

Chapitre III

Consommations, reserves and developments of energy resources

III.1. World energy consumption

World energy supply and consumption refers to the global supply of energy resources and its consumption. The system of global energy supply consists of the energy development, refinement, and trade of energy. Energy supplies may exist in various forms such as *raw resources* or *more processed and refined* forms of energy. The raw energy resources include for example coal, **unprocessed oil & gas**, **uranium**. In comparison, the refined forms of energy include for example refined oil that becomes fuel and electricity. Energy resources may be used in various different ways, depending on the specific resource (e.g. coal), and intended end use (industrial, residential, etc.). Energy production and consumption play a significant role in the global economy. It is needed in industry and global transportation. The total energy supply chain, from production to final consumption, involves many activities that cause a loss of useful energy.

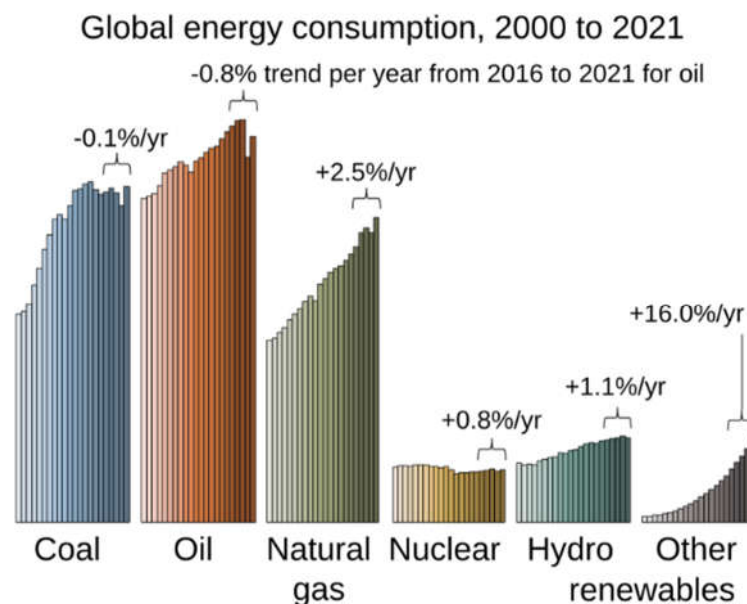


Fig. 1 Global energy consumption, measured in exajoules per year: **Coal, oil, and natural gas** remain the primary global energy sources even as renewables have begun rapidly increasing.

As of 2022, energy consumption is still **about 80% from fossil fuels**. The Gulf States and Russia are major energy exporters. Their customers include for example the European Union and China, who are not producing enough energy in their own countries to satisfy their energy demand. Total energy consumption tends to increase by about 1–2% per year. More recently, renewable energy has been growing rapidly, averaging about 20% increase per year in the 2010s.

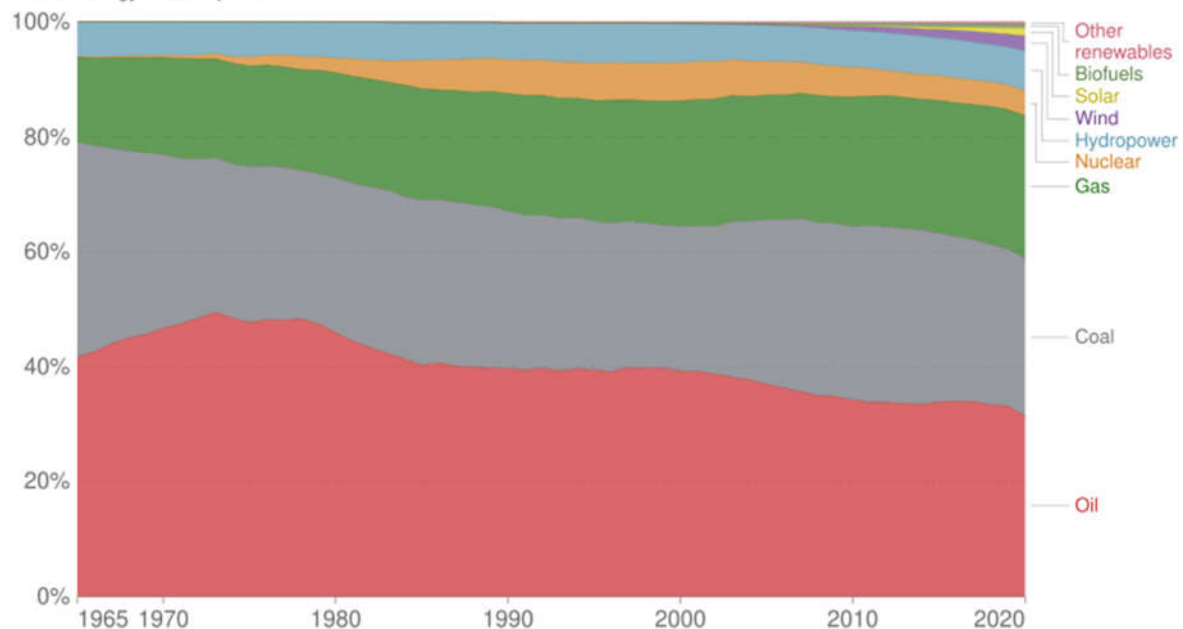
Two key problems with energy production and consumption are greenhouse gas emissions and environmental pollution. Of about 50 billion tonnes worldwide annual total greenhouse gas emissions, 36 billion tonnes of carbon dioxide was a result of energy use (almost all from fossil fuels) in 2021. Many scenarios have been envisioned to reduce greenhouse gas emissions, usually by the name of net zero emissions.

There is a clear connection between energy consumption per capita, and (**Gross Domestic Product**) GDP per capita.

A significant lack of energy supplies is called an energy crisis.

Energy consumption by source, World

Primary energy consumption is measured in terawatt-hours (TWh). Here an inefficiency factor (the 'substitution' method) has been applied for fossil fuels, meaning the shares by each energy source give a better approximation of final energy consumption.



Source: BP Statistical Review of World Energy

Note: 'Other renewables' includes geothermal, biomass and waste energy.

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Fig. 2. Primary energy consumption by source (worldwide) from 1965 to 2020

III.1 Primary energy production

Primary Energy refers to first form of energy encountered, as raw resources collected directly from energy production, before any conversion or transformation of the energy occurs.

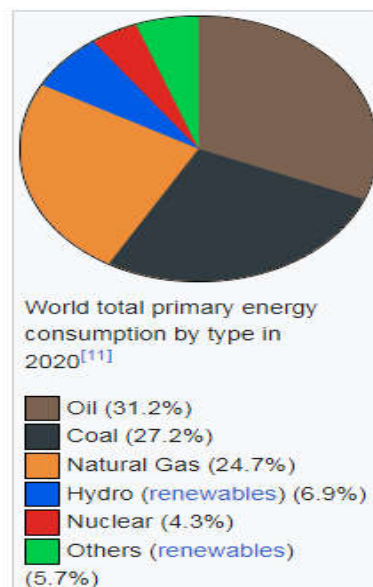
Energy production is usually classified as:

Fossil, using coal, crude oil, and natural gas;

Nuclear, using uranium;

Renewable, using **biomass, geothermal, hydropower, solar, wind, tidal, wave, among others.**

Primary energy assessment by IEA (International *Energy Agency*) follows certain rules to ease measurement of different kinds of energy. These rules are controversial. Water and air flow energy that drives hydro and wind turbines, and sunlight that powers solar panels, are not taken as PE, which is set at the electric energy produced. But fossil and nuclear energy are set at the reaction heat, which is about three times the electric energy. This measurement difference can lead to underestimating the economic contribution of renewable energy.



Enerdata (*Enerdata is an independent research company that specialises in the analysis and forecasting of energy and climate issues.*) displays data for "Total energy / production: Coal, Oil, Gas, Biomass, Heat and Electricity" and for "Renewables / % in electricity production: Renewables, non-renewables".

The table lists worldwide PE and the countries producing most (76%) of that in 2021, using Enerdata. The amounts are rounded and given in million tonnes of oil equivalent per year (1 Mtoe = 11.63 TWh (41.9 petajoules), where 1 TWh = 109 kWh) and % of Total. Renewable is Biomass plus Heat plus renewable percentage of Electricity production (hydro, wind, solar). Nuclear is nonrenewable percentage of Electricity production. The above-mentioned underestimation of hydro, wind and solar energy, compared to nuclear and fossil energy, applies also to Enerdata.

The 2021 world total energy production of 14,800 MToe corresponds to a little over 172 PWh / year, or about 19.6 TW of power generation.

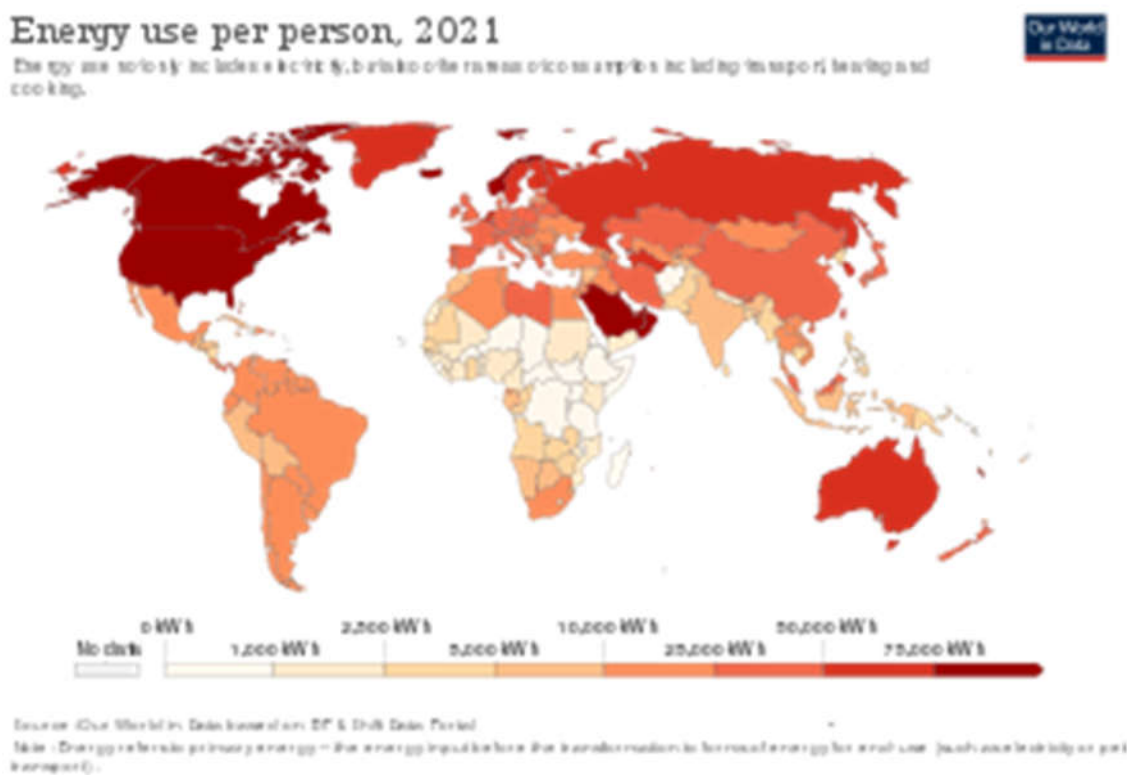


Fig. 4. World map with primary energy use per person in 2021

Largest Primary Energy producers (76% of world production) as of 2021, given in million tonnes of oil equivalent per year

	Total (MToe)	Coal	Oil & Gas	Renewable	Nuclear
China	2,950	71%	13%	10%	6%
United States	2,210	13%	69%	8%	10%
Russia	1,516	16%	78%	2%	4%
Saudi Arabia	610	0	100%	0	0
Iran	354	0	99%	0	1%
United Arab Emirates	218	0	99%	0	1%
India	615	50%	11%	33%	6%
Canada	536	5%	81%	10%	4%
Indonesia	451	69%	17%	14%	0
Australia	423	64%	33%	3%	0
Brazil	325	1%	55%	42%	2%
Nigeria	249	0	47%	53%	0
Algeria	150	0	100%	0	0
South Africa	151	91%	1%	8%	0
Norway	214	0	93%	7%	0
France	128	0	1%	34%	65%
Germany	102	27%	3%	47%	23%
World	14800	27%	53%	13%	7%

III.4. Evolution of global energy demand

The factors that weigh on the evolution of energy demand in the world are:

- The increase in the world population "9 to 10 billion inhabitants by 2050",
- the efforts of **developing countries** to fill their economic gap "growth of 8 to 10% in China and India",
- The maintenance of a slight growth in energy demand in **developed countries**, the demand for primary energy continues to grow but its geographical distribution is changing.