



Claude Monet – Flood (1896)



Hokusai Katsushika – Big wave (1829-1832)

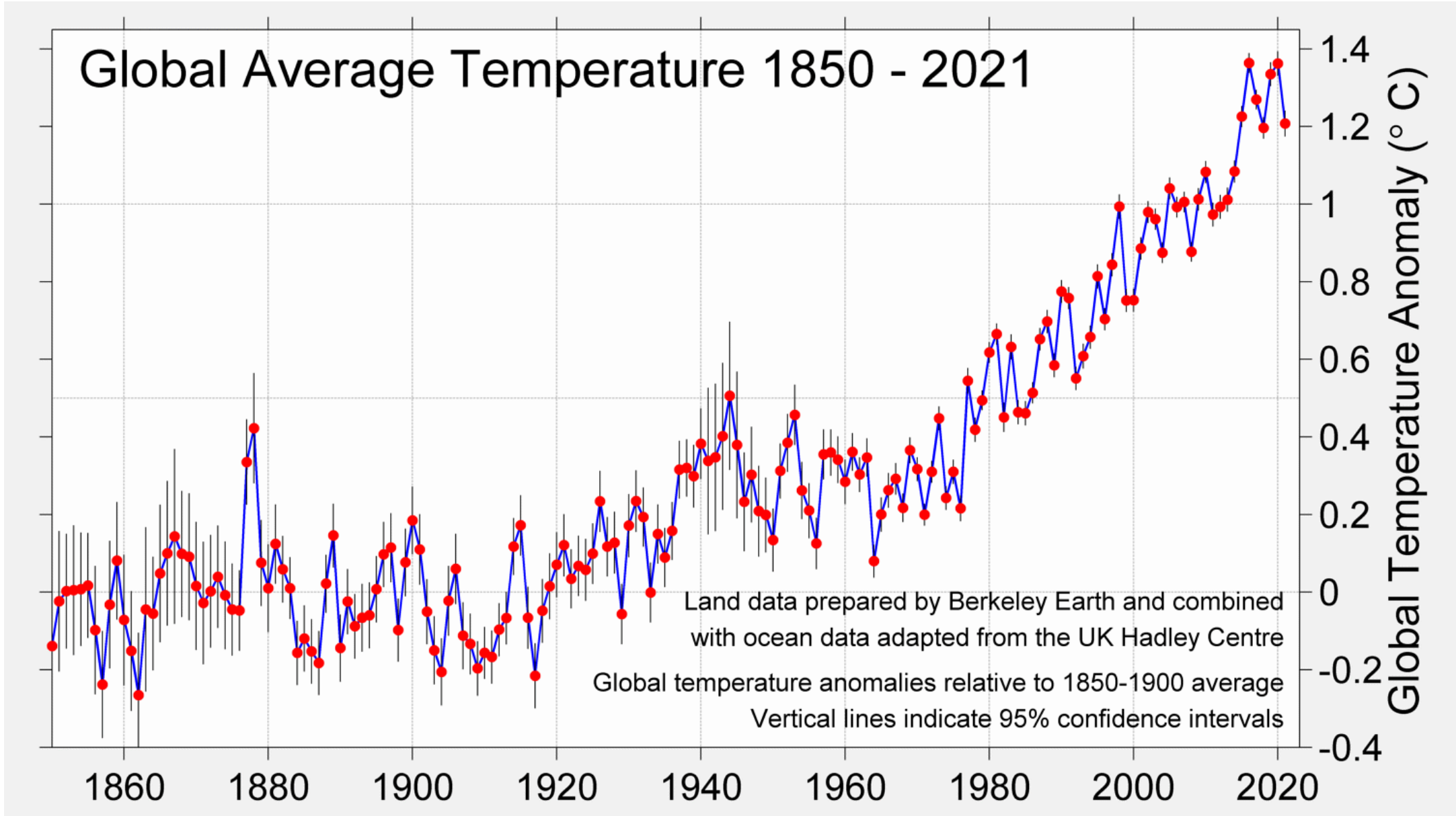
Climate change policies: decarbonisation from Australian, Polish and global perspectives

Jan Kozłowski

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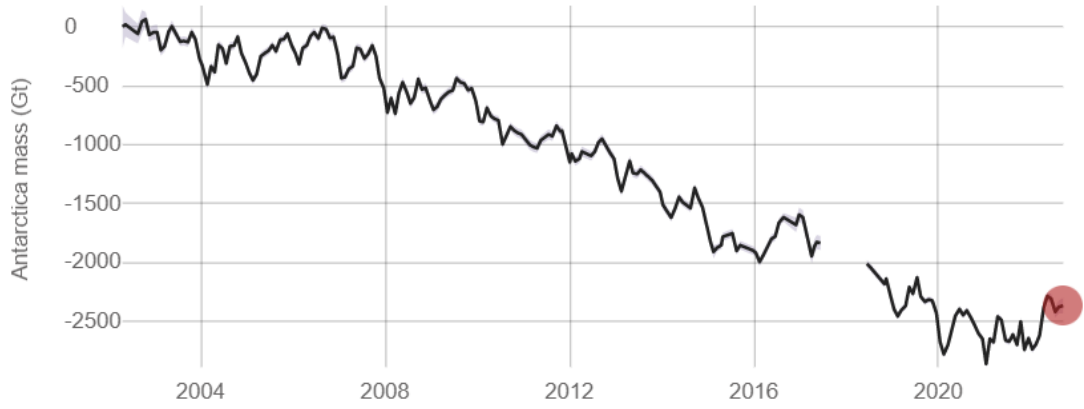
Kraków, Poland



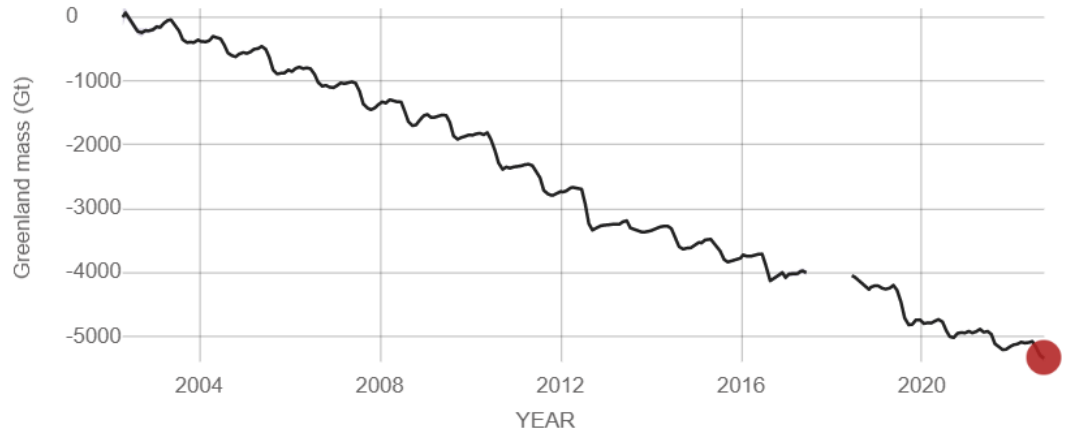


Current growth is $1,3^{\circ}\text{C}$, the safe level according to the IPCC is $1,5^{\circ}\text{C}$, below 2°C means a moderate disaster.

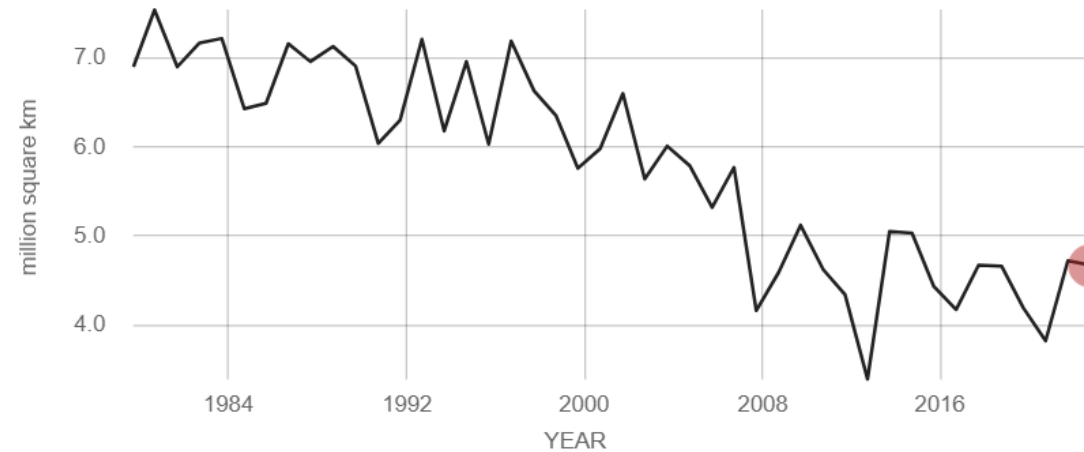
Glaciers are melting



Antarctic ice mass loss



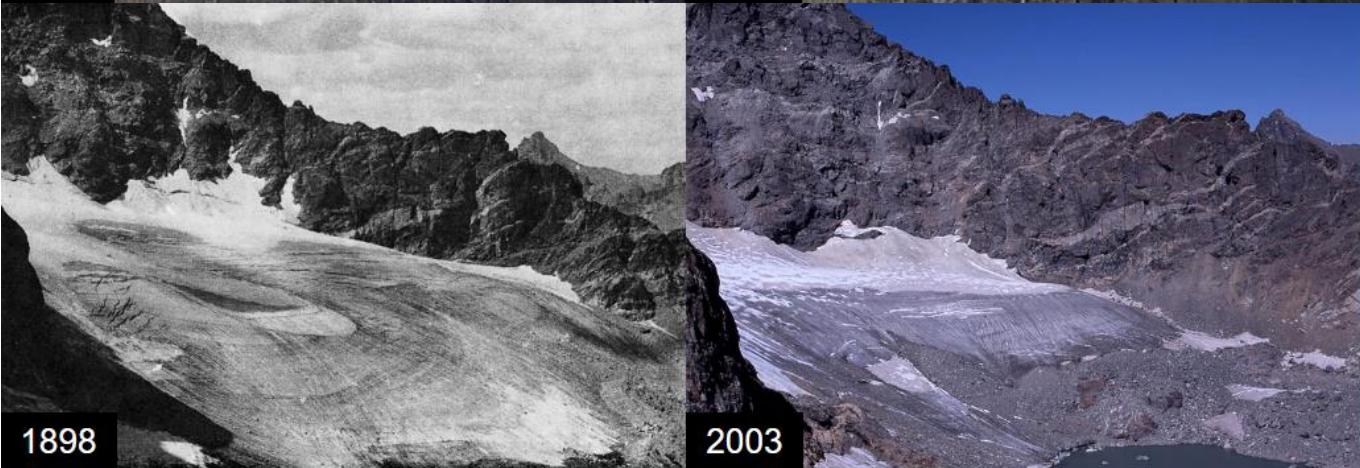
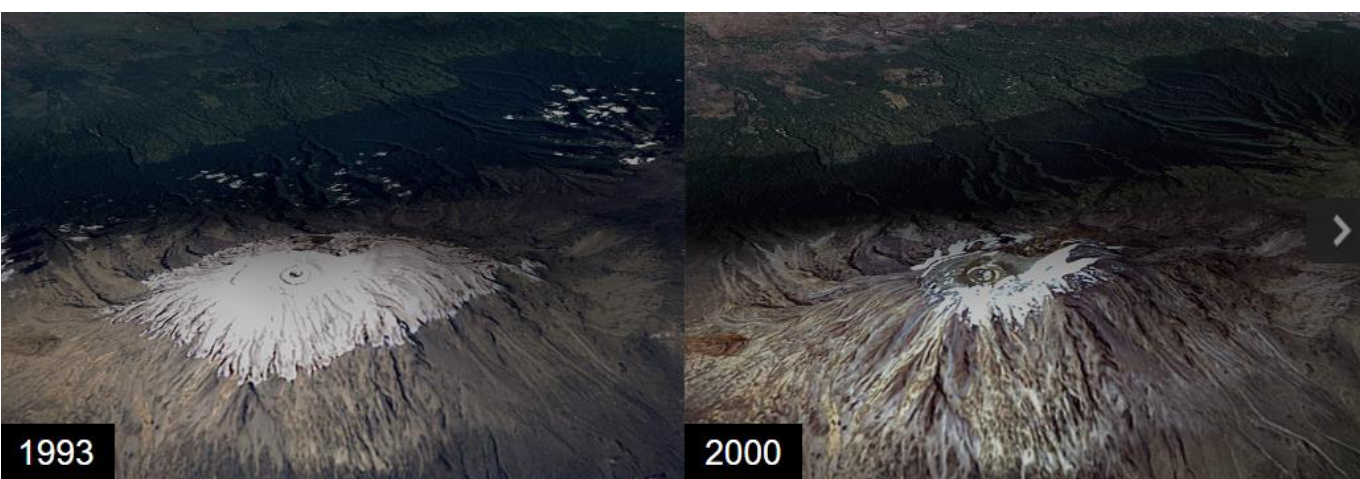
Greenland ice mass loss



Arctic ice surface minimum

Glaciers are melting

Africa
Kilimandjaro

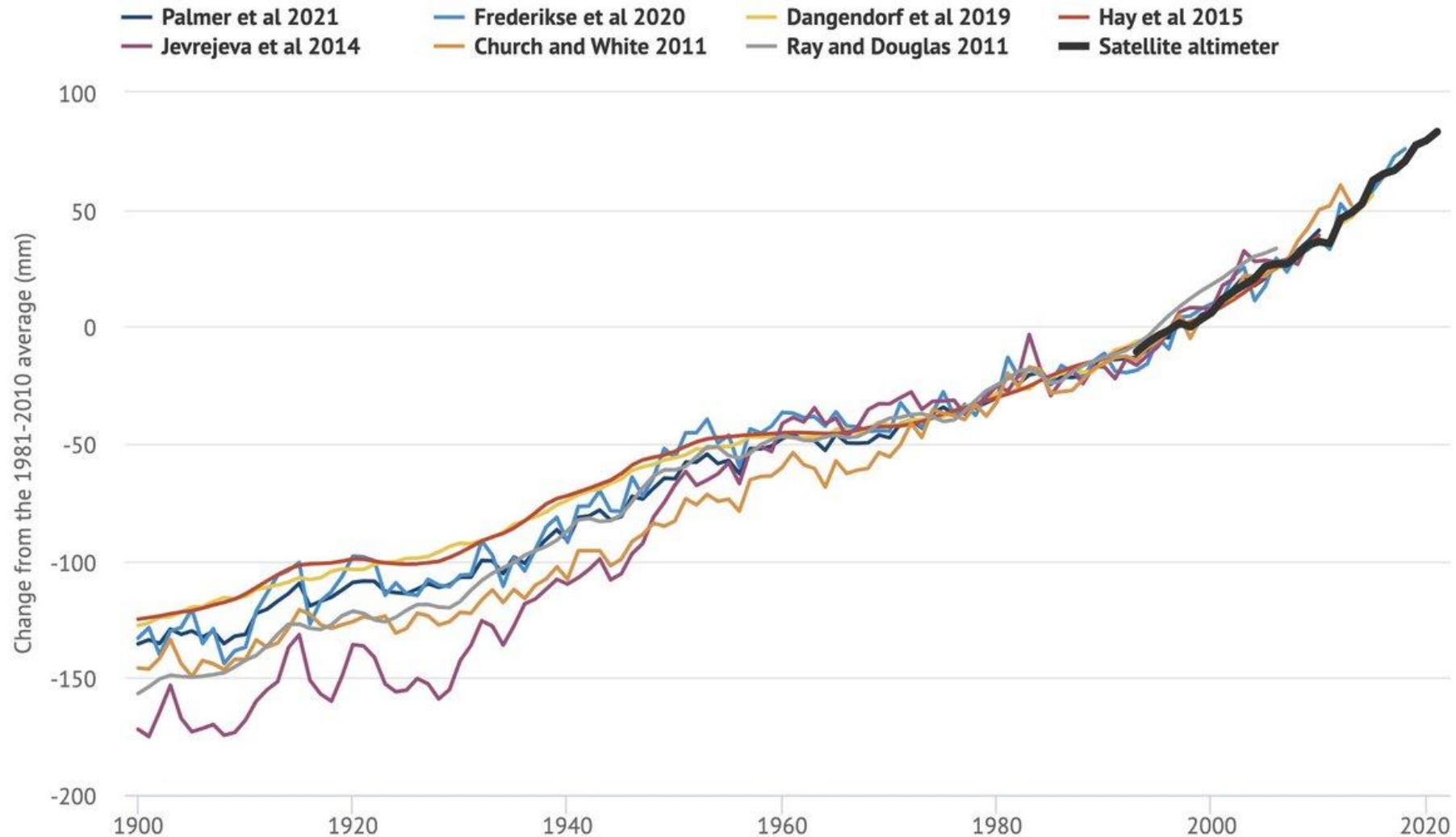


North America
Rocky Mountains
Arapho Glacier



Indonesia
Sudirman Range
Puncak Jaya

Average sea level is rising



A looming catastrophe

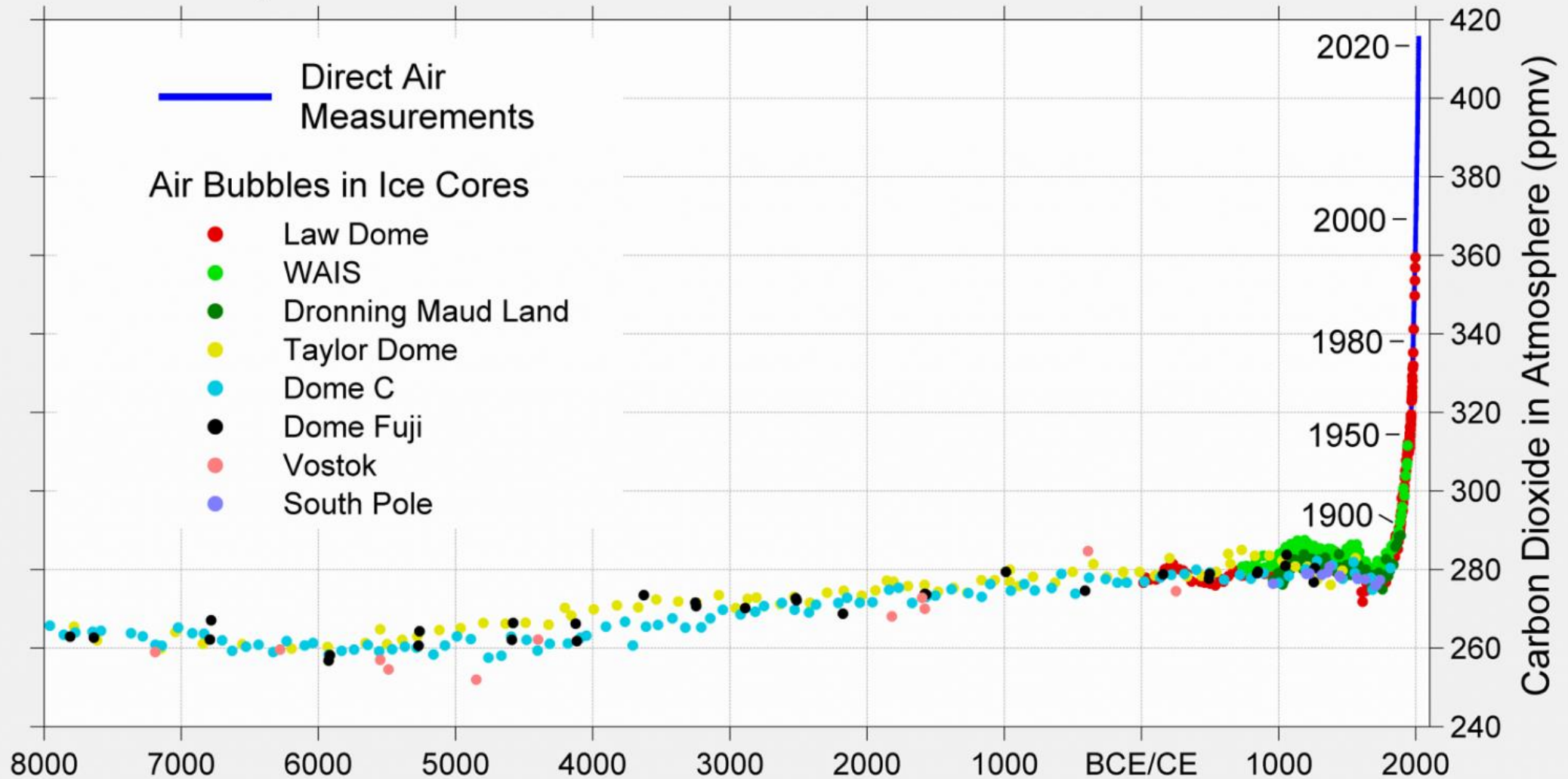
- Sea level rise
- More frequent and more severe hurricanes
- Long periods of drought
- Less mild rains, more violent ones
 - Floods
 - Landslides
- Periods of extremely high temperatures
- Shifts in precipitation zones
- Densely populated areas no longer suitable for life
- As a result, climatic migrations intensify, often preceded by famines and wars.



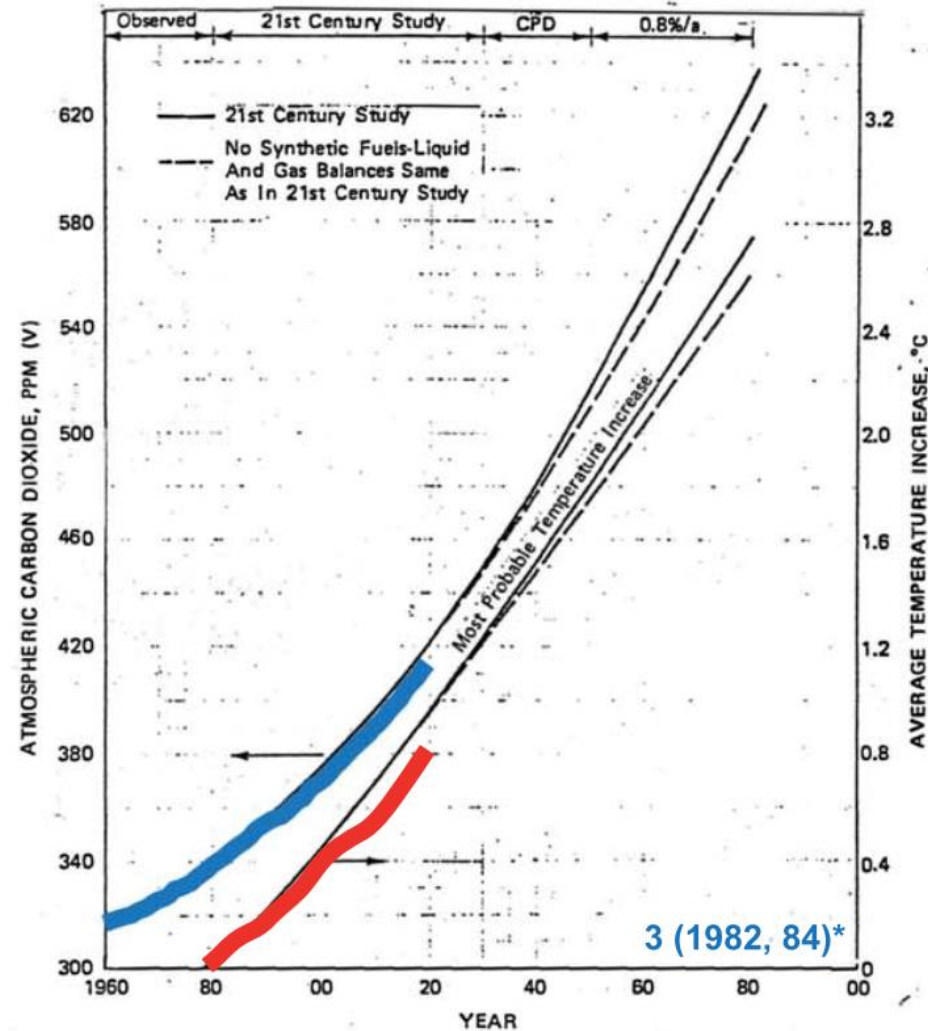
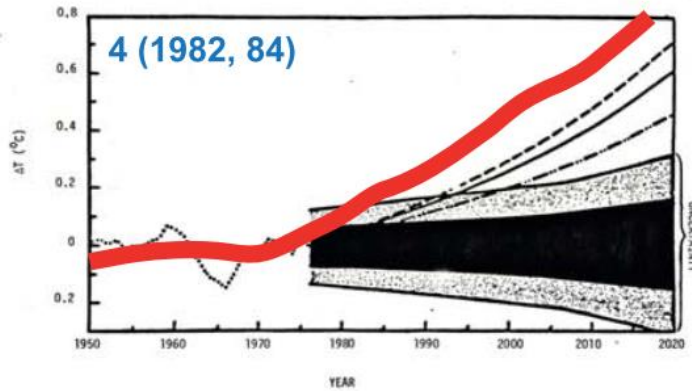
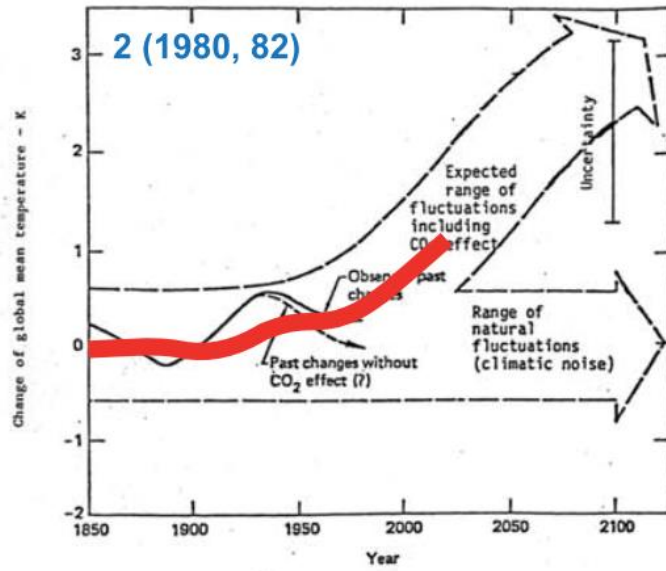
Earth's temperature is rising

- The conclusion is certain
 - Denialists are now in minority.
- Human activity is the cause
 - Conclusion certain, although there are denialists.
- Is the cause greenhouse gas emissions due to human activity?
 - Conclusion certain, although there are denialists.
- How do greenhouse gases (CO₂, CH₄, N₂O) work?
 - Denialists - nothing to worry about, as water vapor is the worst.

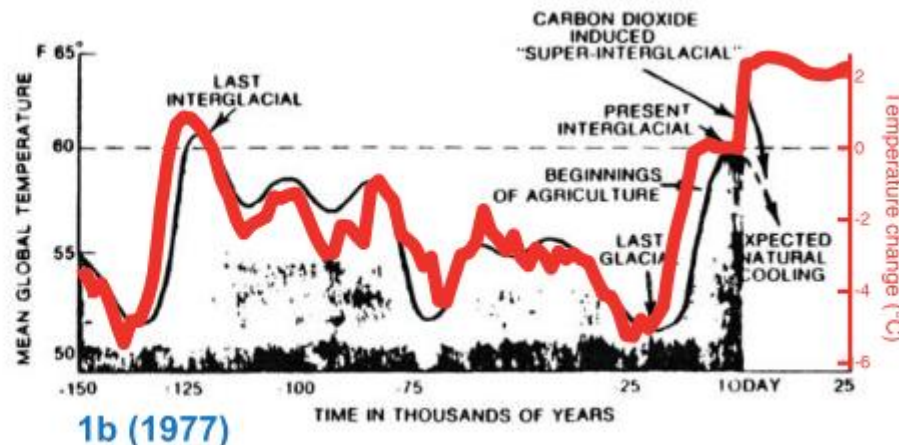
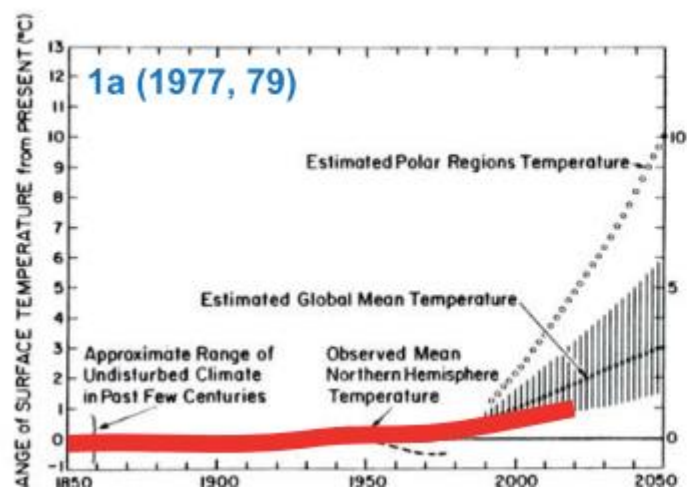
10,000 Years of Carbon Dioxide



Exxon/ExxonMobil knew

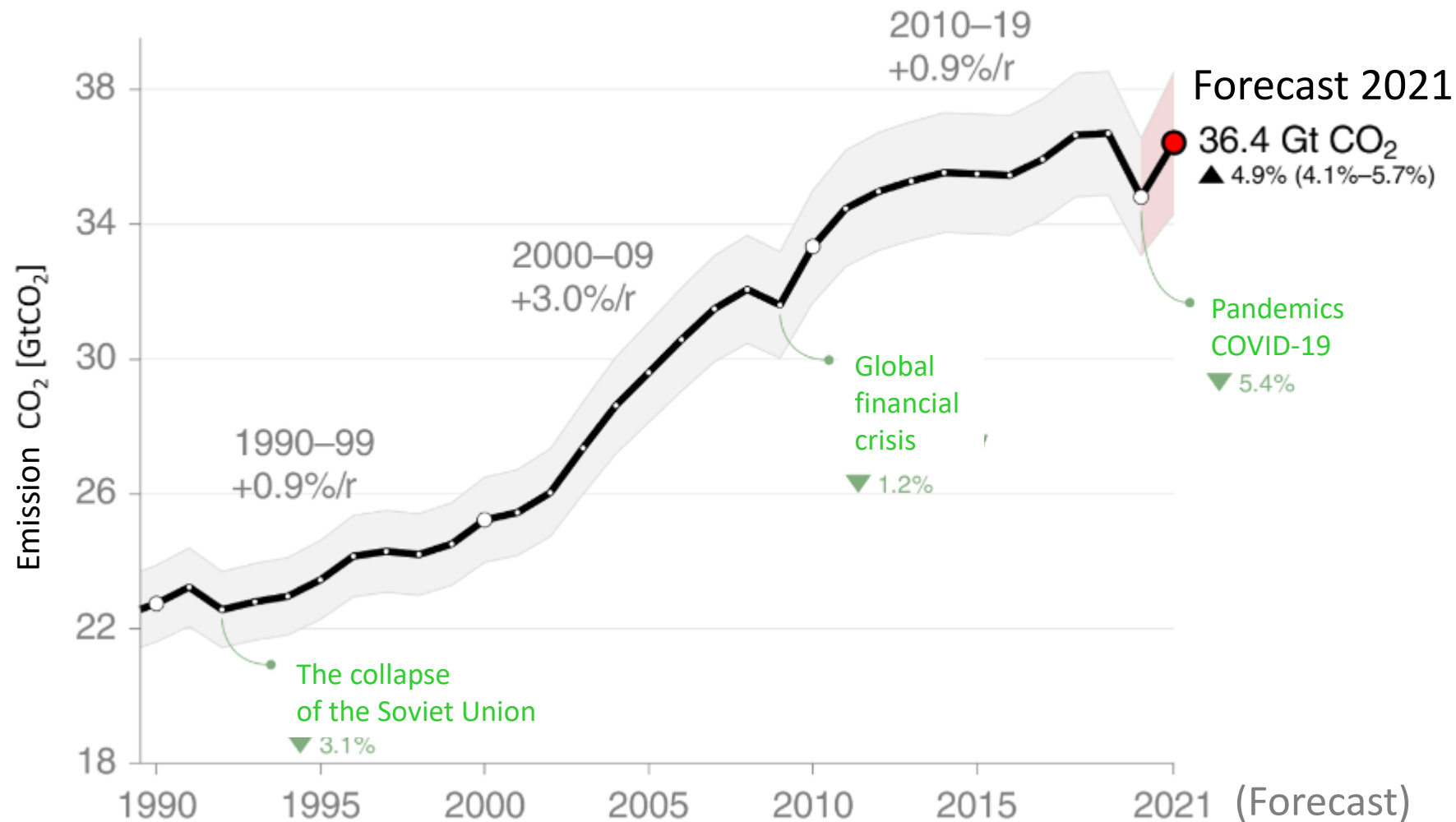


Exxon/ExxonMobil knew



„We find that most of their projections accurately forecast warming that is consistent with subsequent observations. Exxon and ExxonMobil Corp also correctly rejected the prospect of a coming ice age, accurately predicted when human-caused global warming would first be detected, and reasonably estimated the “carbon budget” for holding warming below 2°C. On each of these points, however, the company’s public statements about climate science contradicted its own scientific data.”

Global CO₂ emissions from fossil fuel combustion and cement production



Annual CO₂ emissions into the atmosphere

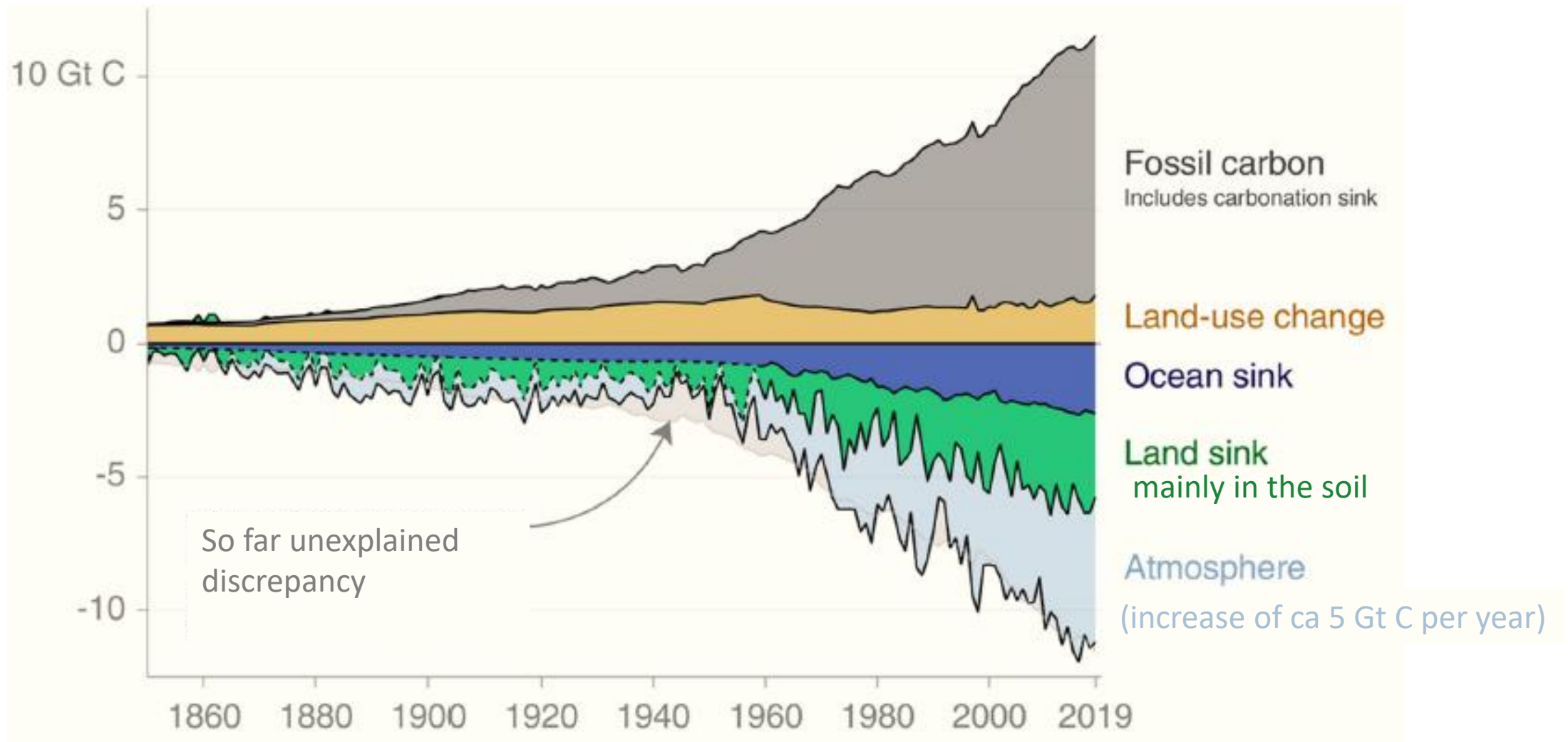
emissions 11,7 Gt C/year
36,4 Gt CO₂/year
(2021 year)



If coal from annual emissions were loaded onto coal cars,
the train would circle the equator 45 times!

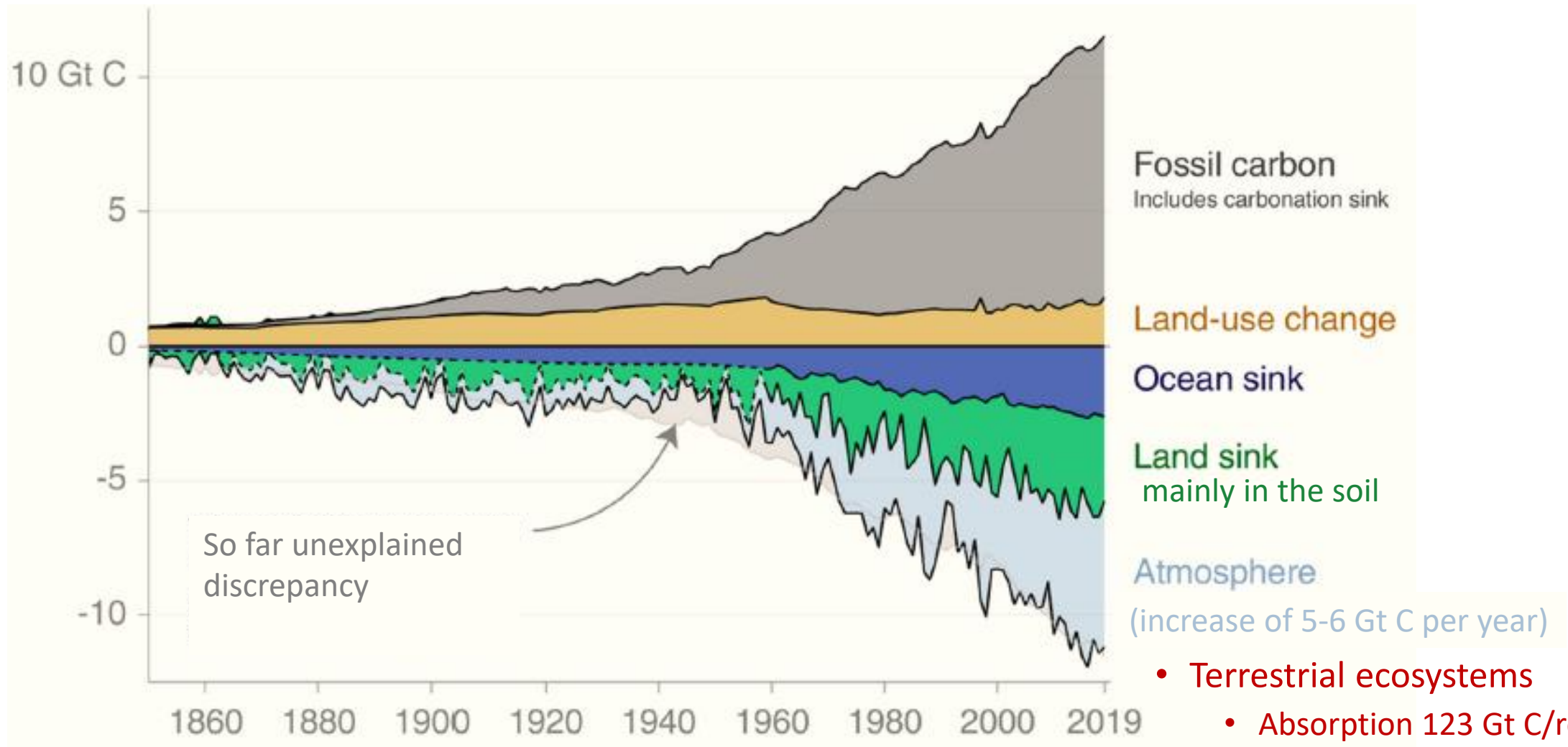


Balance of carbon sources and sinks



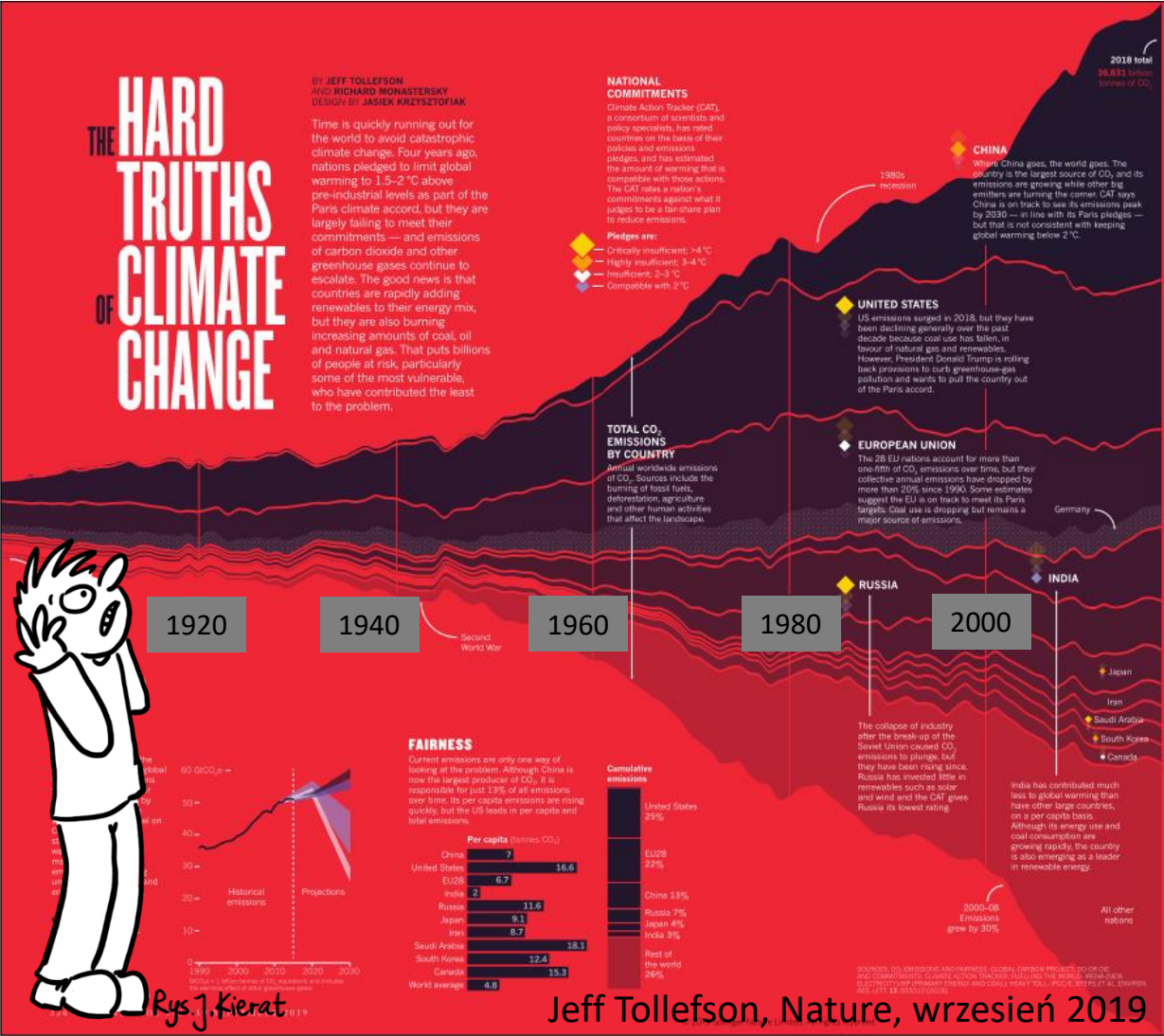
Balance of carbon sources and sinks

- Volcanoes
- average 0.1 Gt C/year

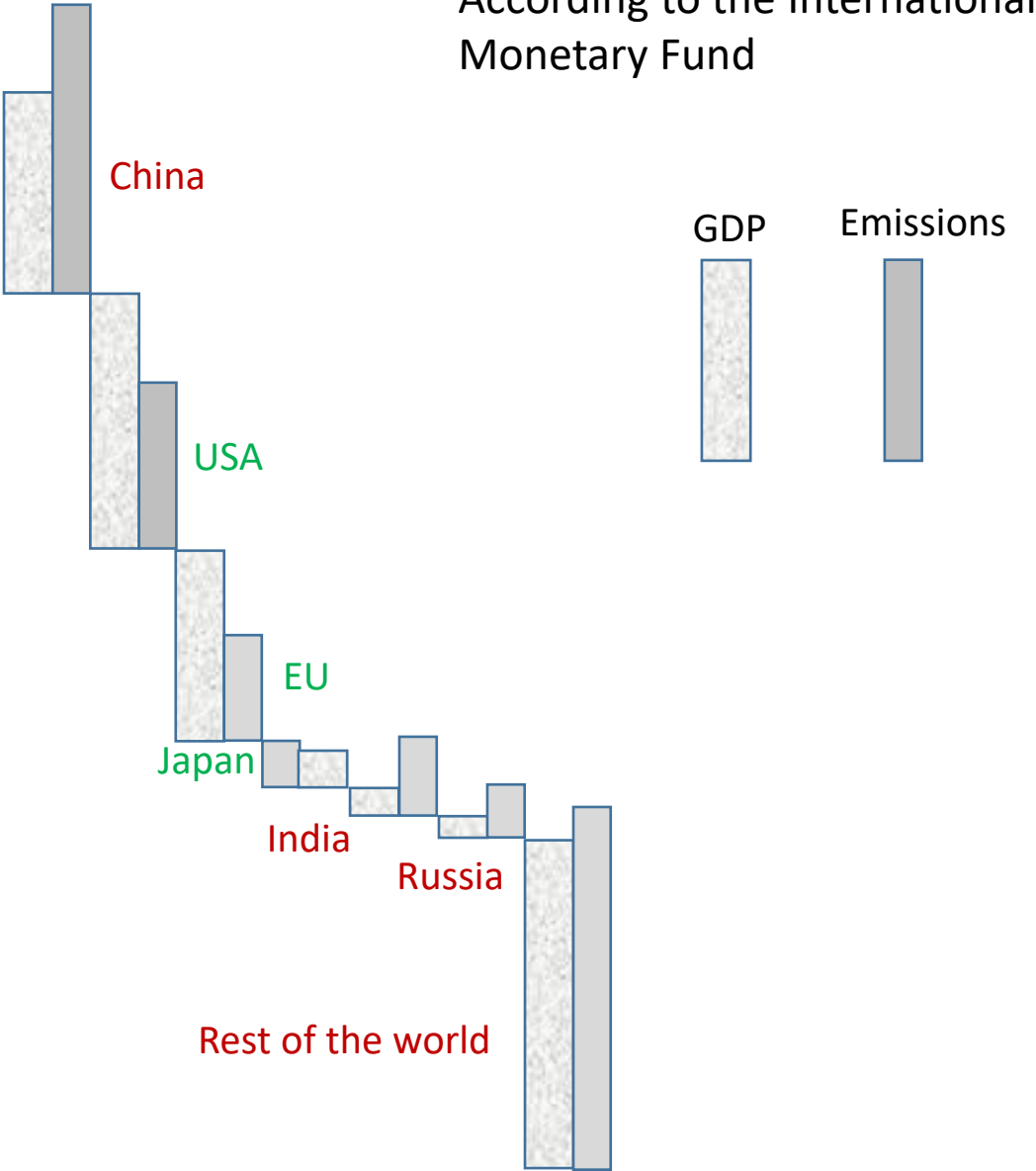


Emissions vs. GDB

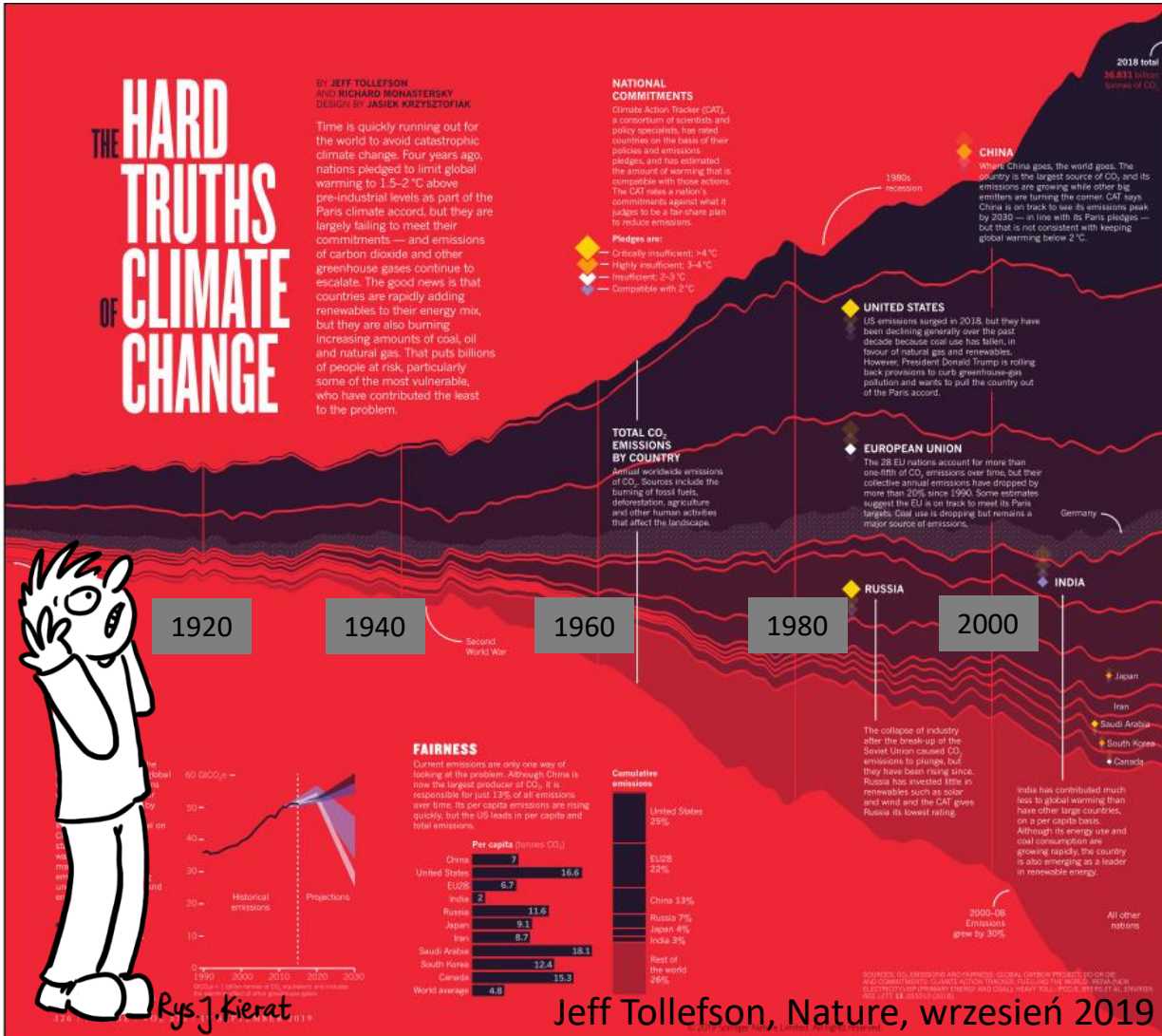
GDP 2021,
According to the International
Monetary Fund



Jeff Tollefson, Nature, wrzesień 2019



Emissions per capita and cumulative emissions



Jeff Tollefson, Nature, wrzesień 2019

FAIRNESS

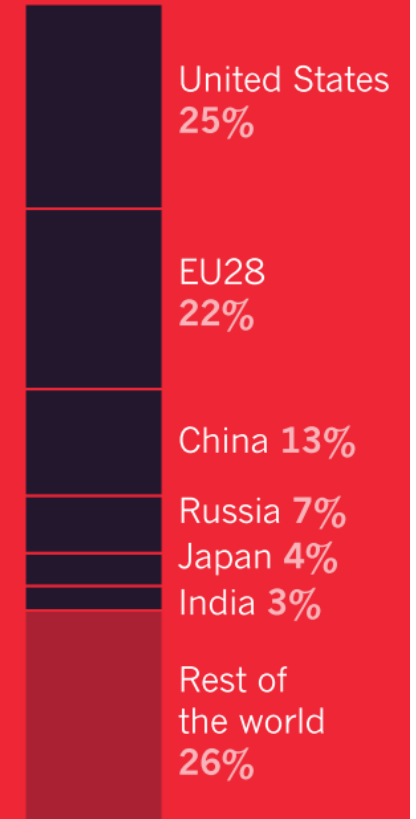
Current emissions are only one way of looking at the problem. Although China is now the largest producer of CO₂, it is responsible for just 13% of all emissions over time. Its per capita emissions are rising quickly, but the US leads in per capita and total emissions.

Per capita (tonnes CO₂)



Polska – 7.9

Cumulative emissions



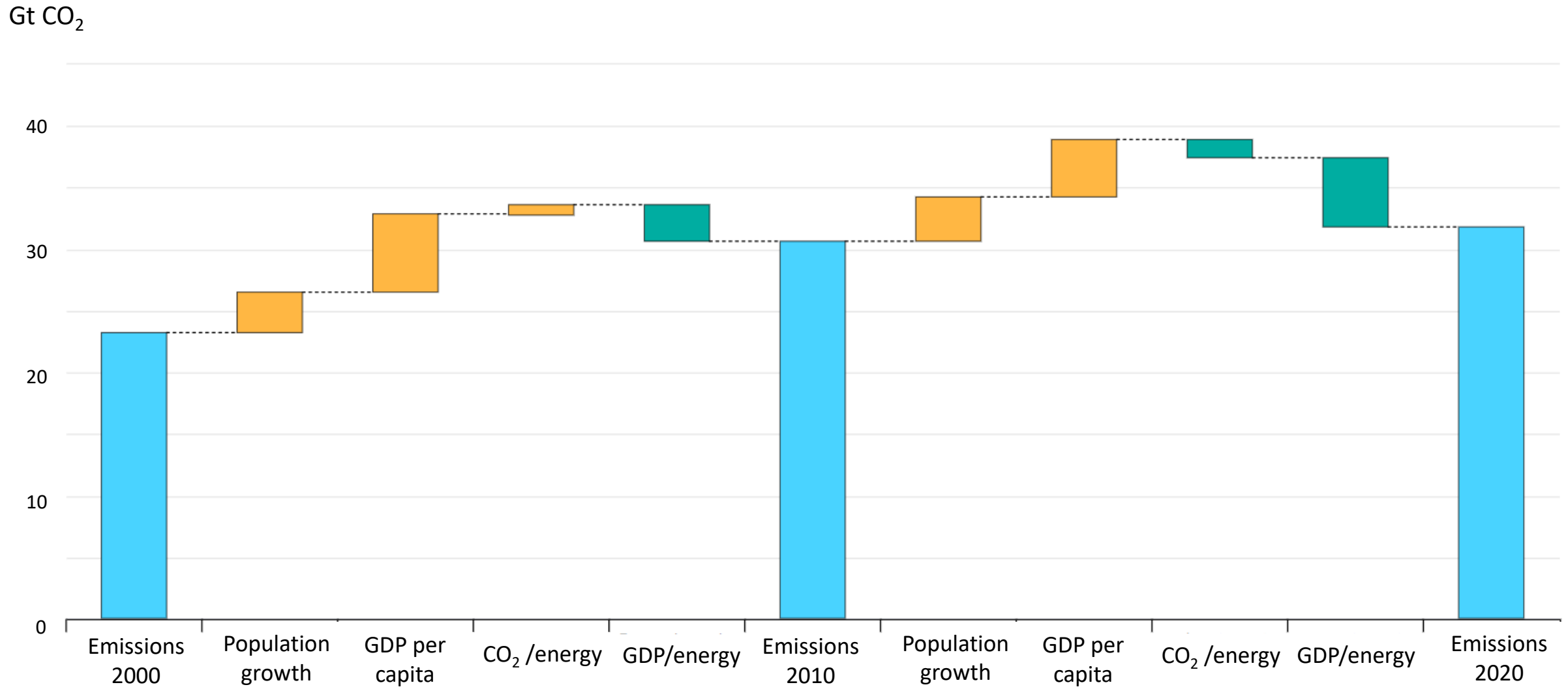
Geotechnical methods of temperature reduction

- Methods
 - Placing reflective films in the upper layers of the atmosphere
 - SO₂ atomization in the atmosphere
 - Iron fertilization of the oceans
 - Etc.

Geotechnical methods of temperature reduction

- Methods
 - Placing reflective films in the upper layers of the atmosphere
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 - Etc.
- This must be very strongly opposed!!!
- Only decarbonization of the economy and safe decarbonization of the atmosphere!!!

Why is it so difficult to reduce emissions?



Is it economically feasible to decarbonize the economy by 2050?

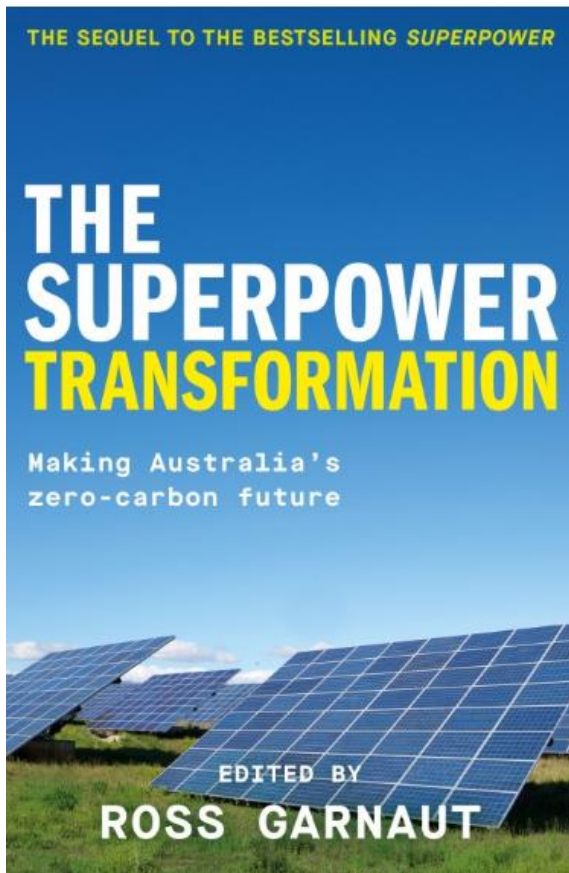
- Estimated cost: \$100 trillion (according to International Energy Agency)
 - Roughly equivalent to the world's GDP;
 - When spread out over the years, only (or as much as?) 3.57% of the world's GDP;
 - The problem is not money
 - The need for a major overhaul of the world's finances;
 - The need for reliable and honest monitoring;
 - The need for mechanisms to force decarbonization throughout the world;
 - The need for massive support for countries with low GDP.



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 - The need for massive support for countries with low GDP;
- The European Union is leading, but the United States has entered the race (US Inflation Reduction Act);
- China is doing a lot;
- Will Australia and Poland enter the race?

Australia is likely to join the race, Poland - it depends



- Australia
 - 21 May elections, majority by Labor Party
 - Anthony Albanese's government should be supported by Greens for changes in climate policy
 - Ross Garnaut ideas are paving the way
- Poland
 - Elections in October
 - Change of the government necessary for change in policy
 - Such plan as Garnaut's should be established for Poland.

Similarities and differences between Australia and Poland

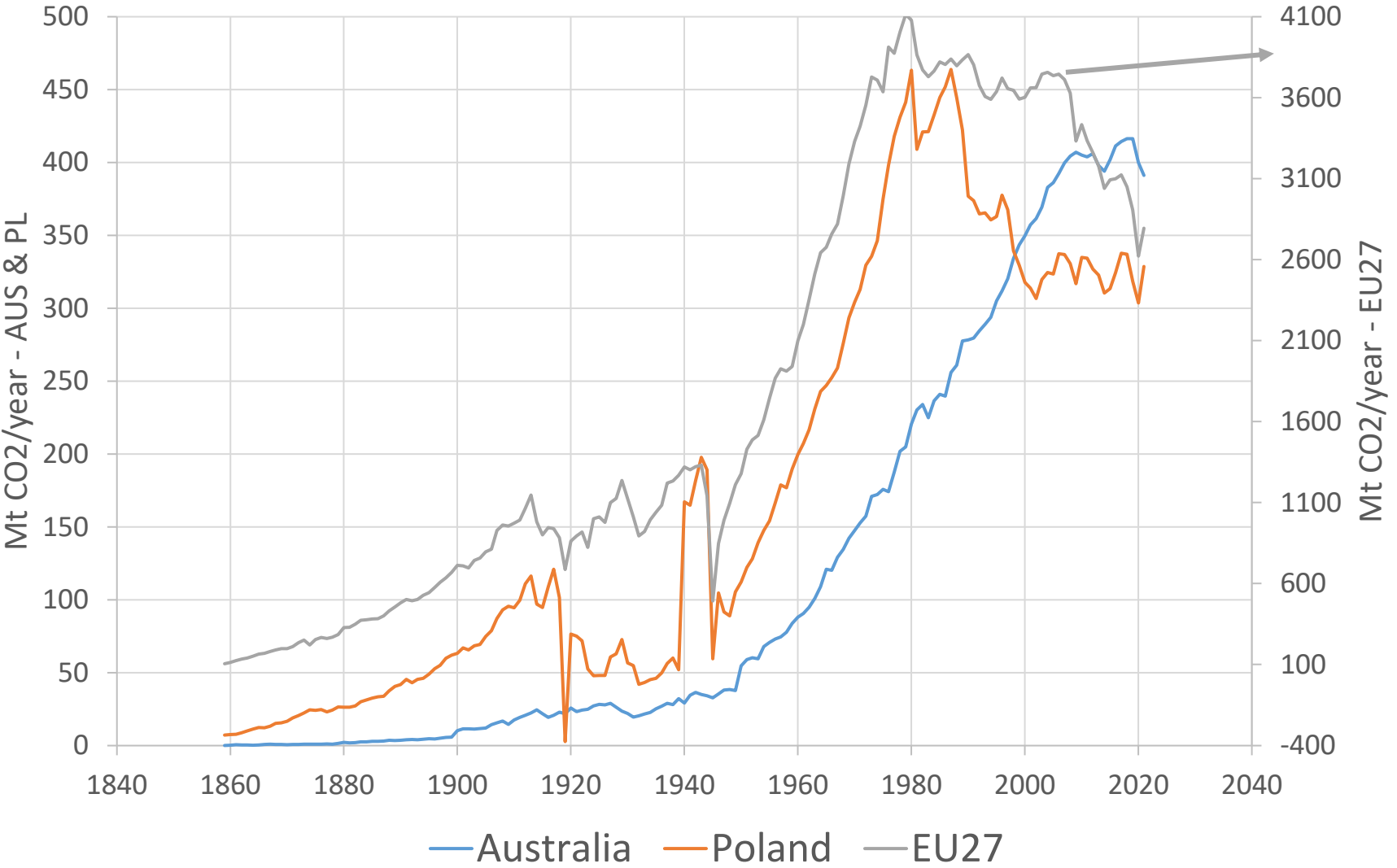
Australia

- Population 25.9 mln
- **Area** **7,617,930 km²**
- GDP(UN data 2022) USD 1,734 bln
- Emissions (2021) 391 mln t CO₂/year
- Emissions per capita 15.09 t CO₂/year
- **Max emissions year** **2019**
- Max emissions amount 416 Mt
- Cumulative emissions 19.0 Gt CO₂

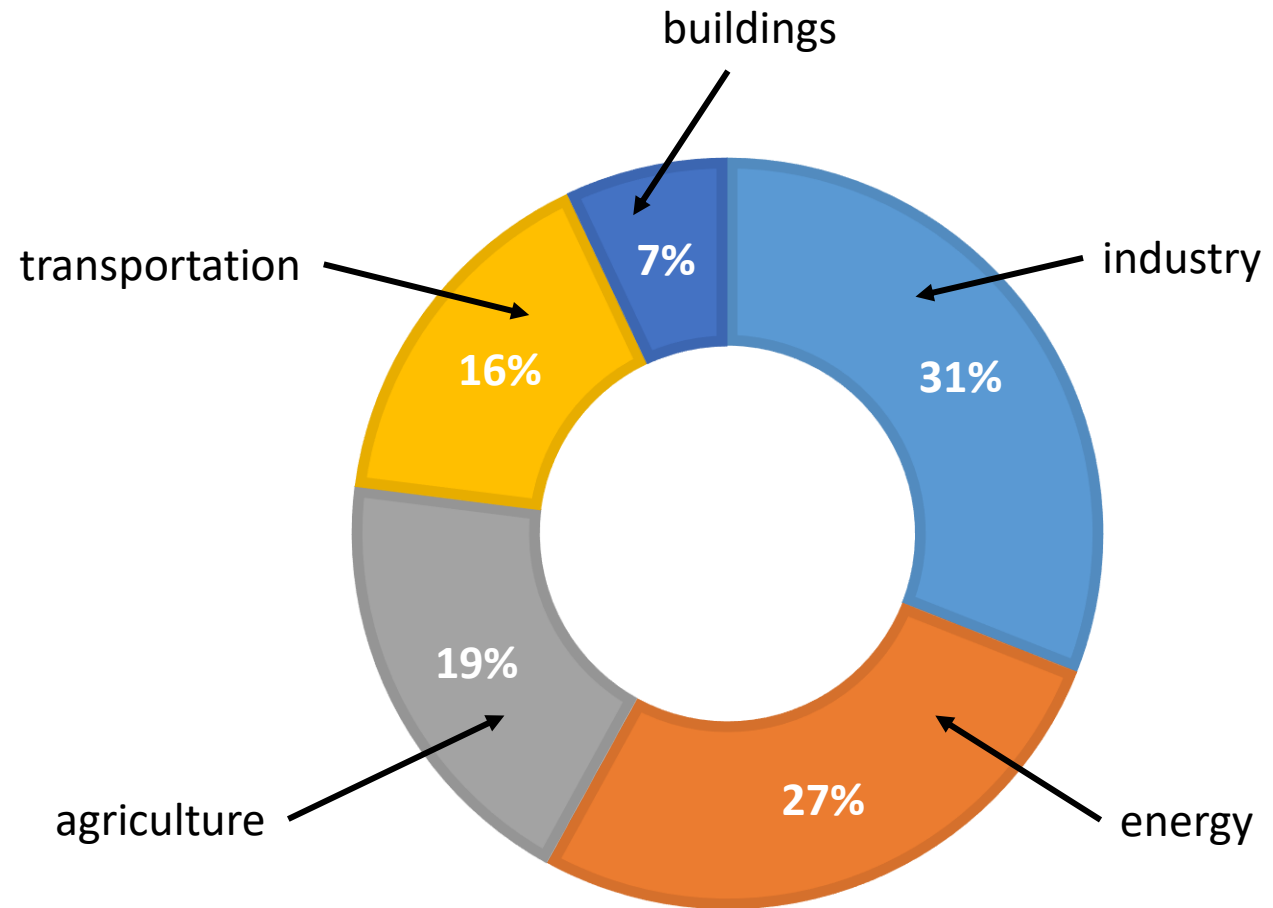
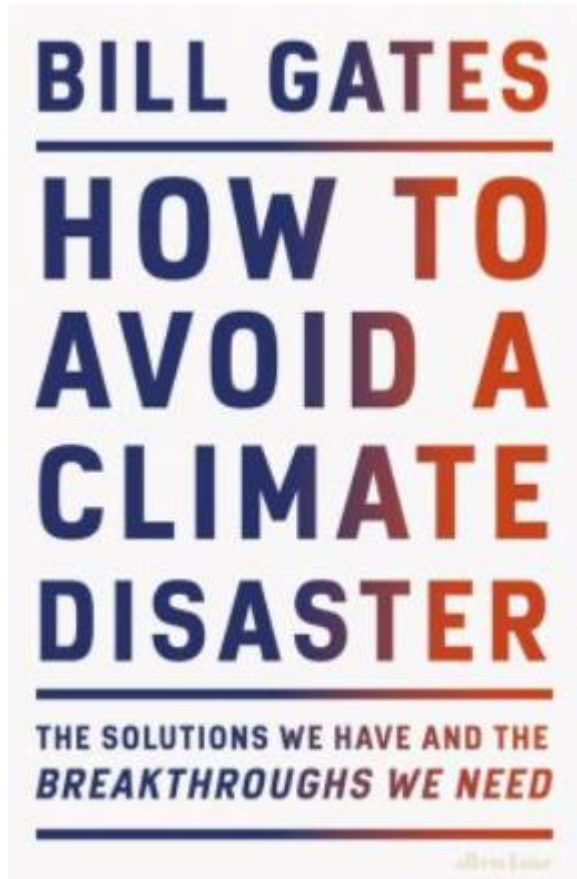
Poland

- Population 37.6 mln
- **Area** **322,575 km²**
- GDP(UN data 2022) USD 716 bln
- Emissions (2021) 328 mln t CO₂/year
- Emissions per capita 8.58 tCO₂/year
- **Max emissions year** **1980**
- Max emissions amount 463
- Cumulative emissions 28.2 Gt CO₂

CO₂ emission dynamics in Australia, Poland and the EU27



Emissions of various sectors



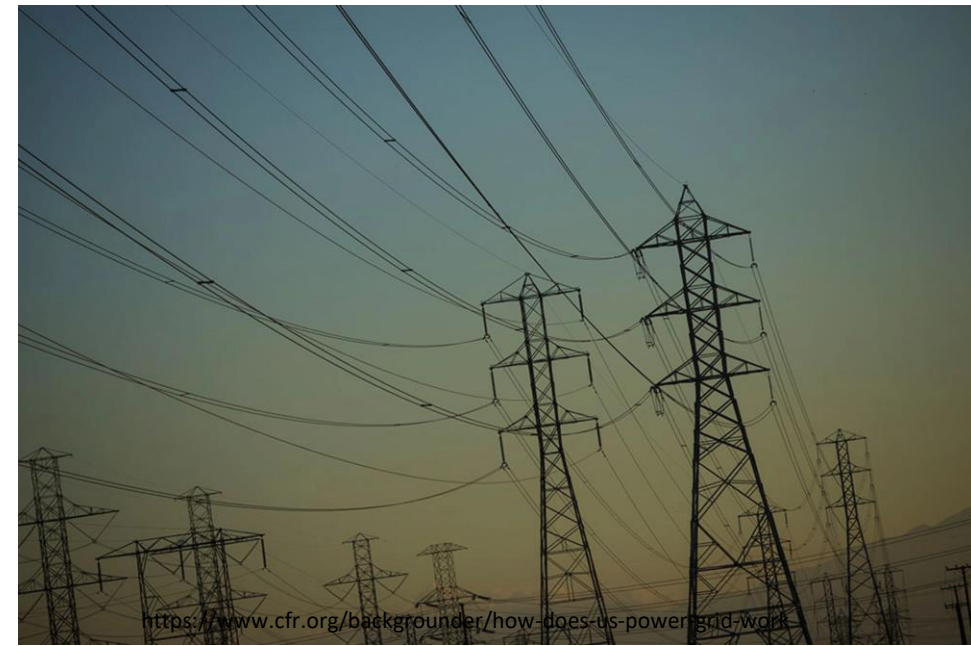
Energy transformation

- The most urgent task - saving energy
 - Still huge potential
- What sources of electricity should remain?
 - Renewable Energy Sources
 - Distributed photovoltaics and photovoltaic farms
 - Wind turbines on land and at sea
 - Biogas
 - Burning or better pyrolysis of biomass
 - Other techniques still immature?
 - Nuclear energy
 - Revitalization of existing nuclear power plants
 - Construction of new large power plants
 - SMRs (small modular reactors)?
- Capture and storage of CO₂ in thermal plants.



Energy transition - problems

- Most serious problems:
 - Grid reconstruction - cost comparable to installation of new sources
 - Energy storage
 - Pumped storage power plants
 - Compressed air
 - Minutes - megacapacitors
 - Hours - batteries
 - Currently, lithium-ion
 - Target - flow batteries (days?)
 - Days, weeks, months
 - Hydrogen - ultimately "green" hydrogen
 - The need to maintain reserve energy sources
 - Transitional role of natural gas gradually being replaced by green hydrogen

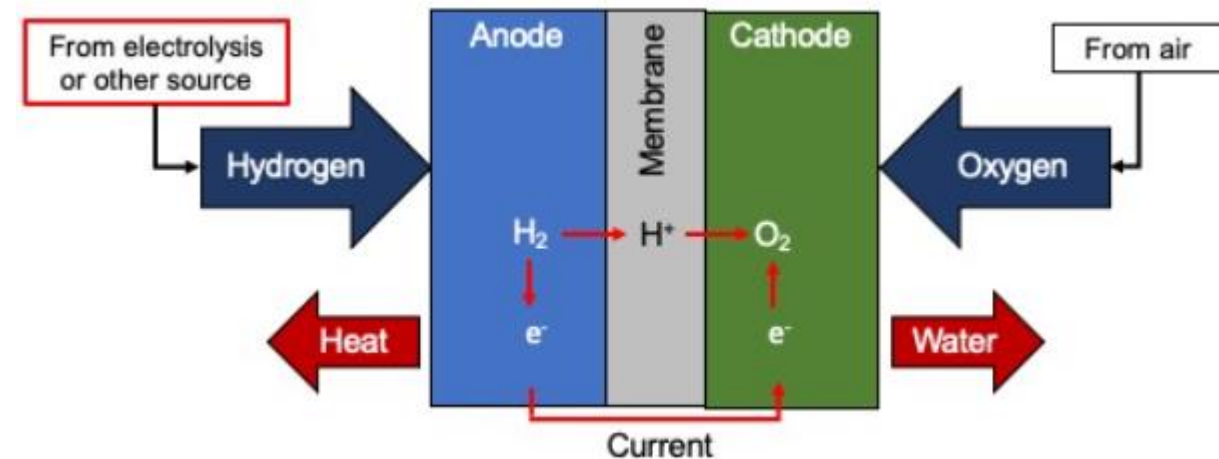


Decarbonization of transportation

- Drives of the future
 - Battery electric drive:
 - Passenger cars
 - Vans
 - City Buses,
 - Coaches?
 - Trucks?
 - Fuel cell electric drive (hydrogen):
 - Long-distance trucks
 - Long-distance buses
 - City buses
 - Trains on non-electrified lines
 - Marine transportation?
 - Planes?
 - Other solutions?



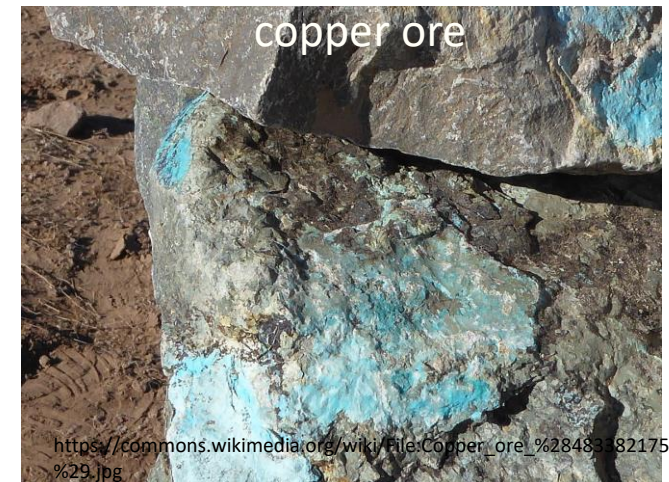
<https://www.farmprogress.com/farm-operations/electric-vehicles-pose-hurdles-in-rural-america>



https://commons.wikimedia.org/wiki/File:Hydrogen_fuel_cell_schematic.jpg

Decarbonization of industry

- Usually lack of mature technologies
- Large role of **hydrogen** as an energy carrier and reducing agent
 - especially in the production of metals from ores;
- It is impossible to completely eliminate emissions (under known technologies), among other things in:
 - the cement industry
 - the production of nitrogen fertilizers
- Capture and storage of CO₂
 - is one of possible solutions.



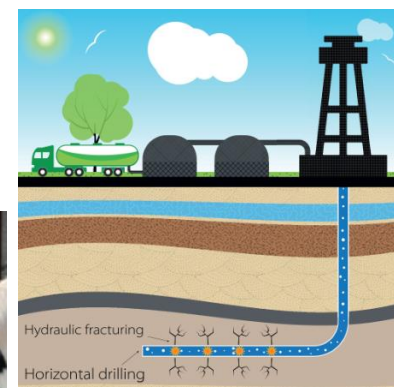
Decarbonization of heating and cooling

- Heating and cooling in dispersed buildings
 - Heat pumps
 - Electric heating?
 - Hydrogen heating?
- System heating
 - Waste heat from small nuclear reactors (SMRs)?
 - Gas-fired combined heat and power plants with CO₂ capture
 - Biomass combined heat and power plants
 - Large scale heat pumps
 - Hydrogen combined heat and power plants – in the distant future.



Reducing emissions of other gases, mainly methane

- From the extraction and processing of fossil fuels
- From landfills
- From the fields, primarily rice
- Of breeding
 - Limitation of ruminant farming
 - Prevention of methane formation and capture of methane from mass cultures



It is necessary to take a certain amount of CO₂ out of circulation.

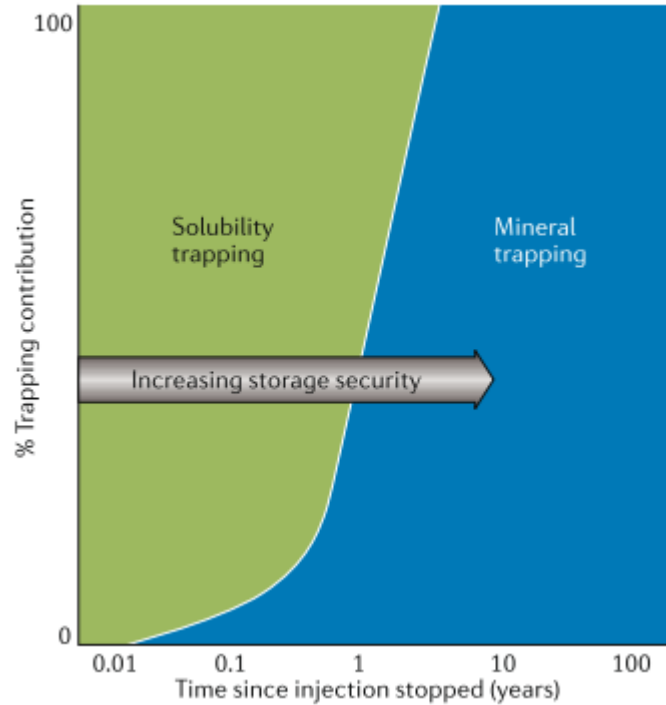
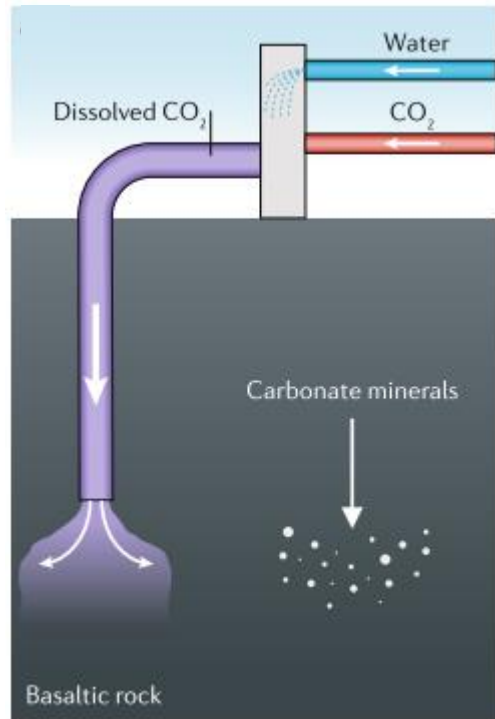
- 10-20% of emissions cannot be eliminated;
- Much of the emissions will be eliminated too late to halt the temperature rise by no more than 1.5° C by 2050;
- CO₂ capture :
 - From the combustion or, better, pyrolysis or fermentation of biomass
 - Waste biocarbon can be added to soil
 - From the atmosphere

Removal of CO₂ from the atmosphere - binding by minerals

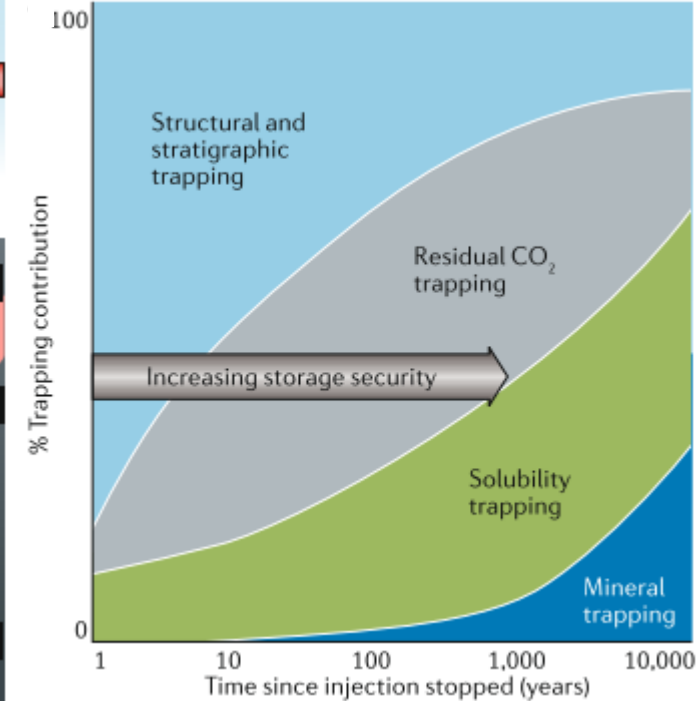
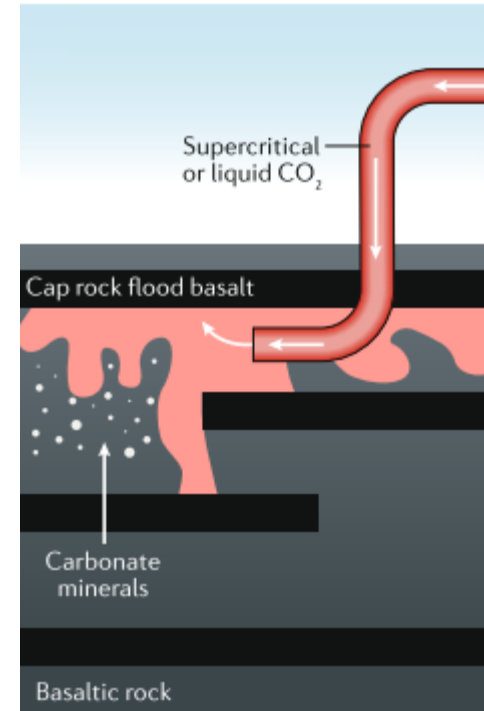
- Rocks that bind CO₂ well
 - Peridotite - huge heaps at diamond mines
 - Kimberlit
 - Basalt
 - Etc.
- Adding crushed rocks to the soil
- Adding rock spray to the oceans (would additionally reduce acidification)

CO₂ storage in rocks on land and in oceans

Injection of water saturated with carbon dioxide



Carbon dioxide injection



Removal of CO₂ from the atmosphere by natural forces

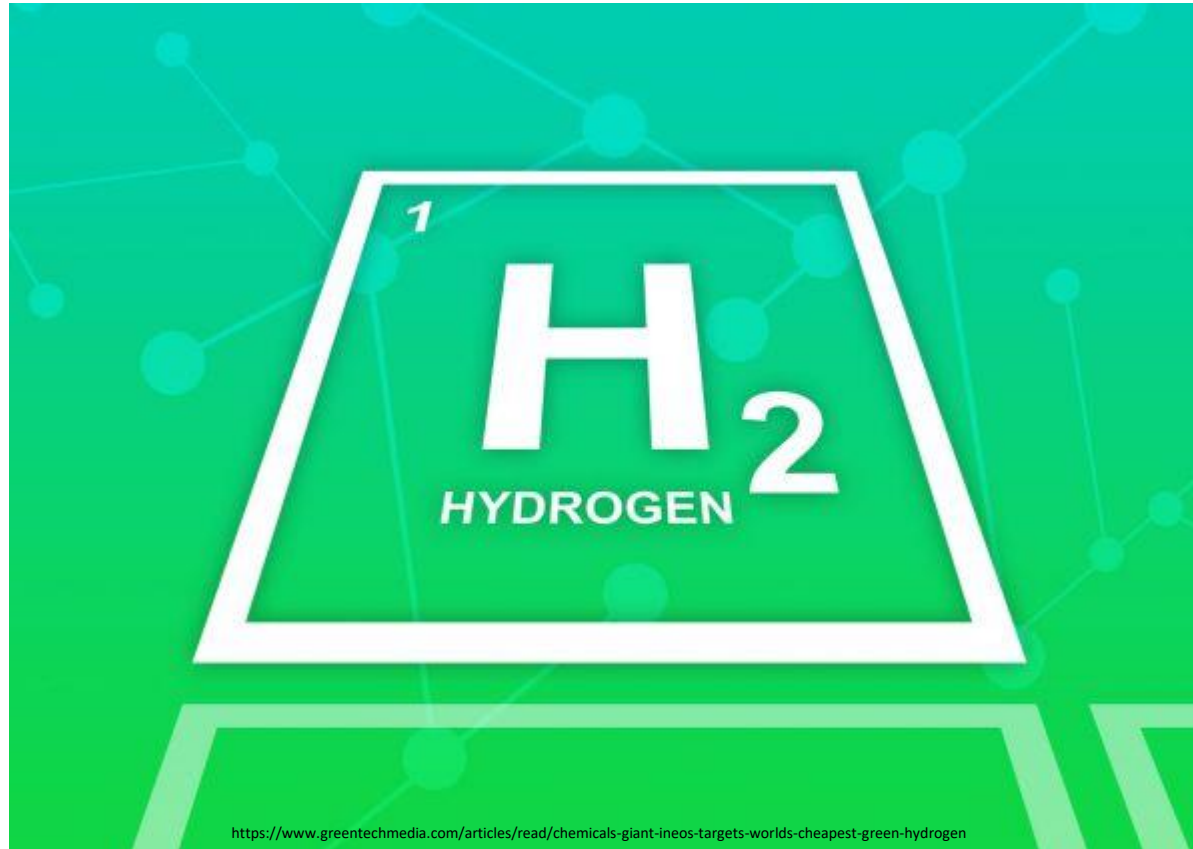
- Emissions are about 10% of natural carbon turnover in terrestrial ecosystems
 - If reduced to 1-2%, natural forces can absorb them
- It is possible to increase the CO₂ absorption potential of forests by:
 - Increasing the area of forests
 - Giving back to nature some of the forests
 - Plantations for wood production
 - Changes in forestry and agricultural practices



more carbon

less carbon



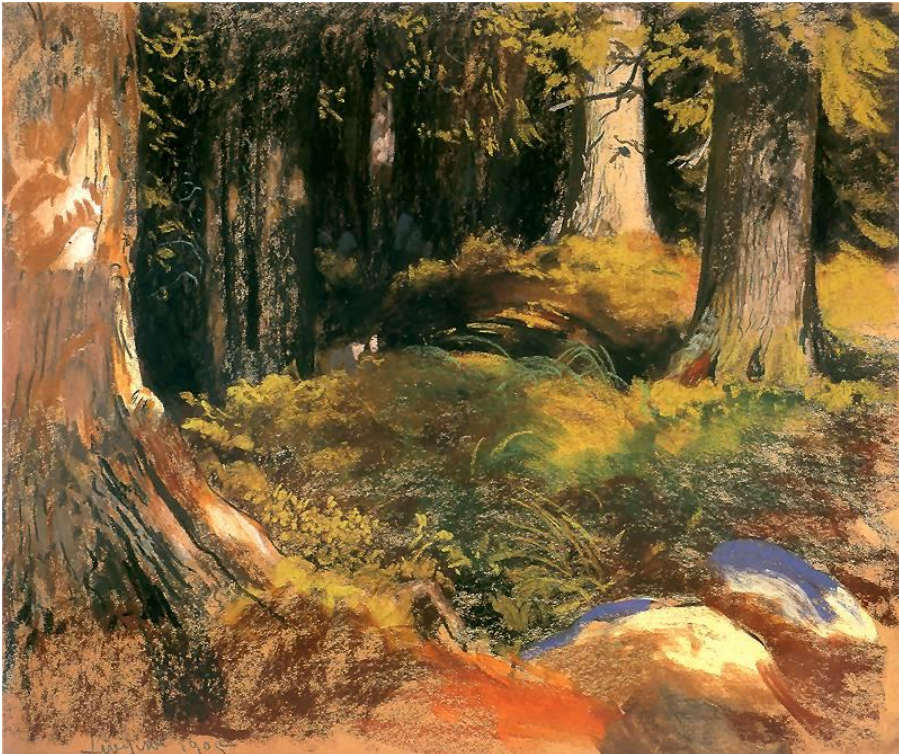


<https://www.greentechmedia.com/articles/read/chemicals-giant-ineos-targets-worlds-cheapest-green-hydrogen>

Decarbonization of economy. Can we make it?

YES!

development over the next 100 years



Leon Wyczółowski - Forest in Zakopane in the sunshine

NO!

climate catastrophe



Michal Mroczka - Landscape after the battle