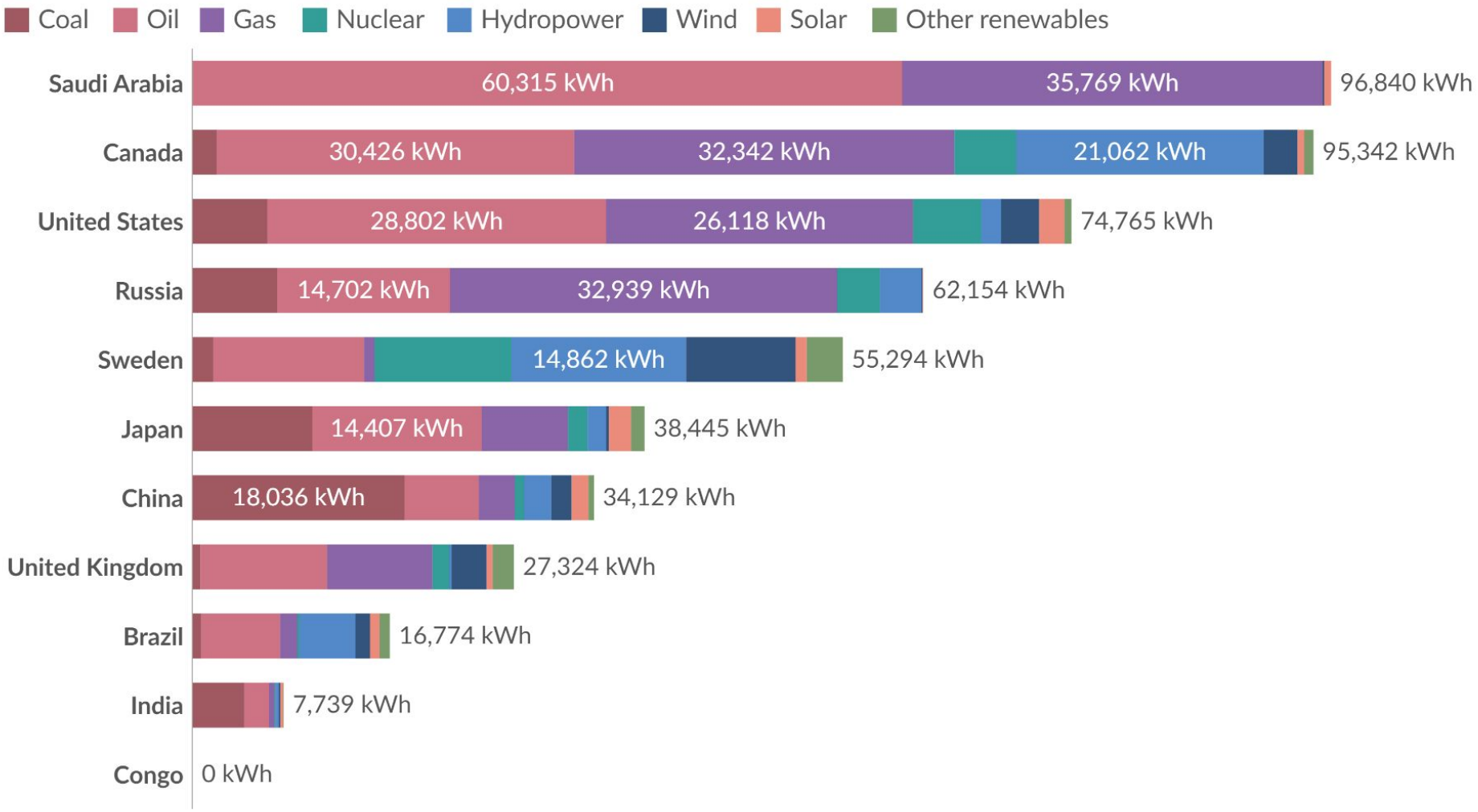
Energy Fundamentals

Per capita primary energy consumption by source, 2024

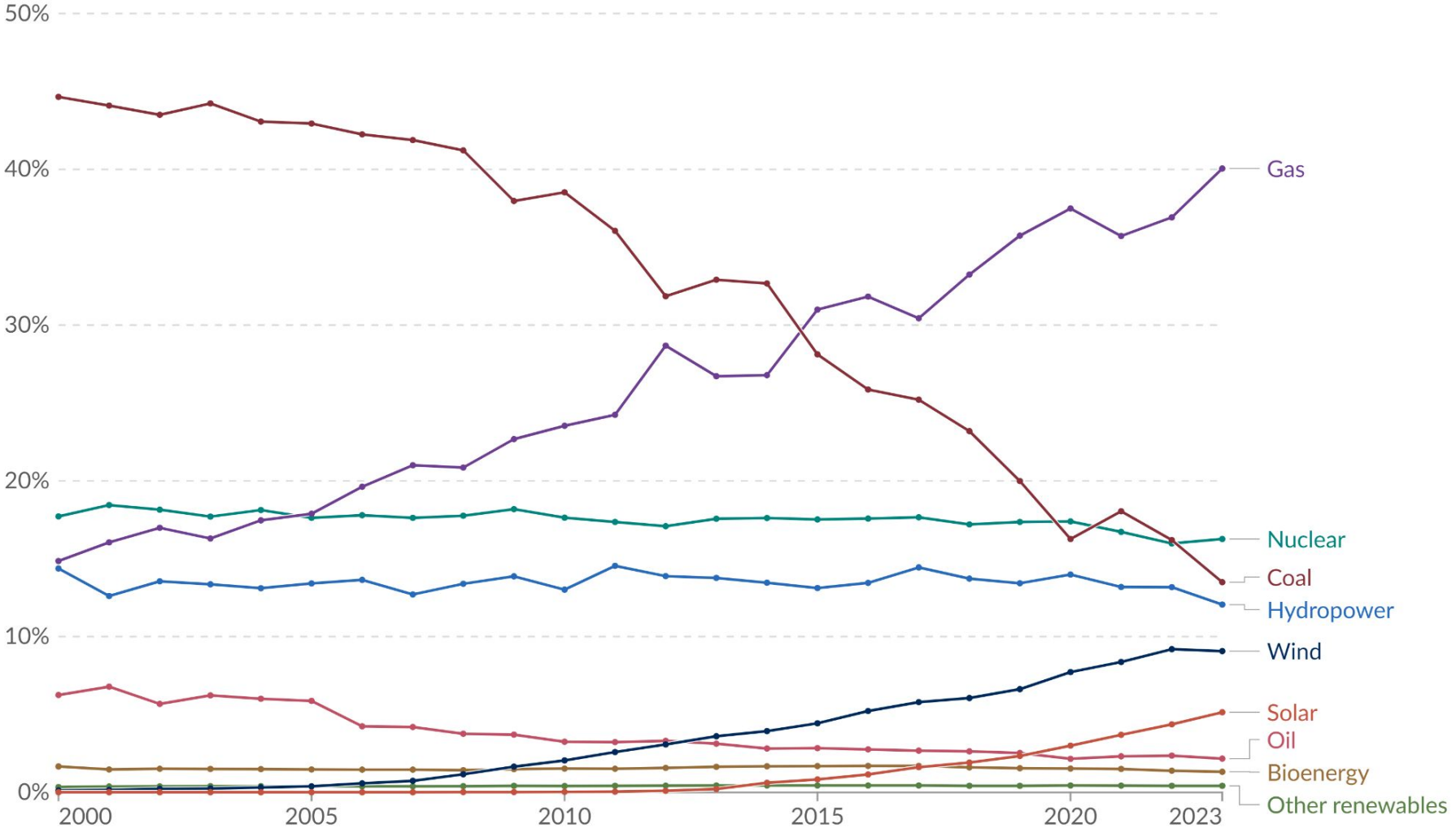
Our World in Data

Primary energy[1] is measured in kilowatt-hours[2] per person, using the substitution method[3].



Data source: Energy Institute - Statistical Review of World Energy (2025); Population based on various sources (2024)

Share of electricity production by source, North America

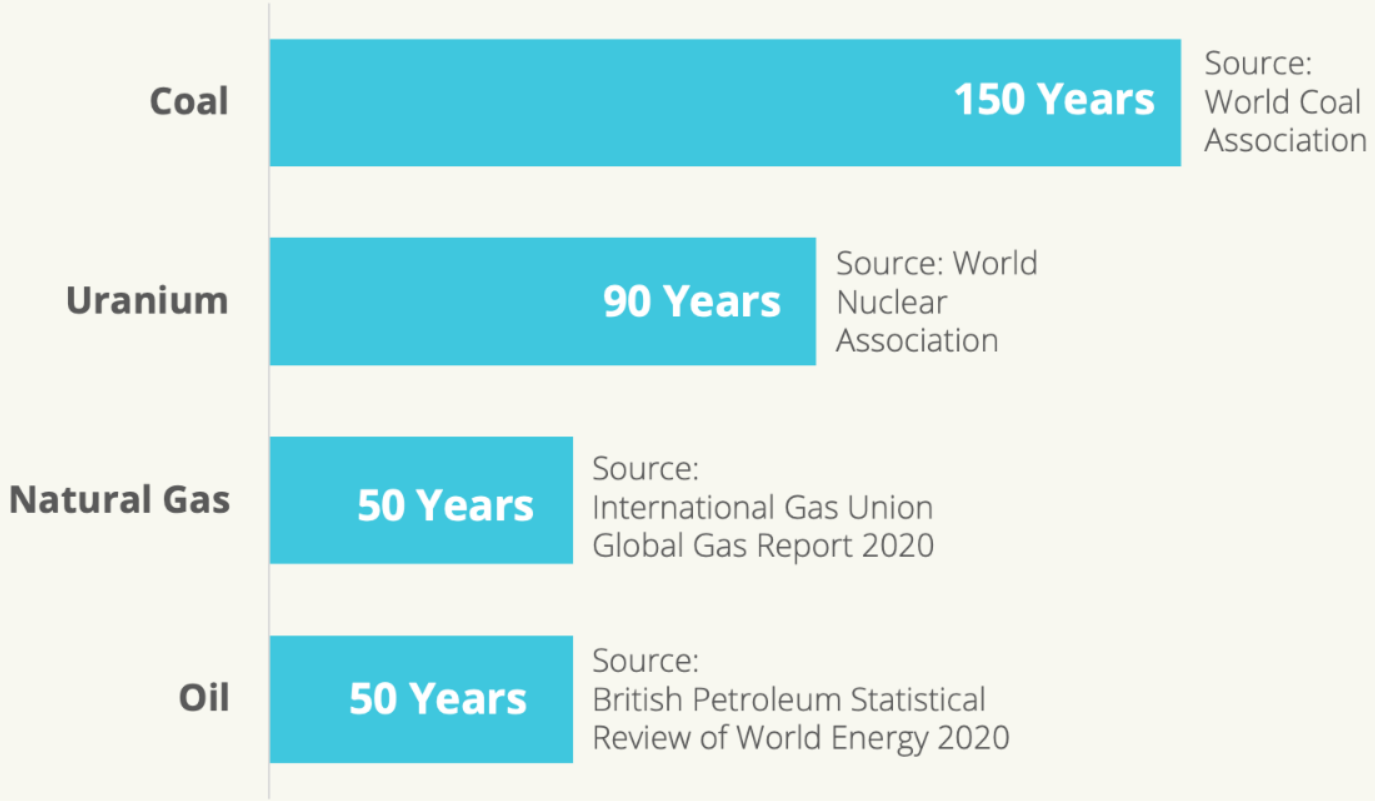


Data source: Ember (2026); Energy Institute - Statistical Review of World Energy (2025)

OurWorldinData.org/energy | CC BY

Note: "Other renewables" include geothermal, wave, and tidal.

Industry estimates of economically viable fossil fuel reserves



FREEING ENERGY

The SI unit of energy is Joule and its commercial unit is kWh.

The relationship between 1 kWh and SI unit of energy is as follows:

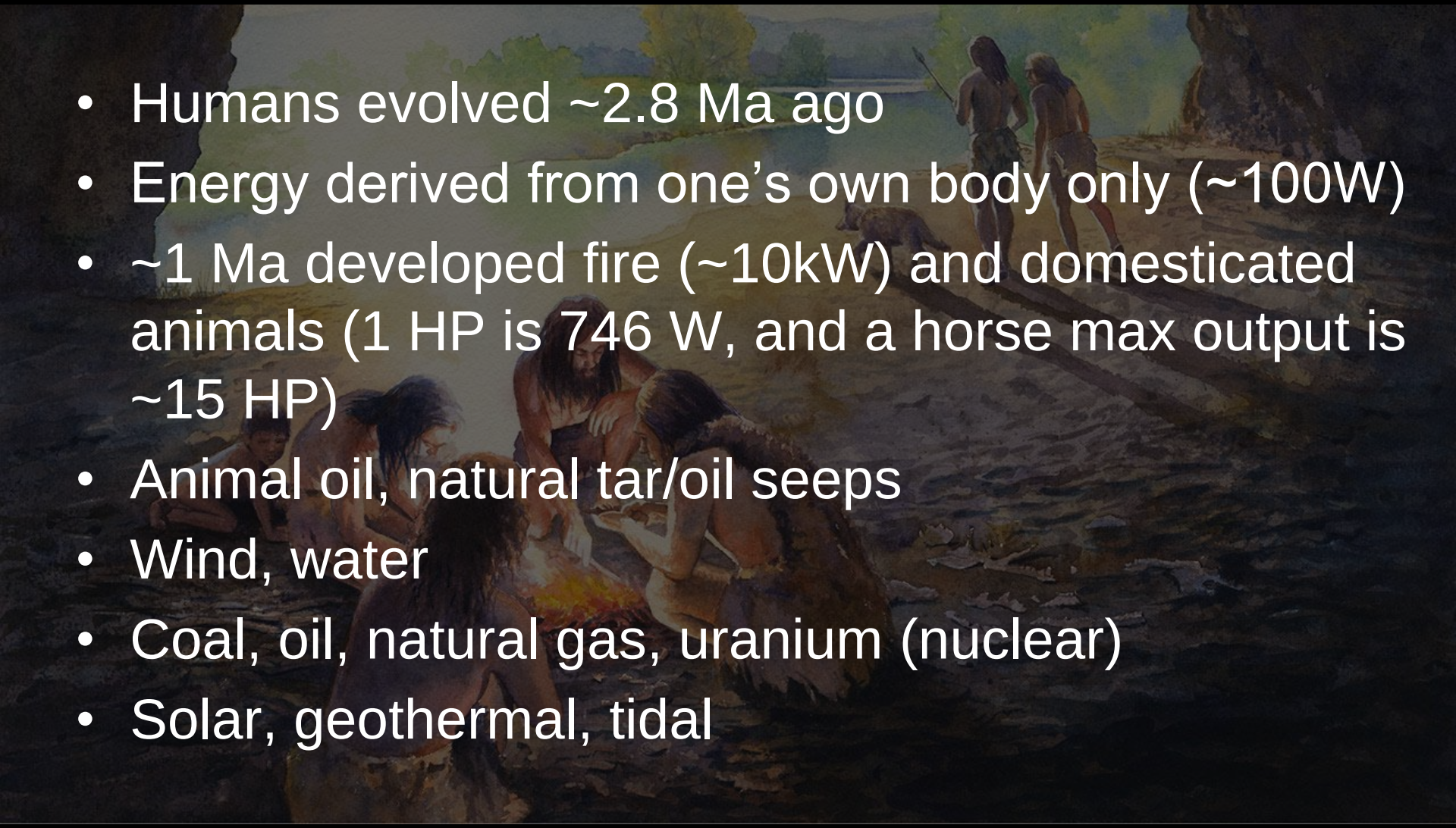
1 kWh = 1 kW x 1 h = 3,412.14 BTU

= 1000 W x 3600 s

1 watt - second = 1 joule

1 kWh = 3600000 J

Evolution of Energy



- Humans evolved ~2.8 Ma ago
- Energy derived from one's own body only (~100W)
- ~1 Ma developed fire (~10kW) and domesticated animals (1 HP is 746 W, and a horse max output is ~15 HP)
- Animal oil, natural tar/oil seeps
- Wind, water
- Coal, oil, natural gas, uranium (nuclear)
- Solar, geothermal, tidal

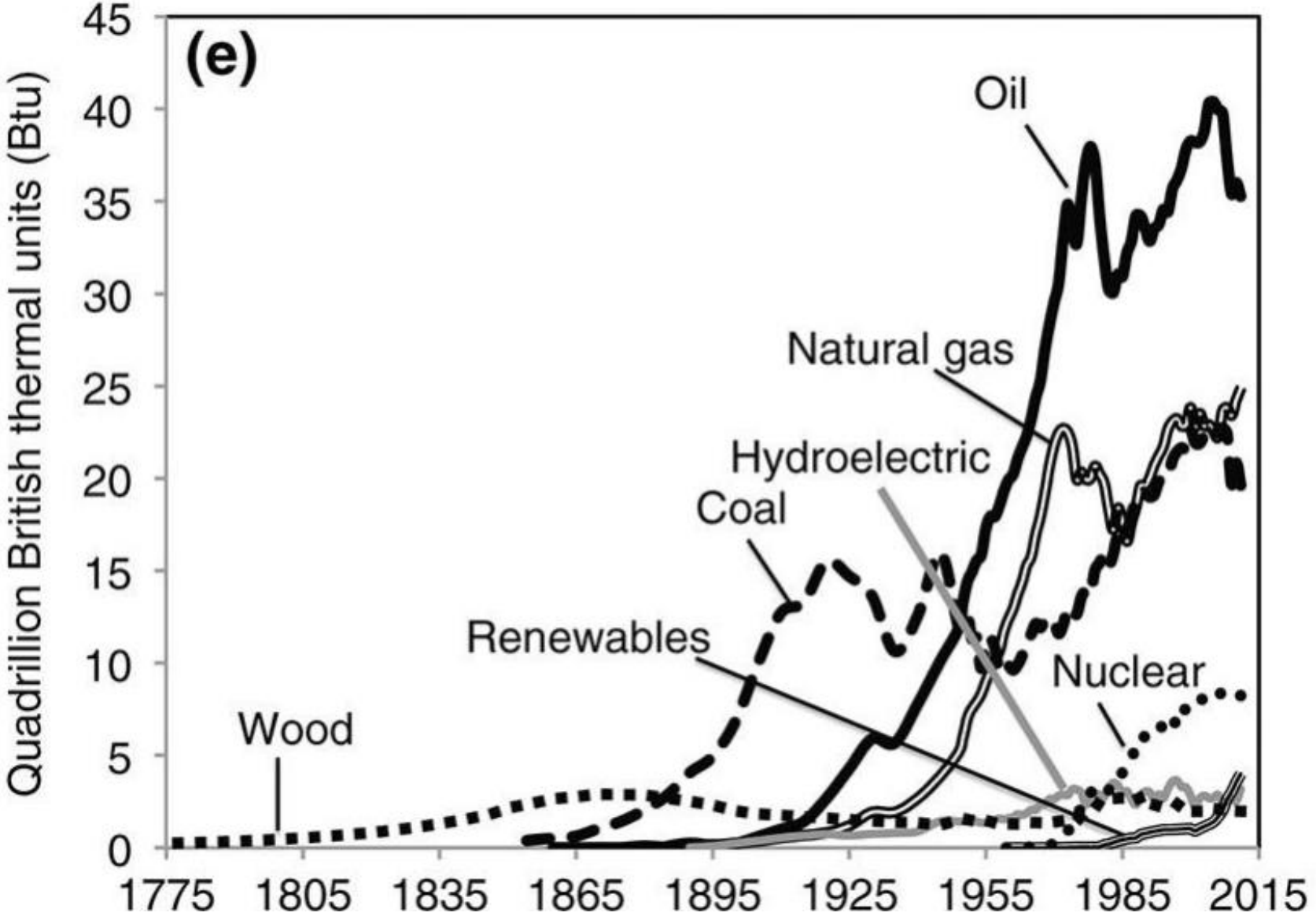
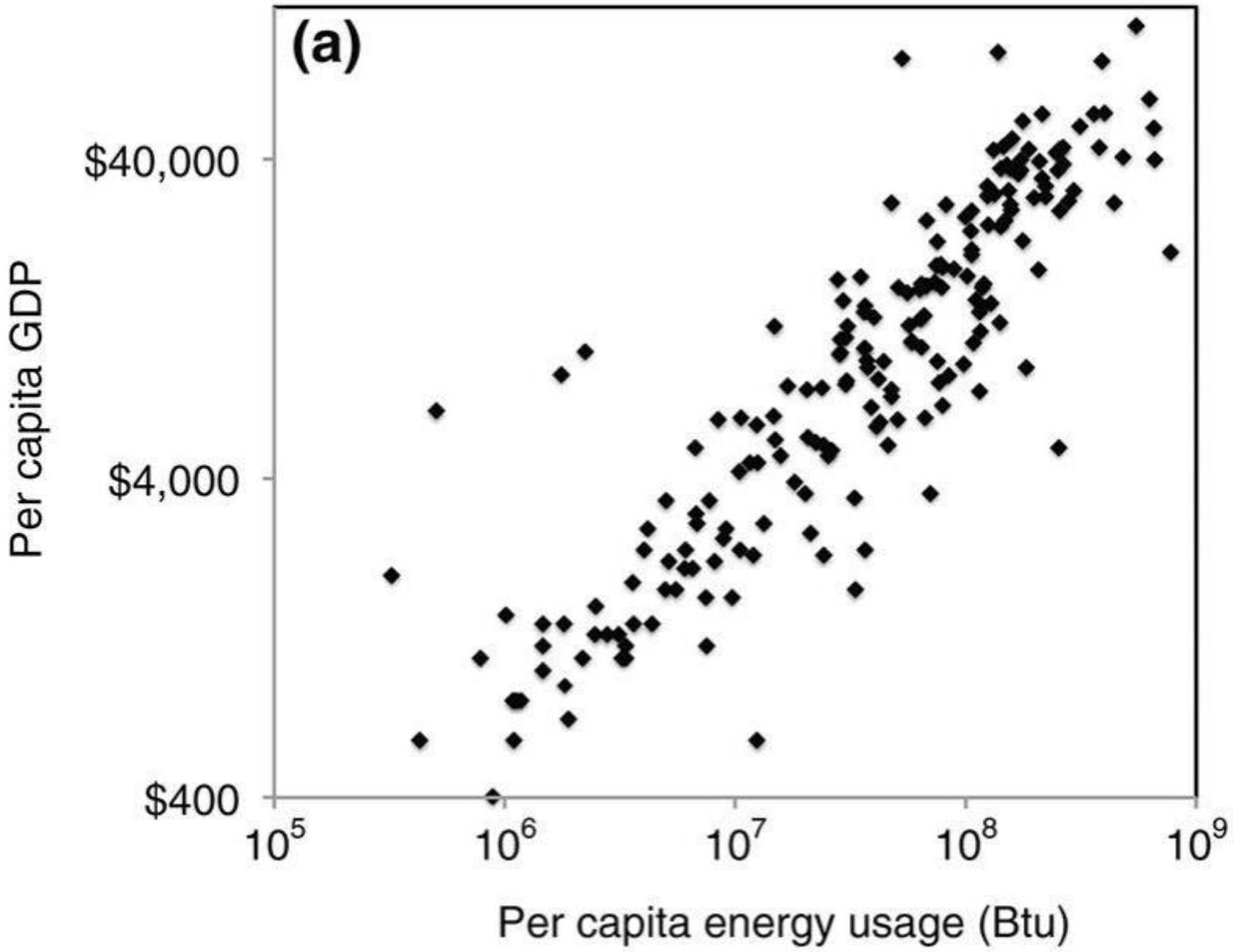

(e)
Quadrillion British thermal units (Btu)
45
40
35
30
25
20
15
10
5
0
1775
1805
1835
1865
1895
1925
1955
1985
2015
Oil
Natural gas
Hydroelectric
Coal
Renewables
Nuclear
Wood

TABLE 3.3 | ENERGY CONTENT OF FUELS

	TYPICAL ENERGY CONTENT (VARIES WITH FUEL SOURCE)	
Fuel	**SI units**	**Other units**
Coal	29 MJ/kg	7,300 kWh/ton 25 MBtu/ton
Oil	43 MJ/kg	~40 kWh/gallon 138 kBtu/gallon
Gasoline	44 MJ/kg	36 kWh/gallon
Natural gas	55 MJ/kg	30 kWh/100 cubic feet 1,000 Btu/cubic foot
Biomass, dry	15–20 MJ/kg	13–17 MBtu/ton
Hydrogen gas (H_2) burned to produce H_2O	142 MJ/kg	320 Btu/cubic foot
Uranium, nuclear fission:		
Natural uranium	580 GJ/kg	161 GWh/tonne
Pure U-235	82 TJ/kg	22.8 TWh/tonne
Hydrogen, deuterium–deuterium nuclear fusion:		
Pure deuterium	330 TJ/kg	
Normal water	12 GJ/kg	13 MWh/gallon, 350 gallons gasoline equivalent per gallon water


(a)
$40,000
$4,000
$400
Per capita GDP
10^5
10^6
10^7
10^8
10^9
Per capita energy usage (Btu)

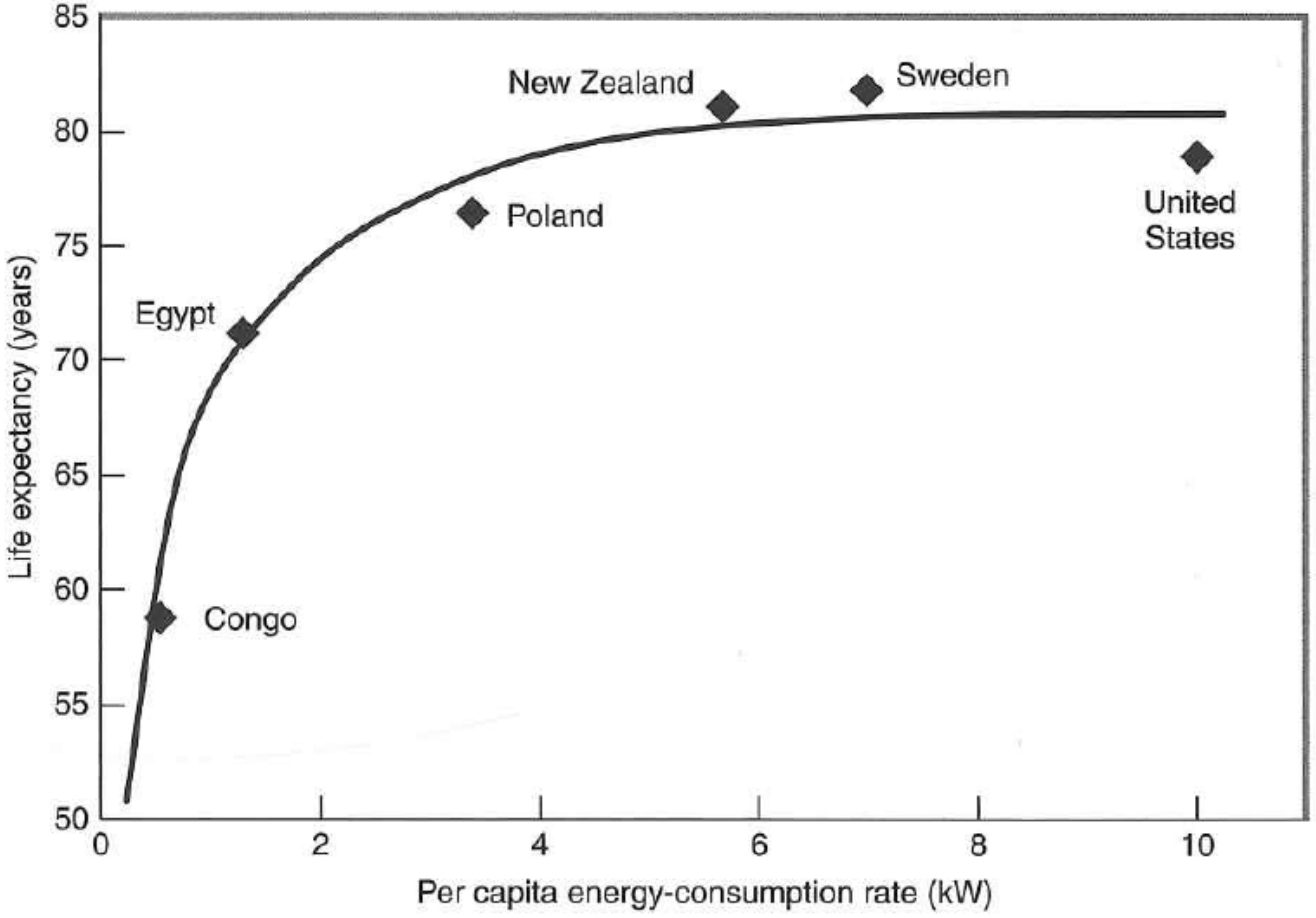


FIGURE 2.9

Life expectancy versus energy consumption for the six countries that lie near the line in Figure 2.7. Only at very low energy-consumption rates is there a correlation; at higher energy-consumption rates, the life expectancy curve saturates. Many other quality-of-life indicators show similar behavior in relation to energy consumption.

Why does the curve flatten?

Is GDP the best indicator of quality of life?

- cleaning up oil spills, building prisons, health care for an unhealthy population