Thougths on the Energy Transition

Julien Jomaux

September 2023

Check out my work on energy here: https://gemenergyanalytics.substack.com/

Julien Jomaux

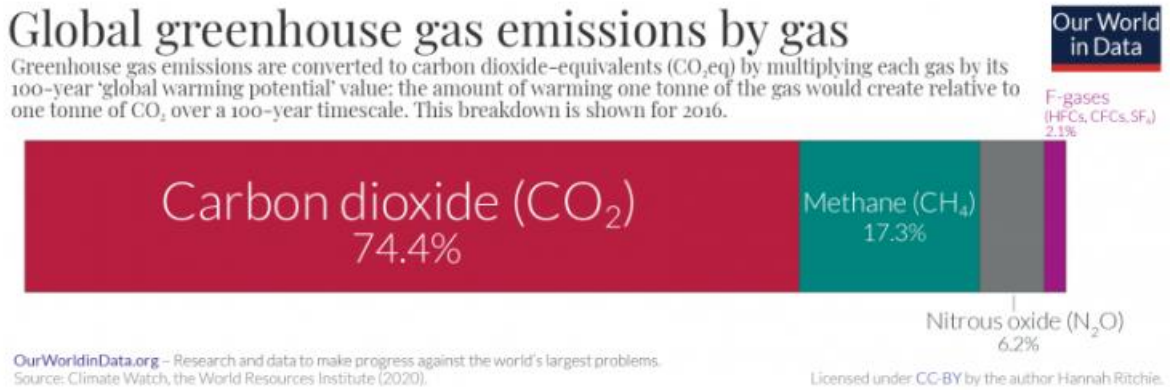
- **Engineer, specialized in electricity and energy systems**
- **Work experiences in Belgium, Rwanda, and Albania**
- **Passionate about electricity, energy, and sustainability**
- **Family with three kids**

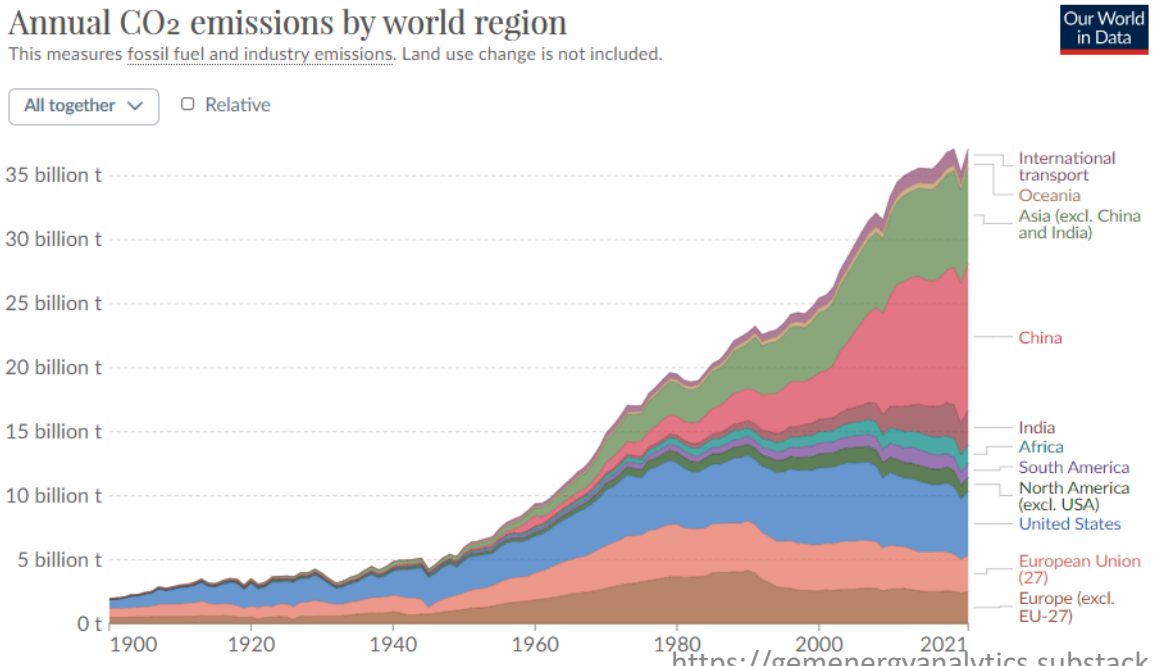
Agenda

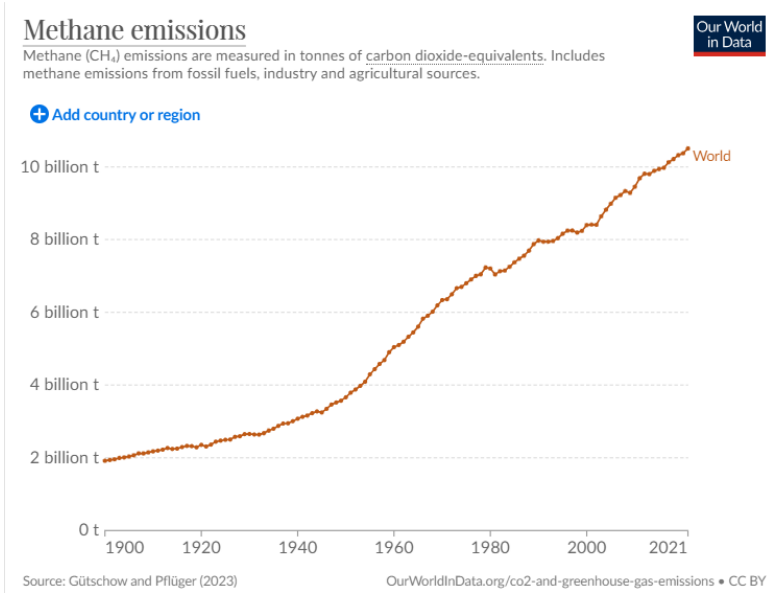
1. A brief history of emissions
2. Energy Transitions?
3. Two different issues: energy poverty and emissions
4. Hopeful developments
5. Focus on particular countries
6. The great challenges
7. What could we do?

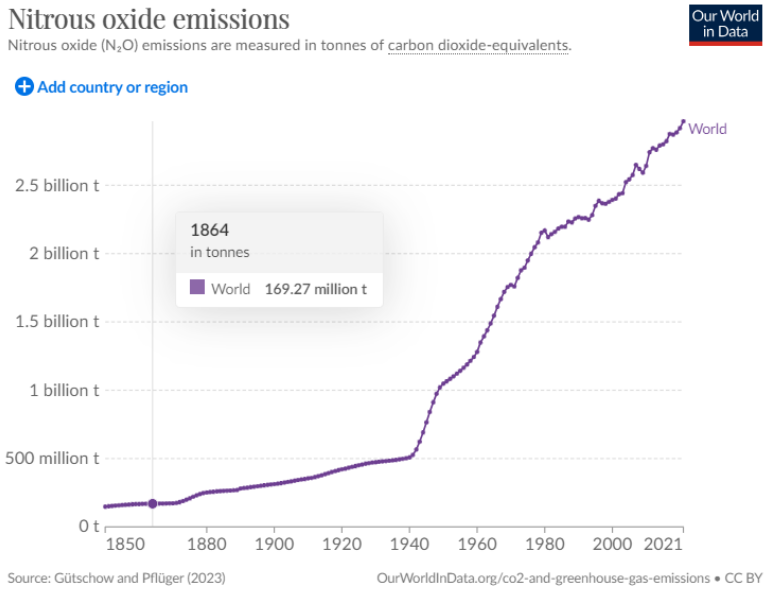
Three main greenhouse gases

CO2 is 75%, CH4 17%, N2O 6%: all growing



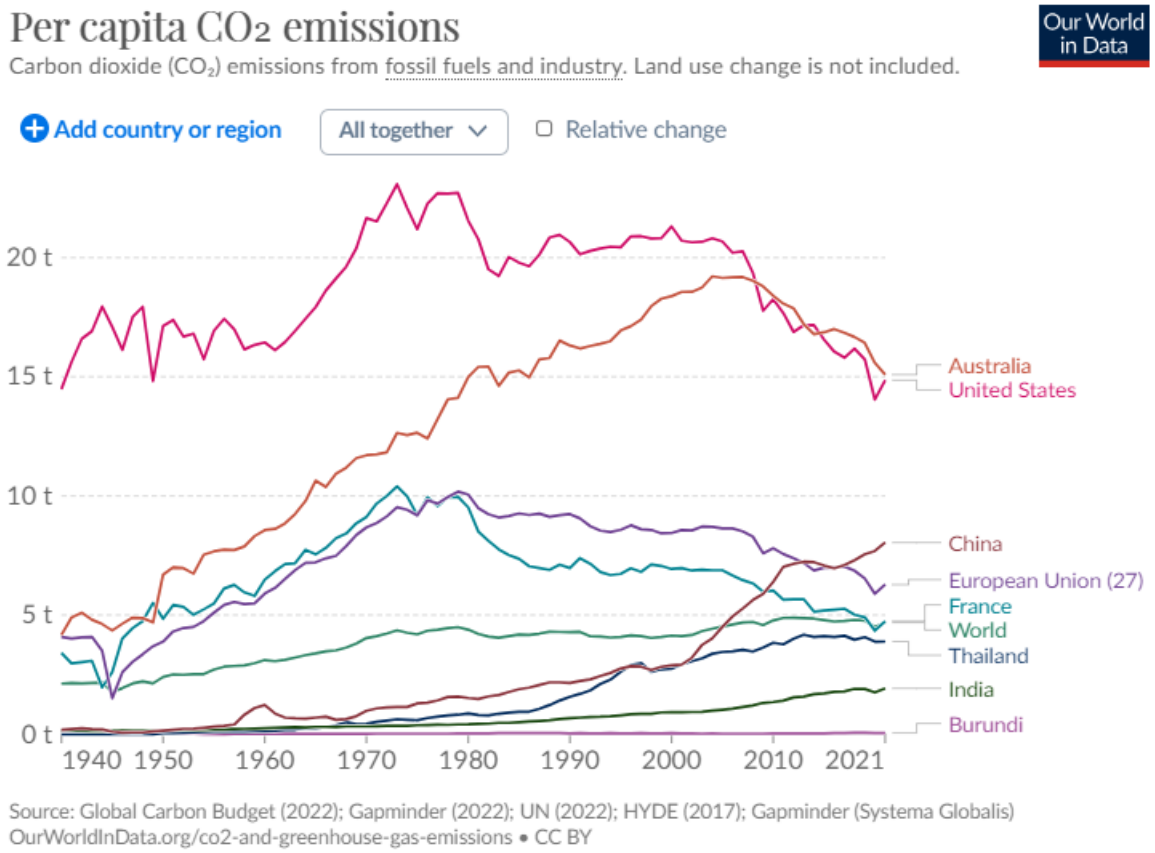


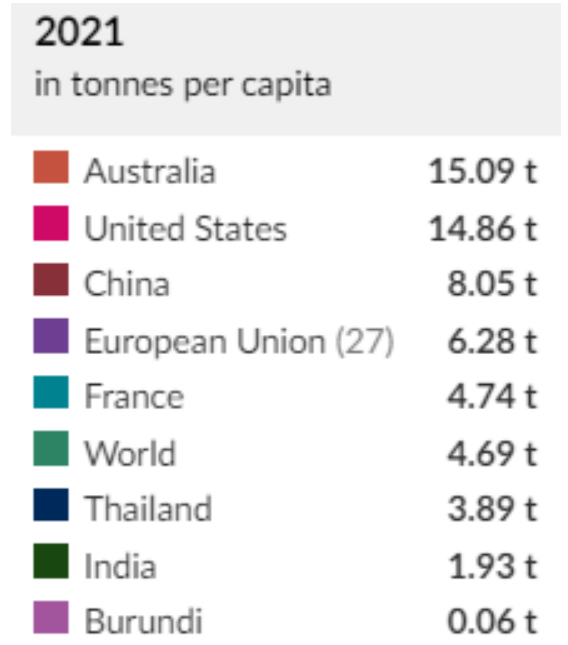




Unequal distribution of emissions across the world

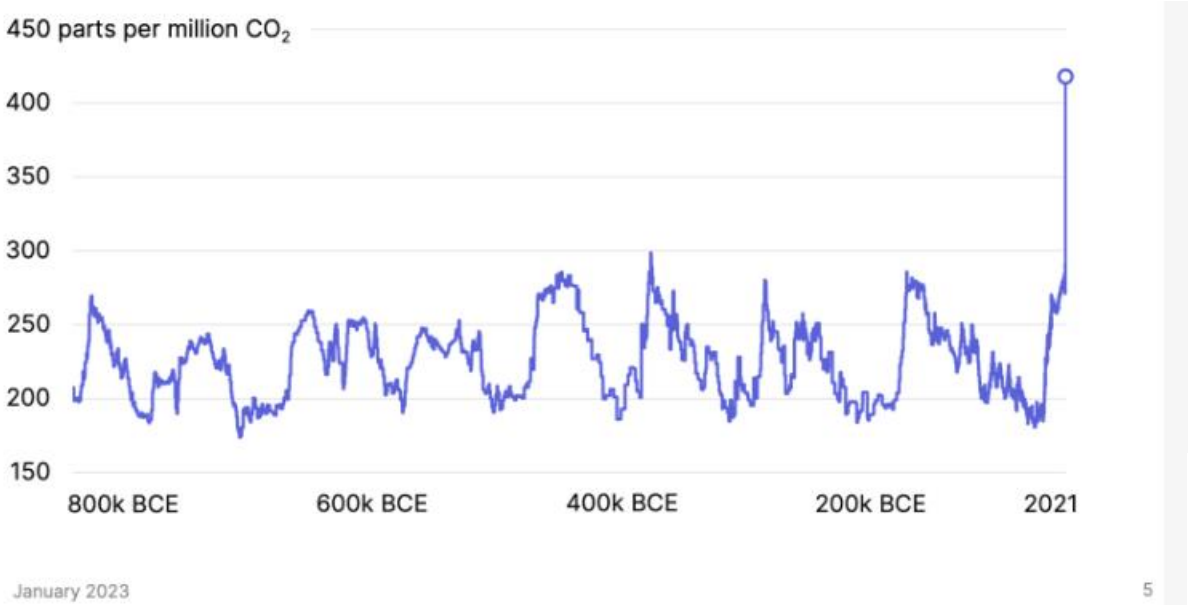
From 0.06 T in Burundi to 15.09 T in Australia



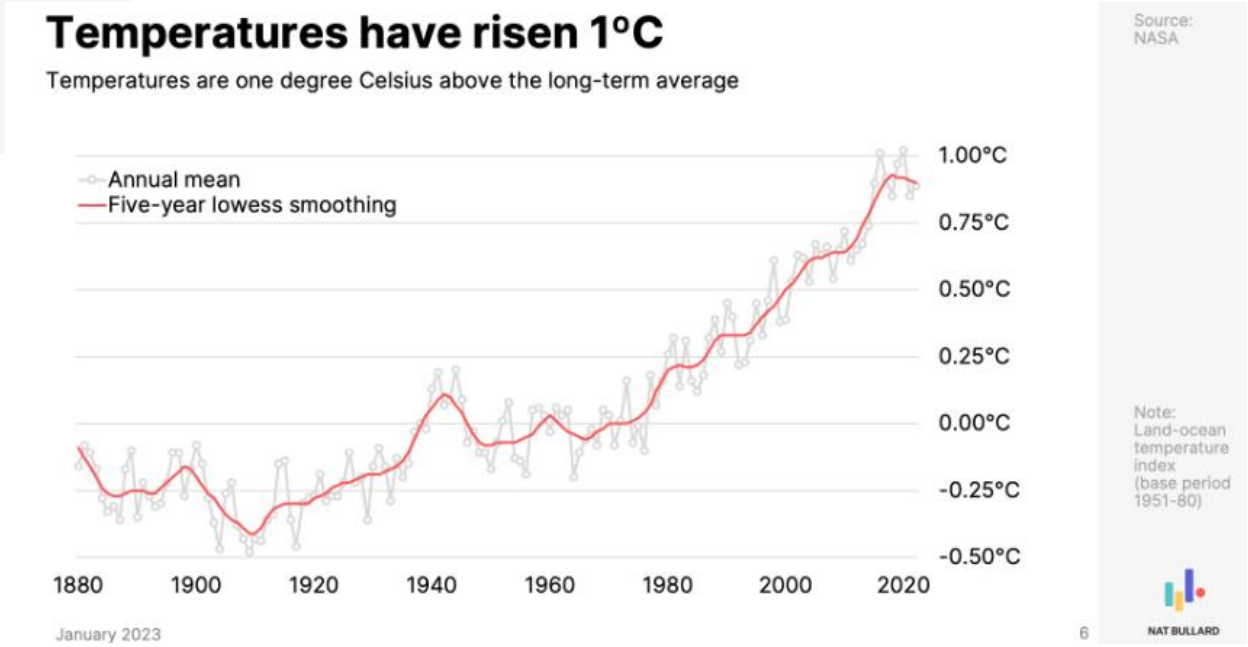


CO2 is at an unprecedented level in human history

And global temperatures are rising

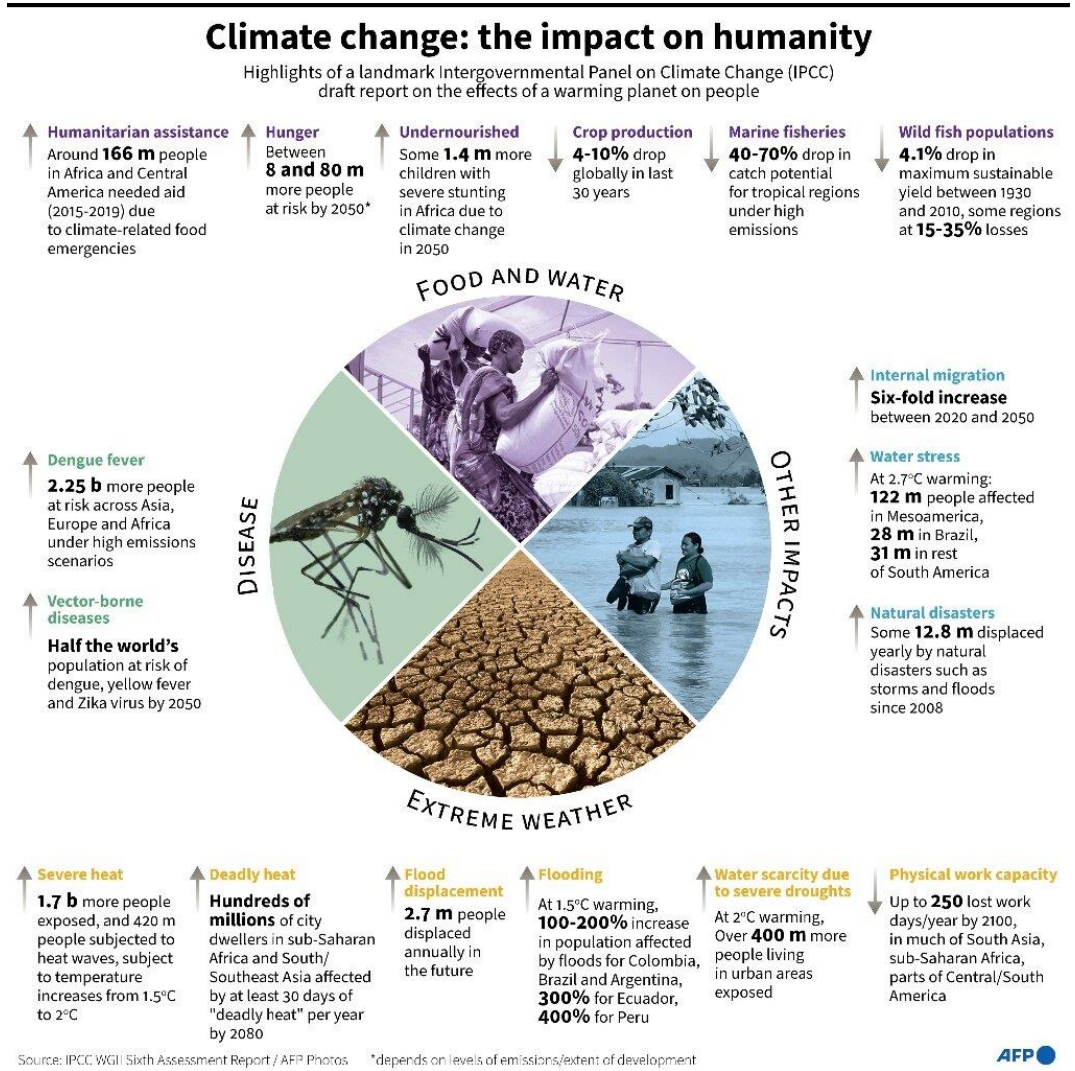


https://www.nathanielbullard.com/



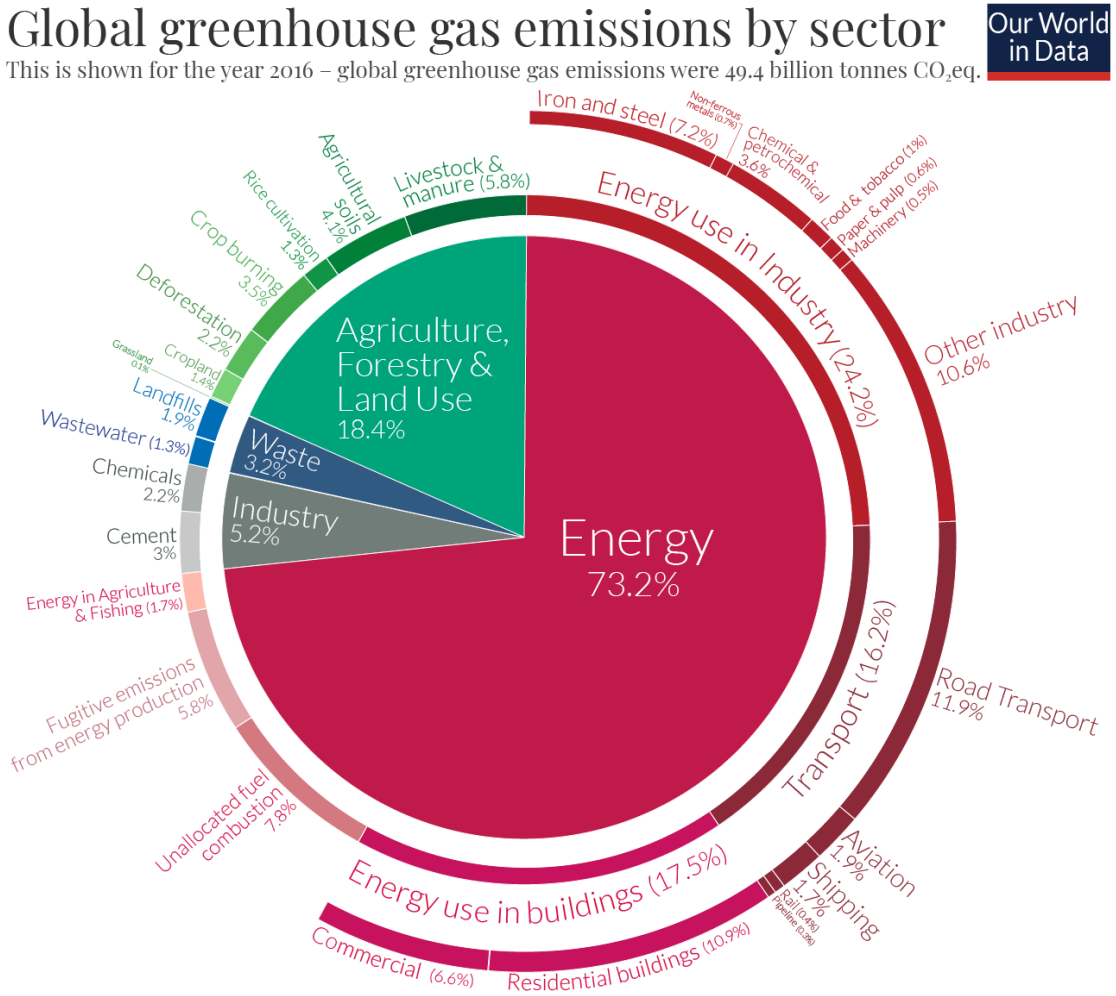
Climate change is real

And it will have a broad range of impacts



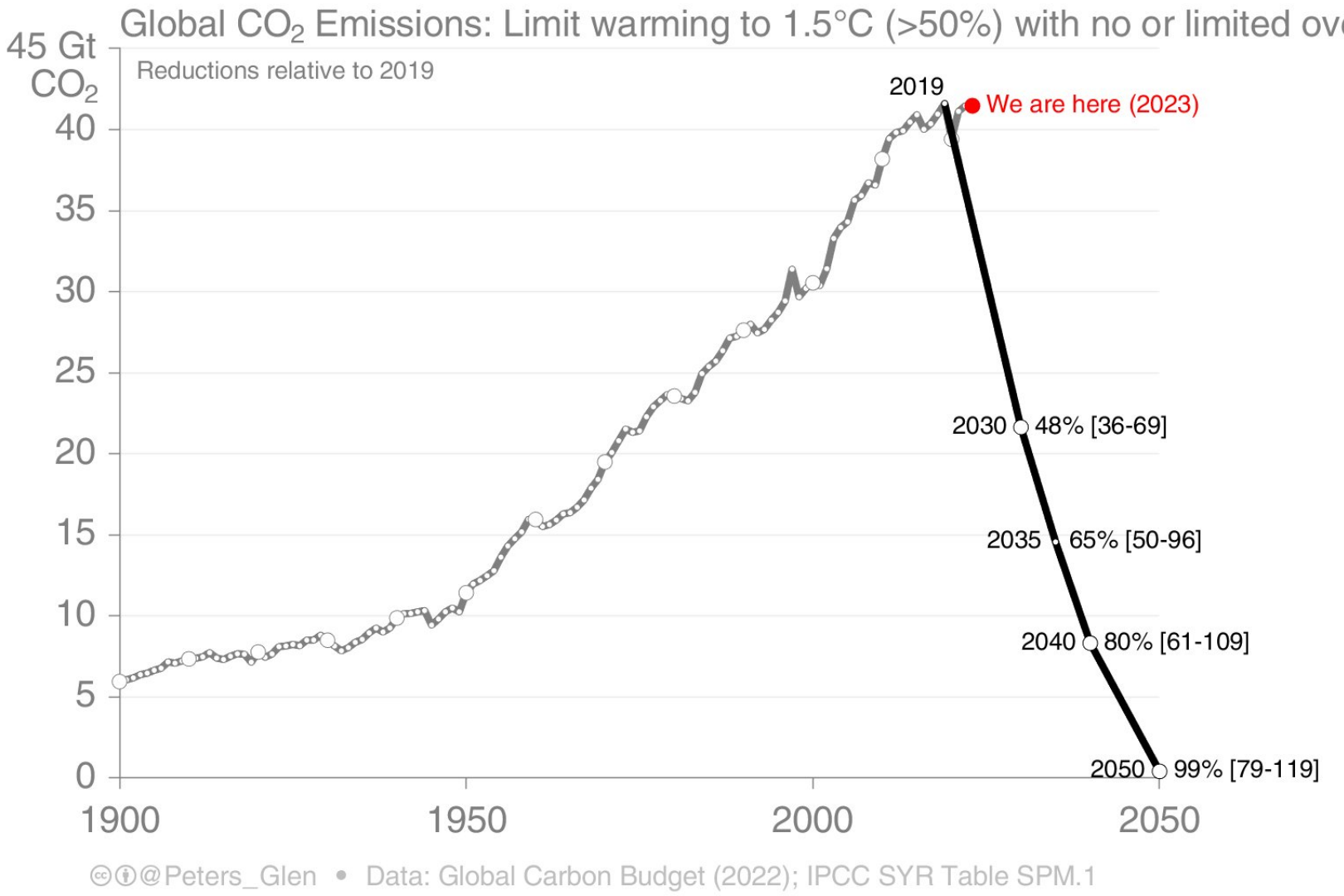
The different sources of emissions

Energy represents 3 quarters of all emissions



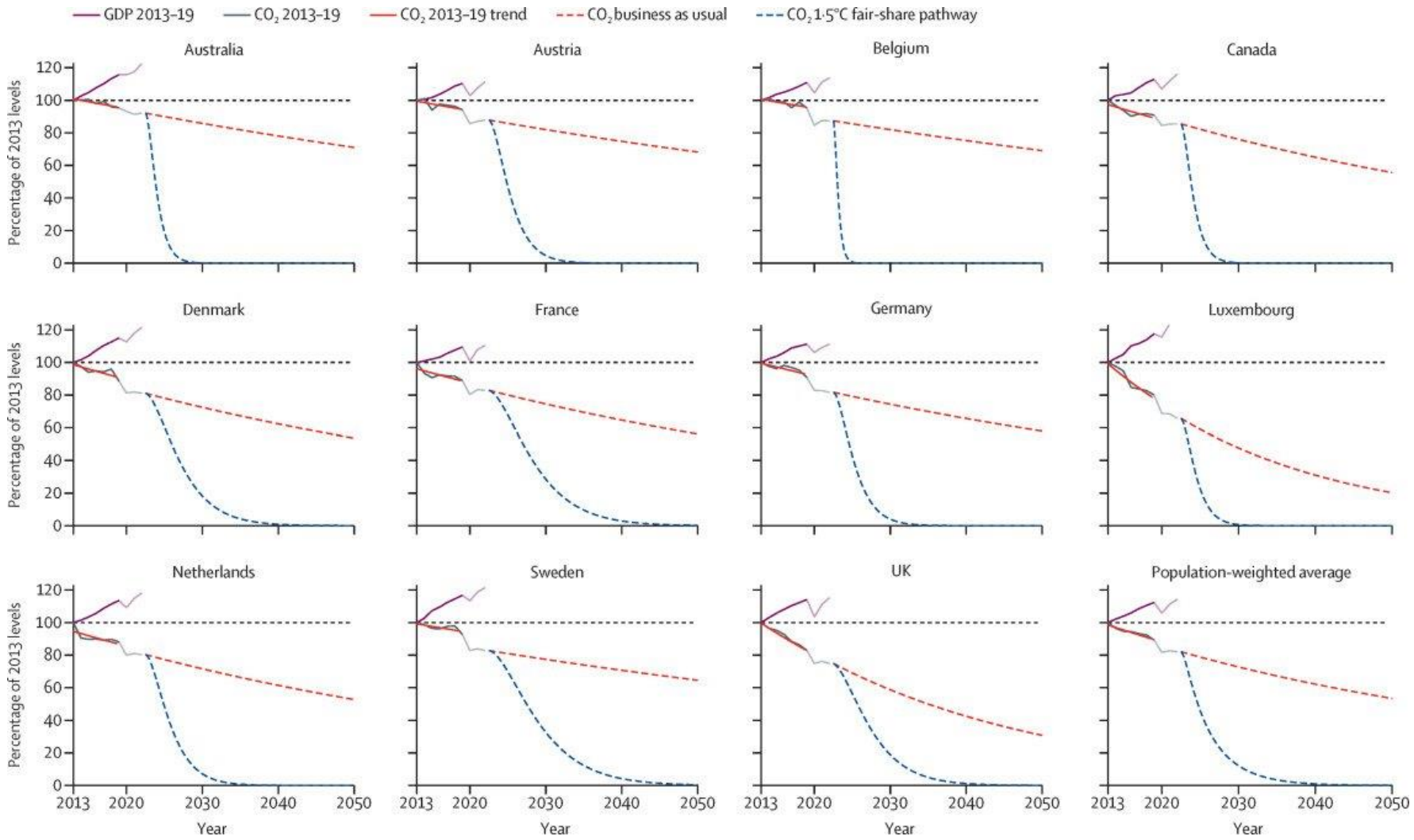
Limiting to 1.5 degrees

Is it still possible ?



Limiting to 1.5 degrees

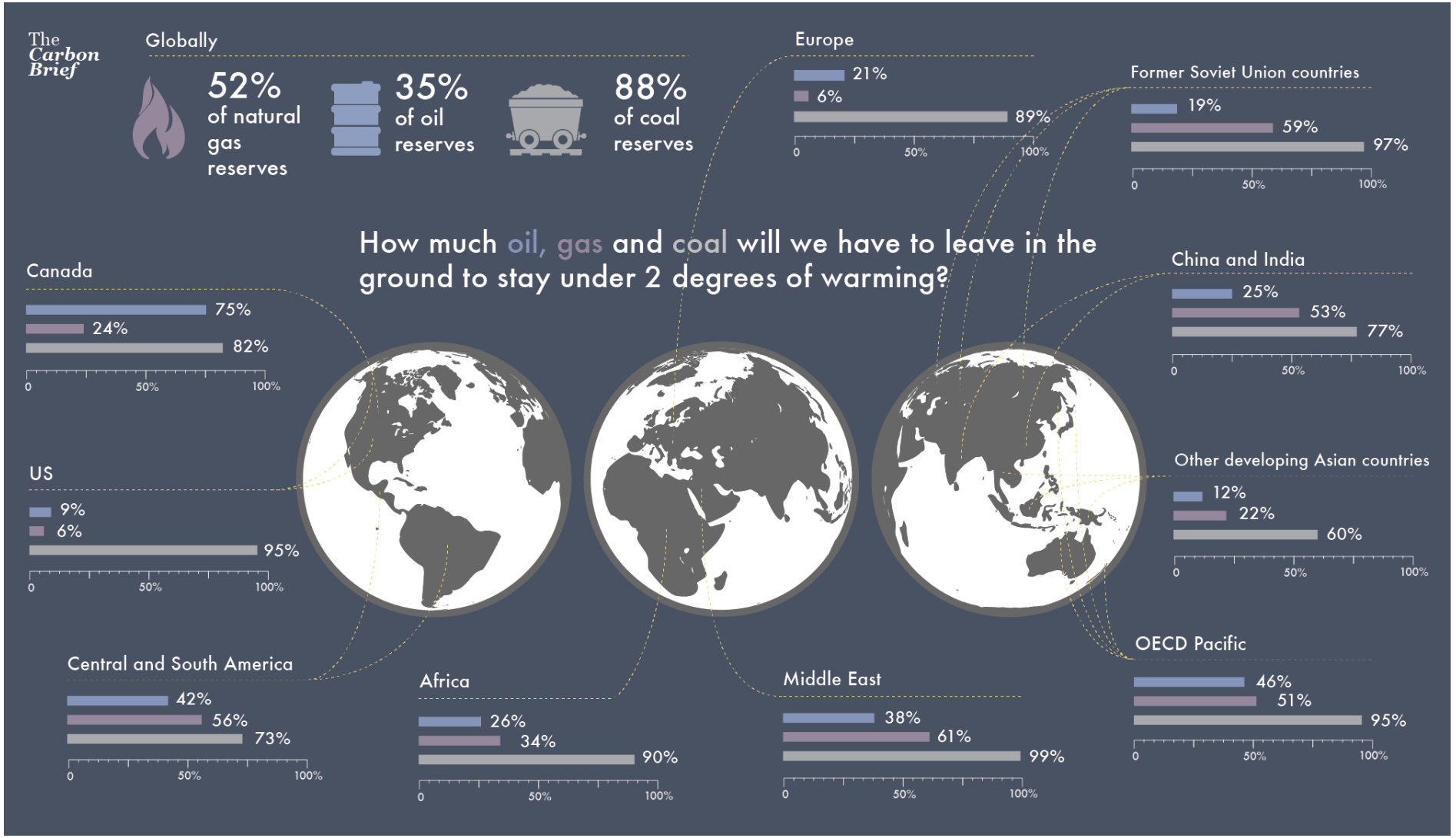
Decoupling GDP and emissions is possible but it is extremely slow



https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(23)00174-2/fulltext

Fossil fuels should stay underground

We cannot burn the known reserves of fossil fuels if we want to stay under 2 degrees.



Always more fossil fuels burned

Consumption of fossil fuels are still increasing

Global oil demand is projected to climb by 2.2 mb/d in 2023 to reach 102.1 mb/d, a new record. However, persistent macroeconomic headwinds, apparent in a deepening manufacturing slump, have led us to revise our 2023 growth estimate lower for the first time this year, by 220 kb/d. Buoyed by surging petrochemical use, China will account for 70% of global gains, while OECD consumption remains anaemic. Growth will slow to 1.1 mb/d in 2024.

We expect coal demand grew by about 1.5% in the first half of 2023 to a total of about 4 665 Mt, backed by both an increase of 1% in power generation and 2% in non-power. We observed continued increases in China, India and Indonesia, which more than offset declines in the United States, the European Union and Japan.

Global gas consumption in 2023 set to increase by 1% on year: GECF

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The energy transition

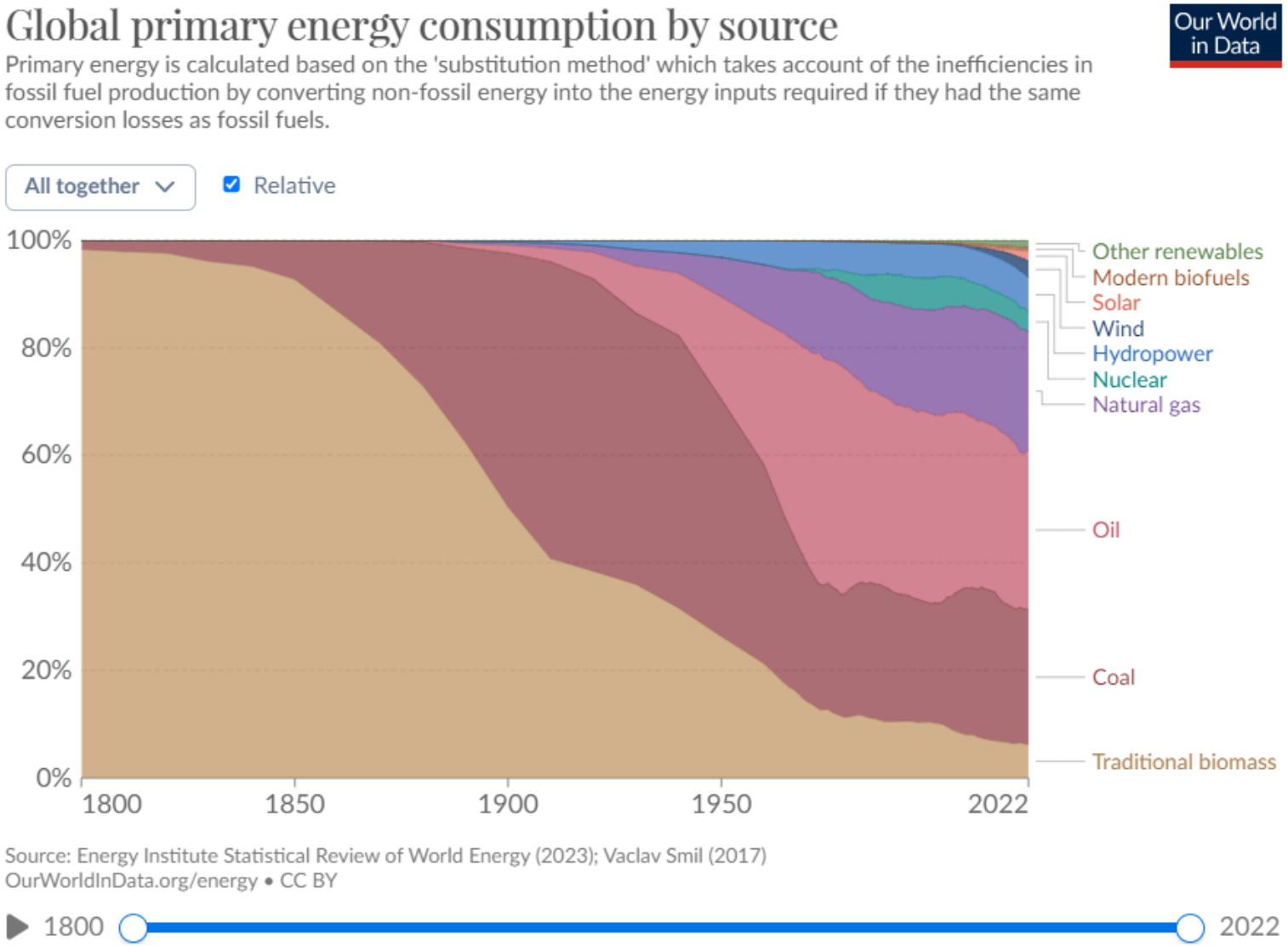
A common view on the past and future energy transitions

Video AREVA:
https://www.youtube.com/watch?v=GPDoWxtwSoY

For a great view on the energy transition: Jean-Baptiste Fressoz, French historian

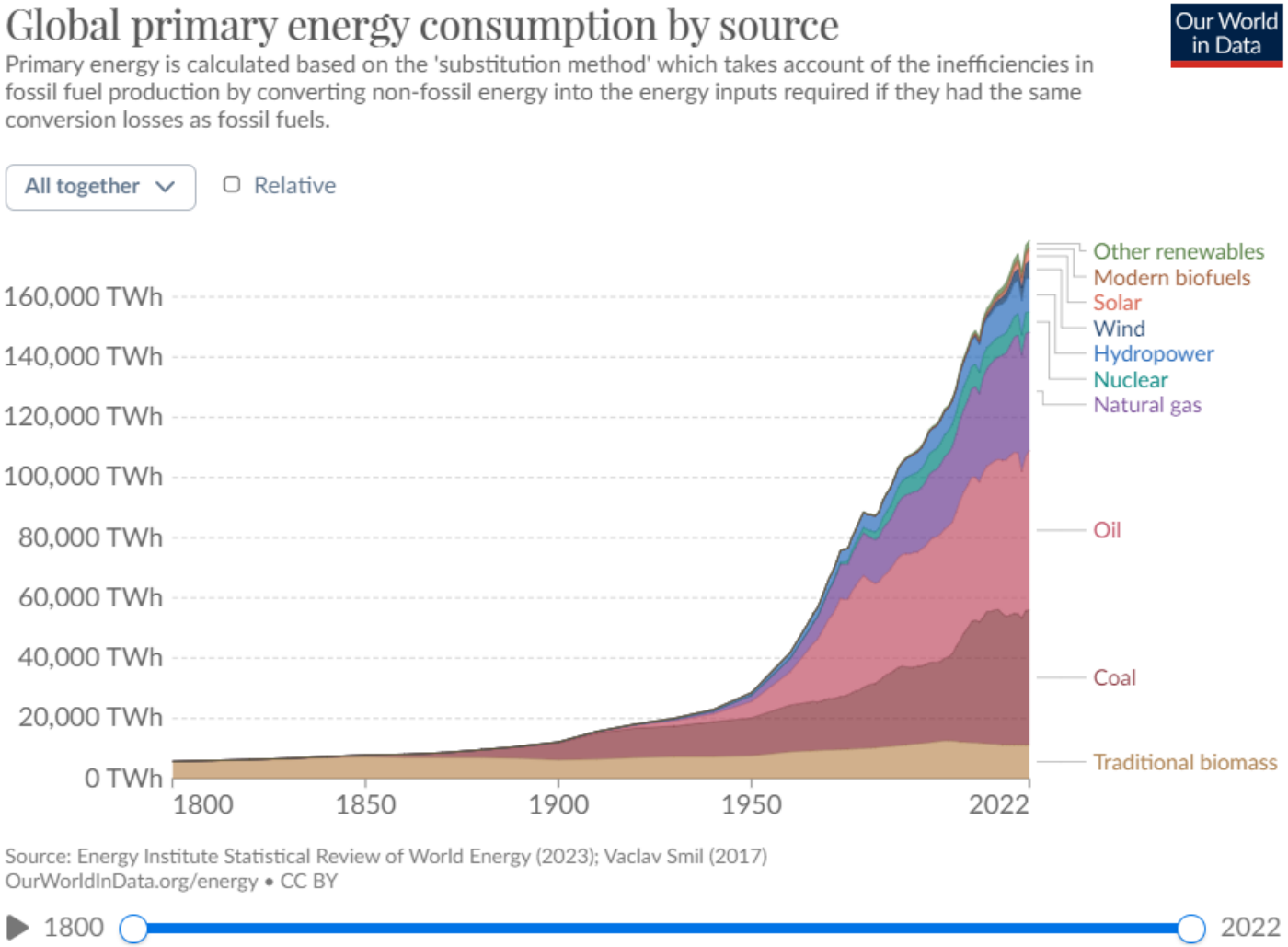
The past energy transitions

From biomass to coal to oil to natural gas… in route to sources with low emissions?



Or the different additions?

It seems that energy has been added on top of each other



Or even symbiosis / mutual reinforcement

The case with the automobile industry

Oil made cars possible

Cars need steel, which requires coal

Or even symbiosis / mutual reinforcement

Would it be the same with renewables?

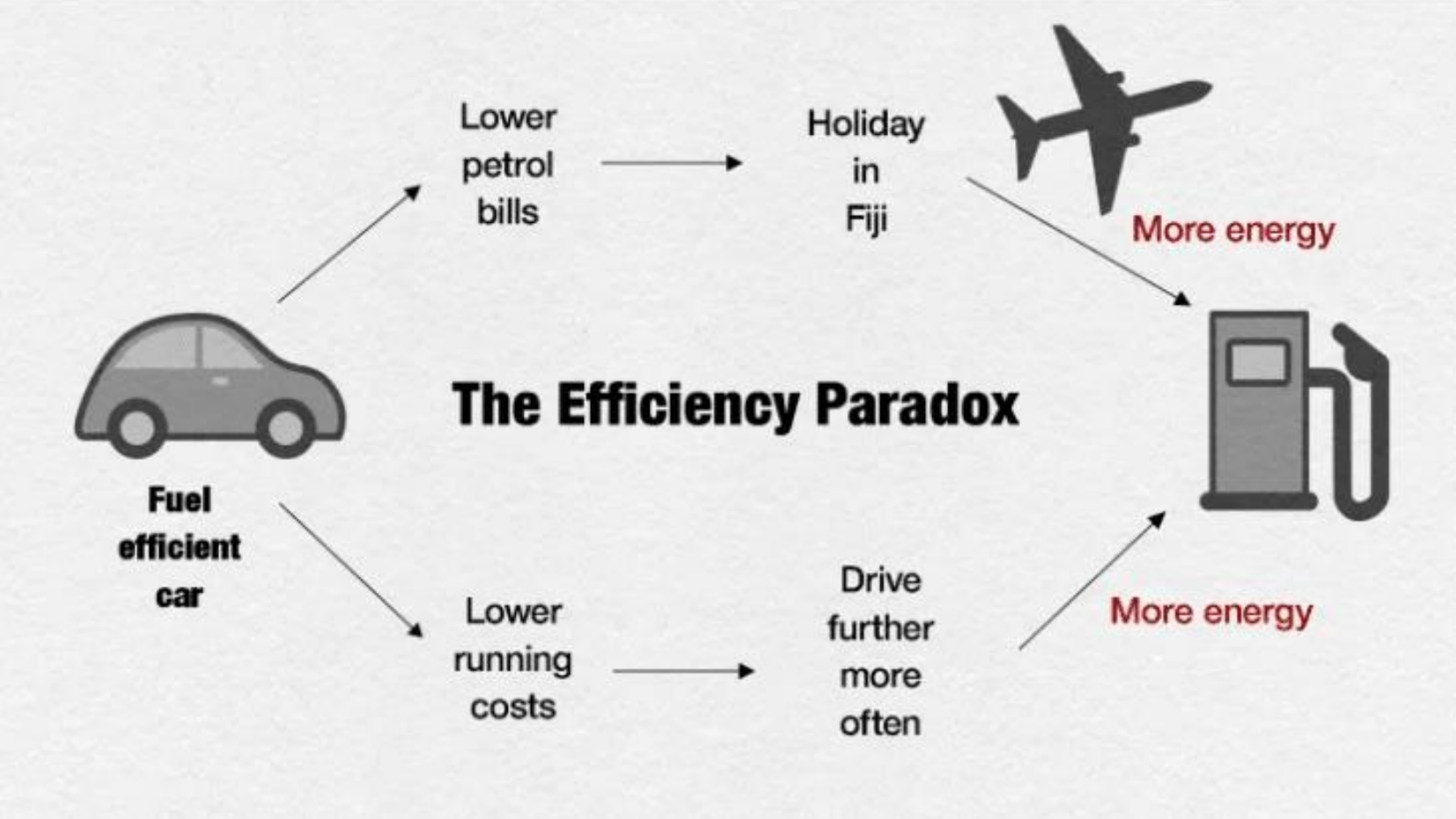
Norway: World's biggest floating wind farm will power oil and gas platforms

By **Lottie Limb** with **Reuters**

Published on 23/08/2023 - 18:00 • Updated 25/08/2023 - 15:43

The rebound effect / Javons paradox

Efficiency reduces energy cost, which contributes to increasing consumption. The motor of socioeconomic development



https://2030.builders/the-hidden-part-of-sustainability-rebound-effect/

The rebound effect with renewables?

Renewables might also lead to a rebound effect

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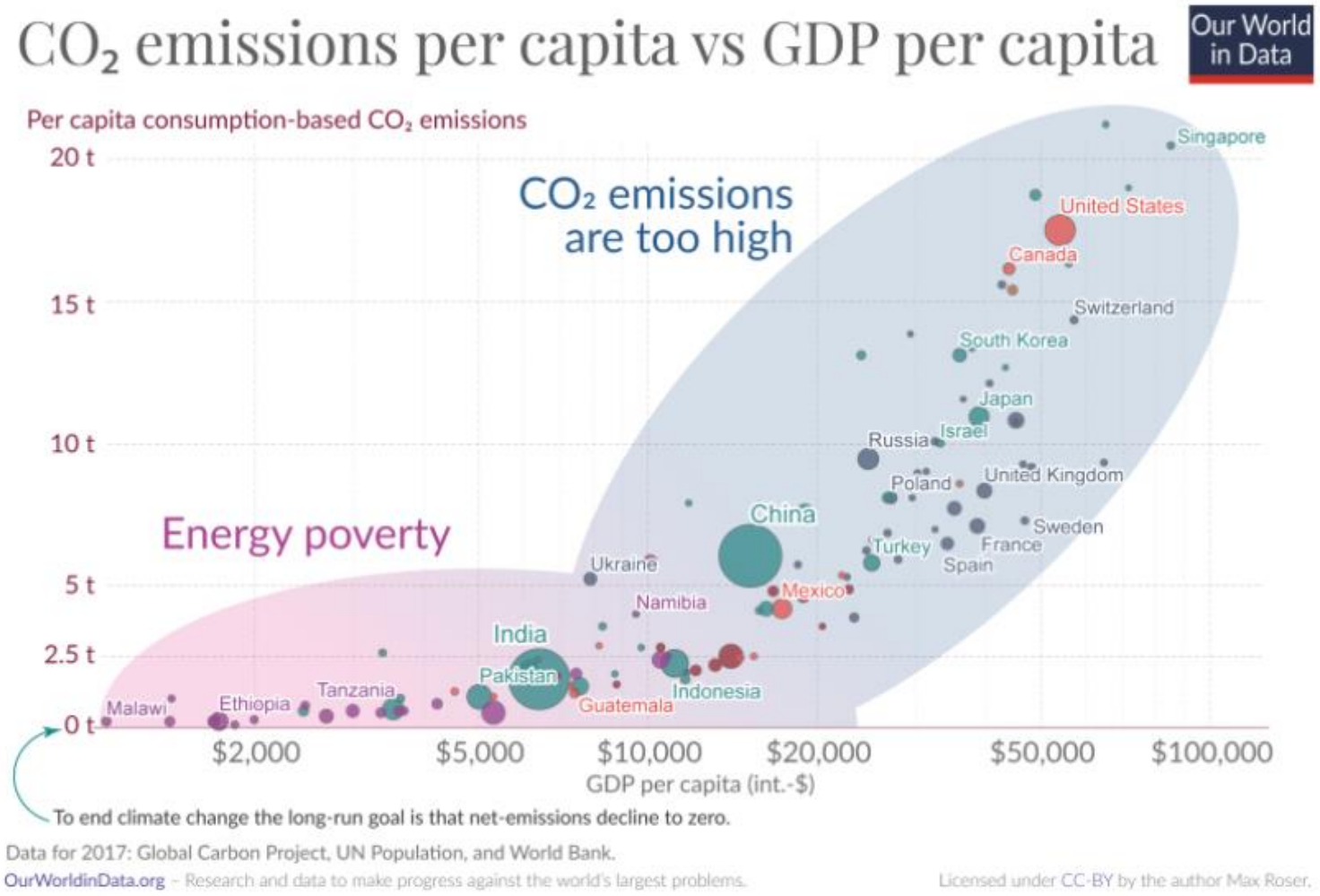
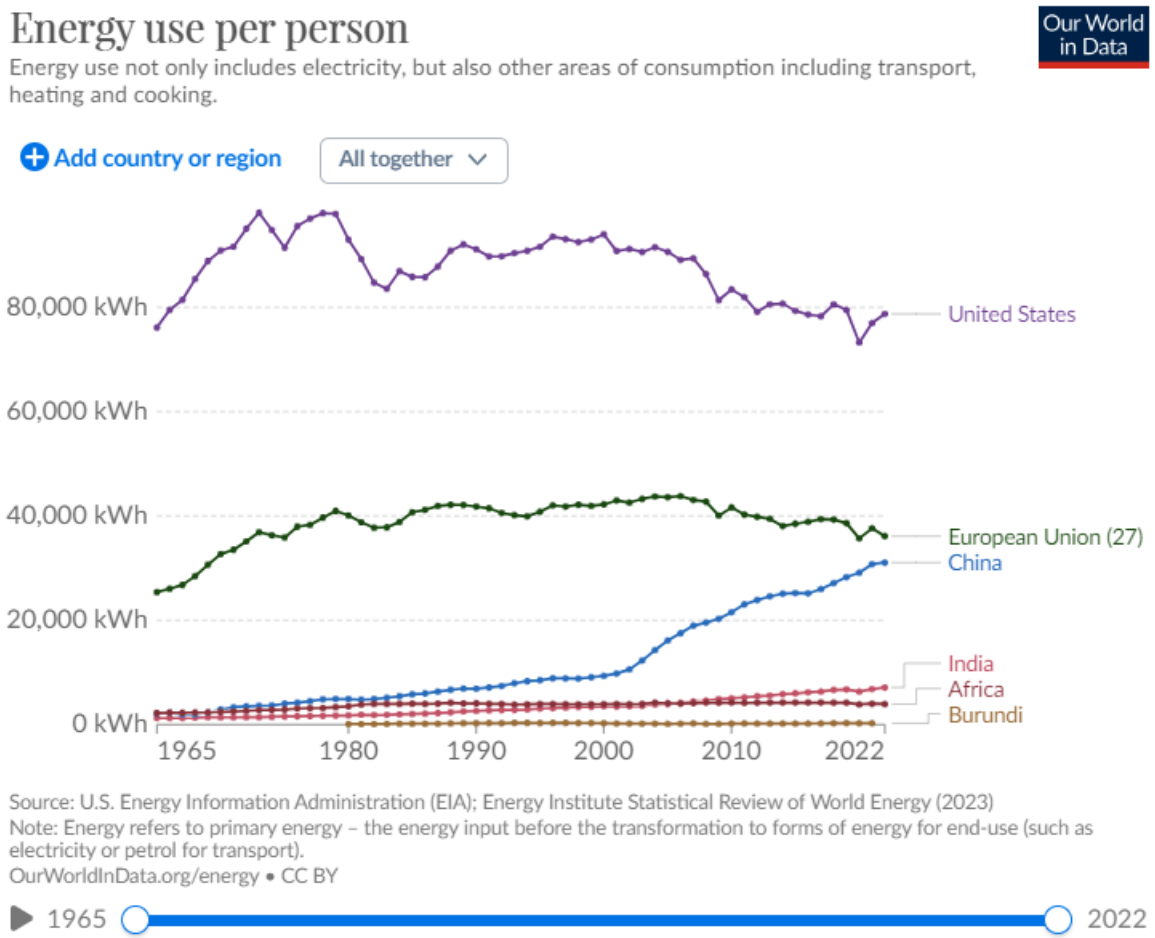
Two different issues

Energy poverty is still very much an issue



The world is unequal

A person in the USA consumes 262 times more than one in Burundi

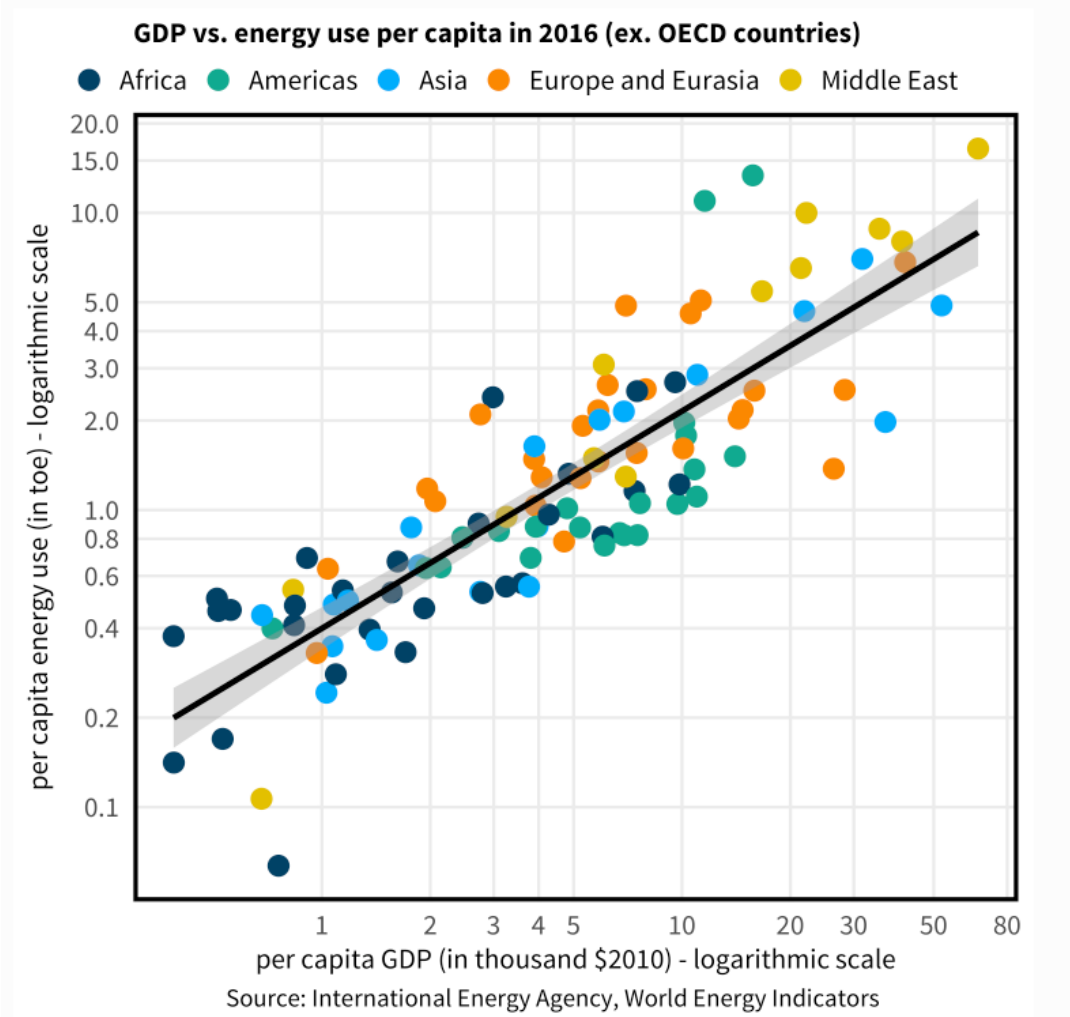


2021
in kilowatt-hours per capita

United States	76,989 kWh
European Union (27)	37,624 kWh
China	30,769 kWh
India	6,810 kWh
Africa	4,027 kWh
Burundi	294 kWh

GDP vs Energy Use

The link is very strong



https://www.csis.org/analysis/energy-and-growth-exploring-nuanced-relationship

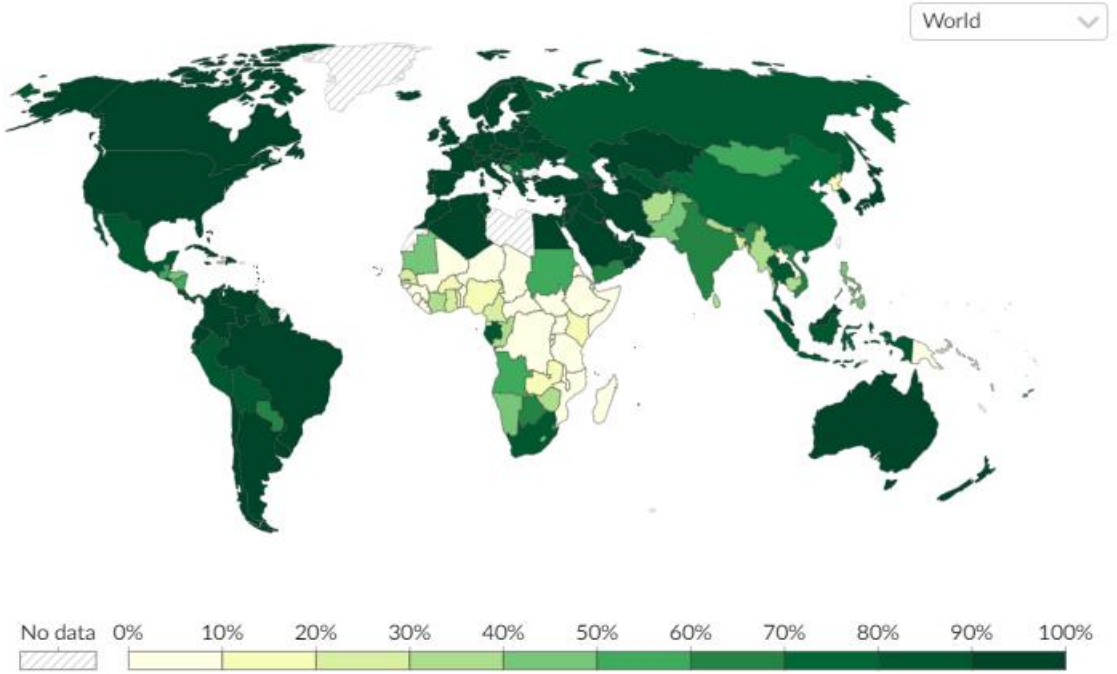
Energy Poverty

Access to electricity and clean cooking

Share of the population with access to clean fuels for cooking, 2020

Our World in Data

Access to clean fuels or technologies such as natural gas, electricity, and clean cookstoves reduce exposure to indoor air pollutants, a leading cause of death in low-income households.



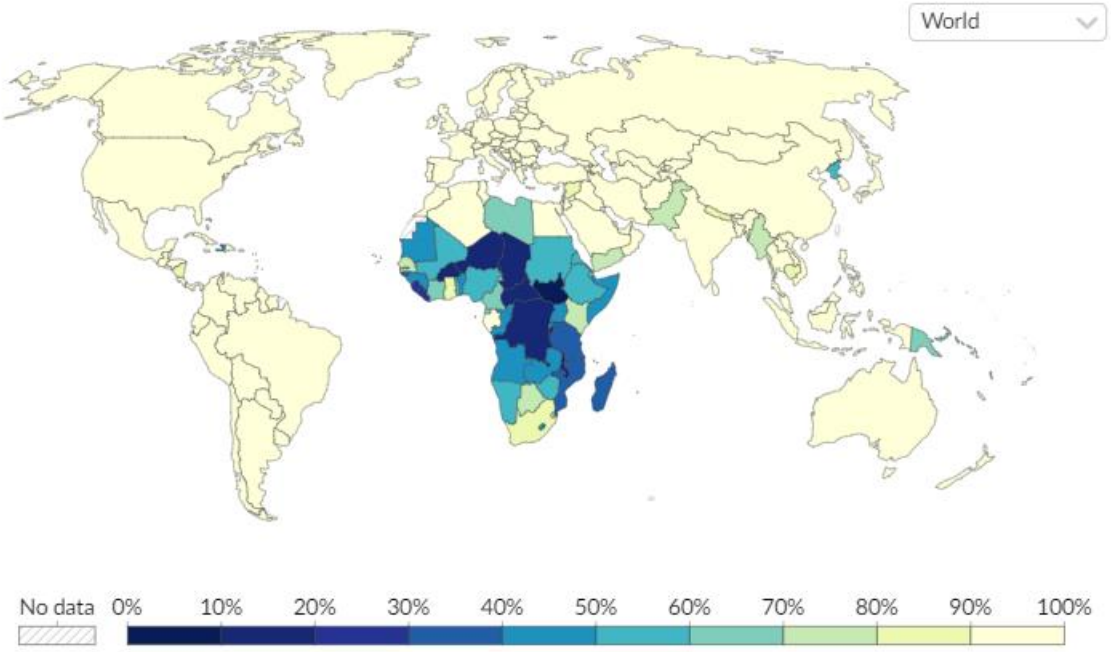
Source: WHO, Global Health Observatory (2022)

OurWorldInData.org/energy • CC BY

Electricity access, 2020

Our World in Data

Share of the population with access to electricity. The definition used in international statistics adopts a very low cutoff for what it means to 'have access to electricity'. It is defined as having an electricity source that can provide very basic lighting, and charge a phone or power a radio for 4 hours per day.



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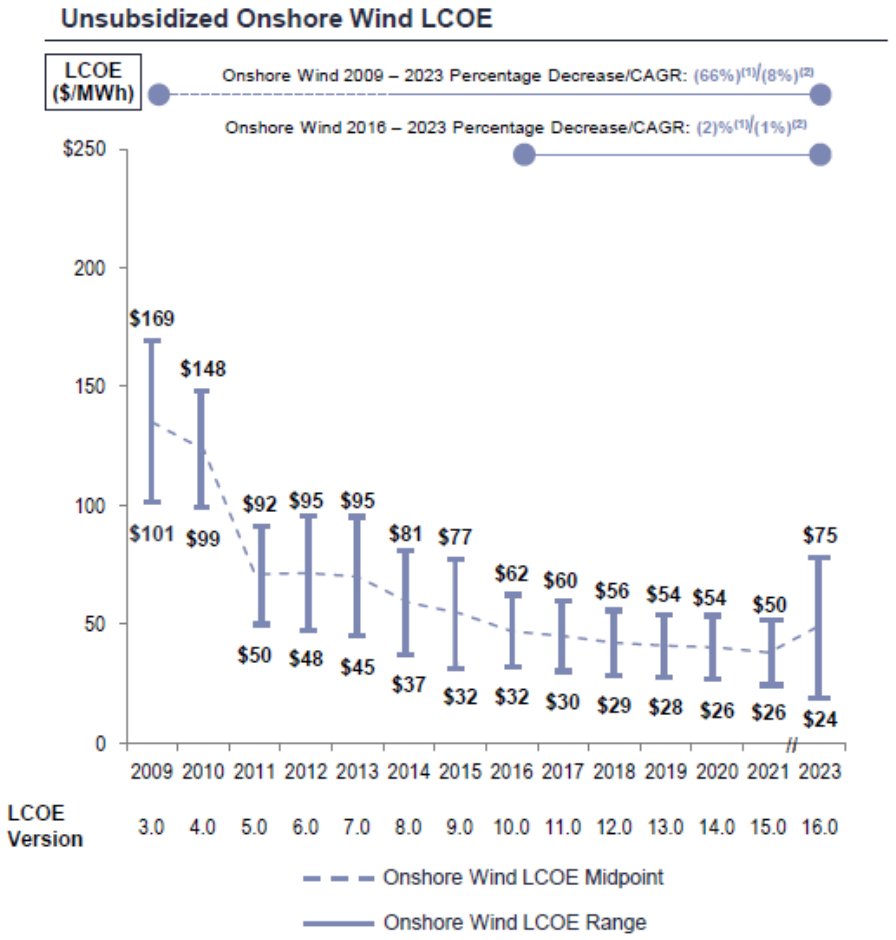
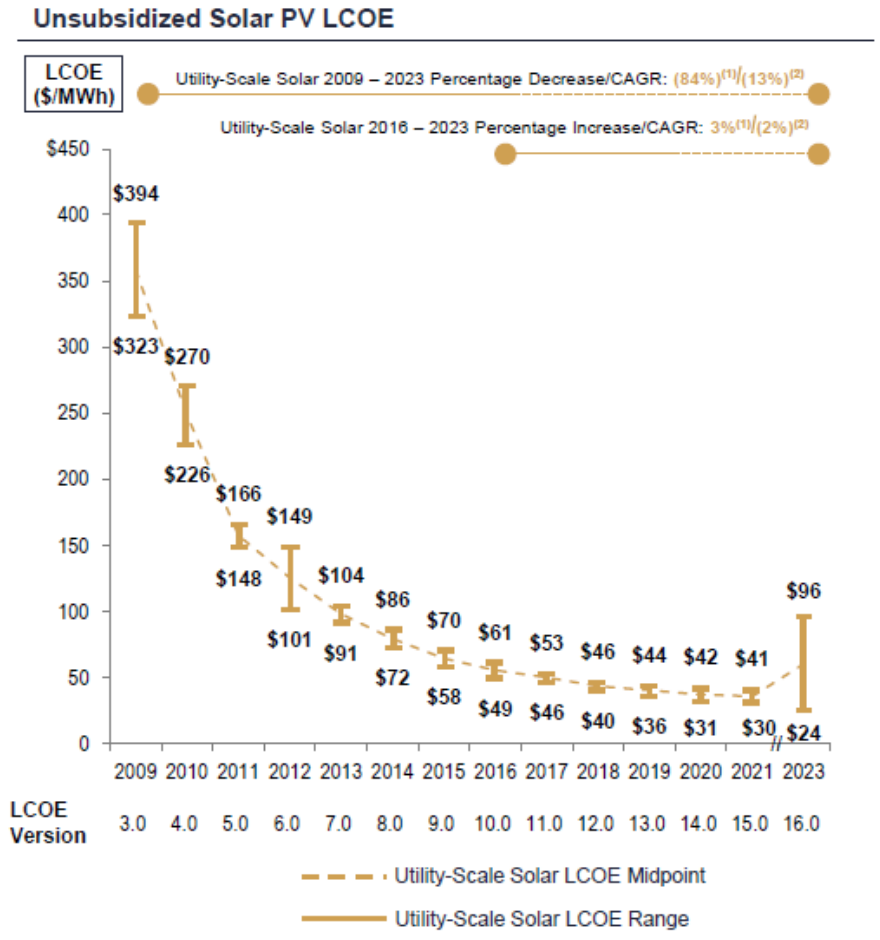
Wind and solar are getting cheaper

Even though there has been a small uptick recently



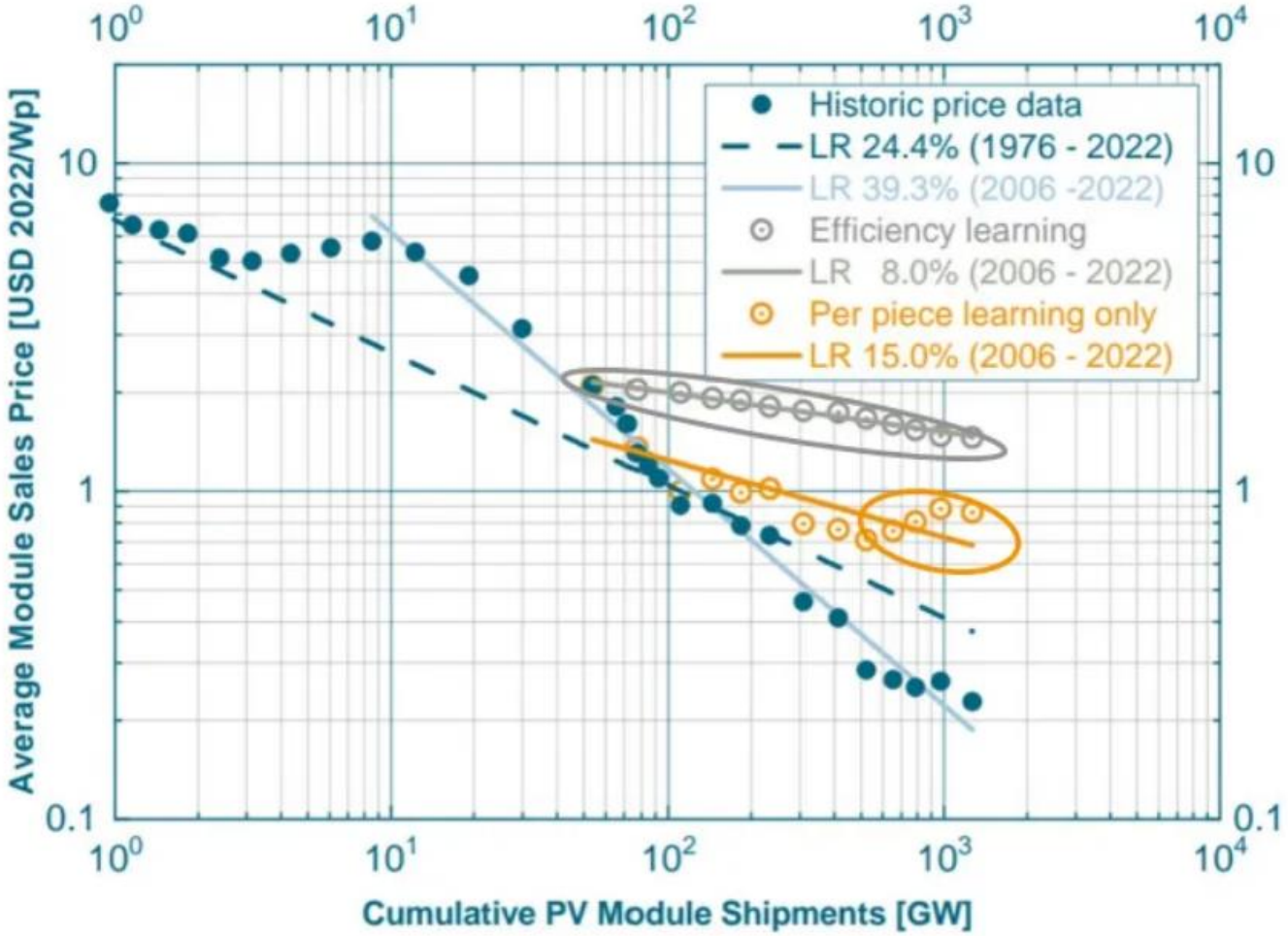


LAZARD

Source: *Lazard and Roland Berger estimates and publicly available information.*
(1) Represents the average percentage decrease/increase of the high end and low end of the LCOE range.
(2) Represents the average compounded annual rate of decline of the high end and low end of the LCOE range.

Solar is leading

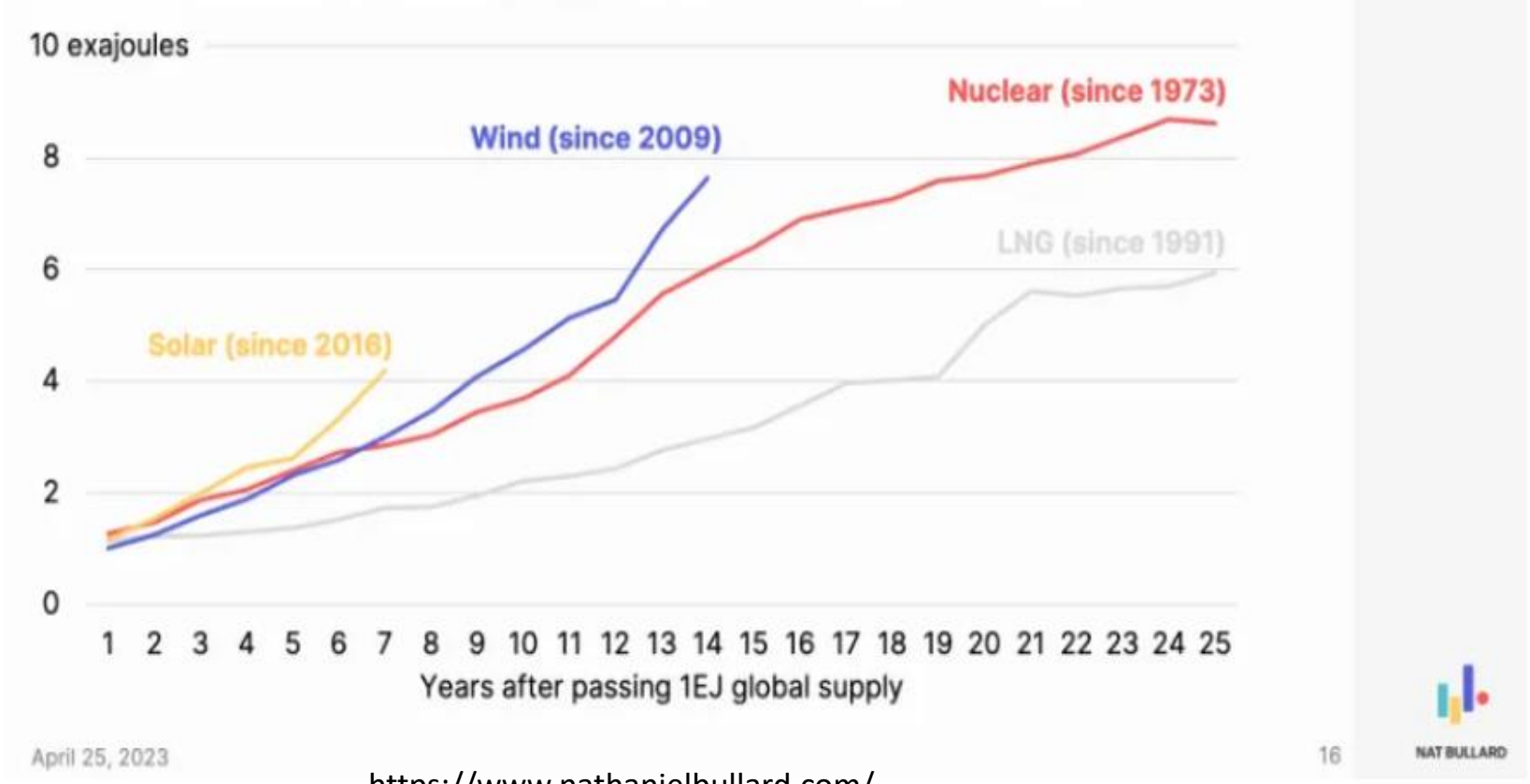
Solar modules cost only 1% of what they use to cost 30 years ago



https://www.vdma.org/international-technology-roadmap-photovoltaic

Solar is leading

Solar is being deployed at an unpreceded speed



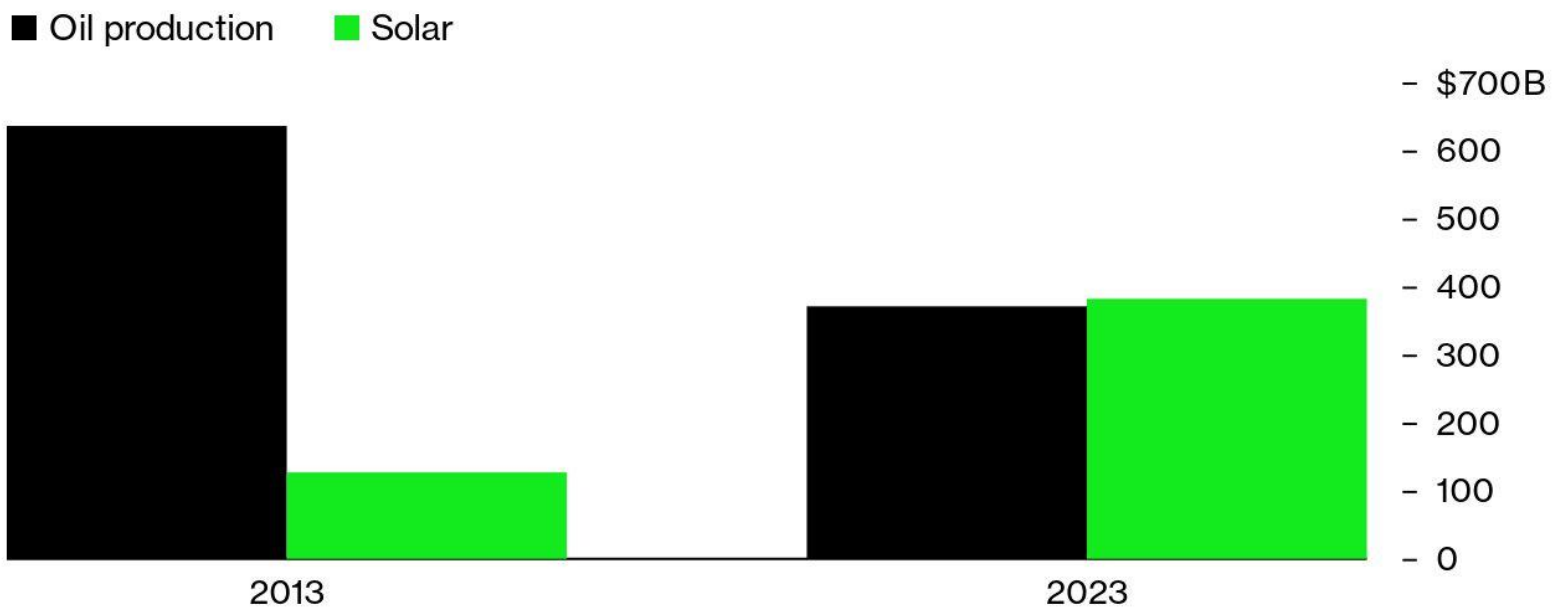
https://www.nathanielbullard.com/

Solar is leading

Investment in solar is overtaking oil production spending in 2023

Solar Investment Will Overtake Oil Production Spending This Year

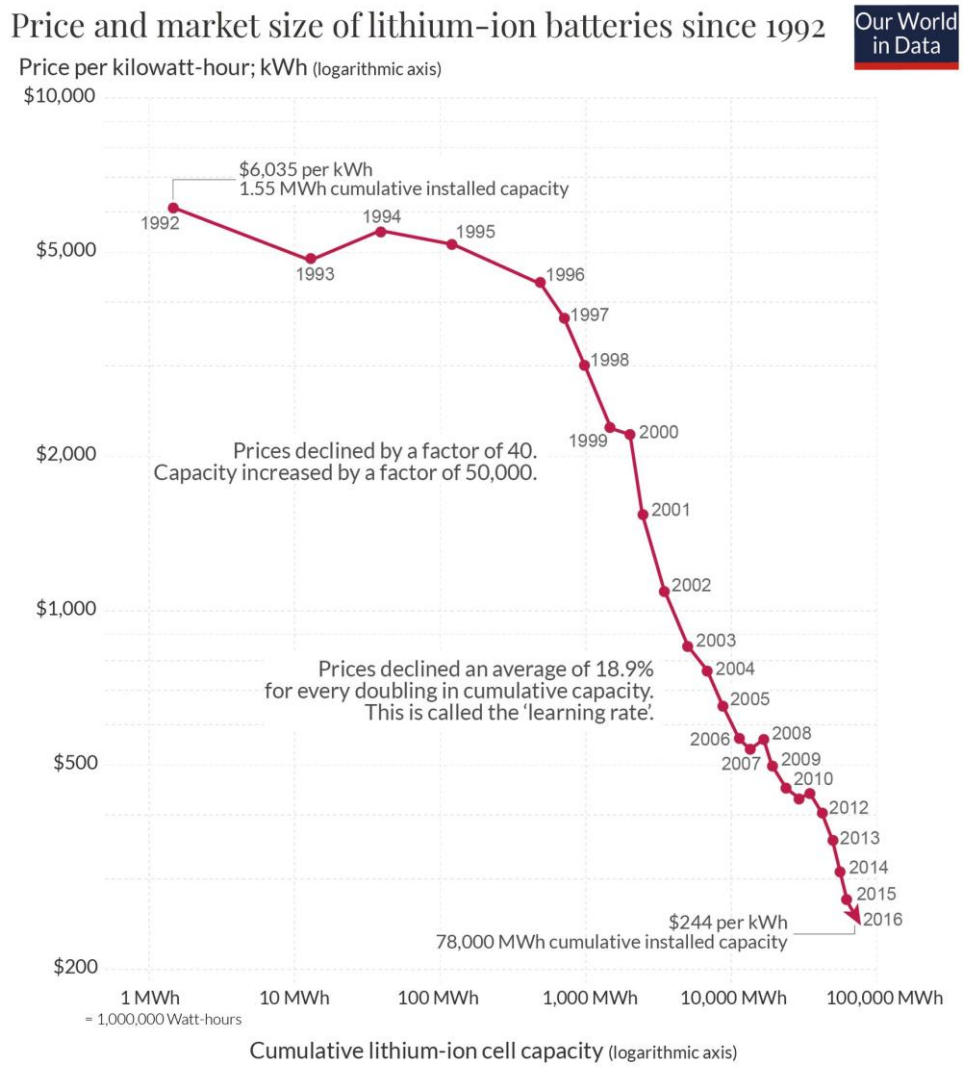
International Energy Agency data show solar investment surge while oil production spending dropped in the last decade



Source: IEA
Note: 2023 data are estimates

Bloomberg

Batteries are getting cheaper

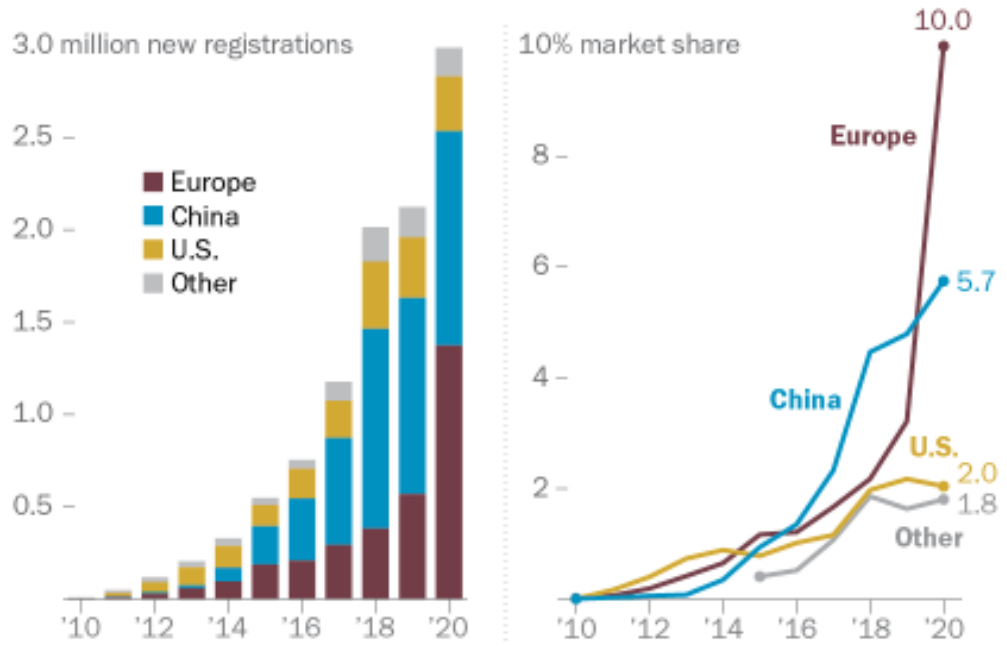


Electric Vehicles

More and more on the road

Europe leads the way in new electric vehicle sales

New global electric car registrations and automobile market share, 2010-2020



Note: Electric car totals include all-electric, plug-in hybrid and fuel cell vehicles. "Europe" includes the 27 nations in the EU, plus Iceland, Norway, Switzerland and the UK. "Other" includes Australia, Brazil, Canada, Chile, India, Indonesia, Japan, Malaysia, Mexico, New Zealand, South Africa, South Korea and Thailand.
Source: International Energy Agency, "Global EV Outlook 2021."

PEW RESEARCH CENTER

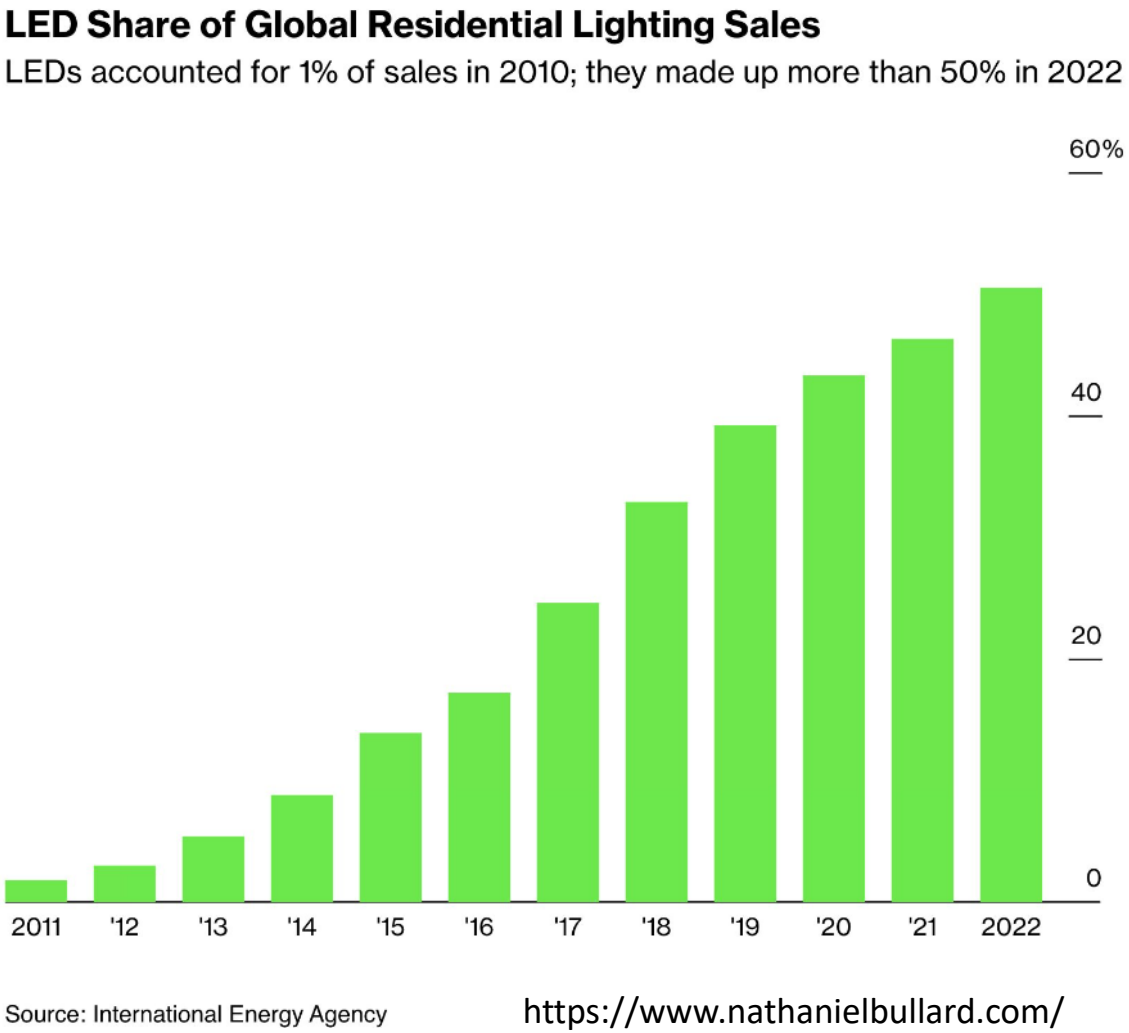
Heat pumps

An important tool for the electrification of heating

https://notesfrompoland.com/2023/04/28/heat-pumps-boom-in-poland-europes-fastest-growing-market/

Lighting

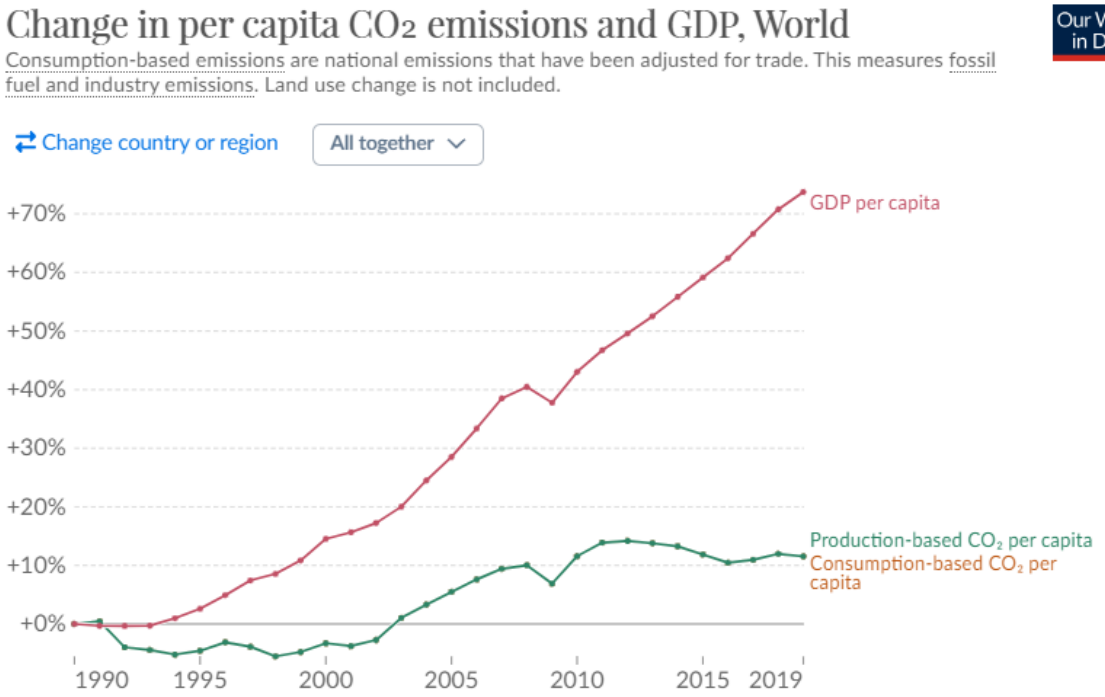
We are increasingly using LED for lighting

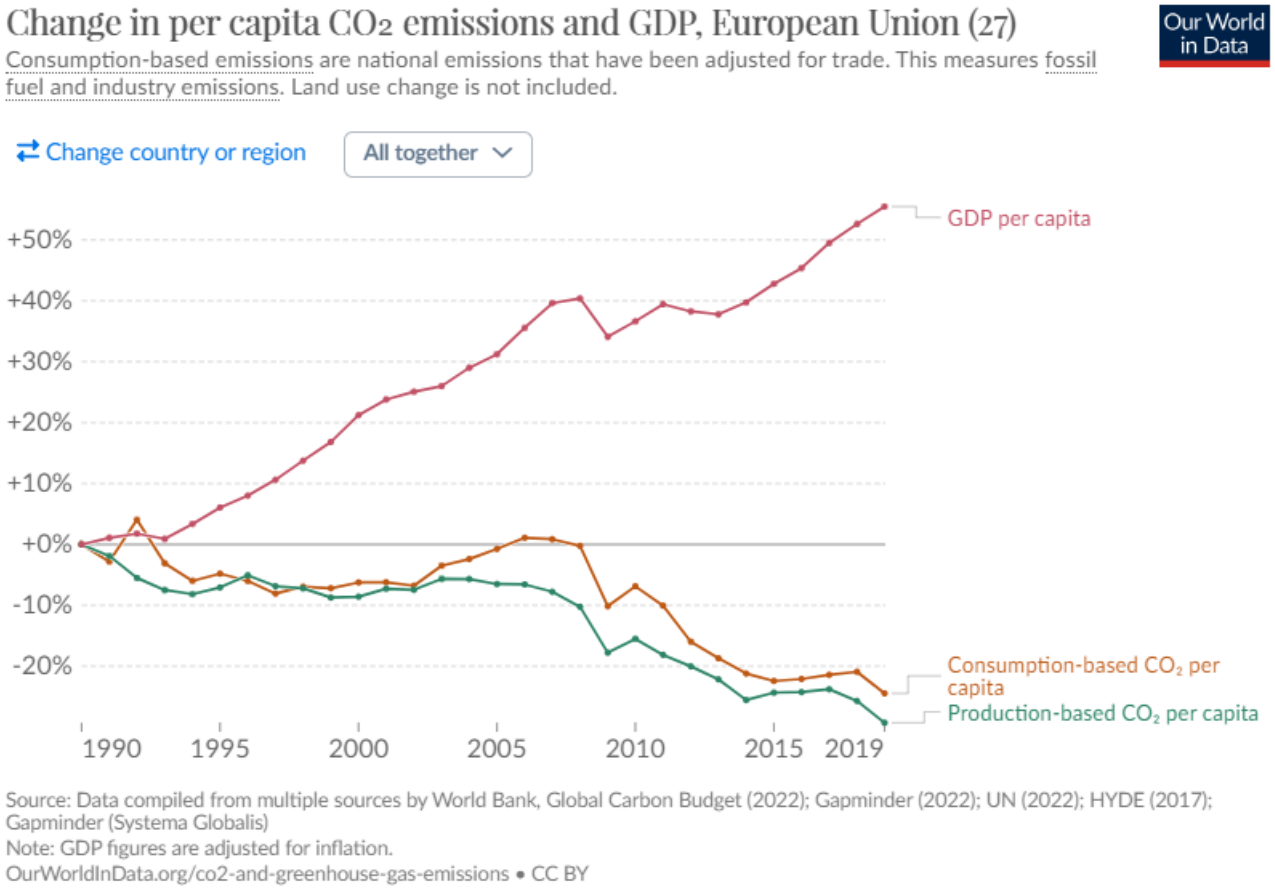


https://www.nathanielbullard.com/

Economy is decoupling from CO2

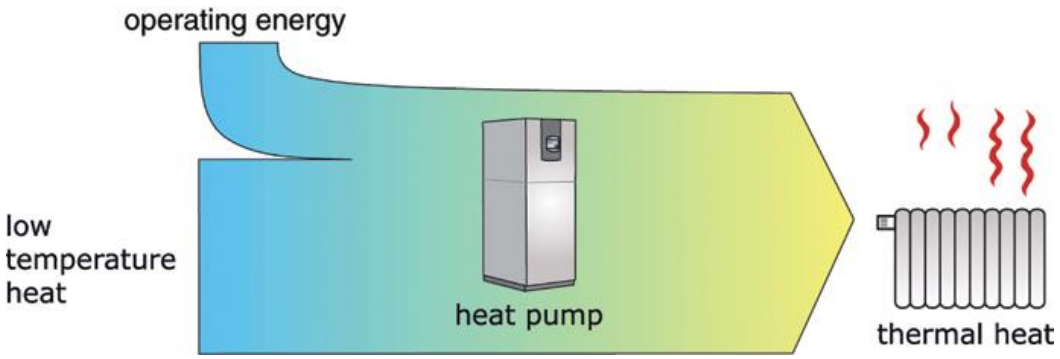
GDP is growing faster than CO2 emissions





Electricity is the best form of energy

No need to replace all the primary energy



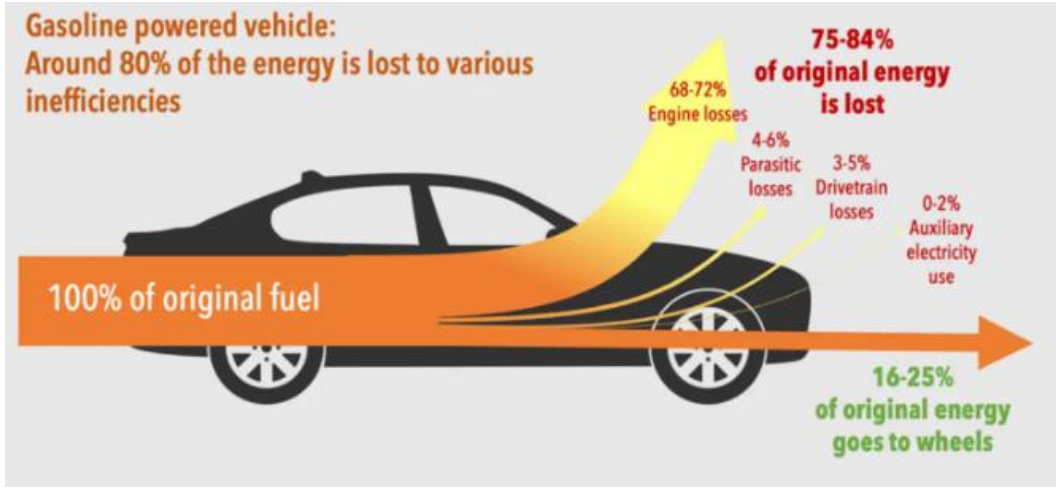
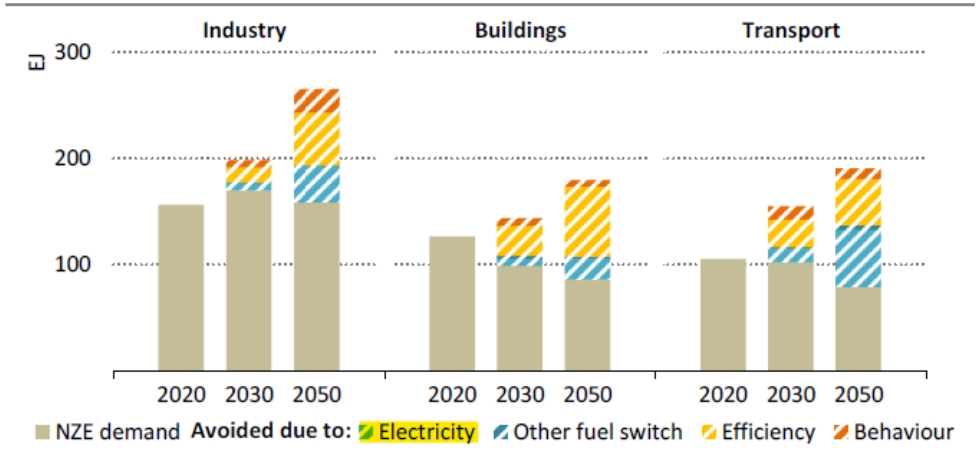
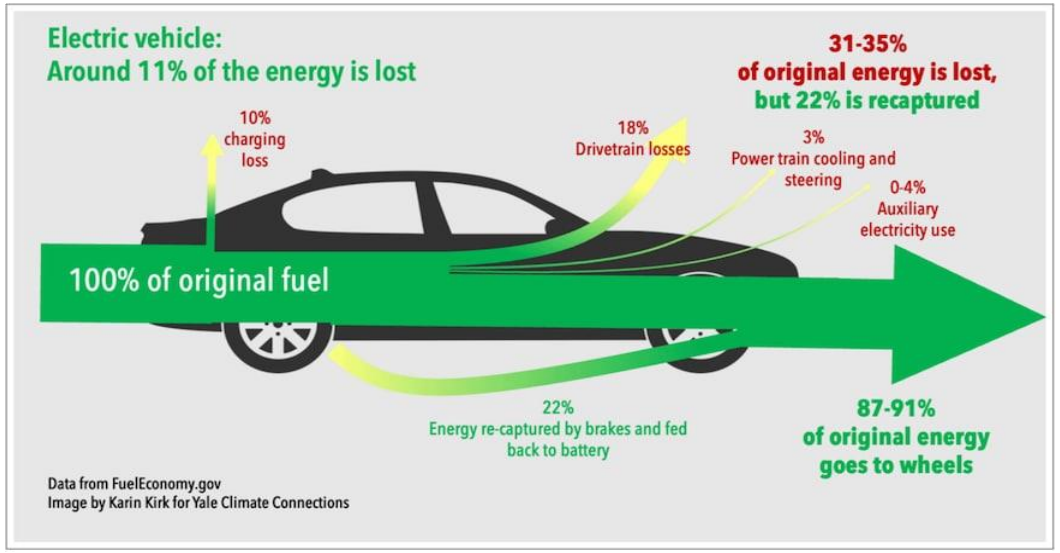


Figure 2.13 ▷ Total final consumption and demand avoided by mitigation measure in the NZE



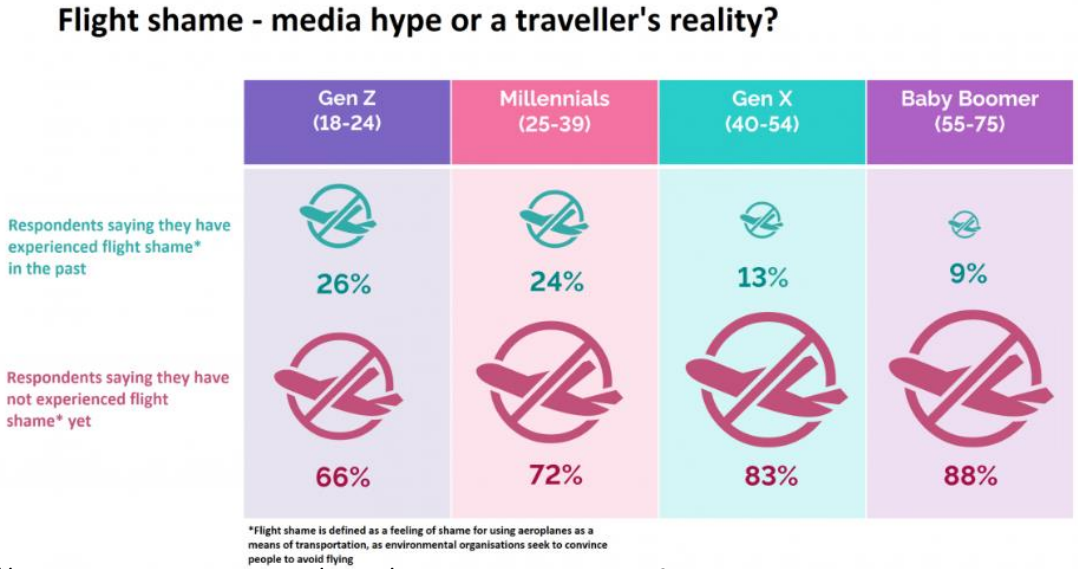
Energy efficiency plays a key role in reducing energy consumption across end-use sectors



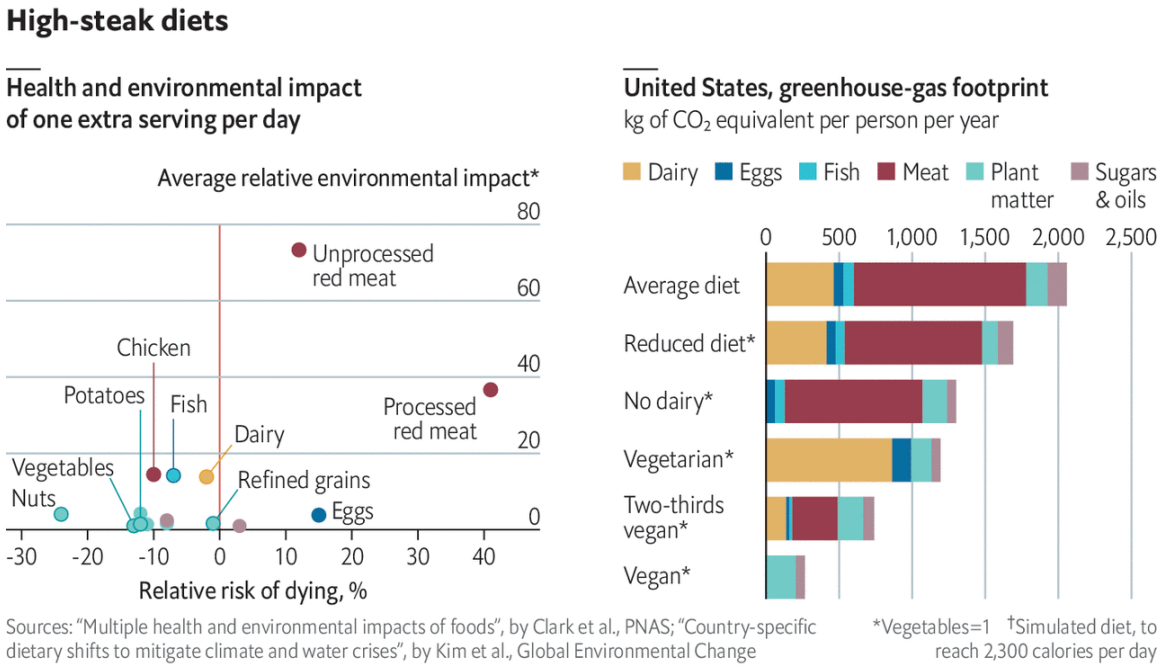
https://www.motortrend.com/news/evs-more-efficient-than-internal-combustion-engines/

Behavioural change

People could have an impact



https://www.cleanenergywire.org/news/sustainable-travel-and-flying-shame-growing-concerns-germans-survey



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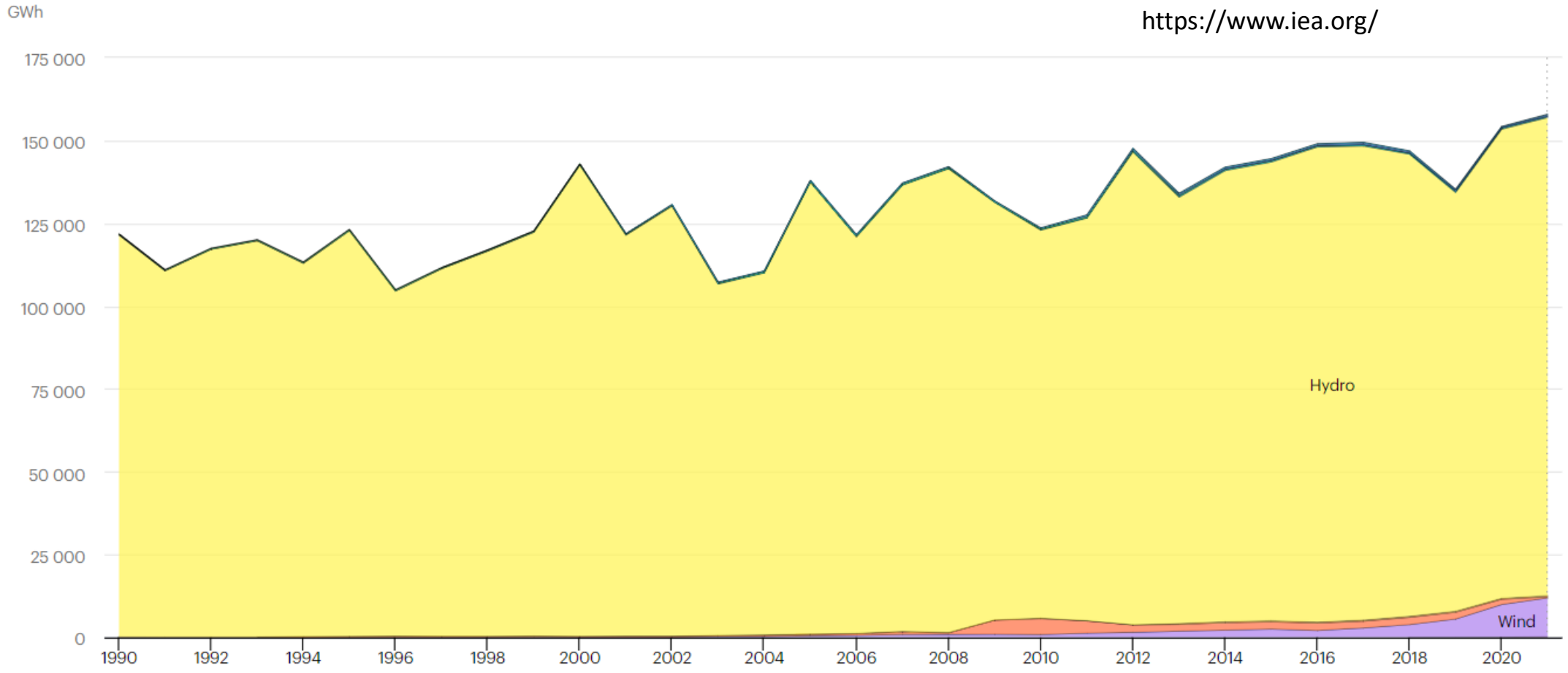
Norway

Hydro country: decarbonized electricity

Electricity generation by source, Norway 1990-2021

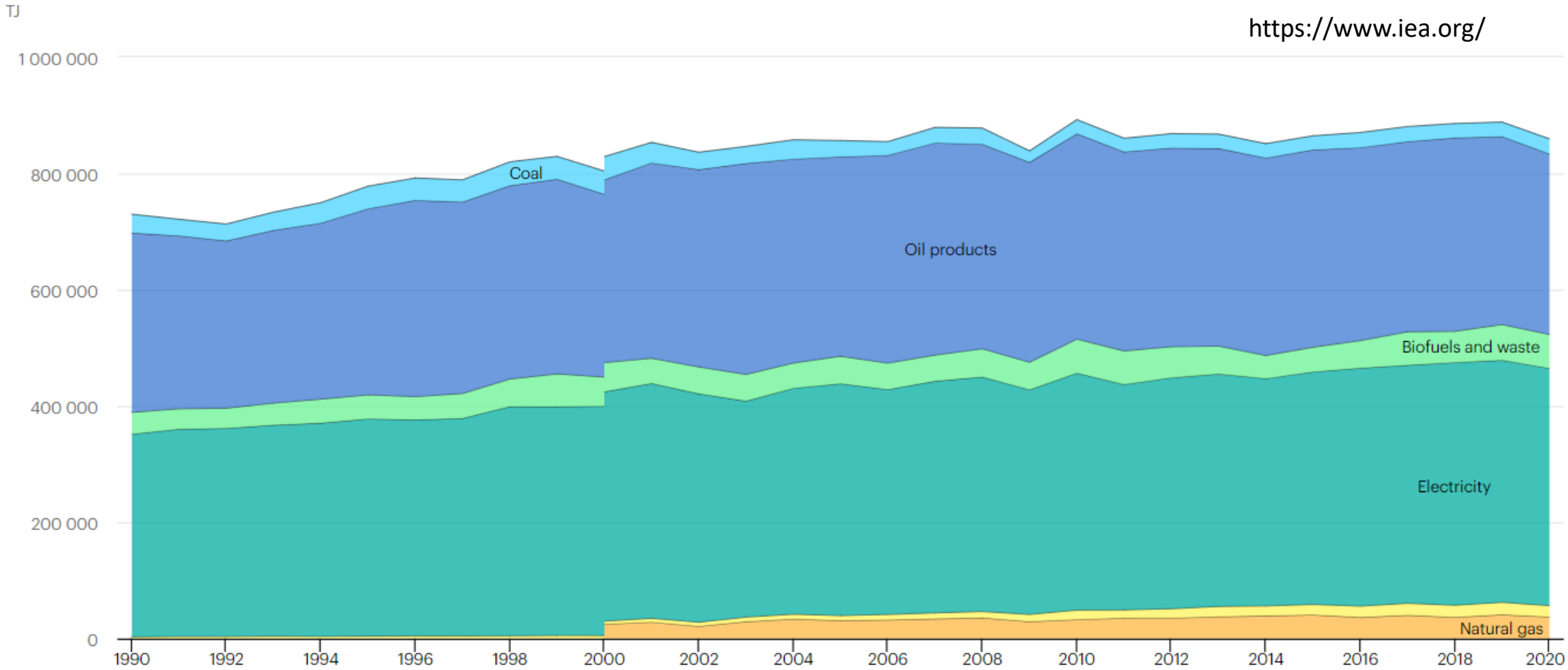


https://www.iea.org/

Norway

Final consumption: still a lot of oil

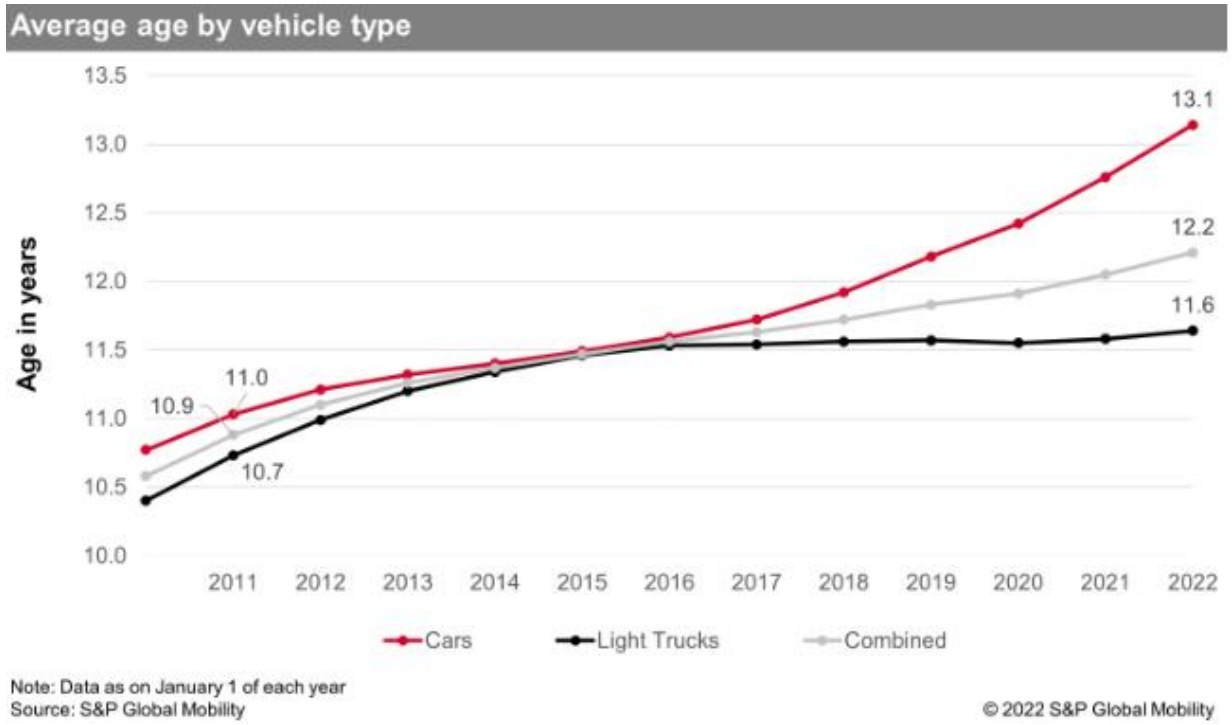
Total final consumption (TFC) by source, Norway 1990-2020

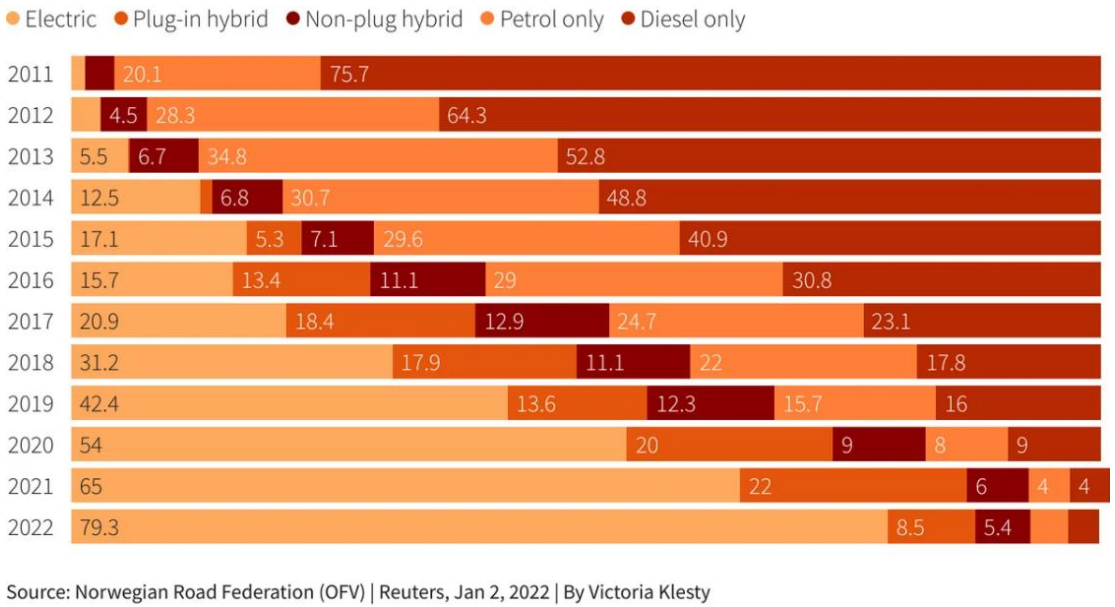


https://www.iea.org/

Norway

Mobility: slow process





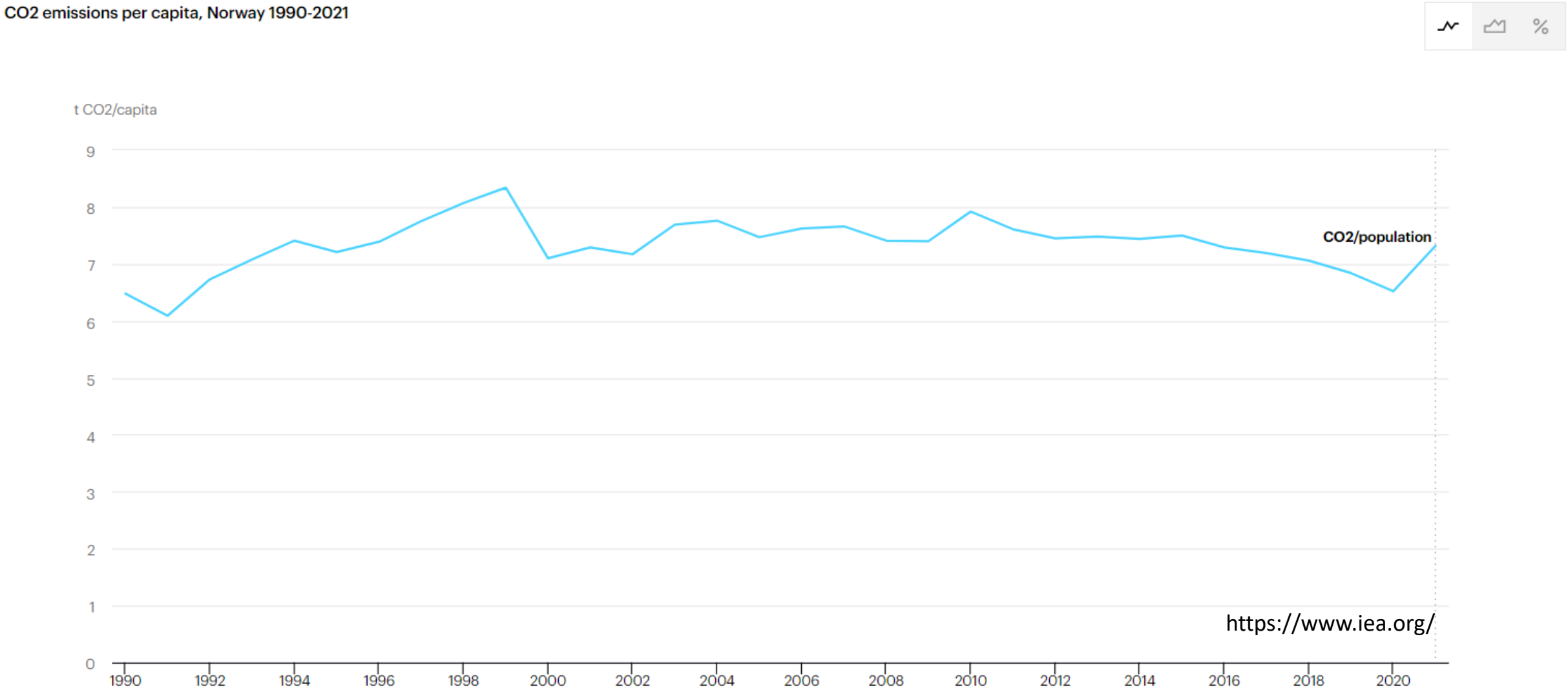
December 13, 2022 05:18 AM

EVs now make up 20% of Norway's cars

EVs now make up 20 percent of Norway's cars after doubling their share in three years.

Norway

CO2 emissions per capita: around 7t CO2 (France is at 4.2)



Norway

Some conclusions

- Some countries with hydro potential have already decarbonized their electricity grid.

➔ Potential for green energy (=geography) plays an important role.

- Decarbonization of the electricity sector is only part of the problem

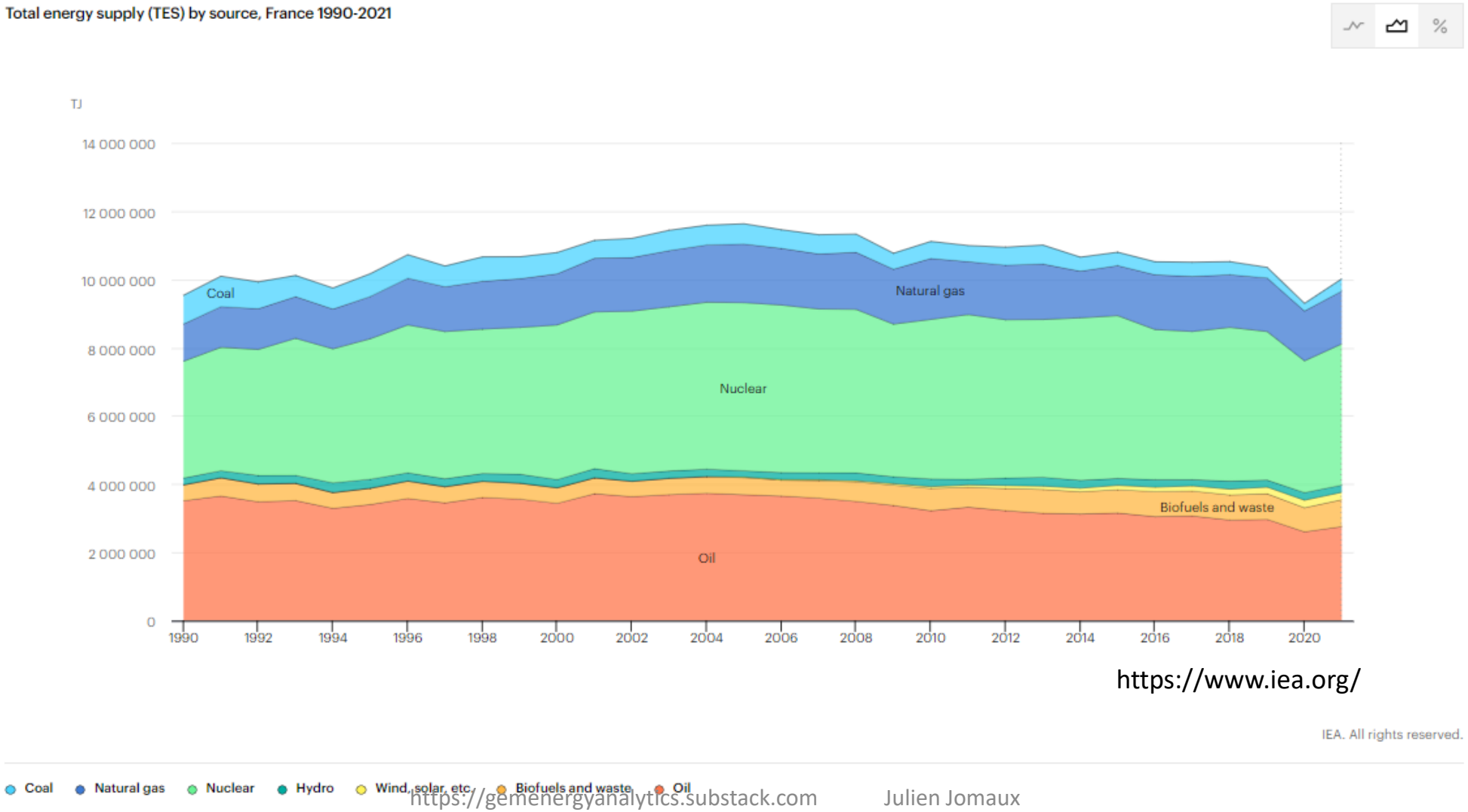
➔ Electricity is the easiest.

- Decarbonization of the transportation sector is relatively slow

➔ Major different between the flux (= the sale of EV) and the stock (the fleet).

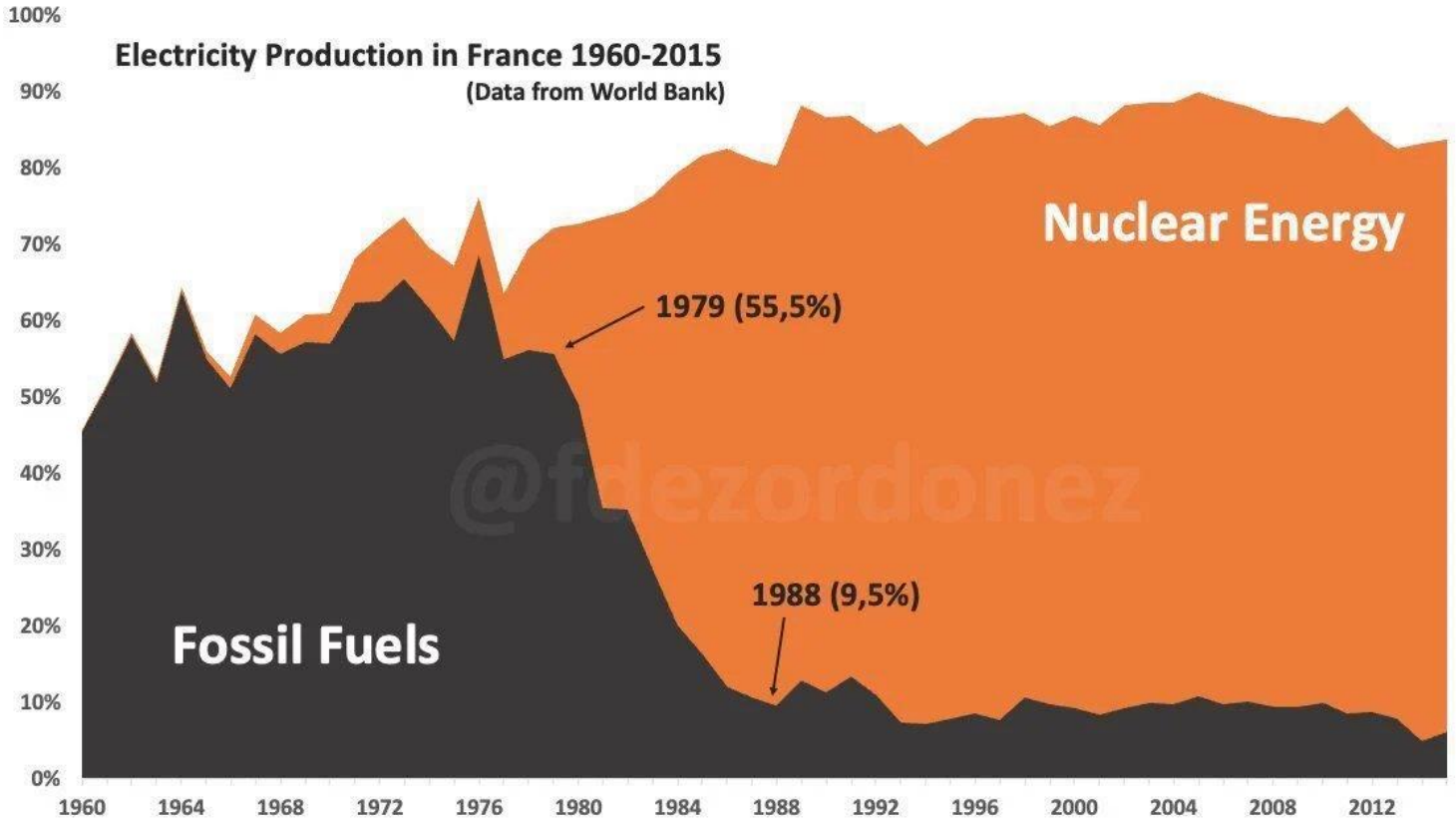
France

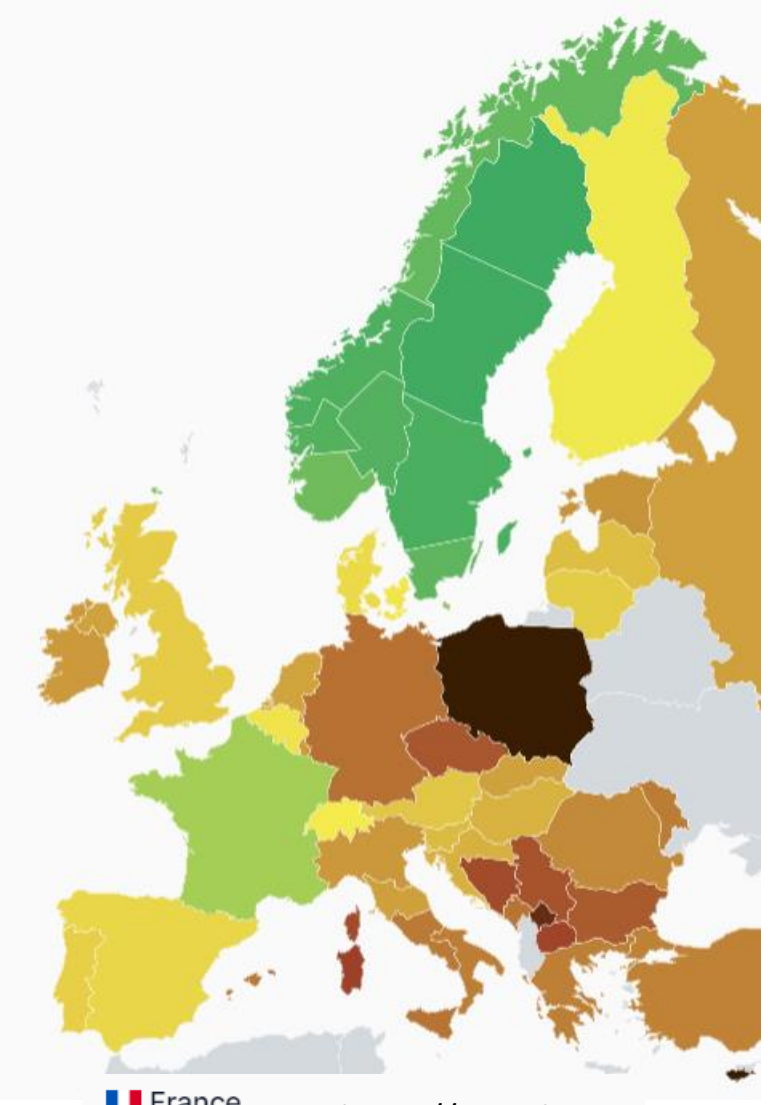
CO2 emissions per capita: around 7t CO2 (France is at 4.2)

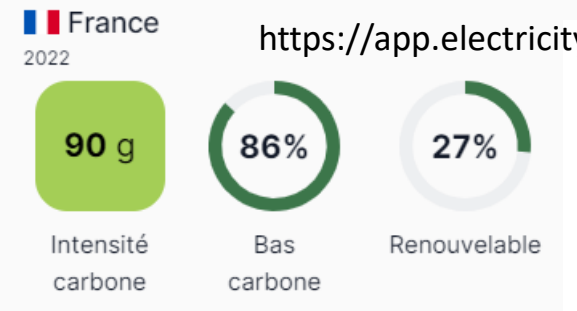


France

Nuclear is low-carbon







https://app.electricitymaps.com/

https://gemenergyanalytics.substack.com Julien Jomaux

France

Some conclusions

- Nuclear provides decarbonized power. Of course, nuclear is not cheap.

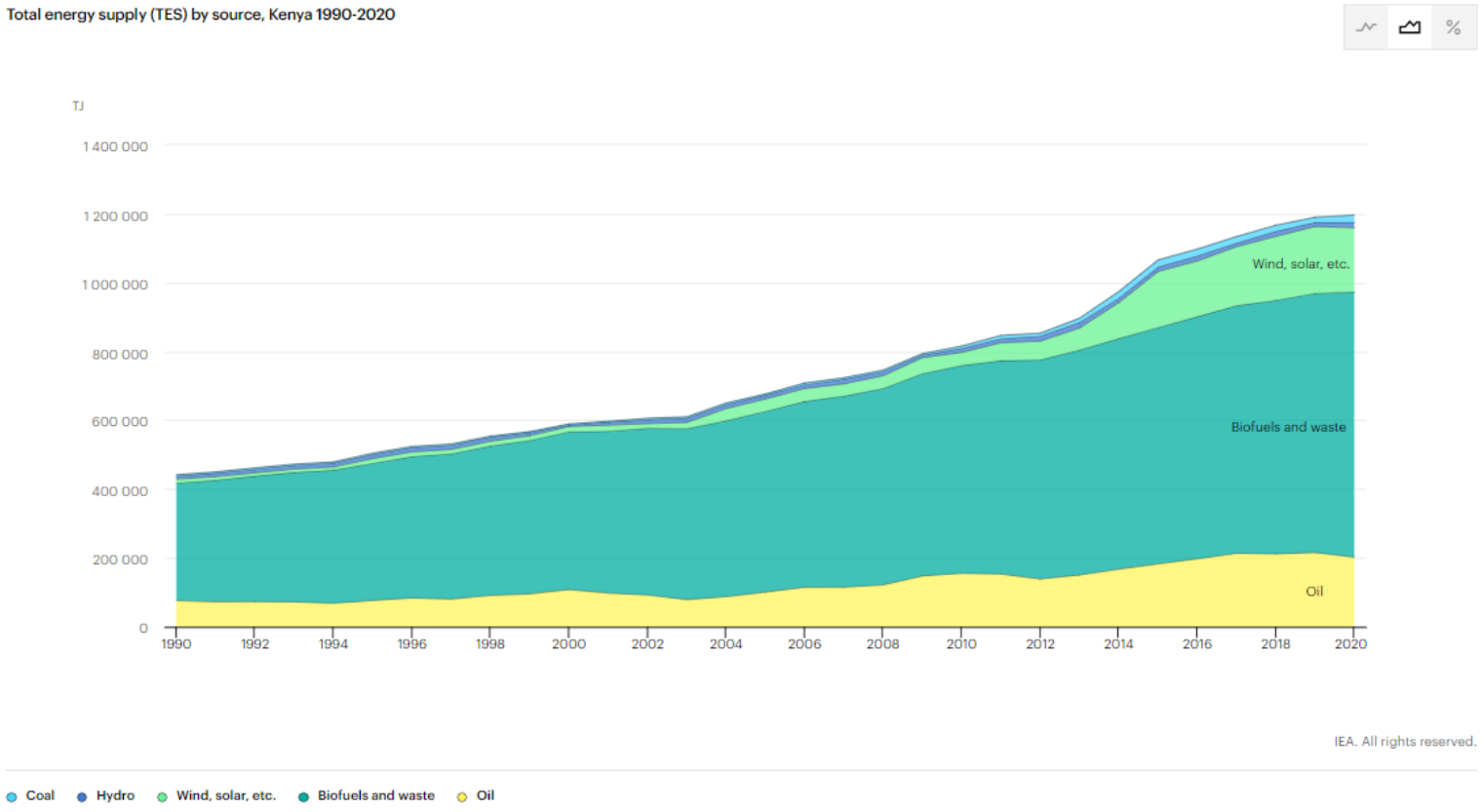
➔ Nuclear could be a way to decarbonize electricity generation.

- Electricity is not energy

➔ We consume a lot of fossil fuels directly (cars, heating, industry). Not only as energy but also a feedstock (plastics, fertilizers).

Kenya

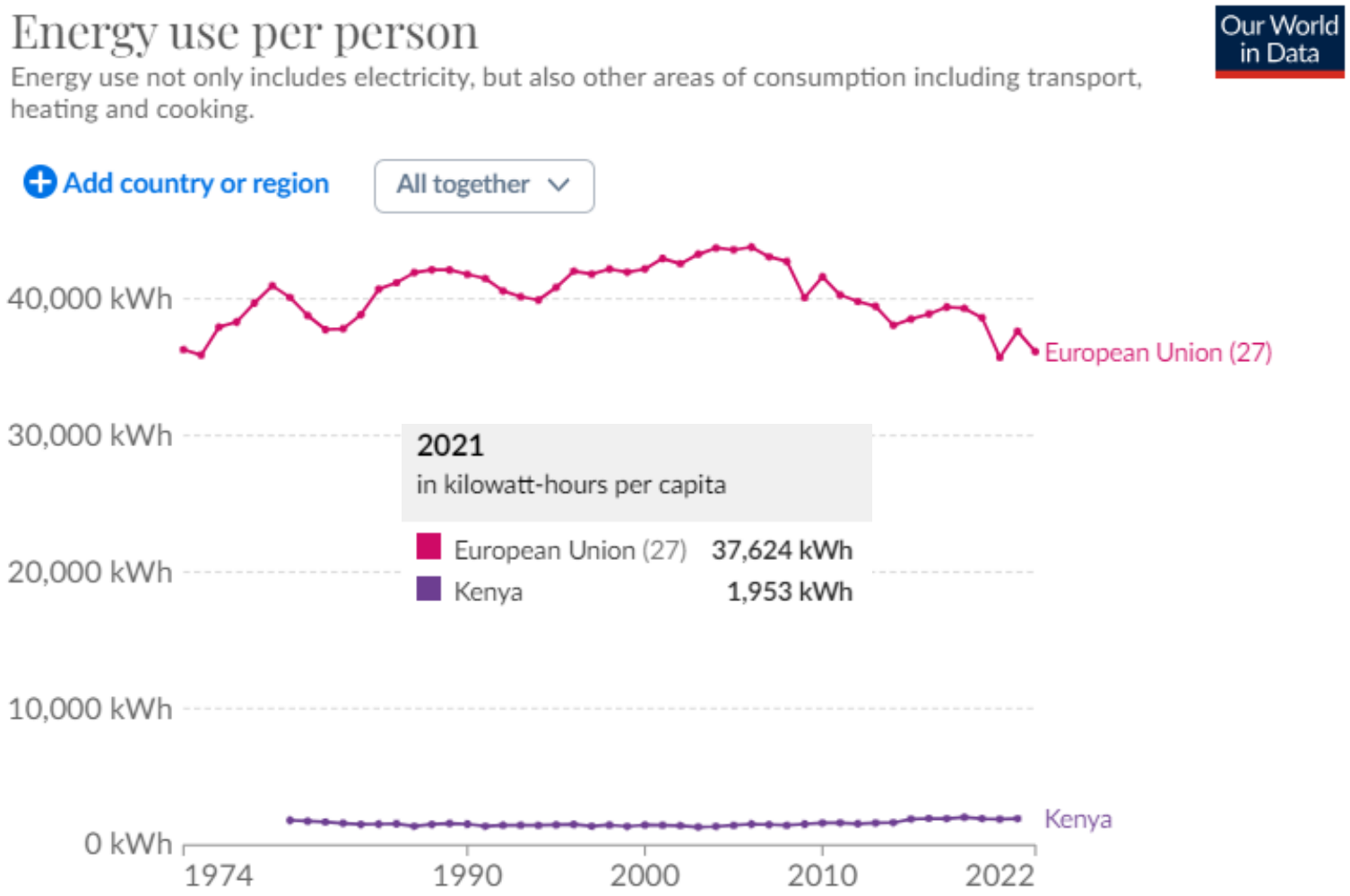
Energy supply still dominated by biofuels



https://africa-energy-portal.org/news/role-clean-cooking-sustainable-development

Kenya

Energy use is still extremely low



Kenya

Some conclusions

- Developing nations are in a very different situation.

➔ Some more obvious actions are needed first, like access to clean cooking, electricity, etc.

- Energy use per capita has to increase

➔ The development of the country would need to go through more consumption.

➔ Could it leapfrog directly to renewables only?

Agenda

1. A brief history of emissions
2. Energy Transitions?
3. Two different issues: energy poverty and emissions
4. Hopeful developments
5. Focus on particular countries
6. The great challenges
7. What could we do?

Clean Energy Tracker

A lot of red in the IEA list

Energy System Overview

- Energy Efficiency
- Behavioural Changes
- Electrification
- Renewables
- Bioenergy
- Hydrogen
- Carbon Capture, Utilisation and Storage
- Innovation
- International Collaboration
- Digitalisation

Cross-Cutting Technologies & Infrastructure

- CO2 Transport and Storage
- CO2 Capture and Utilisation
- Bioenergy with Carbon Capture and Storage
- Direct Air Capture
- Electrolysers
- District Heating
- Data Centres and Data Transmission Networks

Electricity

- Coal
- Natural Gas
- Solar PV
- Wind
- Hydroelectricity
- Demand Response
- Nuclear Power
- Grid-scale Storage
- Smart Grids

Oil & Natural Gas Supply

- Methane Abatement
- Gas Flaring

Low-Emission Fuels

- Biofuels

Transport

- Cars and Vans
- Trucks and Buses
- Rail
- Aviation
- International Shipping
- Electric Vehicles

https://www.iea.org/reports/tracking-clean-energy-progress-2023

Industry

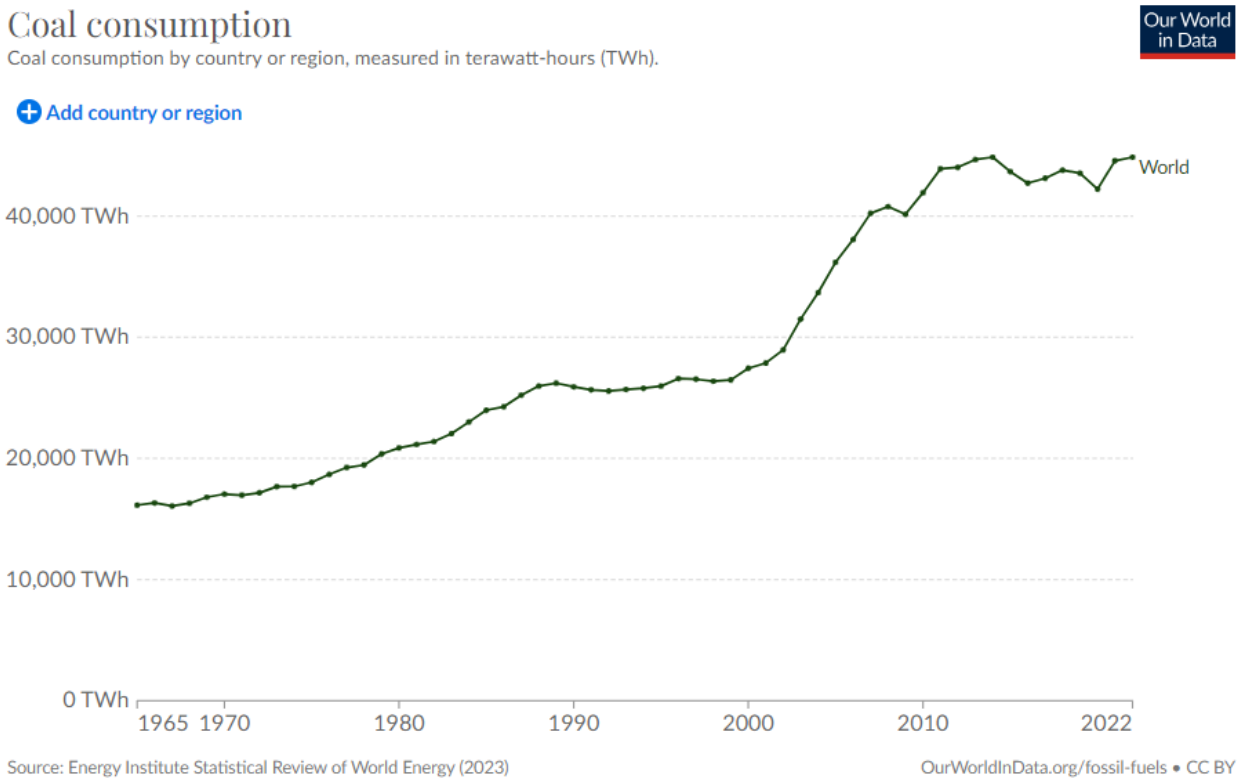
- Steel
- Chemicals
- Cement
- Aluminium
- Paper
- Light Industry

Buildings

- Heating
- Space Cooling
- Lighting
- Appliances and Equipment
- Building Envelopes
- Heat Pumps

Coal in electricity

Coal is dirty but cheap and easy

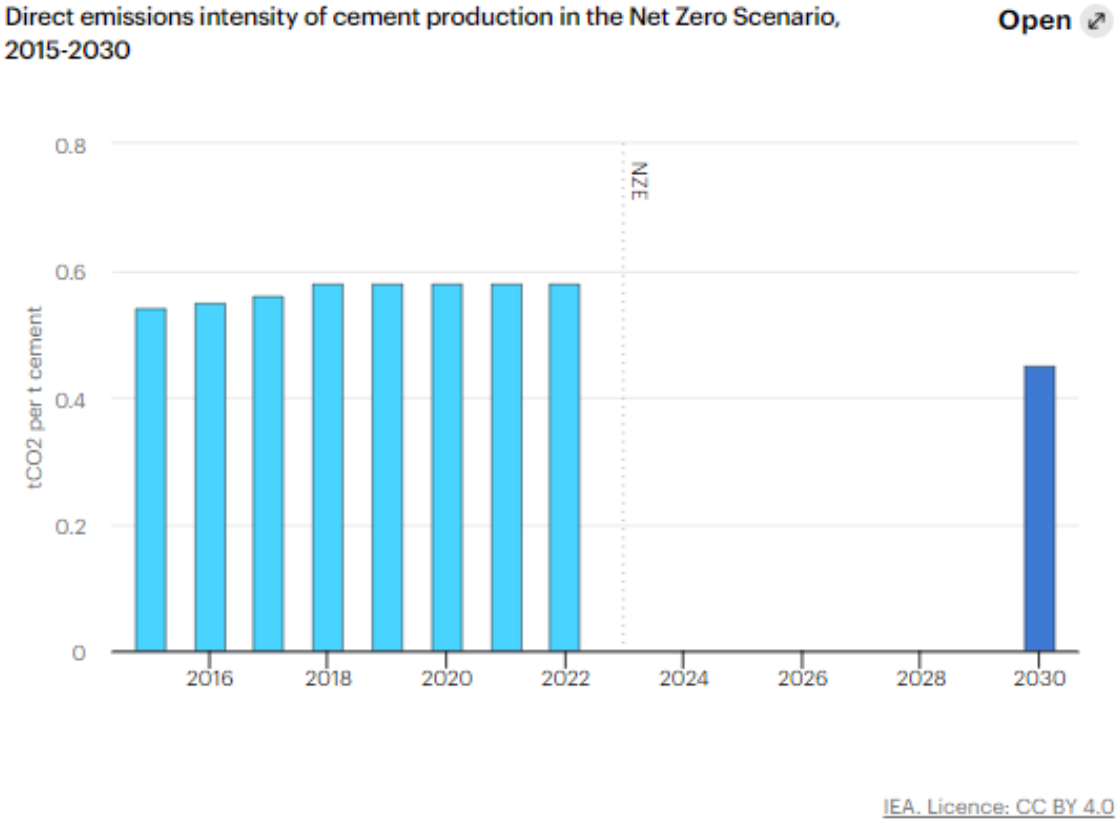


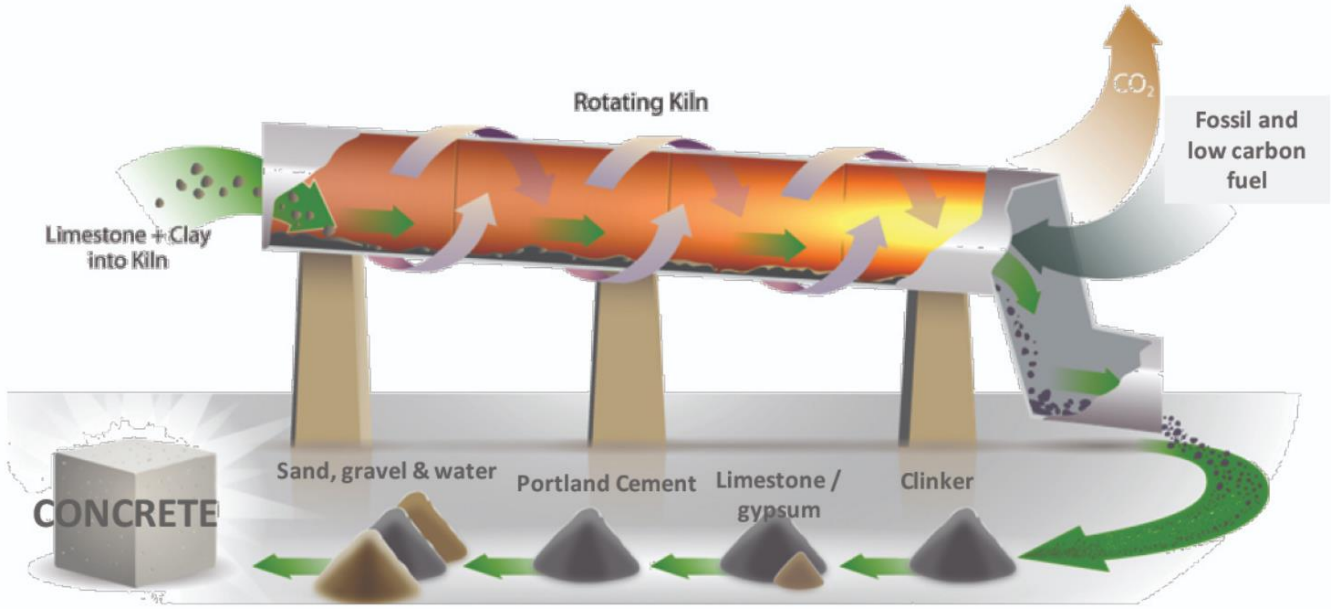
#	Country	Yearly Coal Consumption (MMcf)	World Share	Cubic Feet Per Capita
18	Serbia	43,189,608,110	0.5 %	5,763.77
10	Australia	129,642,679,100	1.5 %	5,358.09
23	Bulgaria	35,234,236,840	0.4 %	4,862.59
13	Kazakhstan	86,633,849,830	1.0 %	4,792.08
17	Czech Republic (Czechia)	49,418,771,720	0.6 %	4,694.21
73	New Caledonia	1,155,220,880	0.0 %	4,071.29
9	Poland	148,799,901,400	1.7 %	3,861.71
7	South Africa	202,298,474,200	2.4 %	3,585.44
22	Greece	38,077,094,330	0.4 %	3,542.14
4	Germany	257,488,592,900	3.0 %	3,127.46
1	China	4,319,921,826,000	50.5 %	3,081.50
14	Taiwan	72,649,581,410	0.8 %	3,079.09
8	South Korea	157,124,158,500	1.8 %	3,062.25

https://www.worldometers.info/

Industry - Cement

No progress





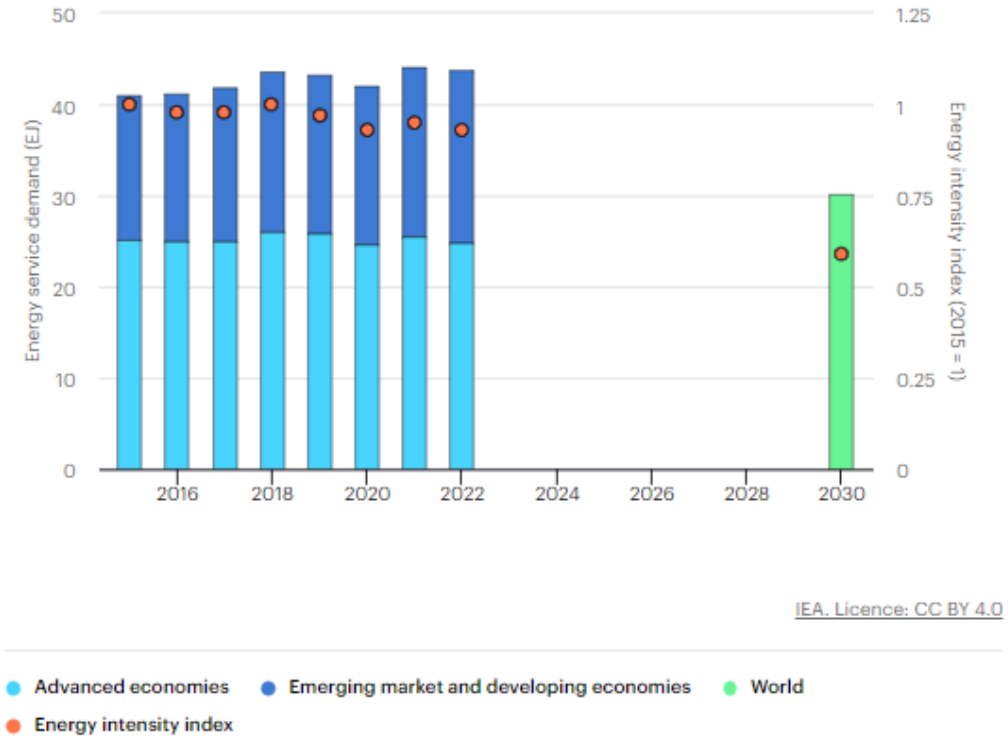
https://www.toppr.com/ask/en-bt/question/how-portland-cement-is-manufactured/

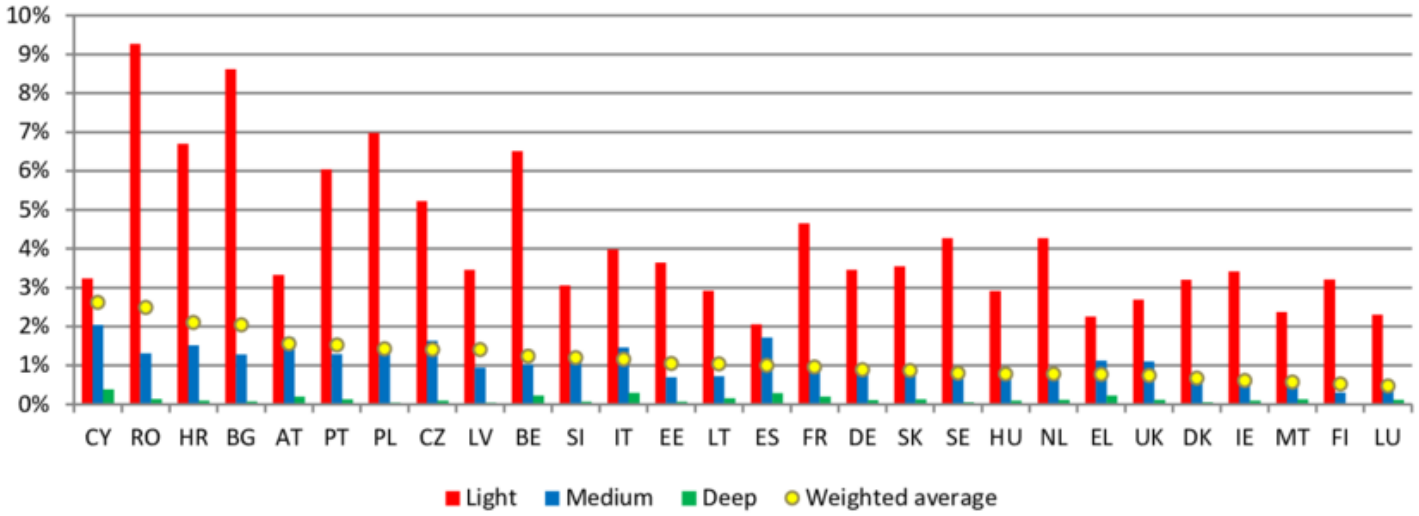
Building Envelopes

Building renovation is really slow and deep ones are almost inexistant

Energy service demand for space heating and energy intensity index in the Net Zero Scenario, 2015-2030

Open





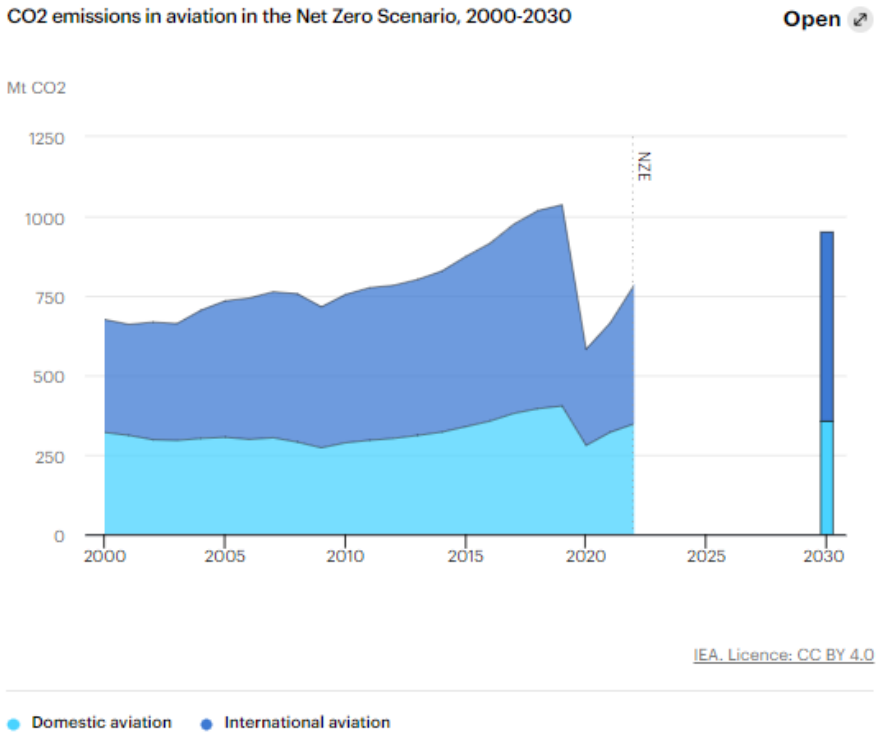
https://www.researchgate.net/figure/Renovation-rates-in-residential-buildings-in-the-EU28-Member-States-by-renovation-level_fig2_366030623

Aviation

Only a tiny fraction of the world is actually contributing

One percent of the world's population accounts for more than half of flying emissions

Published 19 November 2020



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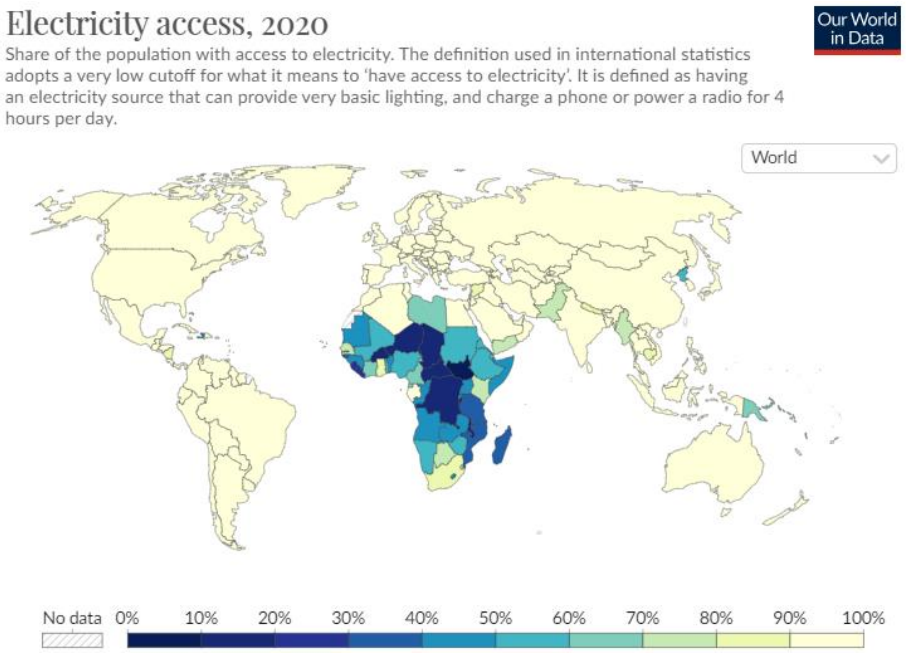
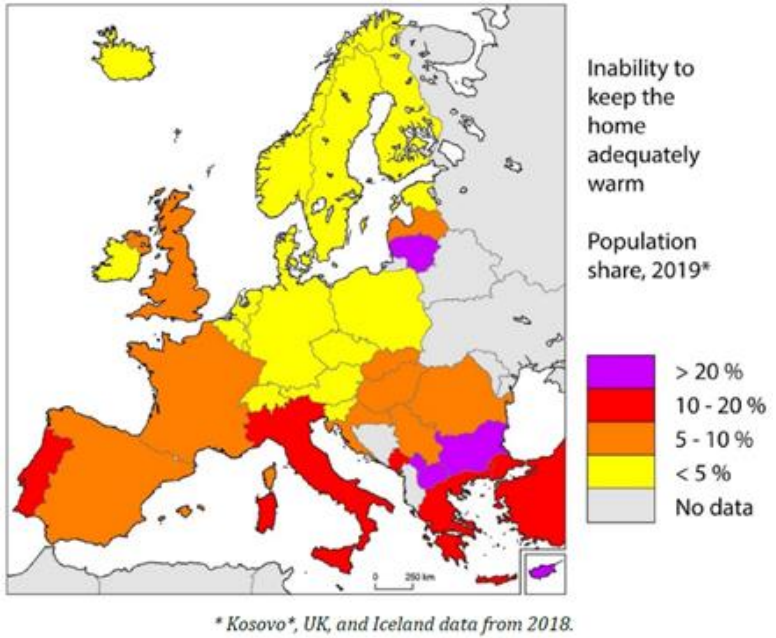
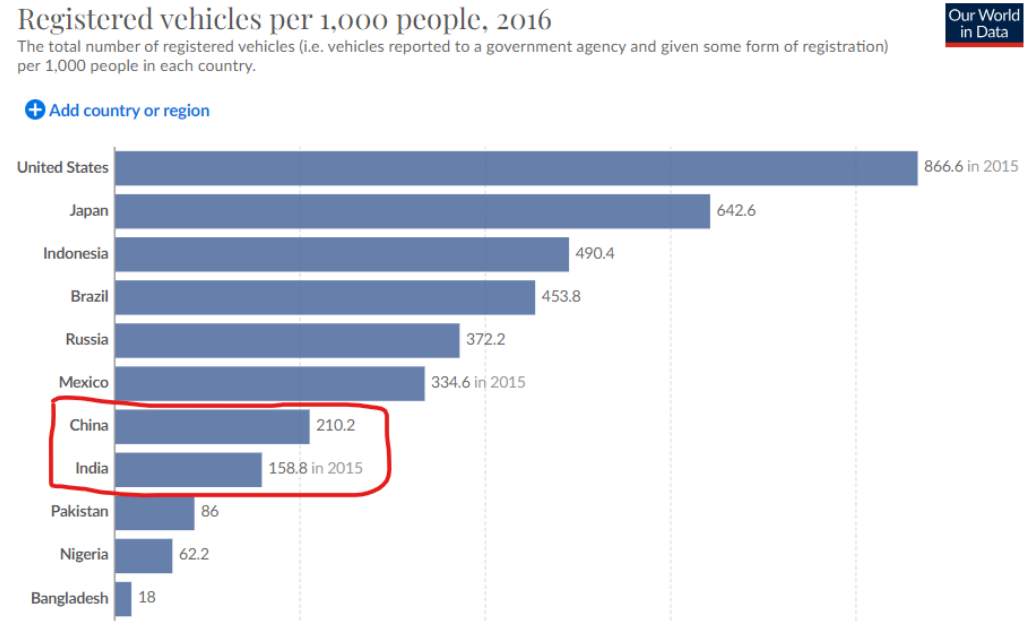
Energy poverty is still very much an issue

Important to note that many countries are still lacking proper energy



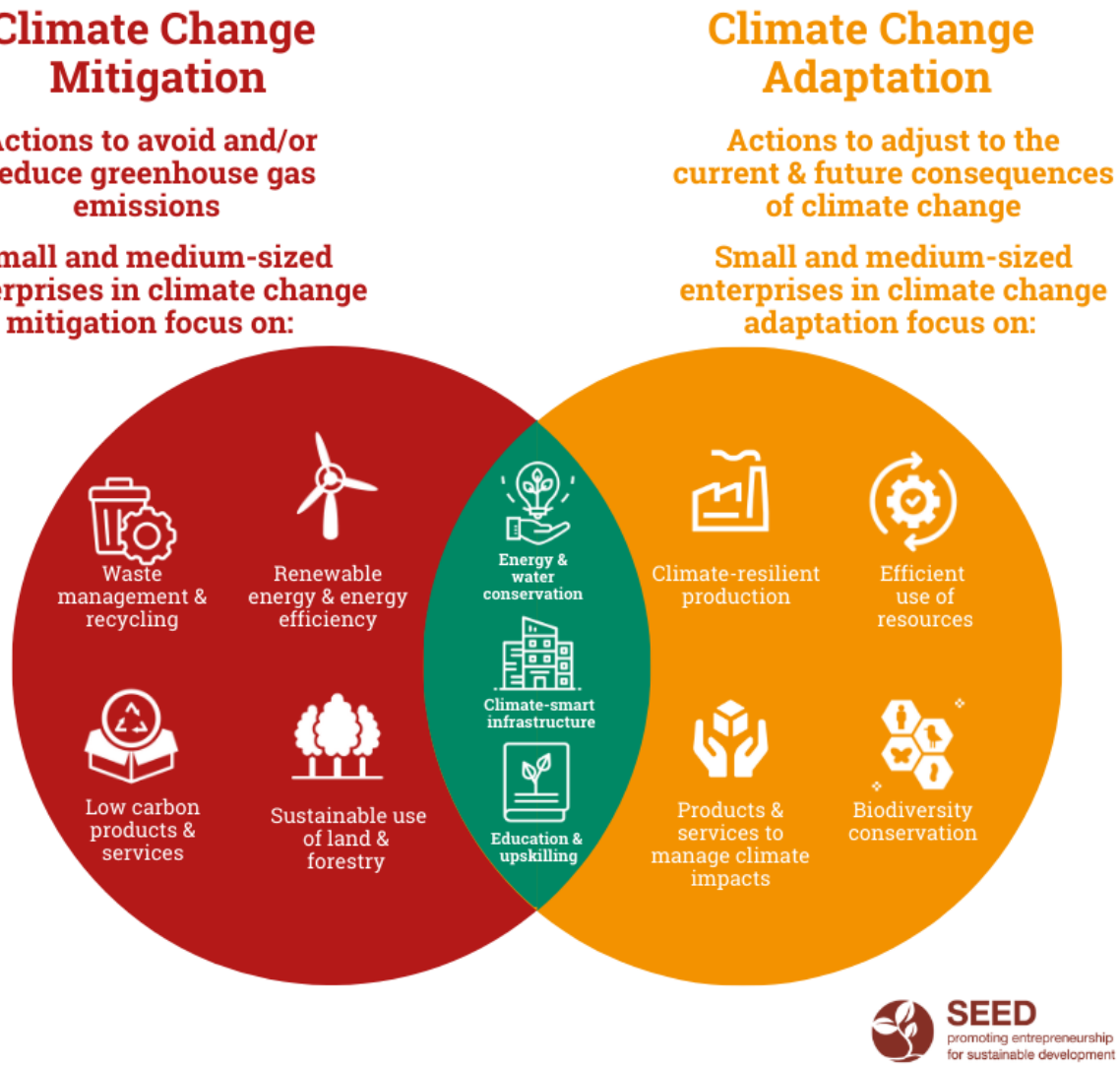


From knowledge to warm home" project -Croatia



Adaptation and Resilience

For local population (especially the ones not responsible), adaptation is key



Low-hanging fruits

Some ideas (not exhaustive of course)

- Solar in dirty grids (replacing diesel generators or coal power plants).
- Solar heaters in sunny countries.
- Investing in public transport system (bus).
- Clean cooking solutions.
- Adaption measures and resilience.
- … measures to be adapted to the context / country specific.

Thank you

Any question?