CZ-AT WINTER-SUMMER SCHOOL 2025

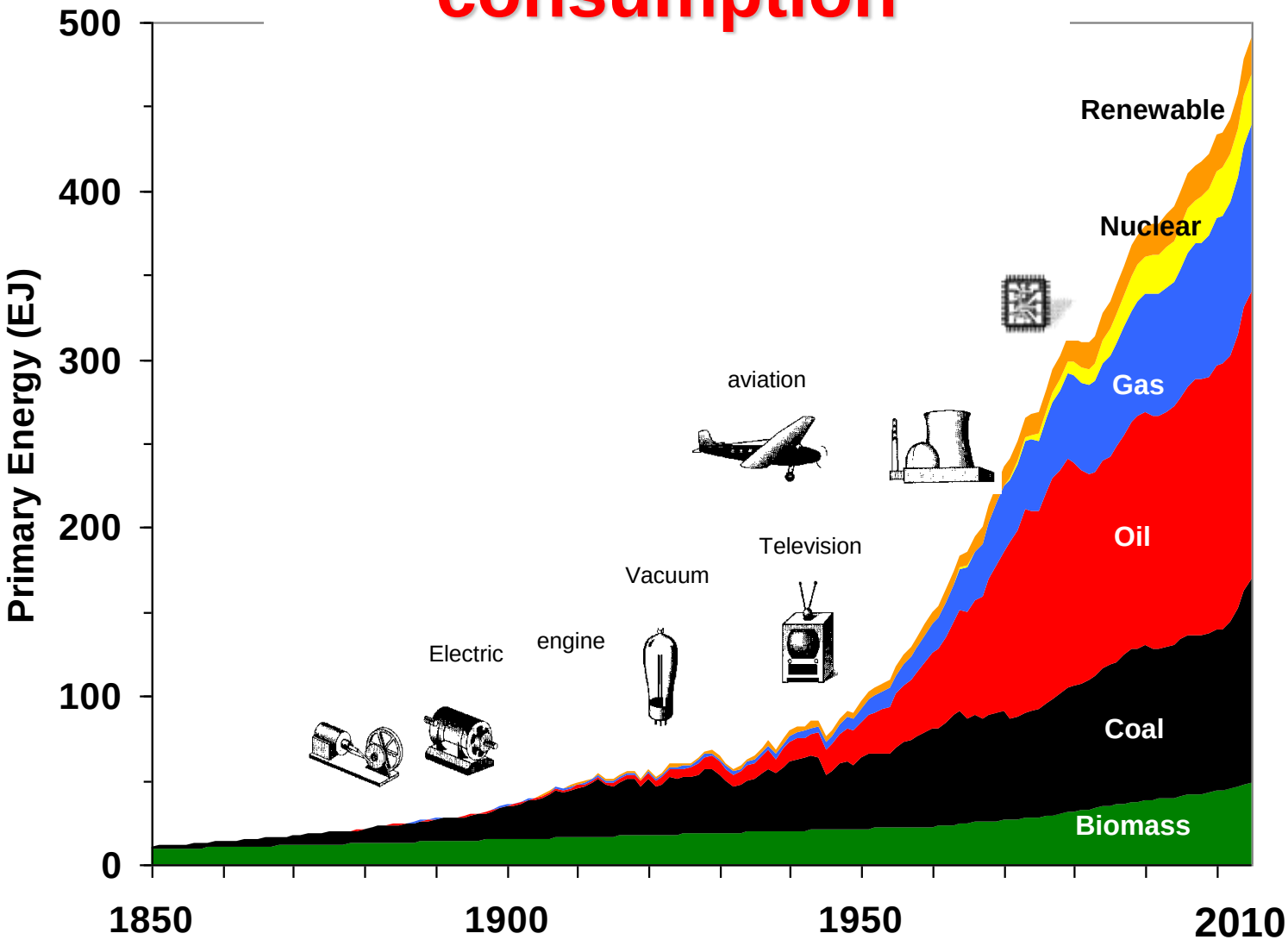
THE WORLD ENERGY SYSTEM – AN INTRODUCTION

Reinhard Haas

Amela Ajanovic

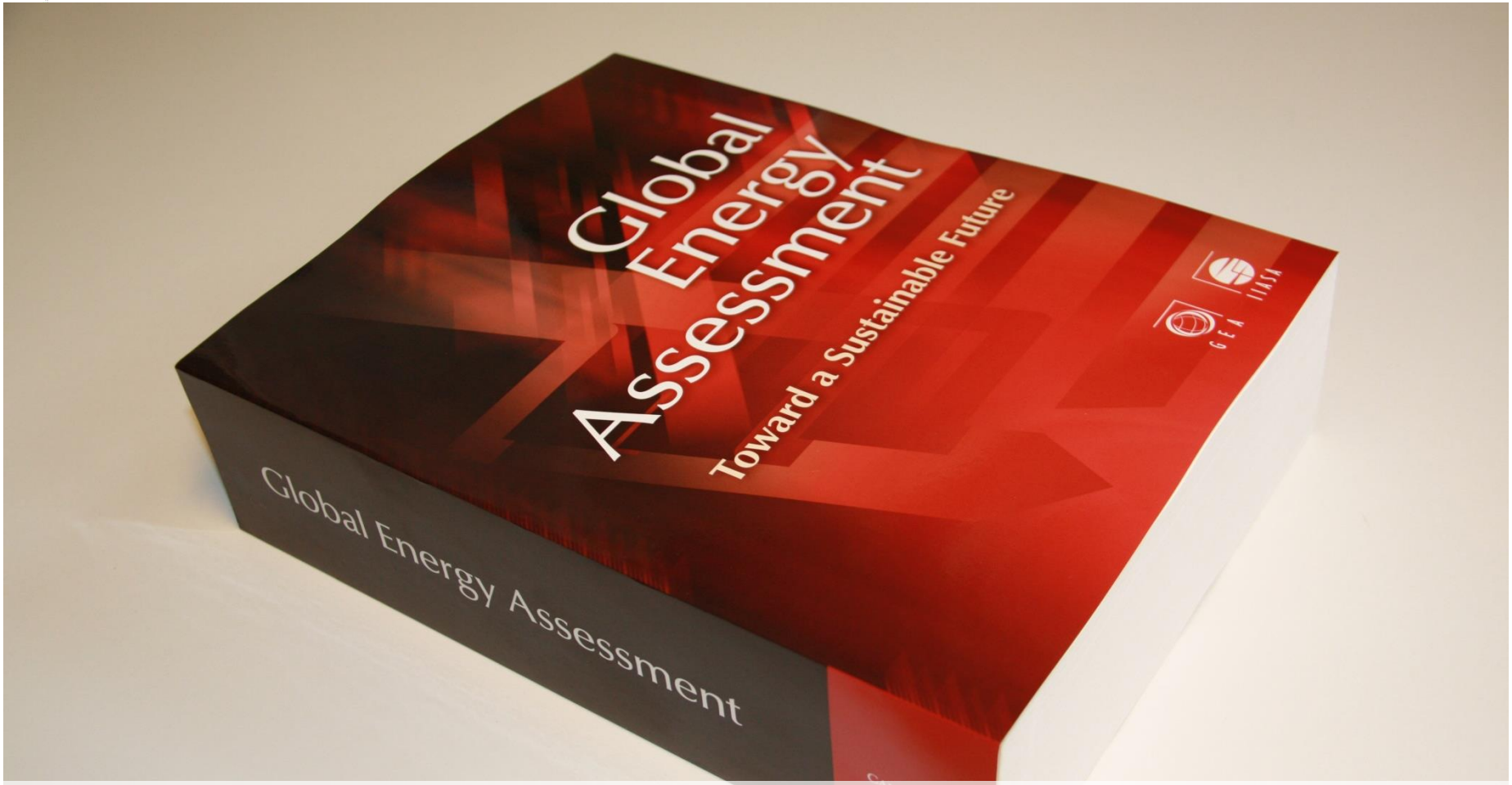
Energy Economics Group (EEG), TU Wien

World Primary Energy consumption



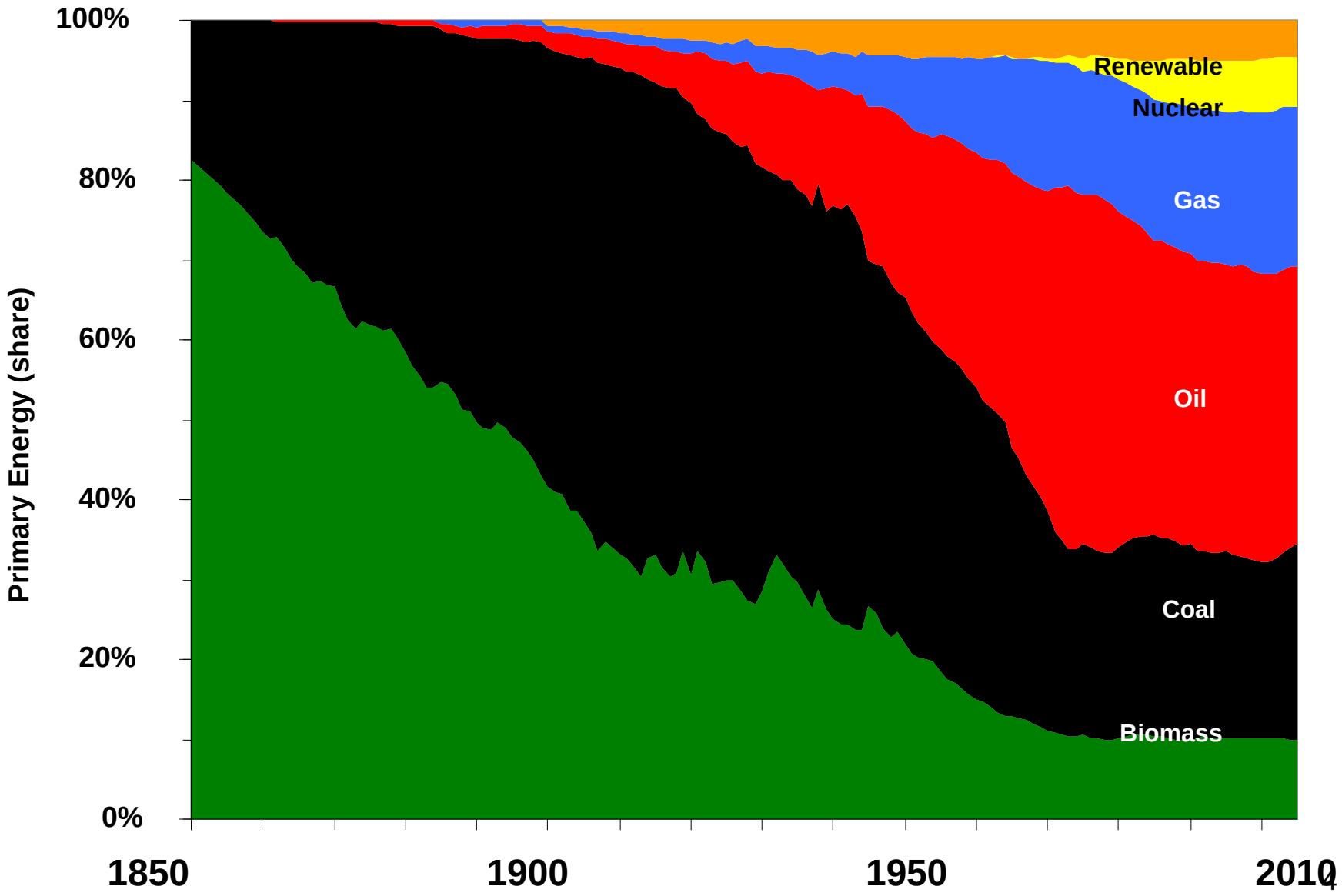
Source: GEA (2012)

www.GlobalEnergyAssessment.org



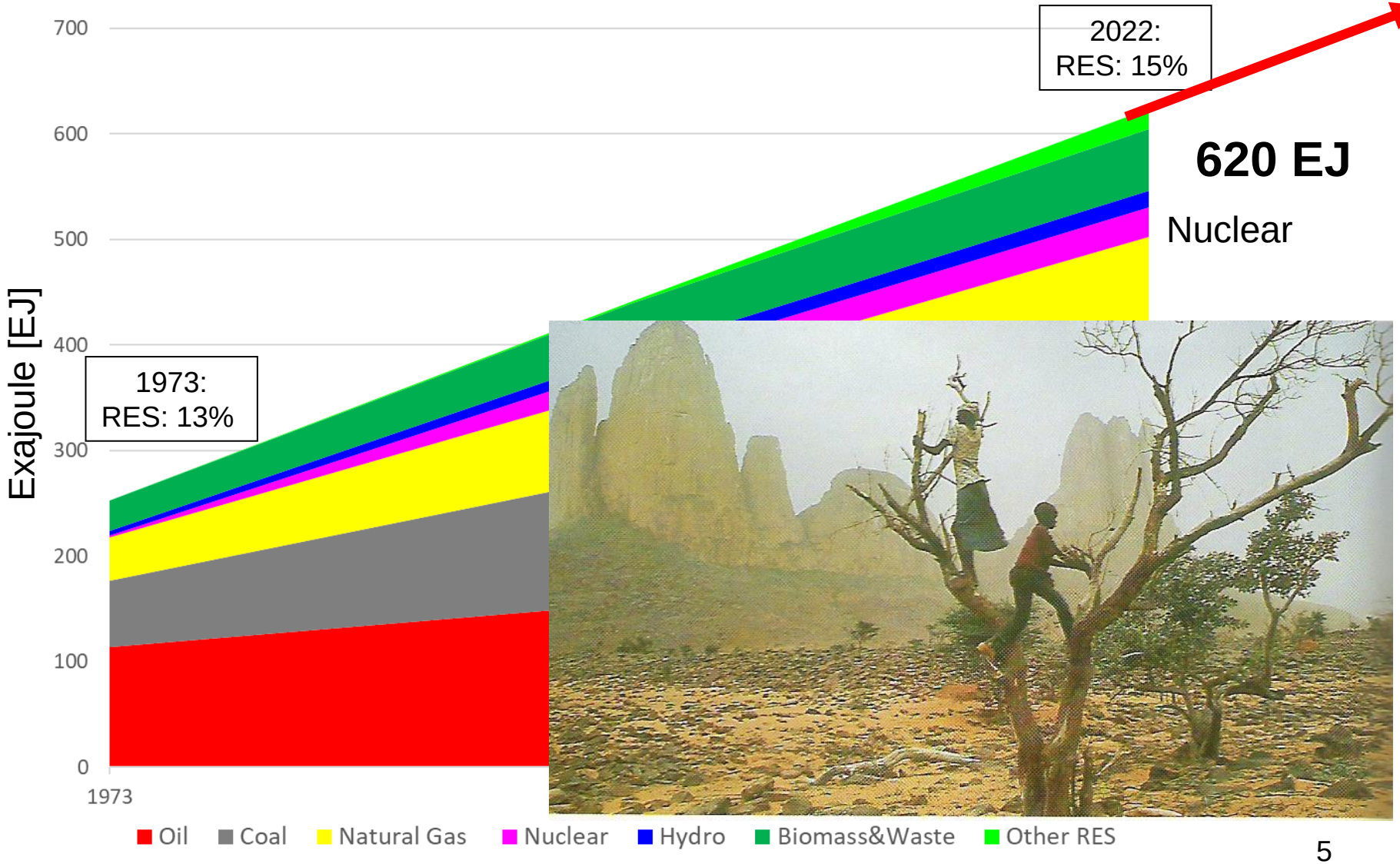
- **Total Effort: 300 Authors; 200 Reviewers**
  > 6 years >> 6m € and >> 100 p-years

Shares of PE world-wide



Source: GEA (2012)

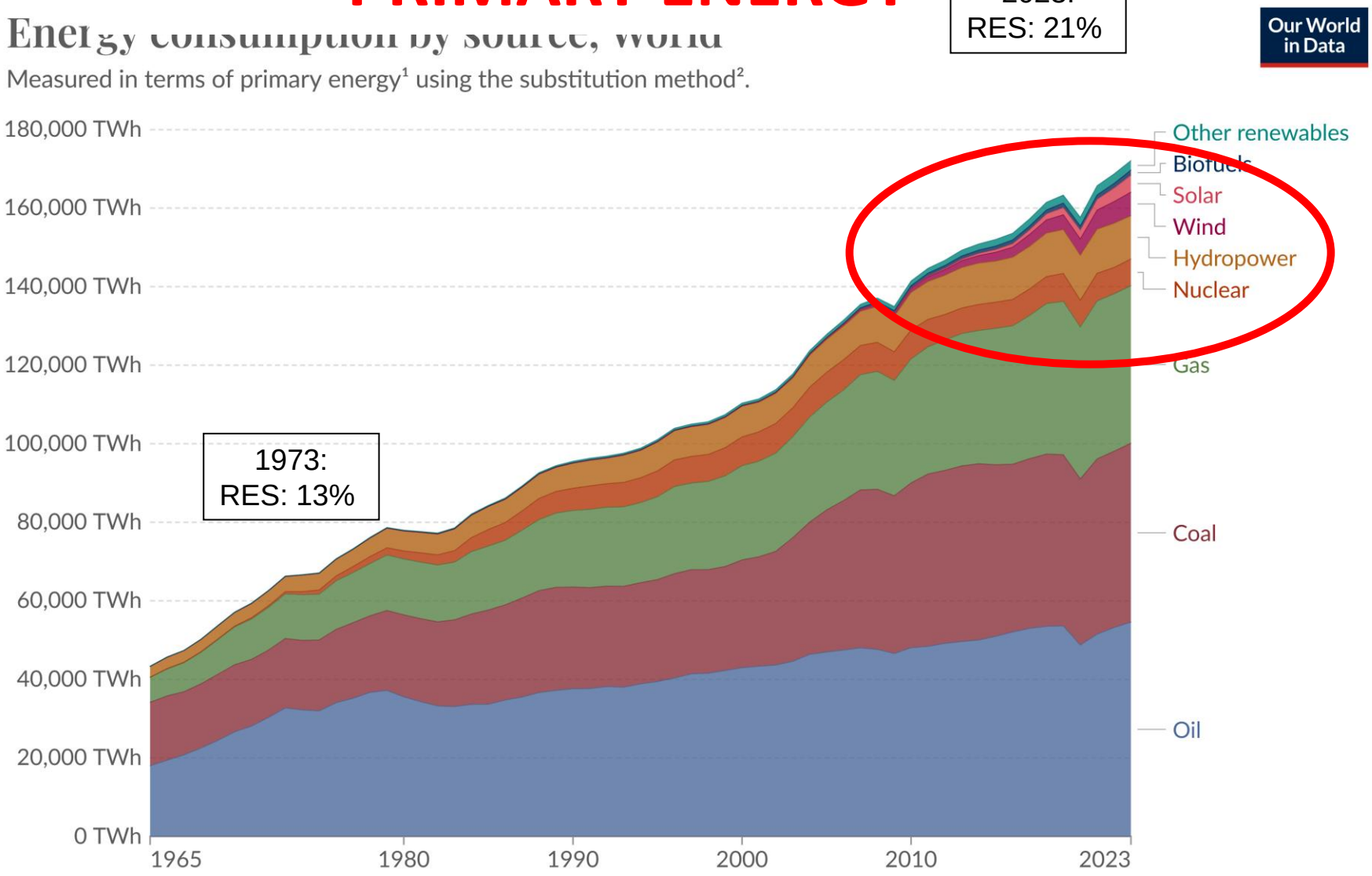
WORLD-WIDE TREND IN PRIMARY ENERGY



Source: IEA (2024)

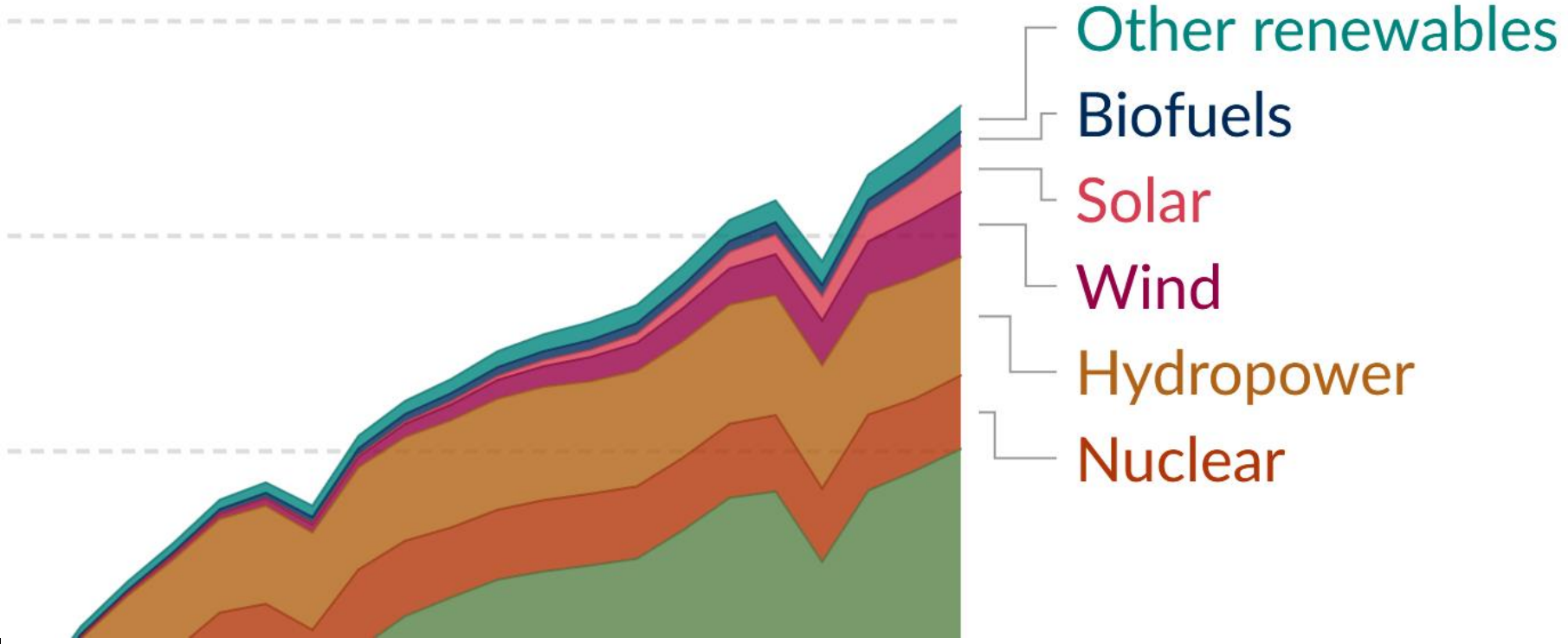
WORLD-WIDE TREND IN PRIMARY ENERGY

2023:
RES: 21%

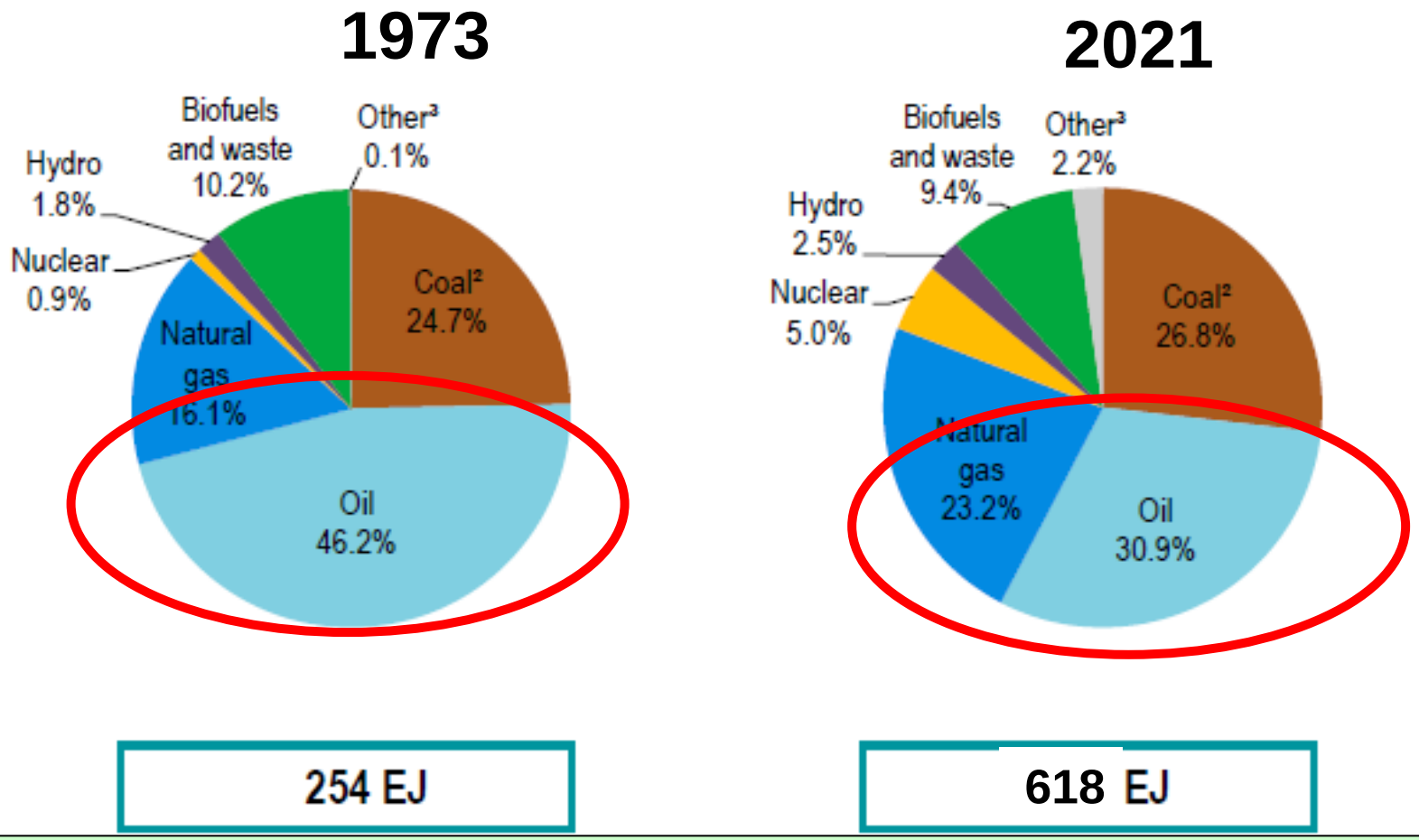


Data source: Energy Institute - Statistical Review of World Energy (2024)
Note: "Other renewables" include geothermal, biomass, and waste energy.

OurWorldinData.org/energy | CC BY


Other renewables
Biofuels
Solar
Wind
Hydropower
Nuclear

World: Primary energy

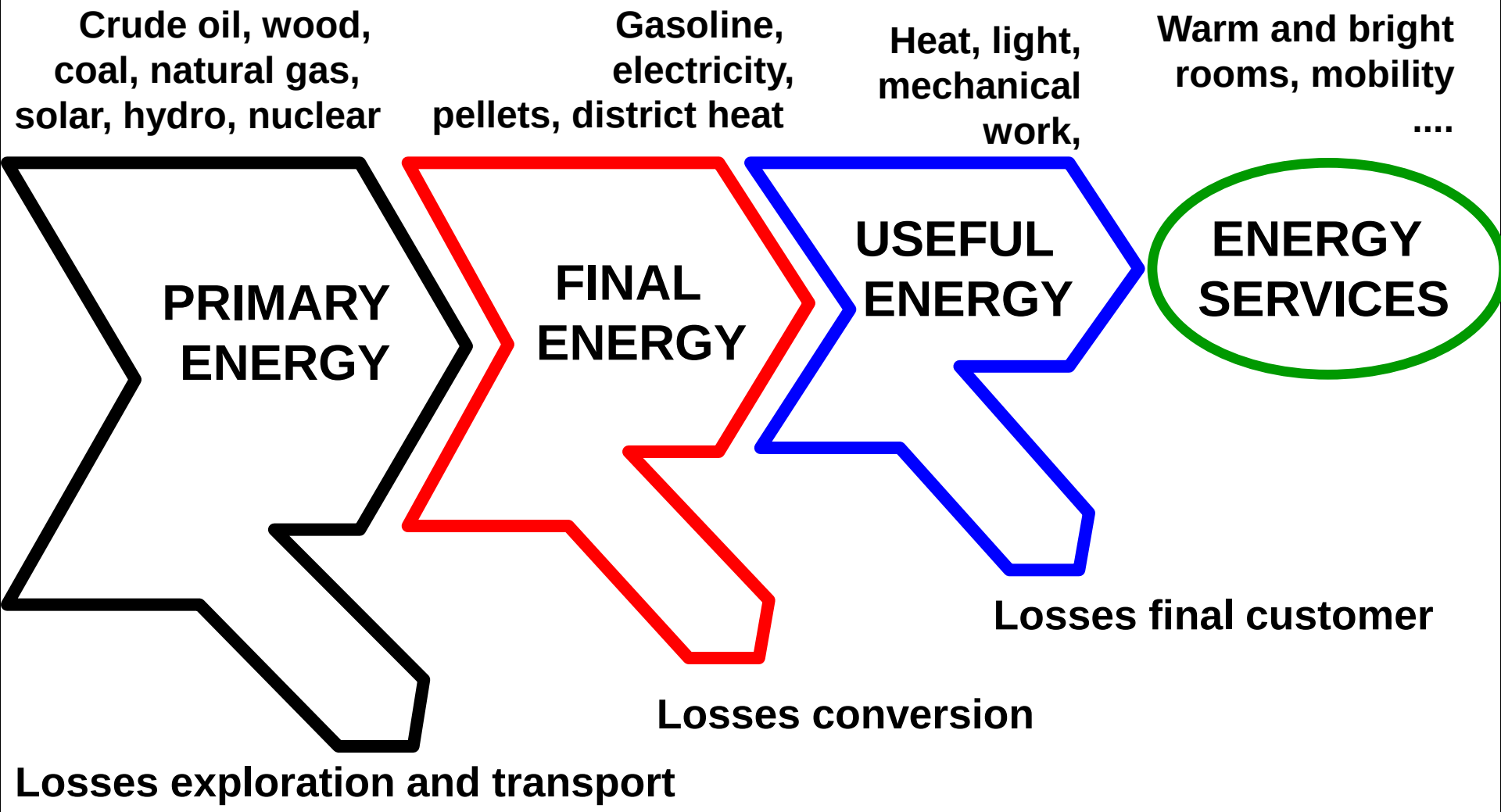


Source: IEA 2023

- ***Total primary energy demand more than doubled between 1973 and 2021;***
- ***Share Oil down (more than -30%!), Gas up, Coal up!***

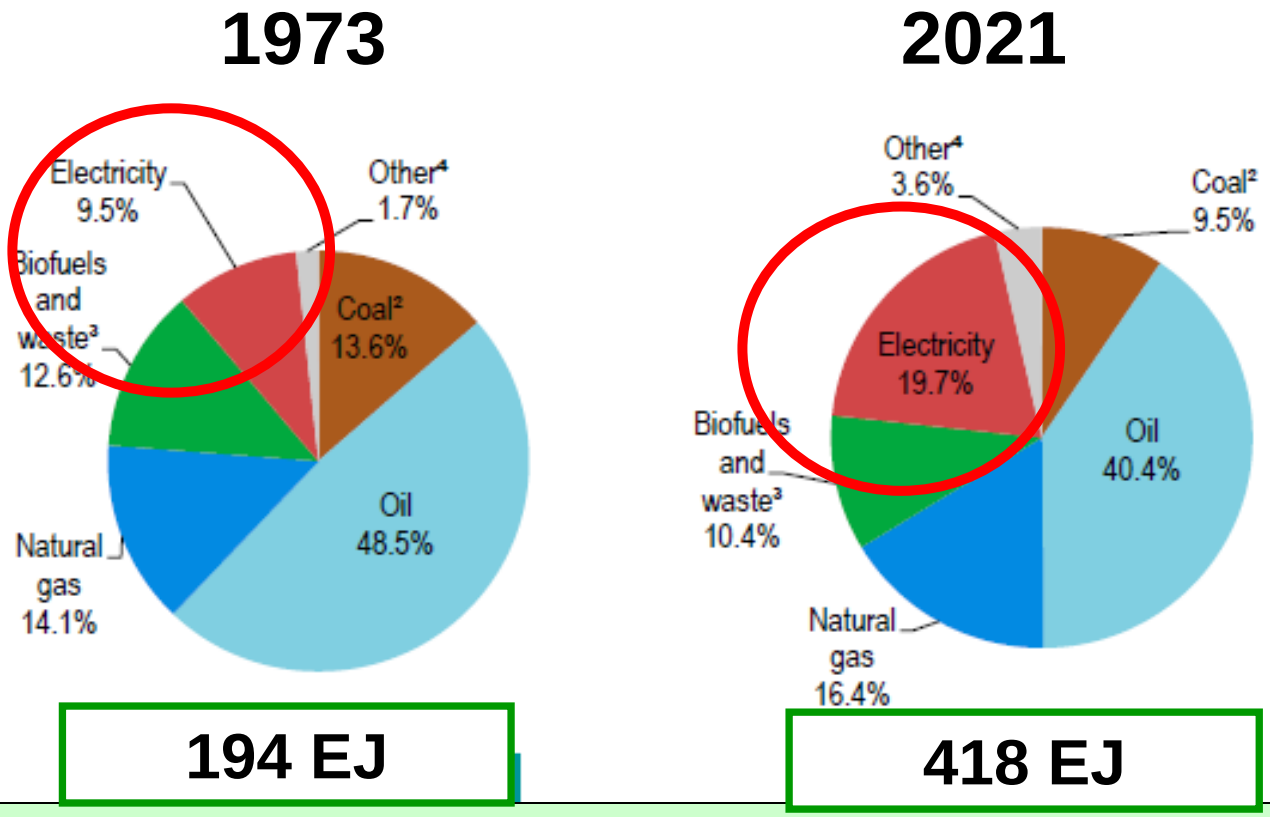
The energy chain

Categories of energy:



World: Final energy

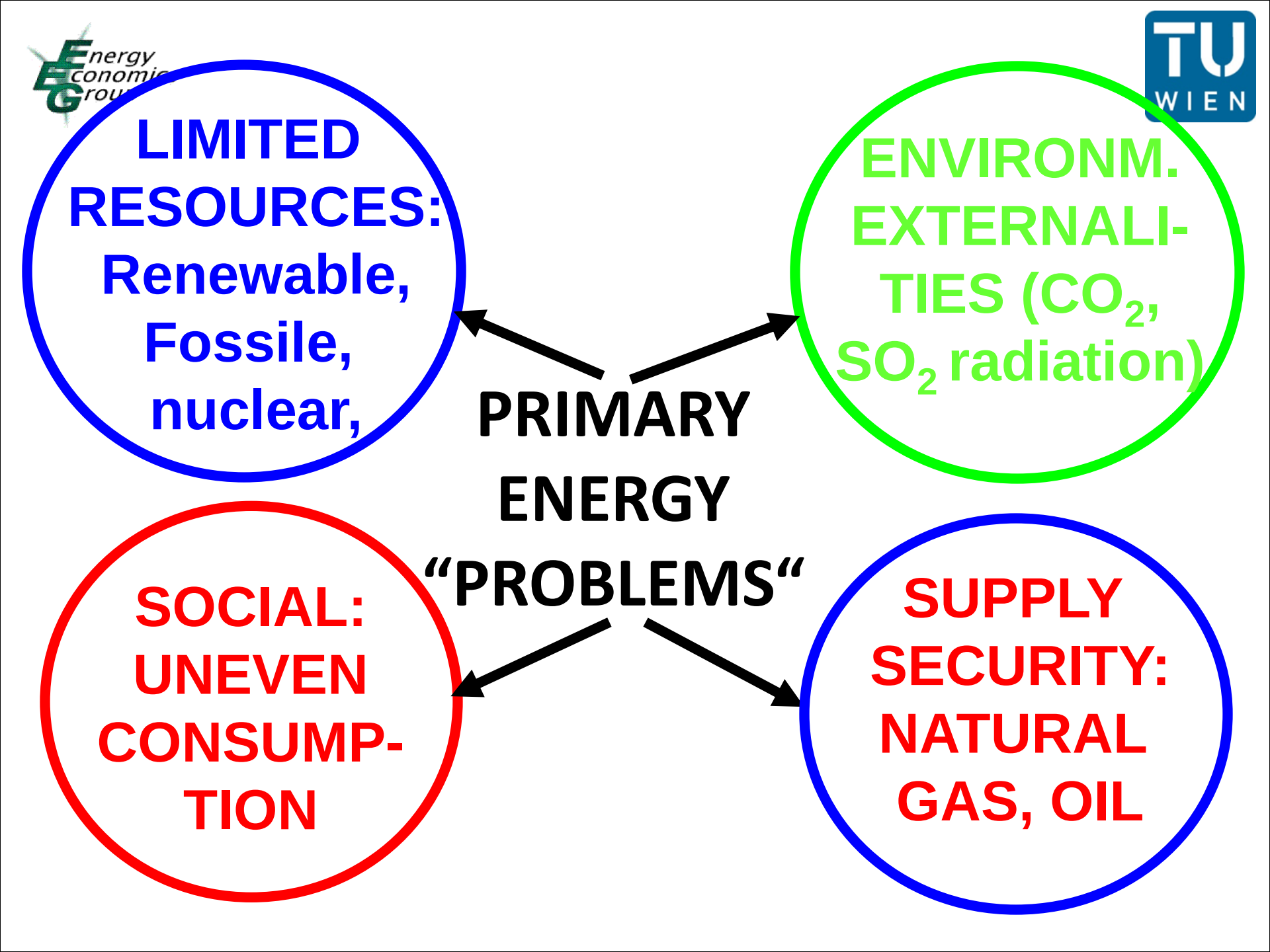
Share of world total final consumption by source, 1973 and 2019



Source: IEA 2021

- ***The share of electricity increases continuously: In 2021 twice of 1973***
- ***Share of oil decreased from 48% to 40%***

** Other includes Solar, Geothermal, Wind


LIMITED RESOURCES: Renewable, Fossile, nuclear,
ENVIRONM. EXTERNALI-TIES (CO_2, SO_2 radiation)
PRIMARY ENERGY "PROBLEMS"
SOCIAL: UNEVEN CONSUMP-TION
SUPPLY SECURITY: NATURAL GAS, OIL

The Key Energy Challenges

Energy Access

Climate Change

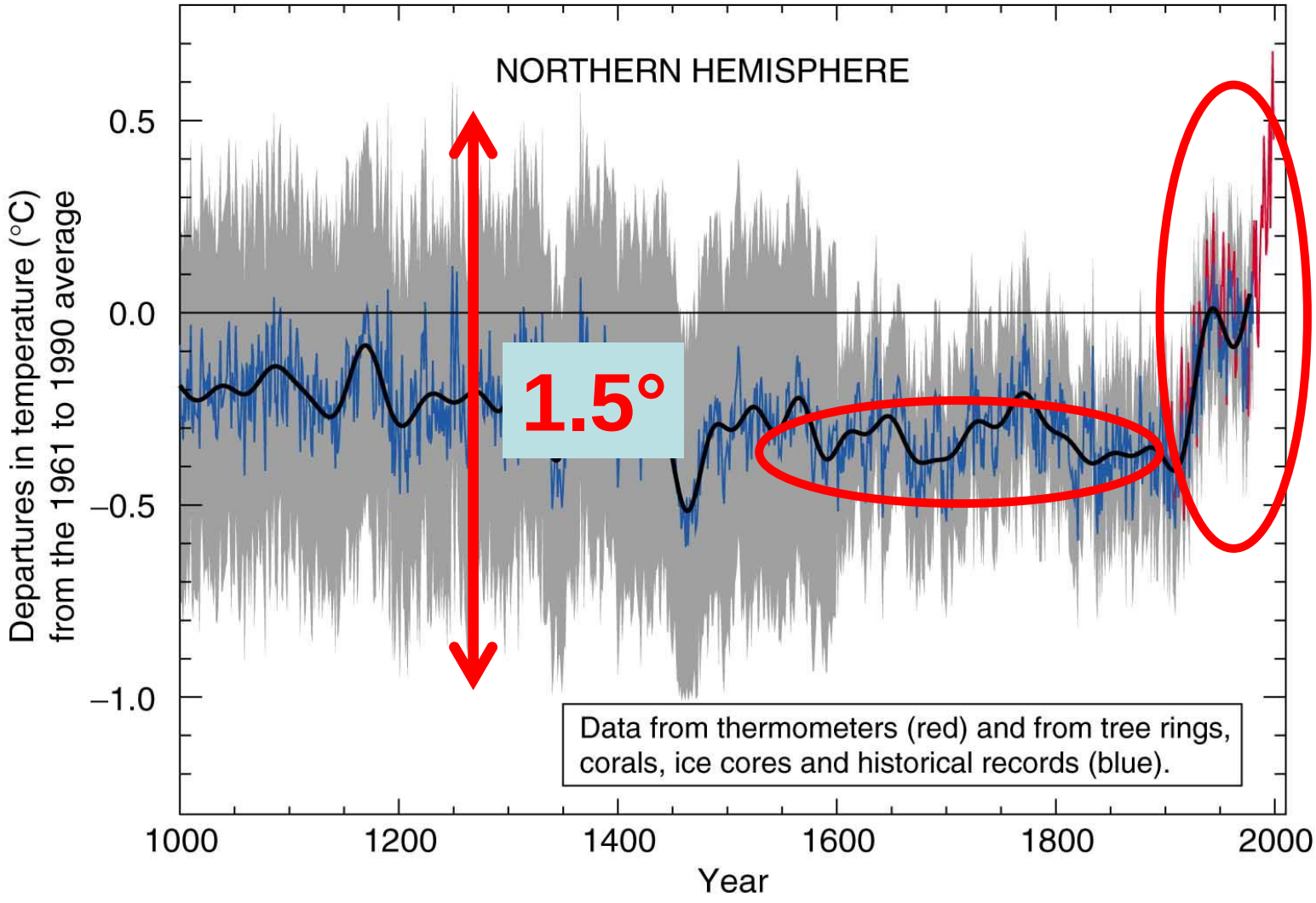
Air Pollution Health Impacts

Energy Security

Wood for Cooking

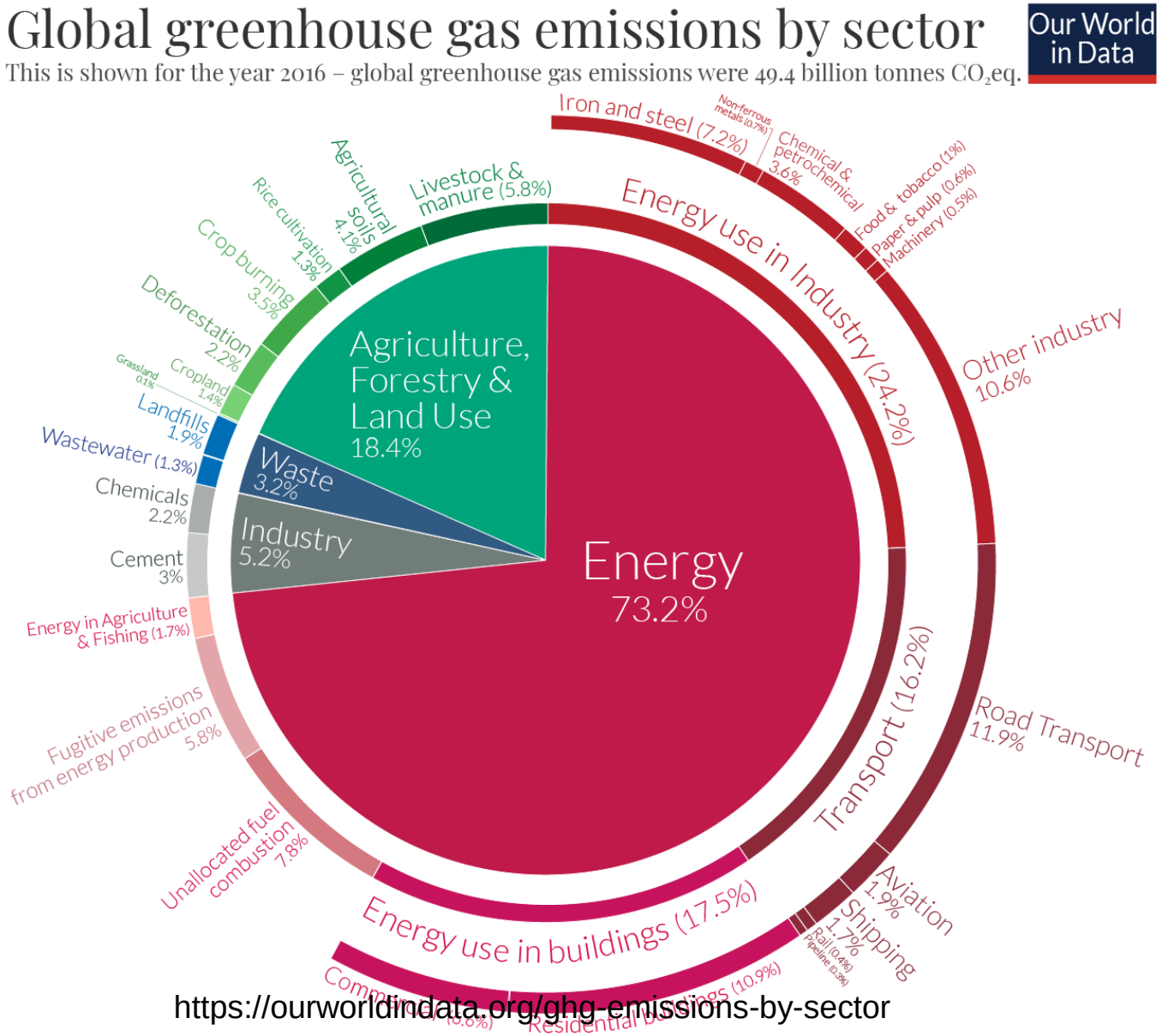
Source: Modi, 2011 and Yumkella, 2013

Long-term Variations of Earth's Surface temperature in the past 1000 years



Source: IPCC, 2001a

What does energy contribute to Global Warming?

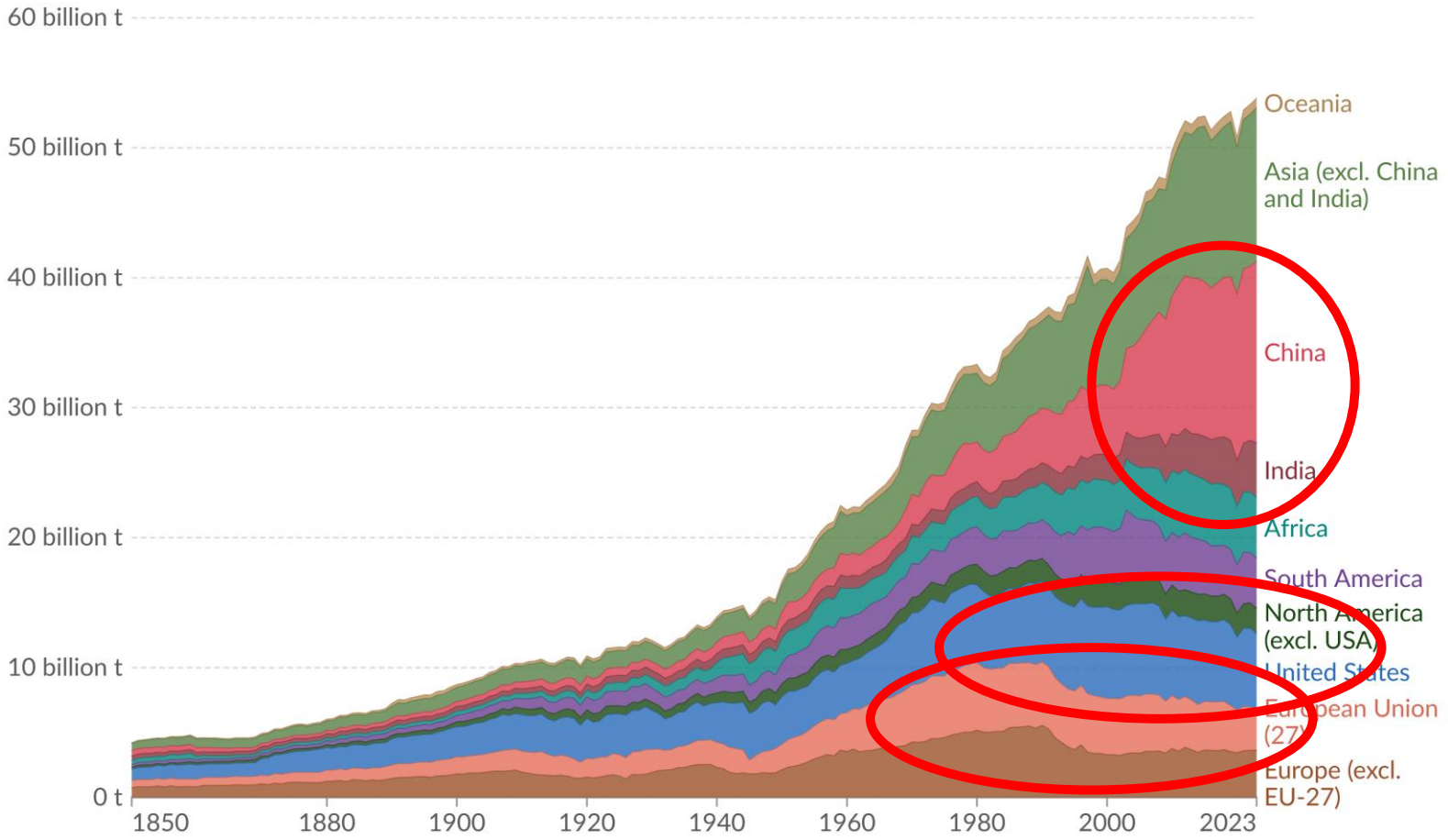


https://ourworldindata.org/ghg-emissions-by-sector

Annual greenhouse gas emissions by world region, 1850 to 2023

Our World in Data

Greenhouse gas emissions[1] include carbon dioxide, methane and nitrous oxide from all sources, including land-use change. They are measured in tonnes of carbon dioxide-equivalents[2] over a 100-year timescale.

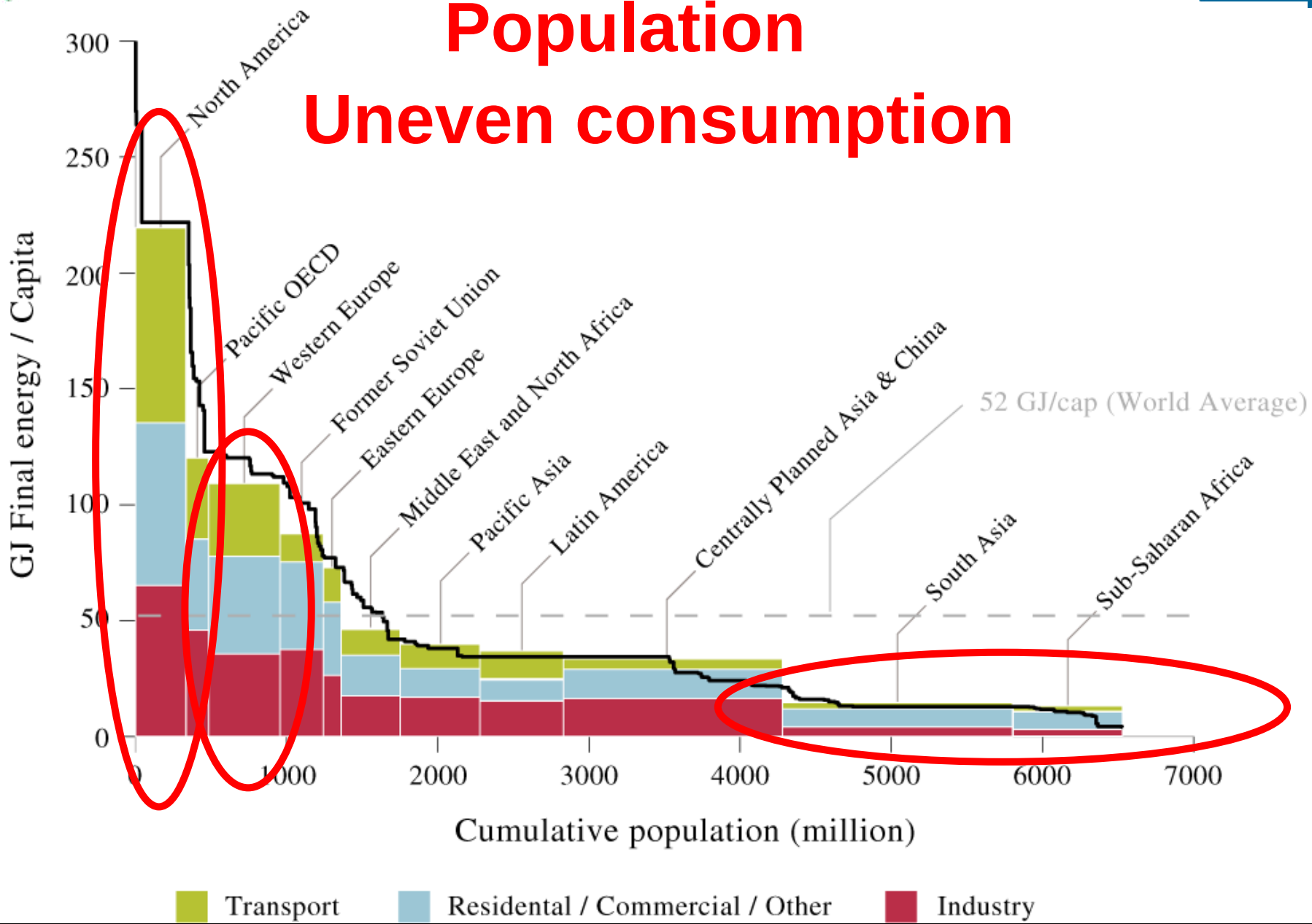


Data source: Jones et al. (2024)

OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY

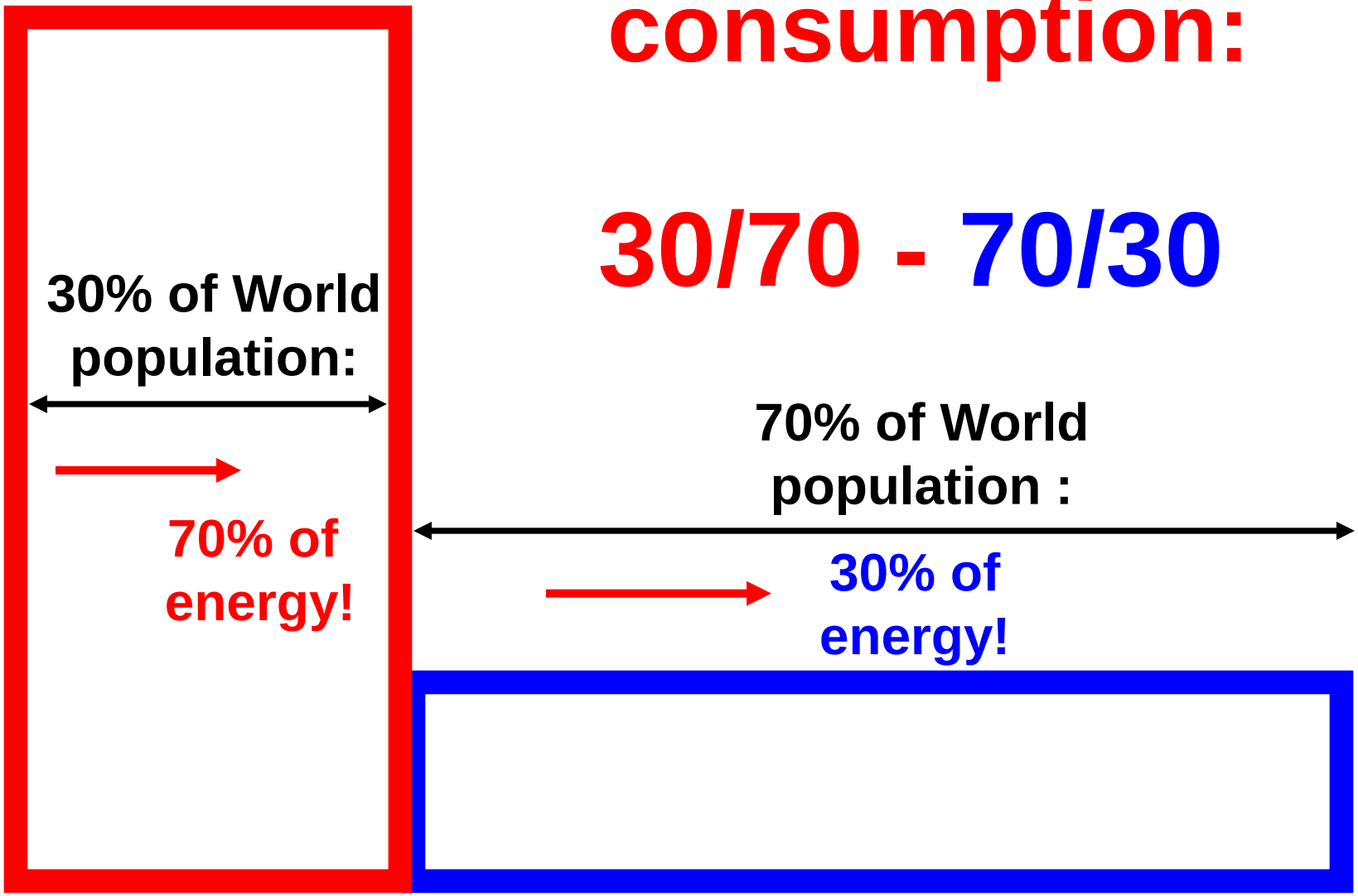
Per Capita Final Energy & Population

Uneven consumption

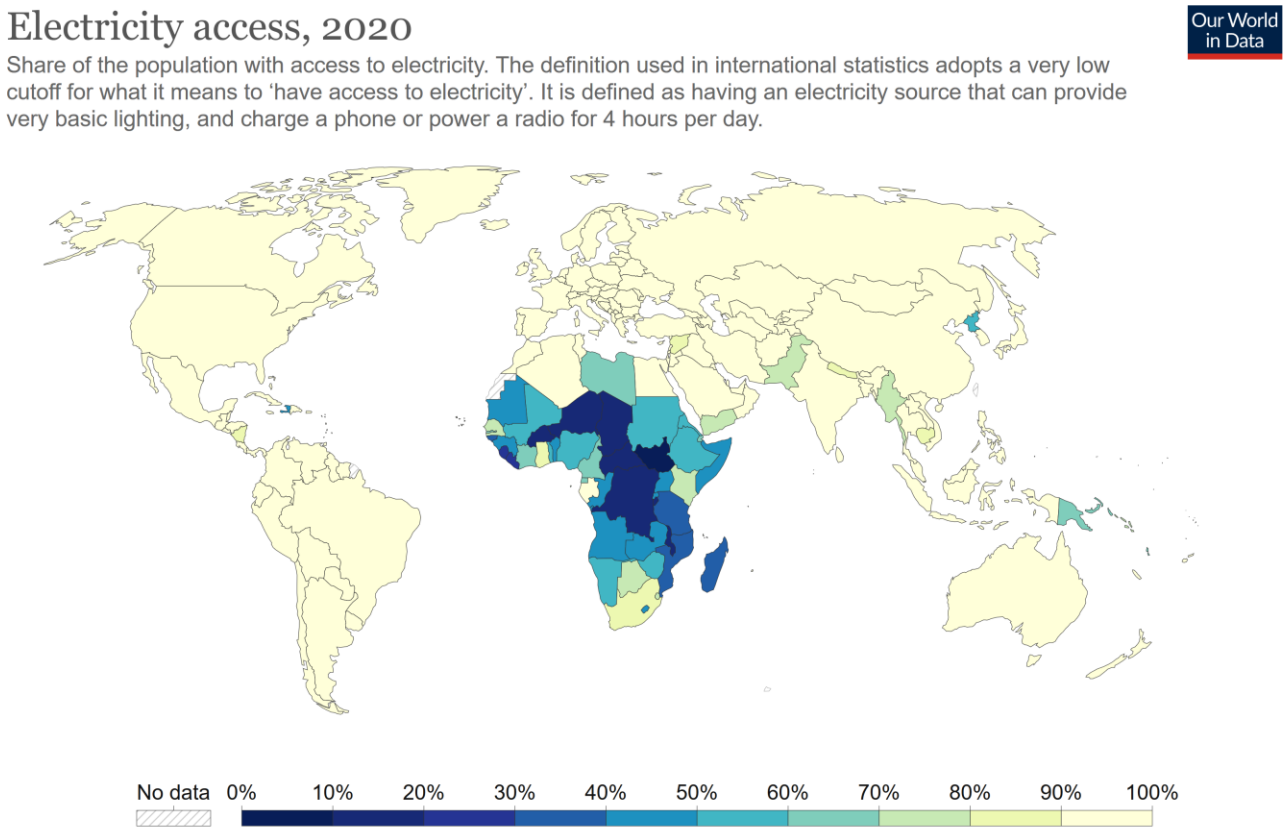


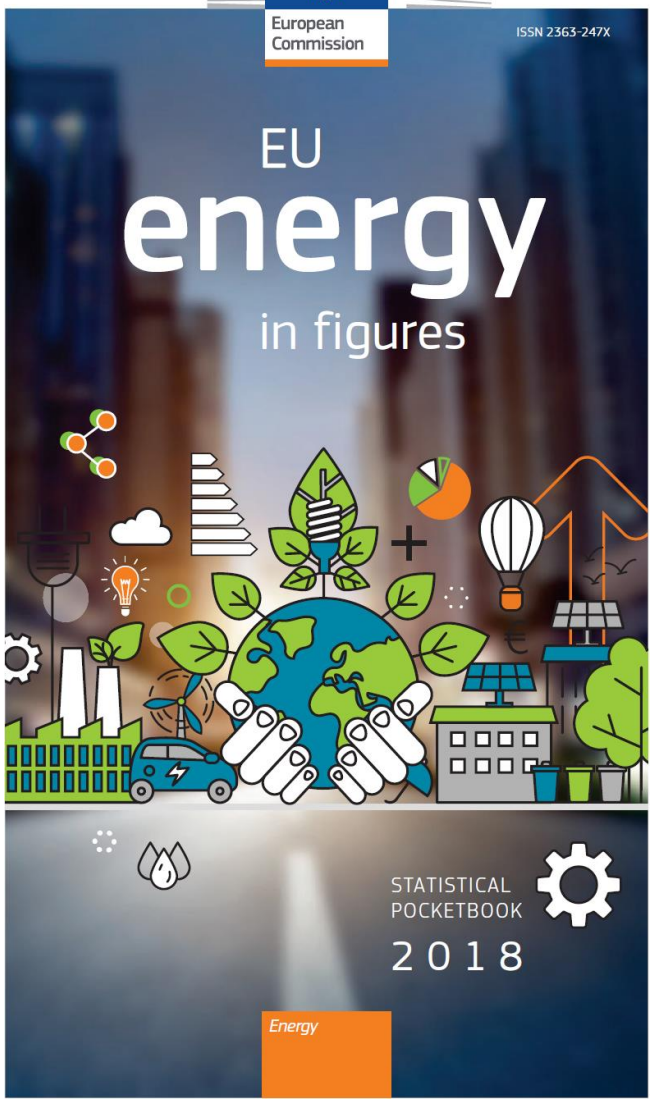
Uneven consumption:

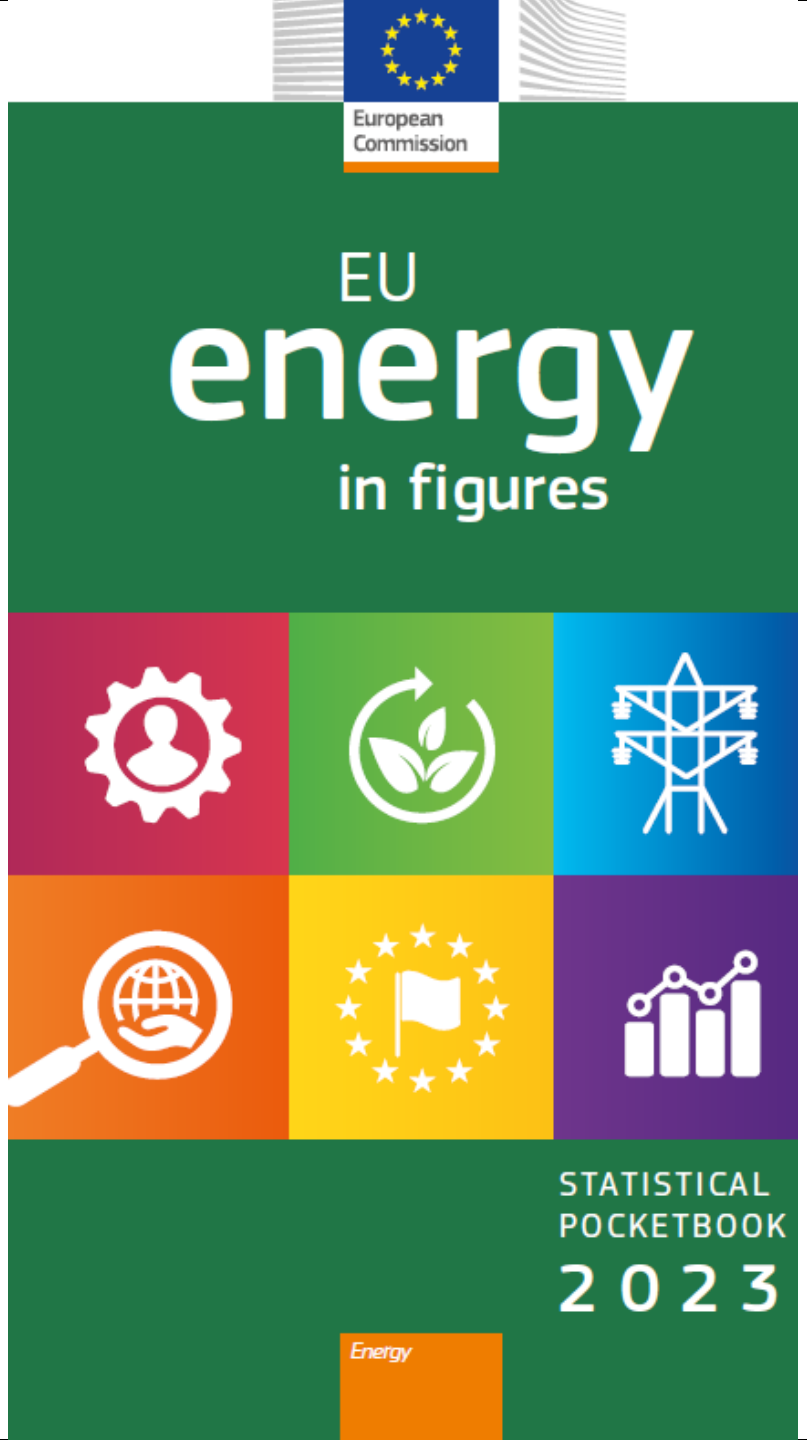
30/70 - 70/30



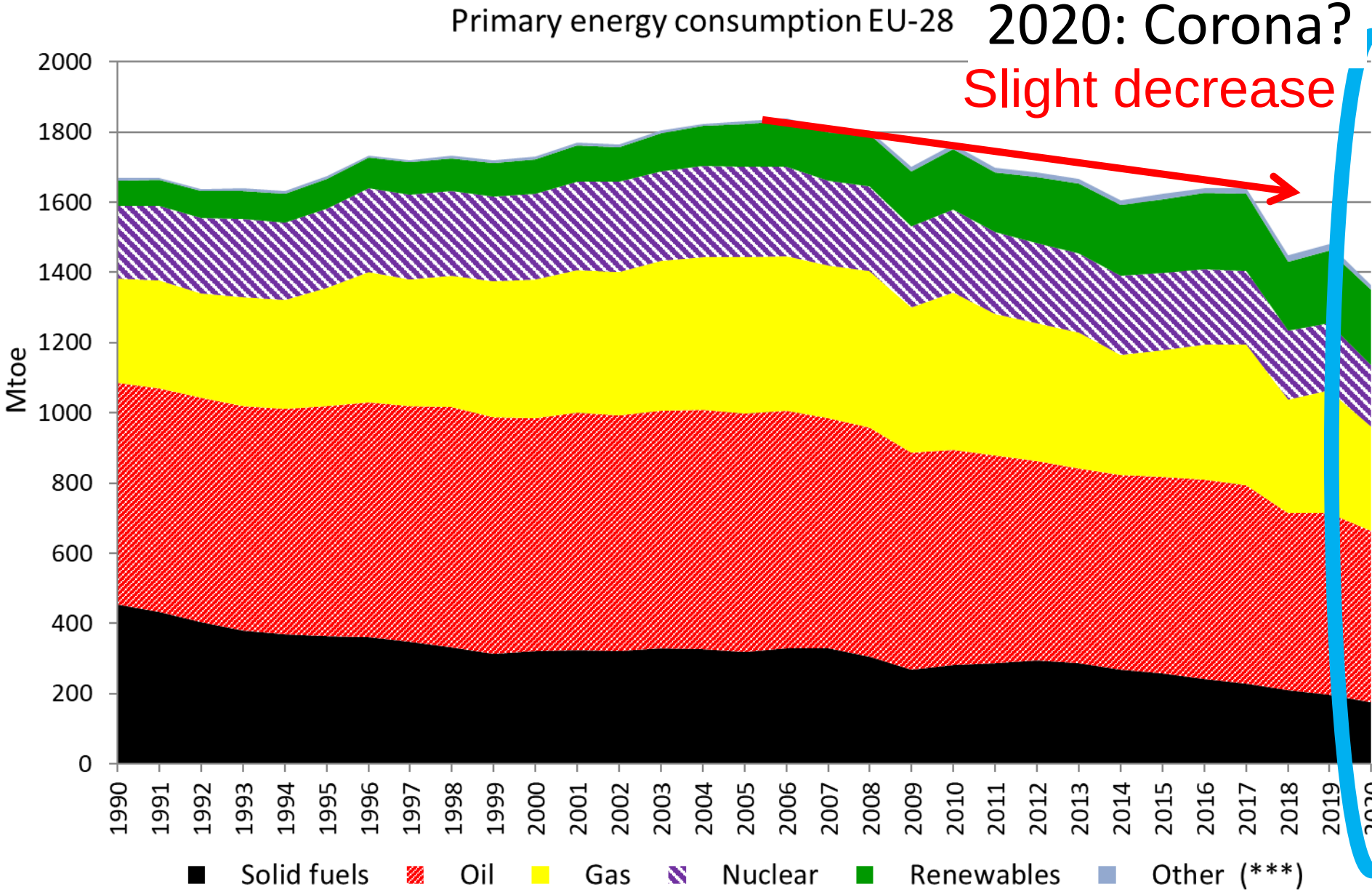
- **The issue of SEA: Sustainable energy access for all ? SDG … ?**



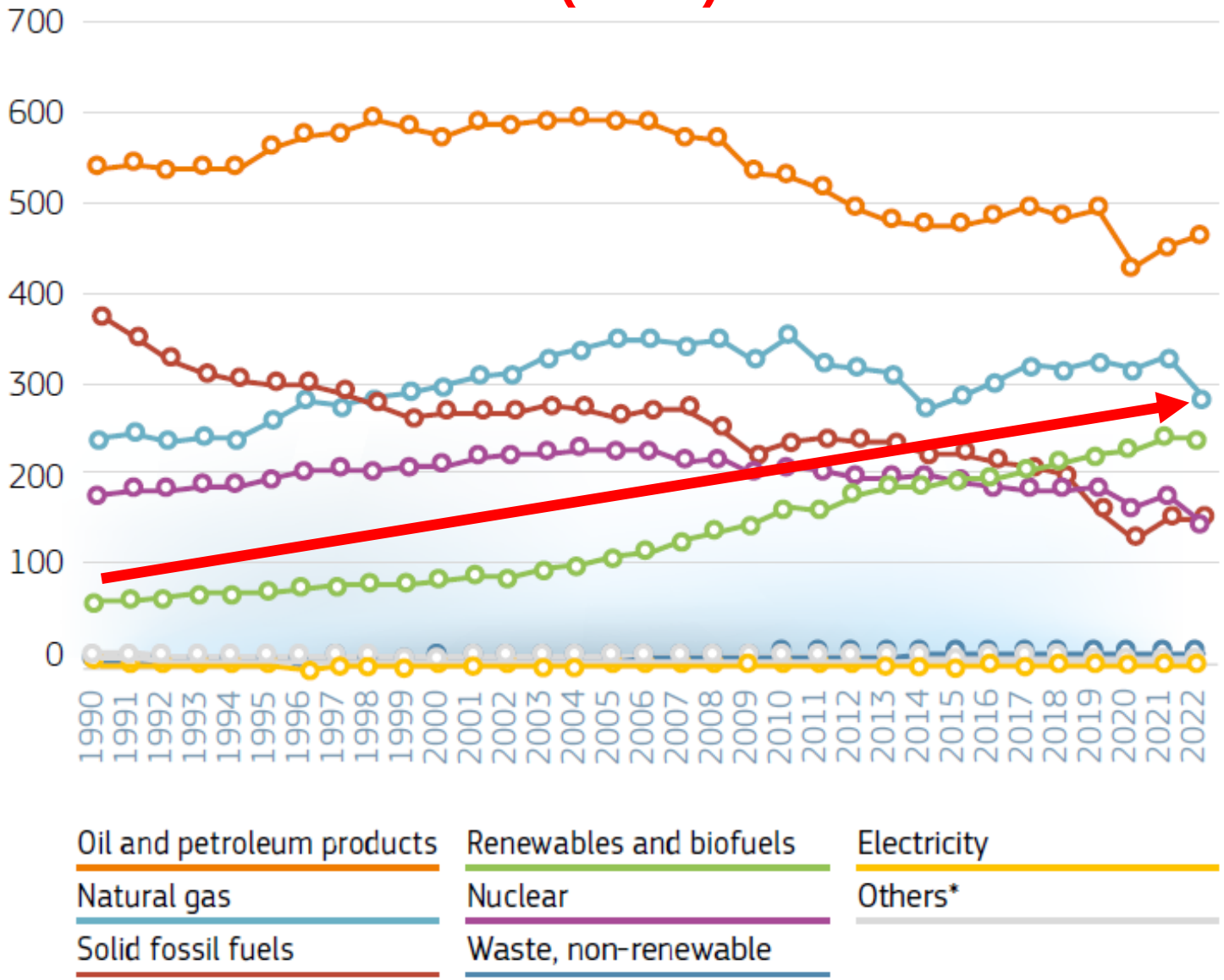

European Commission
ISSN 2363-247X
EU
energy
in figures
STATISTICAL
POCKETBOOK
2018
Energy


European Commission
EU
energy
in figures
STATISTICAL
POCKETBOOK
2023
Energy

Primary energy in Europe

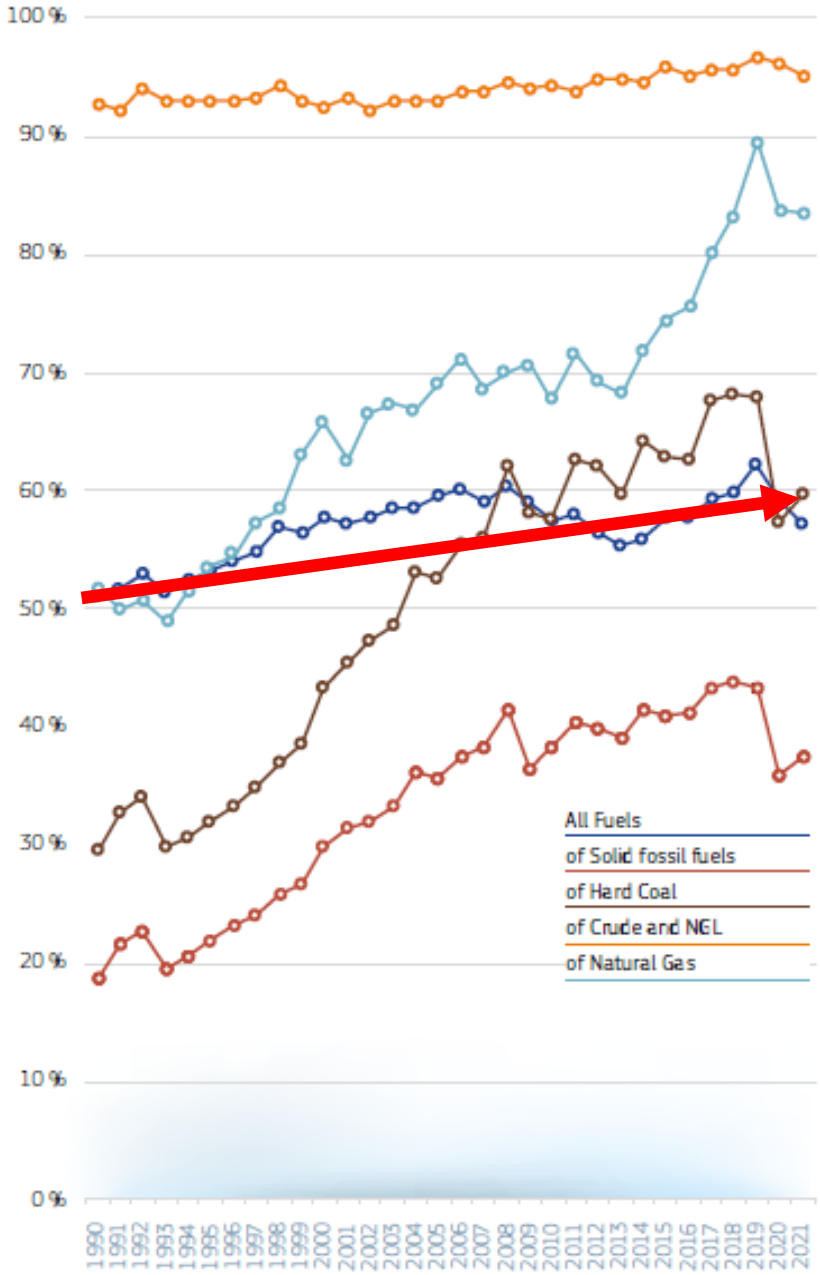


EU-27: Gross inland energy consumption (Mtoe)

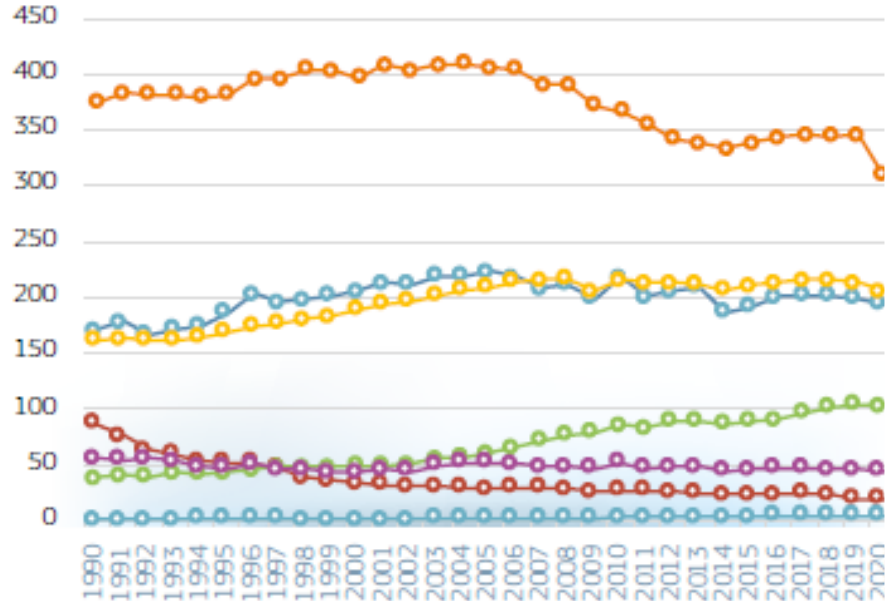


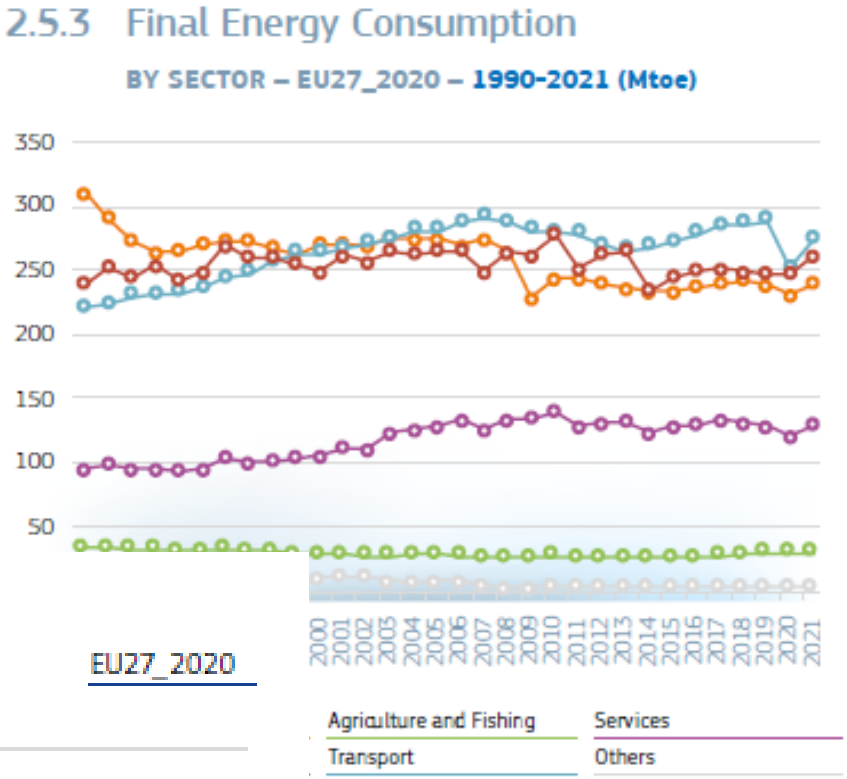
2.3.2 Import Dependency by Fuel

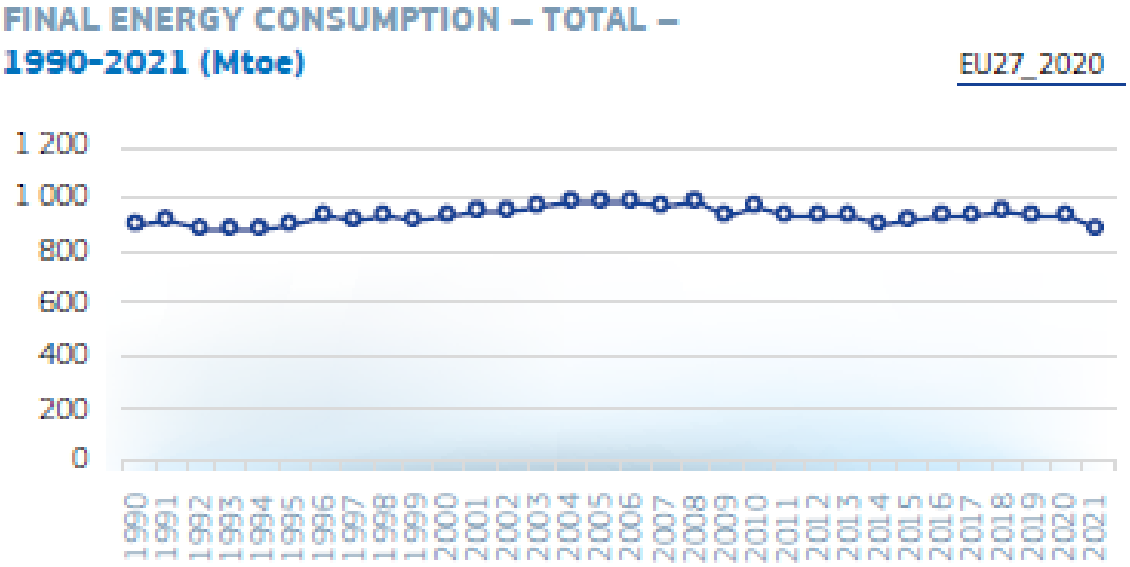
EU27_2020 – IMPORTS FROM EXTRA-EU – 1990-2021 (%)



Final energy EU-27

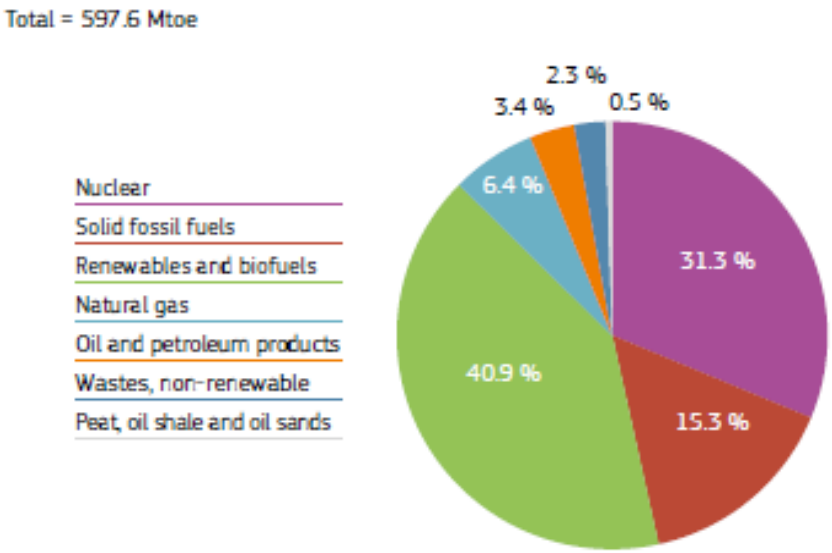






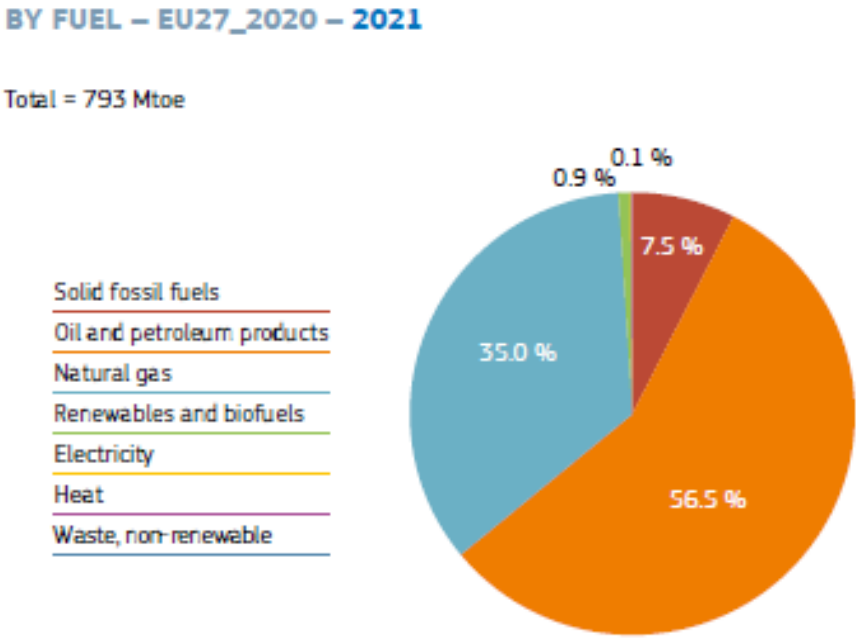
Primary Energy EU-28: origin of resources

Indigenous:



Total 2021: ca. 600 Mtoe

Imports:

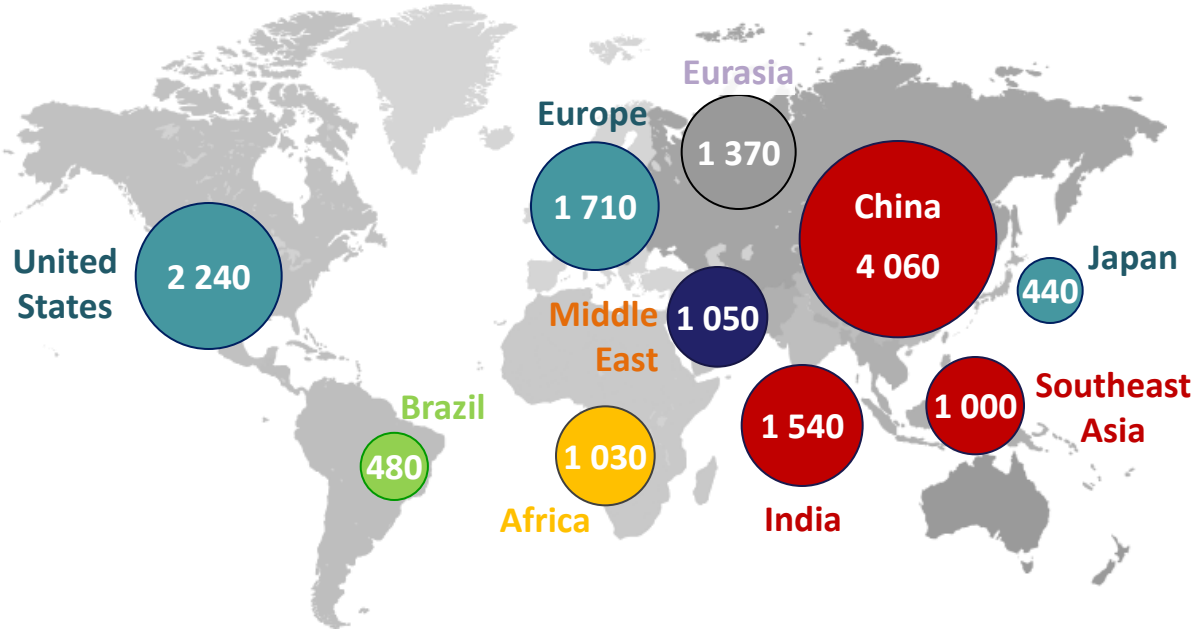


Total 2021: ca. 800 Mtoe

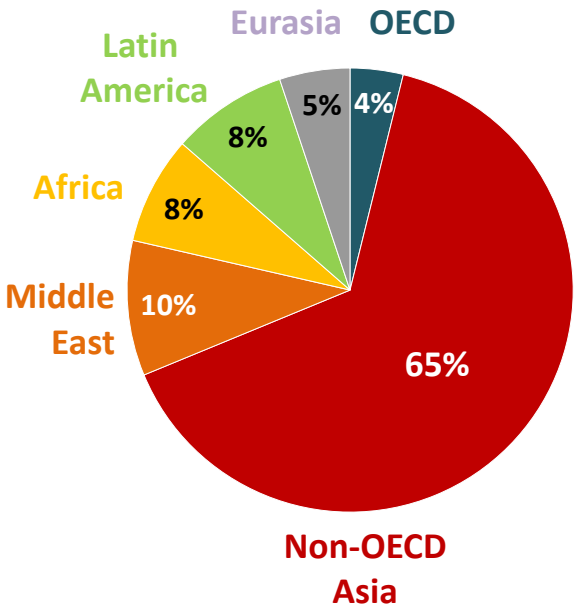
Source: EUROSTAT (2023)

WEO: The engine of energy demand growth moves to South Asia

Primary energy demand, 2035 (Mtoe)

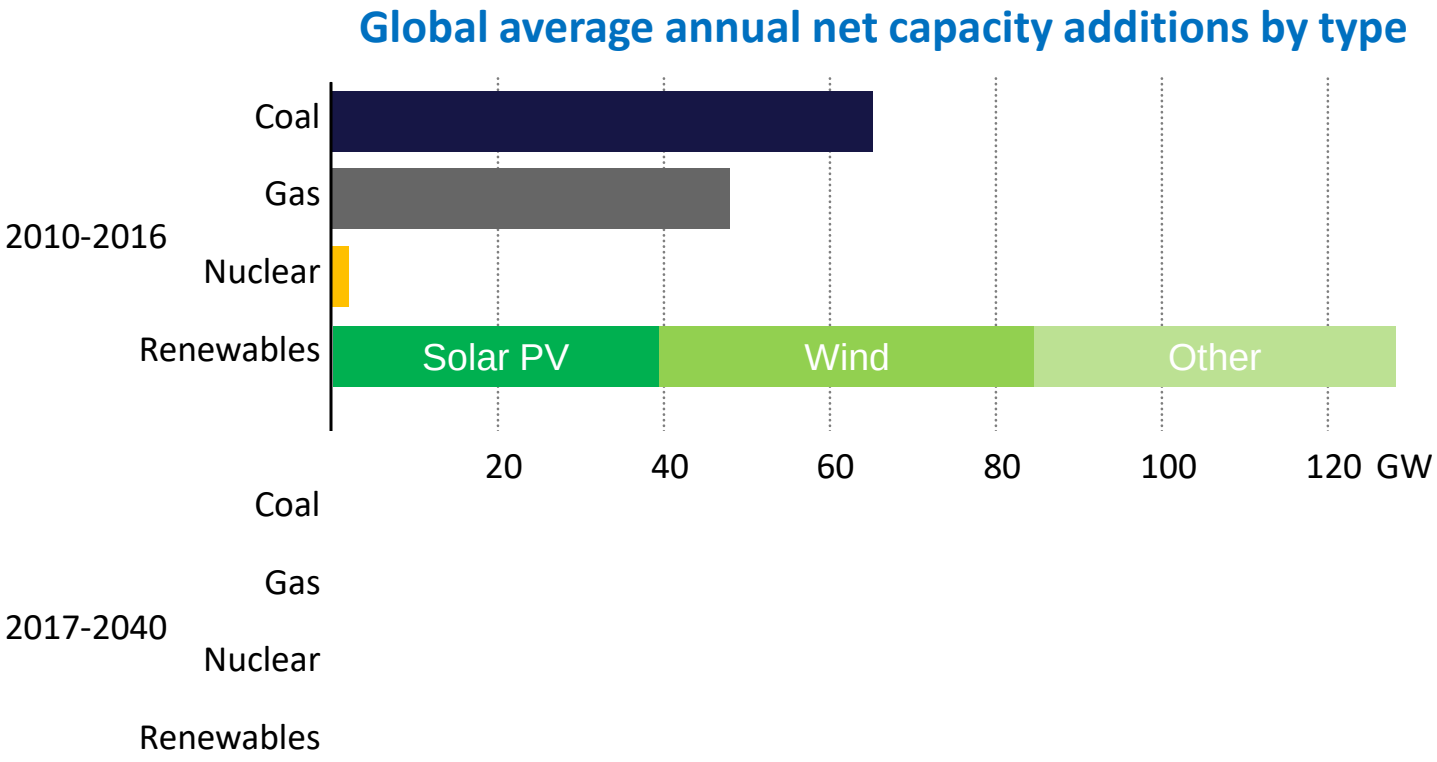


Share of global growth 2012-2035



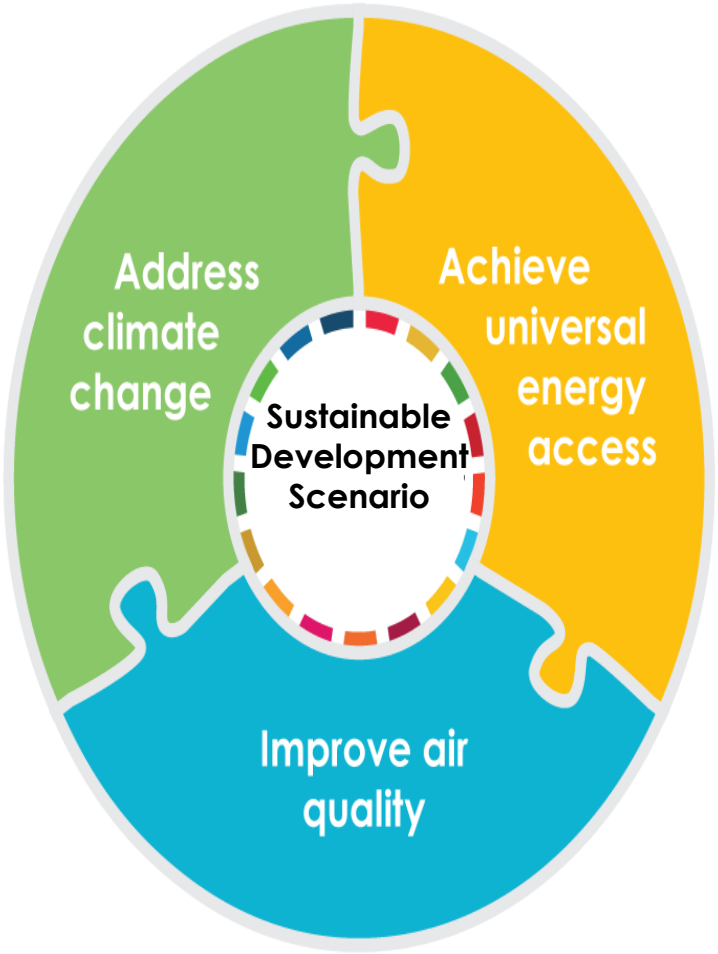
China is the main driver of increasing energy demand in the current decade, but India takes over in the 2020s as the principal source of growth

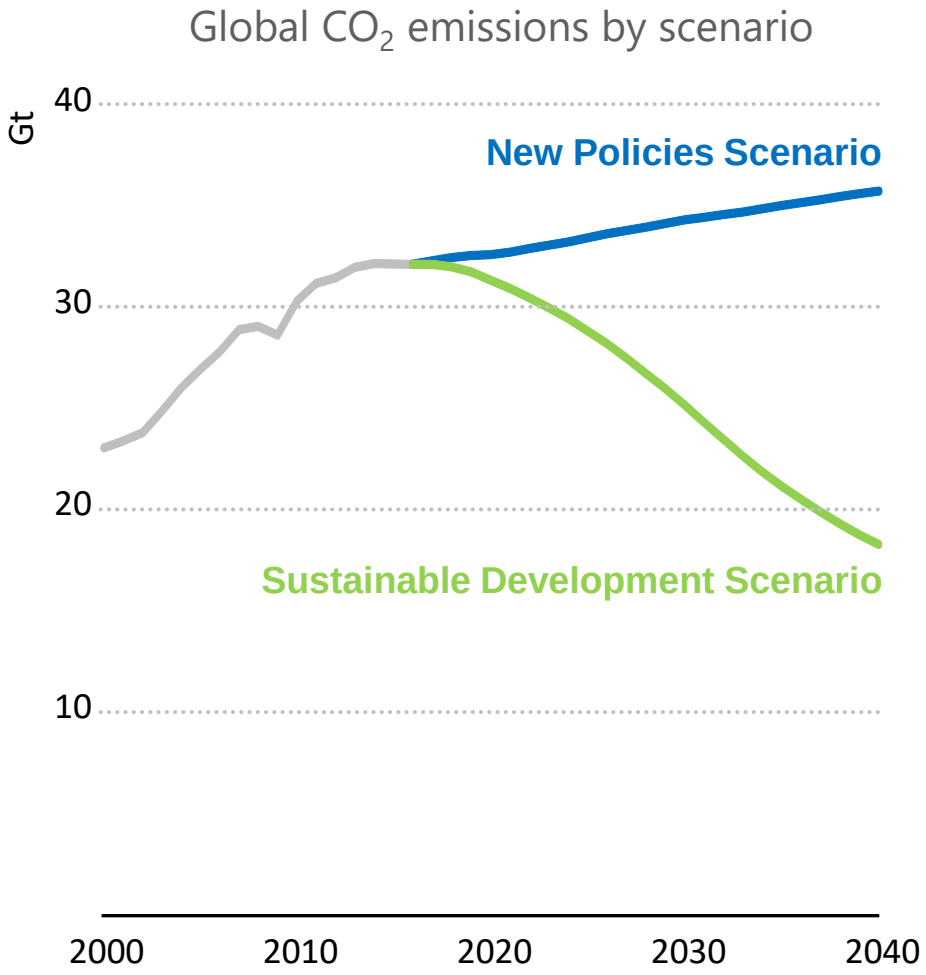
Solar PV forges ahead in the global power mix



China, India & the US lead the charge for solar PV, while Europe is a frontrunner for onshore & offshore wind: rising shares of solar & wind require more flexibility to match power demand & supply

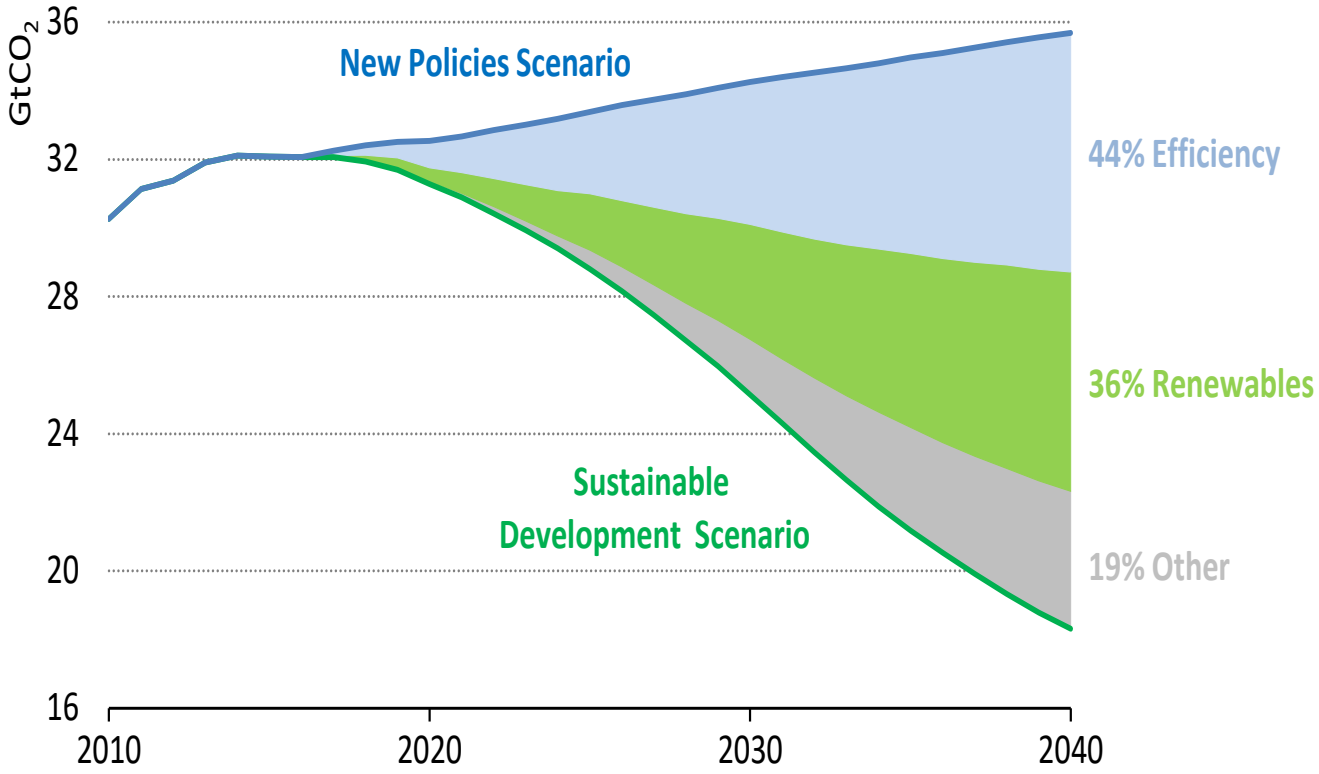
A new strategy for energy & sustainable development





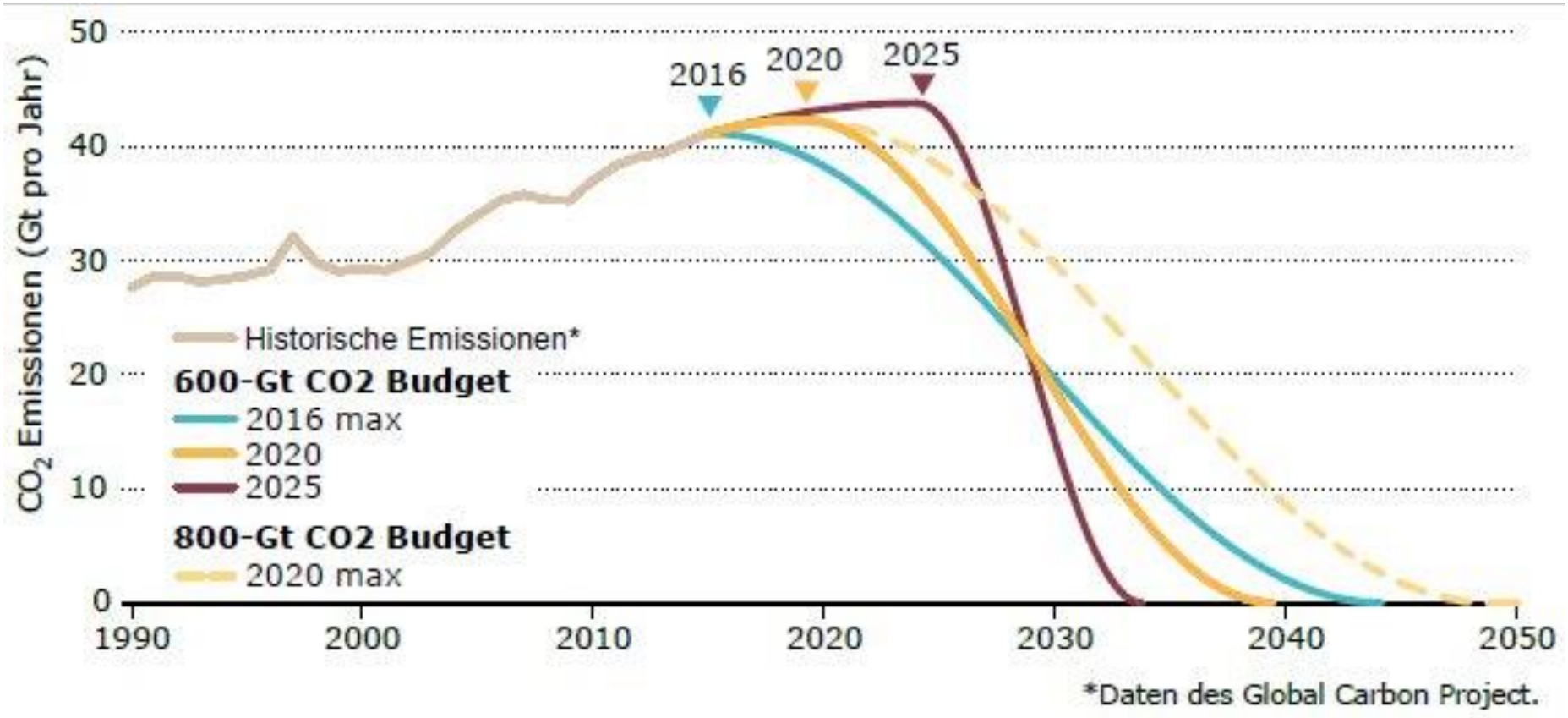
The Sustainable Development Scenario reduces CO_2 emissions in line with the objectives of the Paris Agreement, while also tackling air pollution and achieving universal energy access

Global energy-related CO2 emissions abatement and key contributions in the SDS



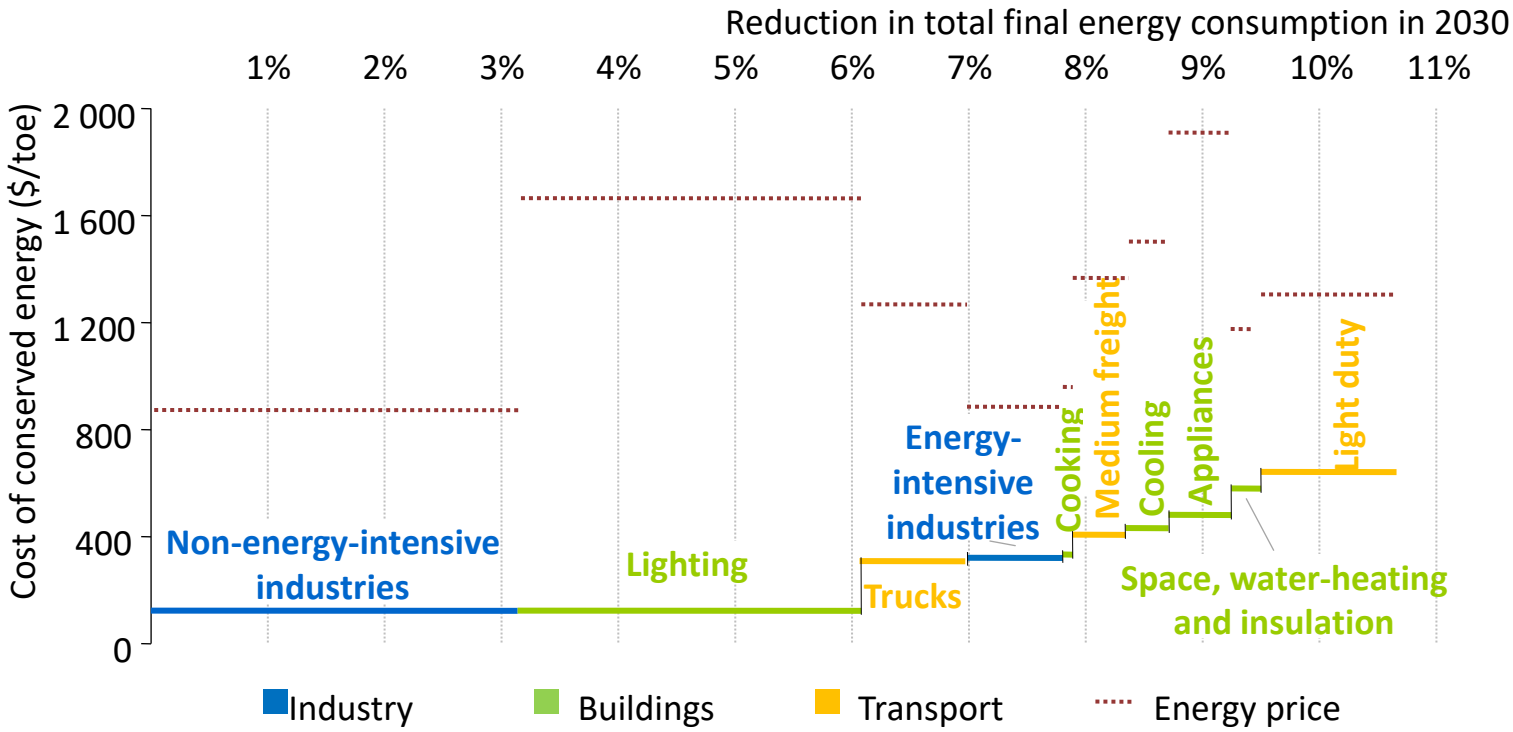
Energy efficiency and renewables are the two key abatement measures in the New Policies and Sustainable Development Scenarios

Scenarios CO2 budgets



Saving more energy is not necessarily expensive

Cost of conserved energy of the untapped global energy efficiency potential, 2030



On average, the cost of conserved energy of efficiency measures beyond the New Policies Scenario is only one-fifth of the respective energy price