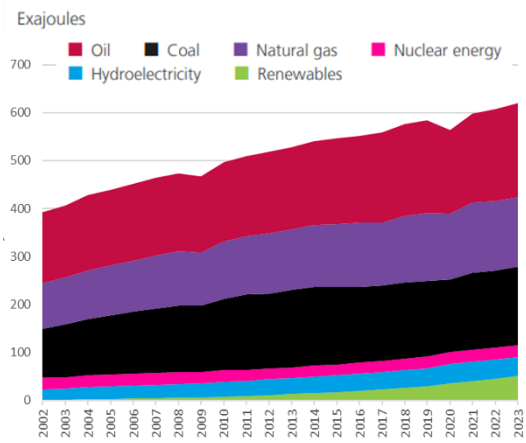
ENG-410 2025.07.02

Memento

Conversions

World Energy consumption (ExaJoules)



- 1kWh = 1000 W x 1 h = 3'600'000 J
- 1 Barrel of oil ≃ 159 liters of oil
- 1 BOE ≃ 6.1 GJ ≃ 1.7 MWh
- 1 TOE ≃ 41.9 GJ ≃ 11'630 kWh
- 1 BTU ≃ 1055 J ≃ 0.293 Wh
- Energy of 1 liter of oil ≃ Energy of 1m^3 of natural gas ≃ 11 kWh. Energy of 1kg of coal ≃ 8 kWh
- Burning 1 liter of oil → 2.3 kg of CO2. Burning 1m^3 of gas → 1.9 kg CO2. Burning 1kg of coal→ 2.6 kg of CO2.

Some orders of magnitude:

- Annual solar energy reaching earth's surface: 1'485'000 PWh = $5.346 \cdot 10^{24}$ J
- World population today: 8.2 billion people, including 4.8 billion Asian
- World annual primary energy consumption: 172 PWh or 172'000 TWh, or 619.2 EJ.
- World current yearly CO2 emission mass: 40 GT (Gigatons), and 57 GT with CO2equivalent
- Daily world oil demand: 103 million barrels or 167 TWh
- Per capita power consumption (permanent): from 100 Watt (Burundi) to > 10'000 W (e.g., USA, UAE)
- Per capita annual CO2 emission: 5 to 15 tons for industrialized countries
- CO2 emission for transport, heating and electricity generation: 70% of total CO2 emission
- Swiss Per capita annual CO2 emission: 4.5 tons (Production based), 14 tons (consumption based)
- Swiss annual electricity consumption: 60 TWh, ~ 25% of the final consumption (rest mostly fossil)
- Efficiency of nuclear, coal, oil power plants: Typical ~ 30-33%, supercritical coal 40-45% (rare)
- Gas power plant efficiency: ~40-45% up to 60% for CC power plant (rare)
- Other emissions "equivalent CO2": ~11-15 GT (Methane + Nitrous oxides + other gases)
- Price of oil in 2024: ≃ 60-80 $ / barrel
- Typical EU market gas price 2024: 30-40 $/MWh
- Typical coal price 2024: 90-120 $/ton
- Typical marginal kWh cost of burning coal: 3-4 cts/kWh without CO2 tax
- LCOE of large solar or wind parks: 2-5 cts/kWh (n.b. offshore wind costs more)
- LCOE of electricity from new fossil plants: 5-10 cts/kWh (estimates) without CO2 taxes
- Car Battery pack cost in 2025: ~100 $/kWh
- New Renewable electricity (outside hydro) produced in 2023: 4'700 TWh (2'304 wind, 1'629 solar, 767 other), around 10% of total electricity production (0 TWh in 1995). (Data from chart Electricity production by source, World (ourworldindata.org))
- Typical good CO2 emission per capacity: 200gCO2/W for wind turbines, 300g CO2/W for solar panels

Definitions

- LCOE: The average net present cost of energy (electricity) generation for a generating plant over its lifetime (including construction, maintenance, operation, interest etc.). Calculated in $Price$/Energy.
- In BP reports, the electricity production from renewables translates into primary energy consumption multiplied by a factor of 1/0.41 (substitution method). This results in primary energy consumption showing over 80% fossil fuels share, including 27% coal.
- The Swiss energy statistics based on IEA or on the Swiss Federal office for energy apply a factor of 1/0.33 for Primary Nuclear energy and of 1 for non-thermal renewable sources (e.g., Hydro, wind, solar).
- The temperature around the globe since civilization development varied of ± 0.5°C until 1900. Nowadays, business as usual scenarios lead to a rise of +3.5 to +7°C in temperature by the end of the century. With current emission rate, we have roughly 4 years left for the 1.5°C scenarios, and 21 years for the 2° scenarios.