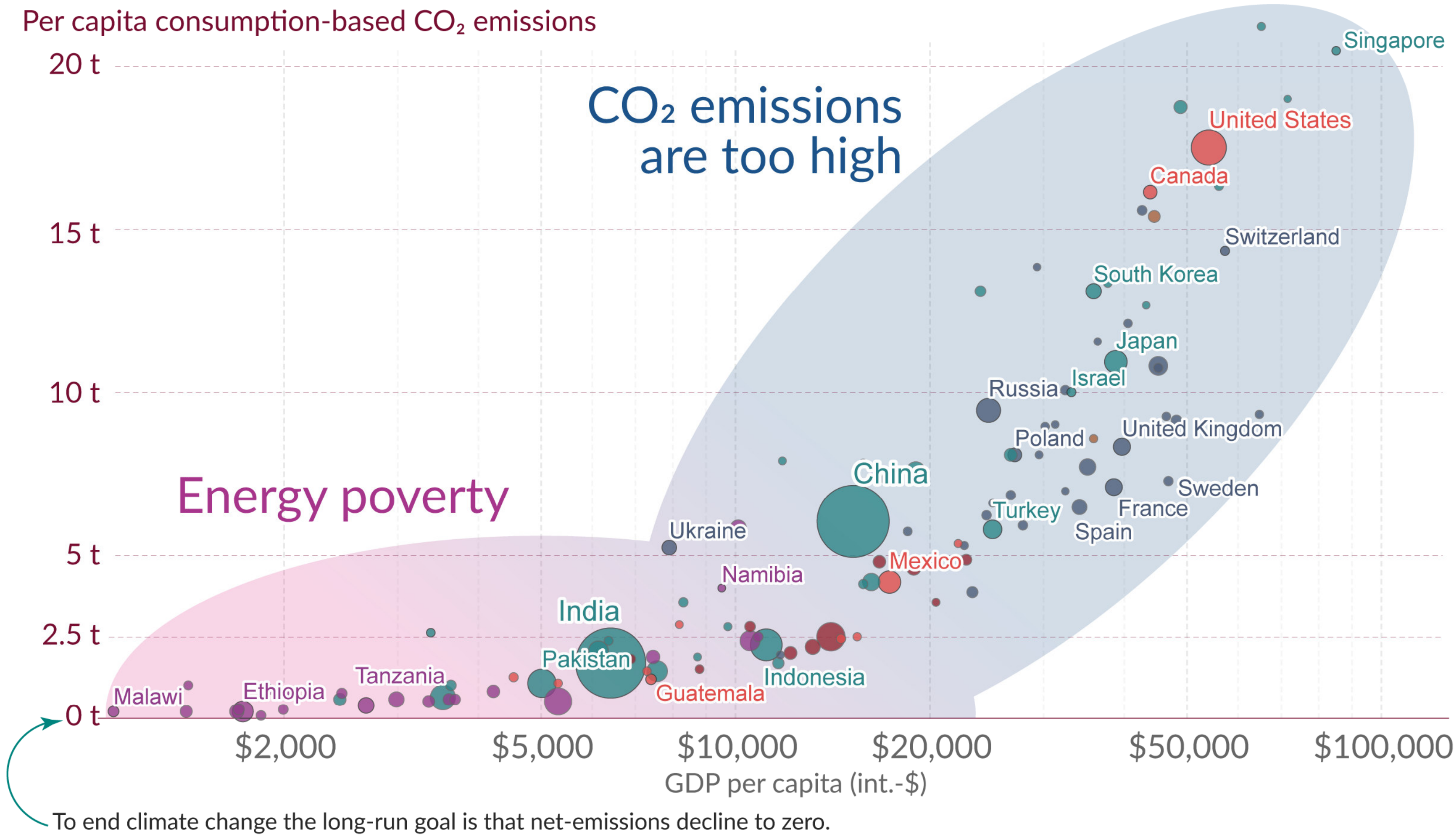
# Evolution of world population and projections until 2101



# Most populous countries in the world from 1950 to 2023



# $CO_2$ emissions per capita vs GDP per capita




Data for 2017: Global Carbon Project, UN Population, and World Bank.

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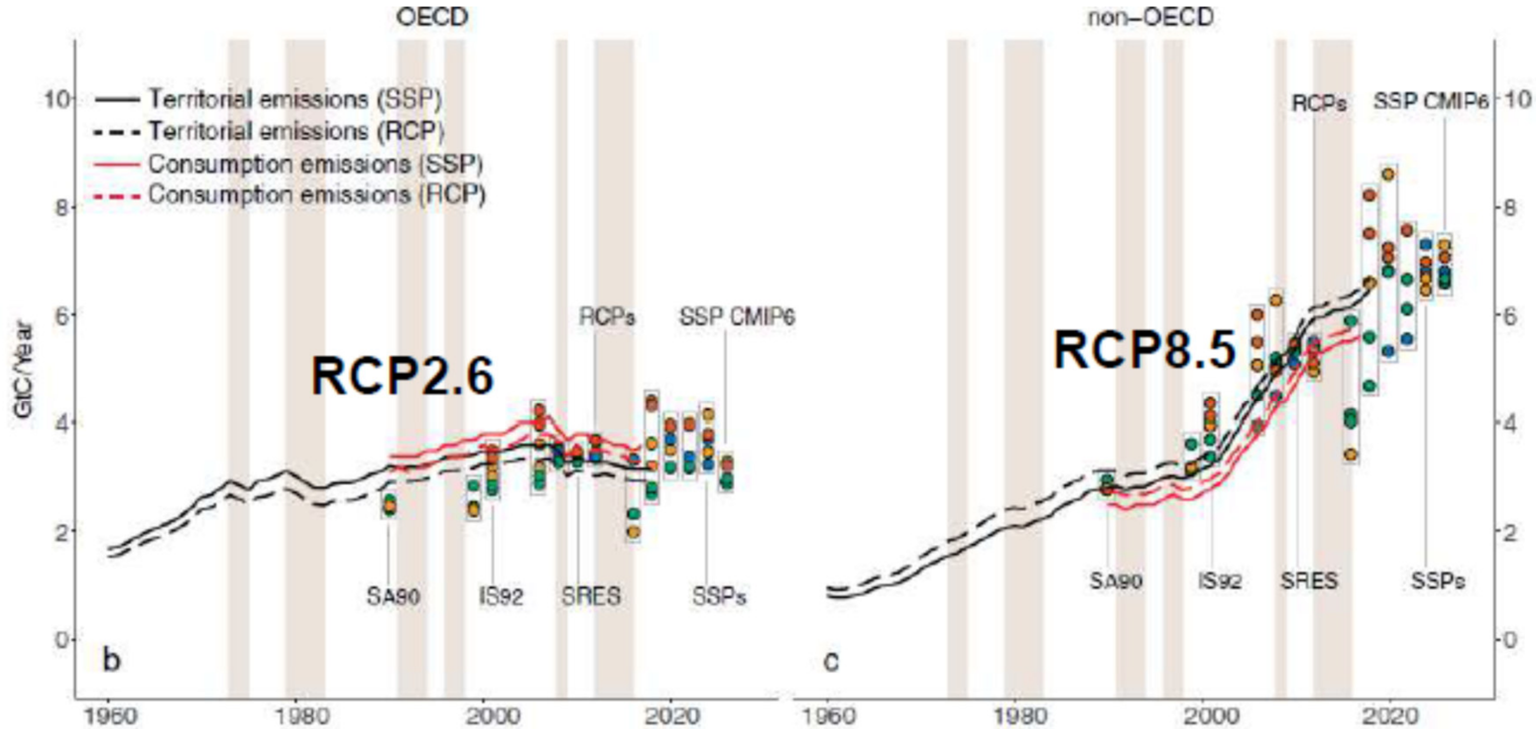


**Fig. 2 Global, non-OECD, and OECD historical CO2 emissions (1959–2018) compared to SA90, IS92, SRES, RCP, SSP-BL, and SSP (CMIP6) emission scenarios. a** Global emissions with low to medium-low growth periods of ≤1% annual growth (gray shaded areas) and periods of global emissions growth above 1% (white areas). **b** OECD territorial/production (black) and consumption (red) emissions[16] compared to scenario projections. **c** non-OECD territorial/production (black) and consumption emissions (red) compared to scenario projections. Historical data are presented by solid lines (SSP definitions[8]) and dashed lines (RCP definitions[9]). The definitions of OECD and non-OECD differ between the SA90[19], IS92[20], SRES[21], RCP and SSP databases (e.g., RCP OECD is based on OECD90 (32 countries) and thus including fewer countries than the SSP OECD category, including OECD90 + EU member states and candidates (44)). Scenarios are grouped into four cumulative emissions categories (total $CO_2$ emissions 1990–2100): low (vermillion), medium-low (bluish-green), medium-high (orange), and high (blue) emissions. (Furthermore, see growth rate comparisons in Supplementary Fig. 2).

**Jiesper Pedersen, Detlef van Vuuren, Bruno Aparício, Rob Swart, Joyeeta Gupta, Filipe Duarte Santos, Nature Communications Earth and Environment, 2020**

# Conclusions

1. **World Energy Consumption will grow in the next years (given population and quality life impulse)!**
2. **What we can do**: Be aware of the problem, understand and promote action at a personal, work and society level.
3. **Usual strategies**:
    1. Increase energy efficiency
    2. Rethink service levels
    3. Diversify energy sources
    4. Maximize renewable energy use
    5. Reduce emissions by the right energy mix and energy efficiency

## Eco-innovators | Be part of the urban energy transition

How can we turn the existing energy problems today and tomorrow? Become an eco-innovator and focus on renewable energy systems, energy efficient buildings, sustainable transport, energy storage and circular economy to find solutions for a sustainable future.

- **How to developing smart renewable energy systems for rural communities:** Students could research and design sustainable energy systems that could be implemented in rural communities, such as solar or wind power systems.
- **How to improving smart energy efficiency in buildings:** Students could investigate ways to improve energy efficiency in buildings, such as through the use of smart building technology or energy-efficient building materials.
- **Designing sustainable transportation systems:** Students could research and design sustainable transportation systems, such as electric or hybrid vehicles, bike-sharing programs, or public transportation systems that run on renewable energy.
- **Developing energy storage systems:** Students could research and design energy storage systems that can store excess renewable energy for later use, such as batteries or hydrogen fuel cells.
- **Investigating ways to reduce carbon emissions:** Students could research and design solutions to reduce carbon emissions, such as carbon capture and storage technologies, or sustainable land-use practices that sequester carbon.
- **Exploring the possibility of a circular economy:** Students could research the concept of a circular economy and explore ways to apply it to sustainable energy, where waste is minimized, and resources are conserved in a closed loop.