Fission is in Fashion

Osher @ Dartmouth

Robert Hargraves

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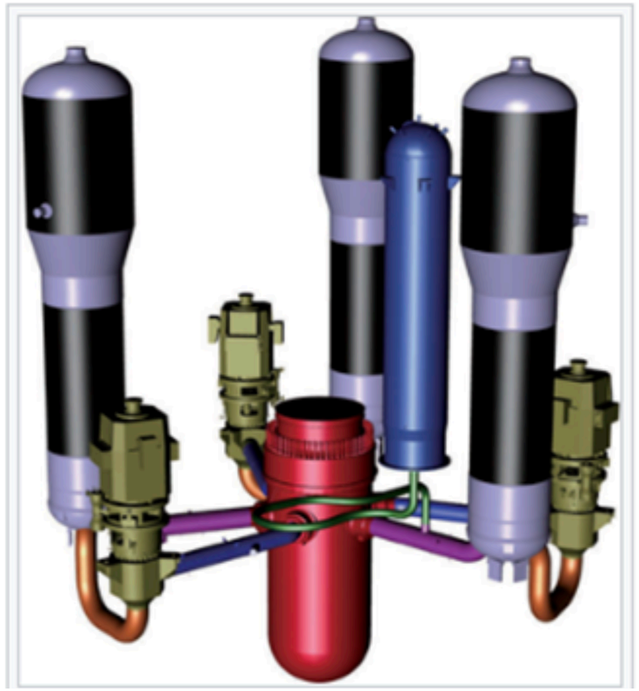
Argentina Signs $8B Deal for China's Hualong One PWR

(NucNet) State companies Nucleoeléctrica Argentina and China National Nuclear Corporation (CNNC) have signed an engineering, procurement and construction (EPC) contract for construction of a China-supplied HPR1000 nuclear power plant at what will become the Atucha III nuclear power station.



The cost of the project is estimated to be $8 billion with China providing 85% of the costs. A key remaining hurdle, and it's a big one, is financing Argentina's 15% share worth $1.2 billion.

Overwhelming support from college of commissioners for including nuclear in EU green taxonomy

France to build up to 14 new nuclear reactors by 2050, says Macron

French president says 'renaissance' of atomic energy industry will help end country's reliance on fossil fuels

WORLD NUCLEAR ASSOCIATION

Power reactors und

Start †				
2022	Belarus, BNPP			
2022	China, CGN			
2022	China, CGN	Fangchenggang 4	Hualong One	1180
2022	China, CGN	Hongyanhe 6	ACPR-1000	1119
2022	Finland, TVO	Olkiluoto 3	EPR	1720
2022	India, NPCIL	Kakrapar 4	PHWR-700	700
2022	India, NPCIL	Kalpakkam PFBR	FBR	500
2022	India, NPCIL	Rajasthan 7	PHWR-700	700
2022	Korea, KHNP	Shin Hanul 1	APR1400	1400
2022	Pakistan	Karachi/KANUPP 3	ACP1000	1161
2022	Russia, Rosenergoatom	Kursk II-1	VVER-TOI	1255
2022	Slovakia, SE	Mochovce 3	VVER-440	471
2022	USA, Southern	Vogtle 3	AP1000	1250
2023	Argentina, CNEA	Carem	Carem25	29
2023	Bangladesh	Rooppur 1	VVER-1200	1200

Chapters

1 Energy in the evolution of civilization

Population

Wealth

Heat

Electricity

Wealth dependence on energy

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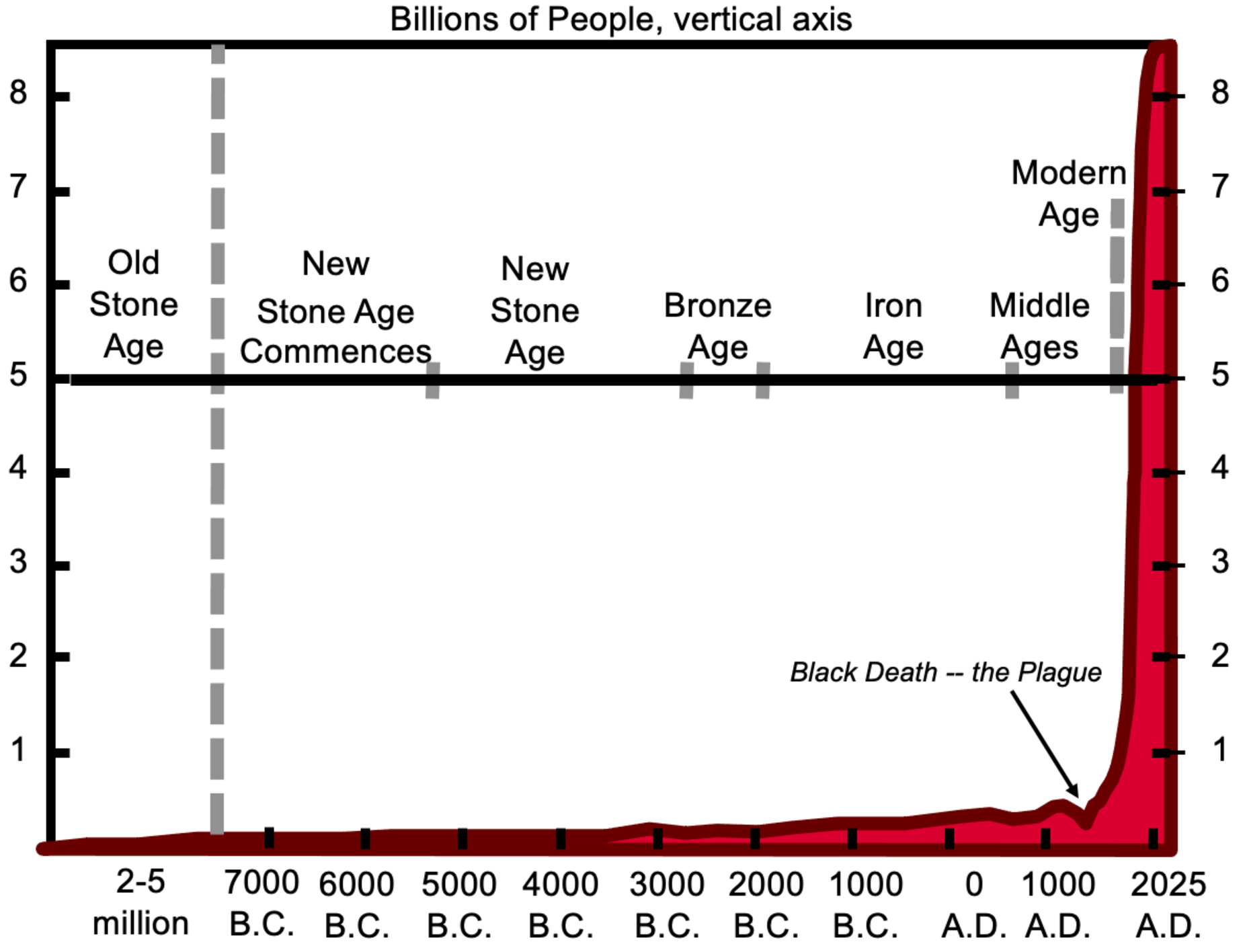
What's the value of energy to civilization?



Humans harnessed fire 1.8 million years ago.

The final confrontation with the Environmental Anti Fire Party

Cooking with heat energy.

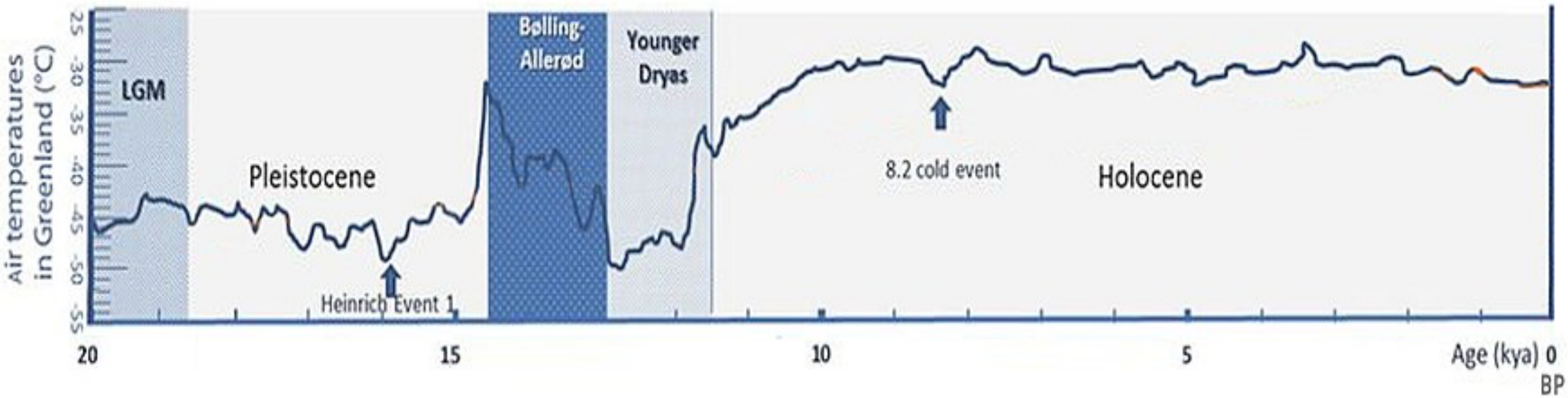
Cooking food saved time and energy. Primates still spend half their day chewing raw food.

By switching to cooked, softer, more energetically rich food homo erectus was able to **devote time to more productive activities**, making tools, farming, and interacting socially

Reduced kinetic energy demands for metabolism permitted **evolution of the human's large brain**, which consumes a quarter of the body's energy.

Fossil records show evolution to larger brains and smaller guts, jaws, and teeth.

Climate warming in 10,000 BC enabled agriculture.



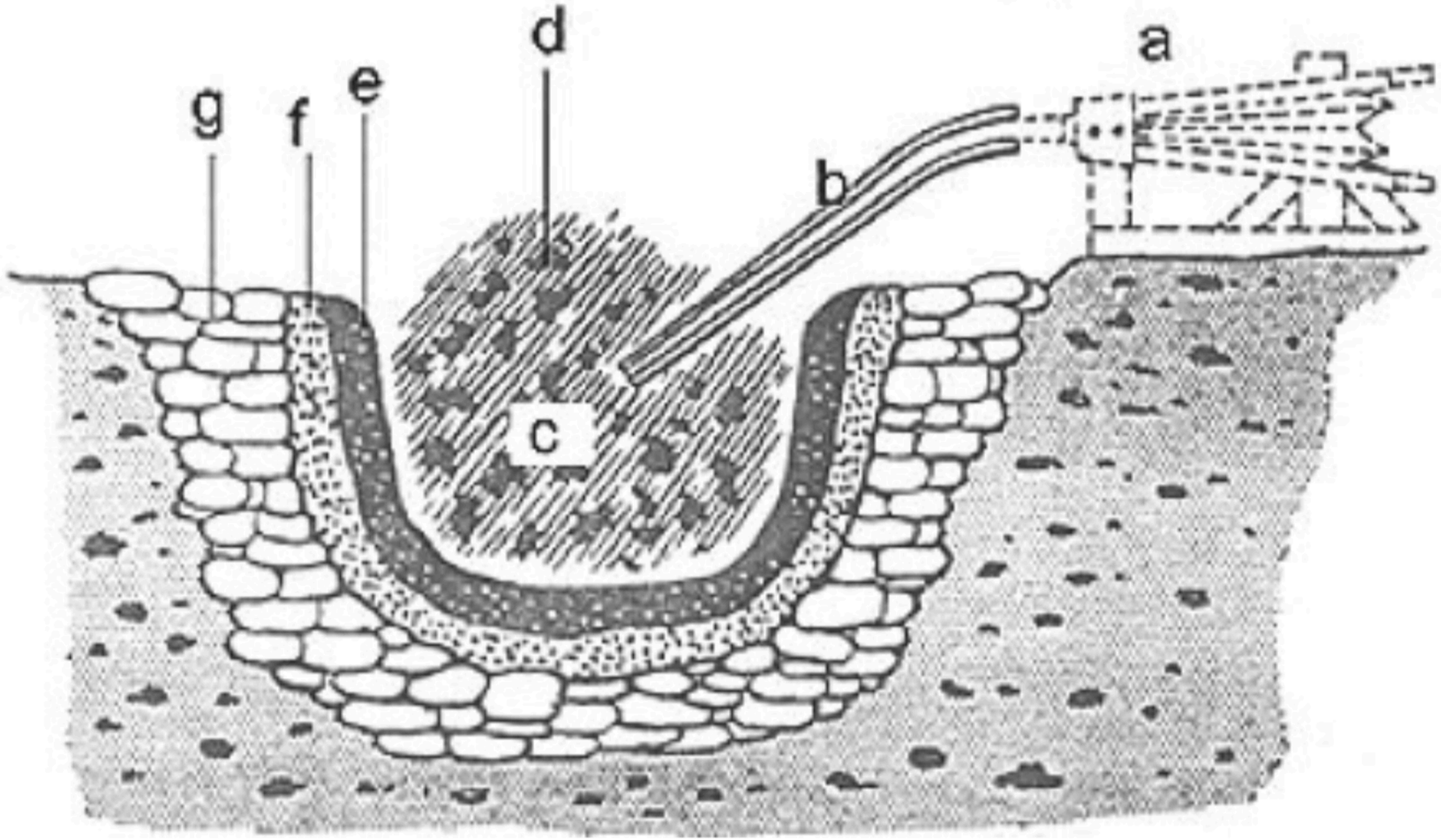
Earlier stone age roving bands subsisted on hunting animals and gathering food.

Productive agriculture of cereals enabled storage of food and free time to make tools, build shelters, develop writing, and advance civilization.

Stored food was **wealth**.

https://en.wikipedia.org/wiki/Neolithic_Revolution#Social_change

Bronze Age 3000 BC
1100°C furnace for melting copper and tin



a-Smile

b-nozzle

c-charcoal (wood?)

d-fine "grind" of copper and tin ore

e-lining of clay

f-priming with pen

g-stone lining

https://www.researchgate.net/publication/233731071_The_investigation_of_microstructure_and_hardness_of_archaeological_alloys/figures?lo=1

Iron Age 1200 BC; 1250-1535°C heat needed.

Killick A well-preserved tall (2.2 m) natural draft iron smelting furnace in the Kasungu National Park, Malawi

https://www.researchgate.net/publication/298801110_A_global_perspective_on_the_pyrotechnologies_of_Sub-Saharan_Africa/figures?lo=1

Iron ore is plentiful, inexpensive.

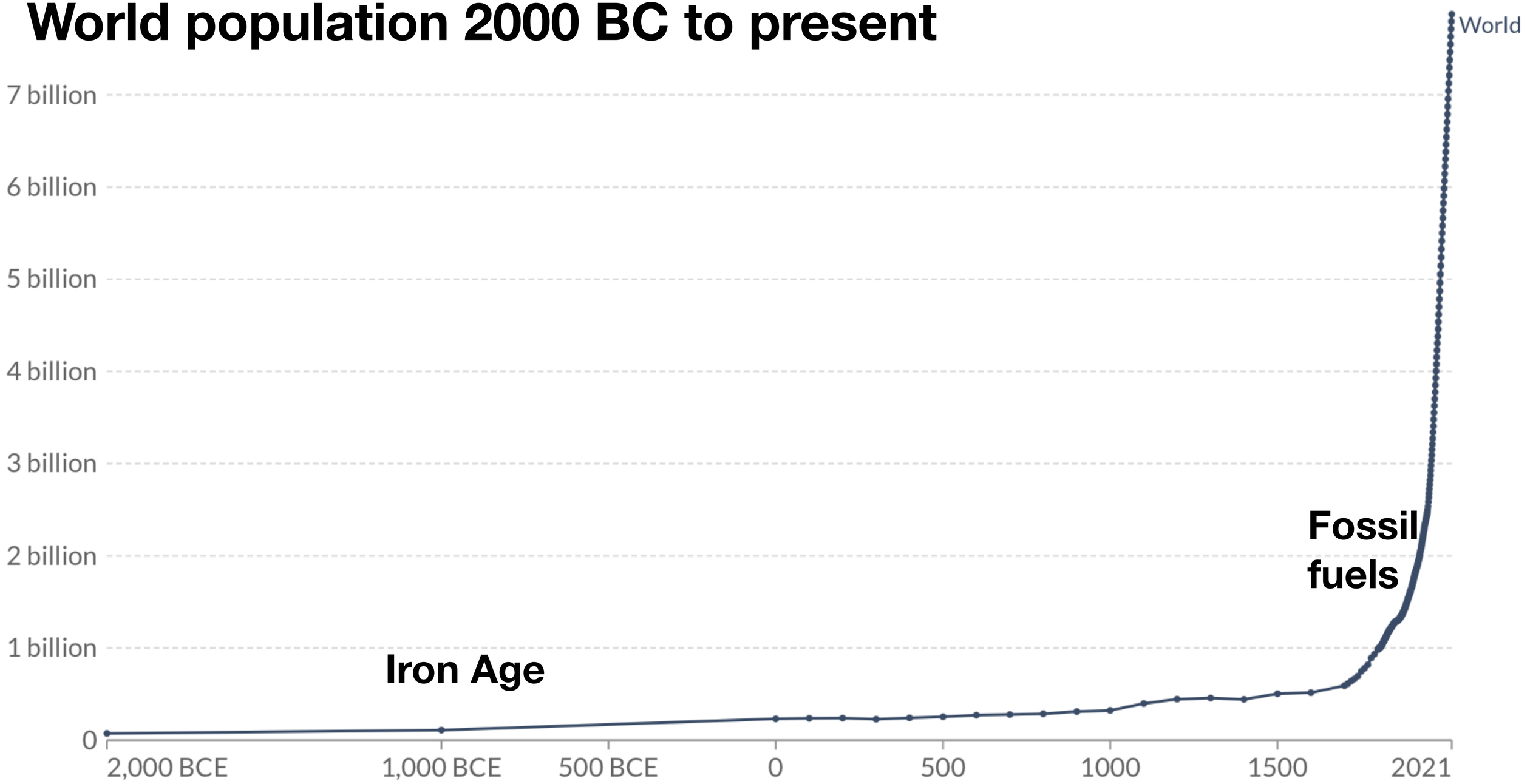
1250°C to reduce iron ore to iron bits that could be pounded together, **forged**, to form “wrought iron”.

African hardwood fuel burns hotter, as does charcoal.

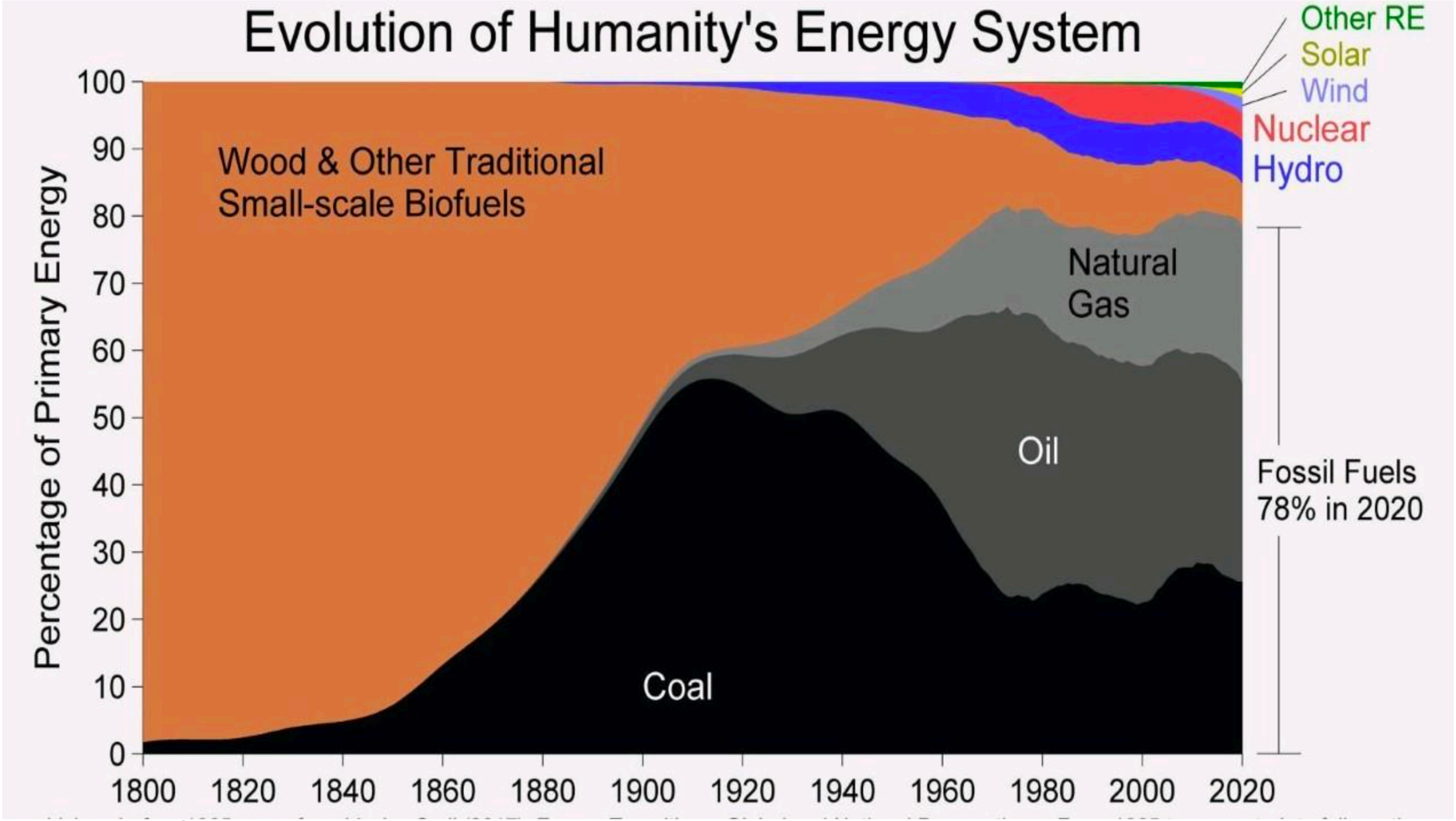
1535°C to melt iron to form “cast iron”.

Adding carbon lowers iron melting point to 1150°C, but iron is brittle.

World population 2000 BC to present



https://ourworldindata.org/grapher/population?time=-2000..latest



Jim Kennedy, Vaclav Smil, BP, valuing 1 kW electricity as 2.6 kW heat


JUICETHEMOVIE.COM
JUICE
Coca-Cola
USE ME
TRAILER HD

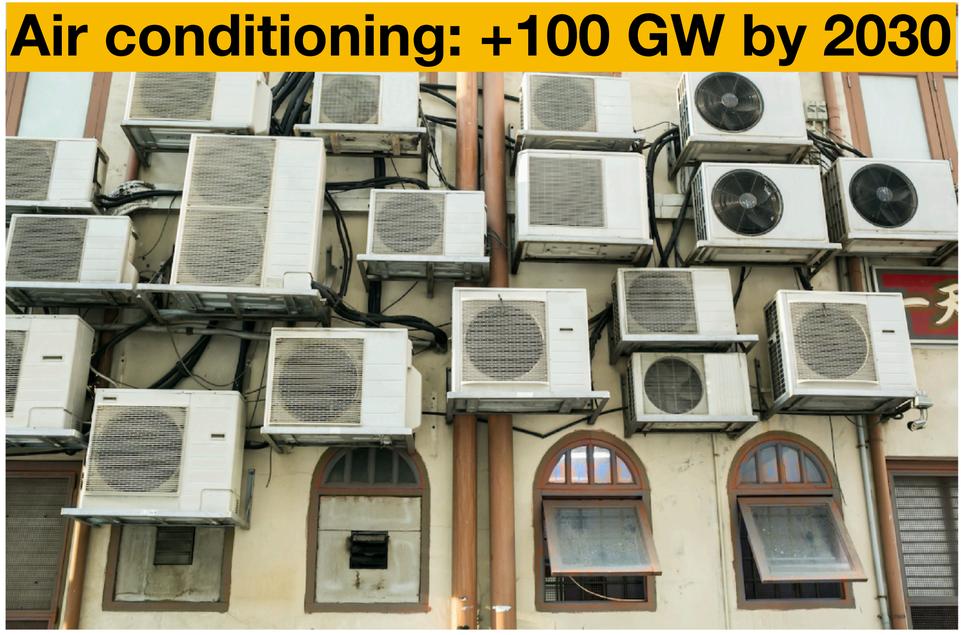
Connecting a billion poor to power by 2030: **+100 GW** (at only 100 W/person)

Connecting one billion powerless people with just 100 watts of power — a tenth of US and EU average electricity use.

2030 GW growth +42 +62 +100 +300 +100 ....

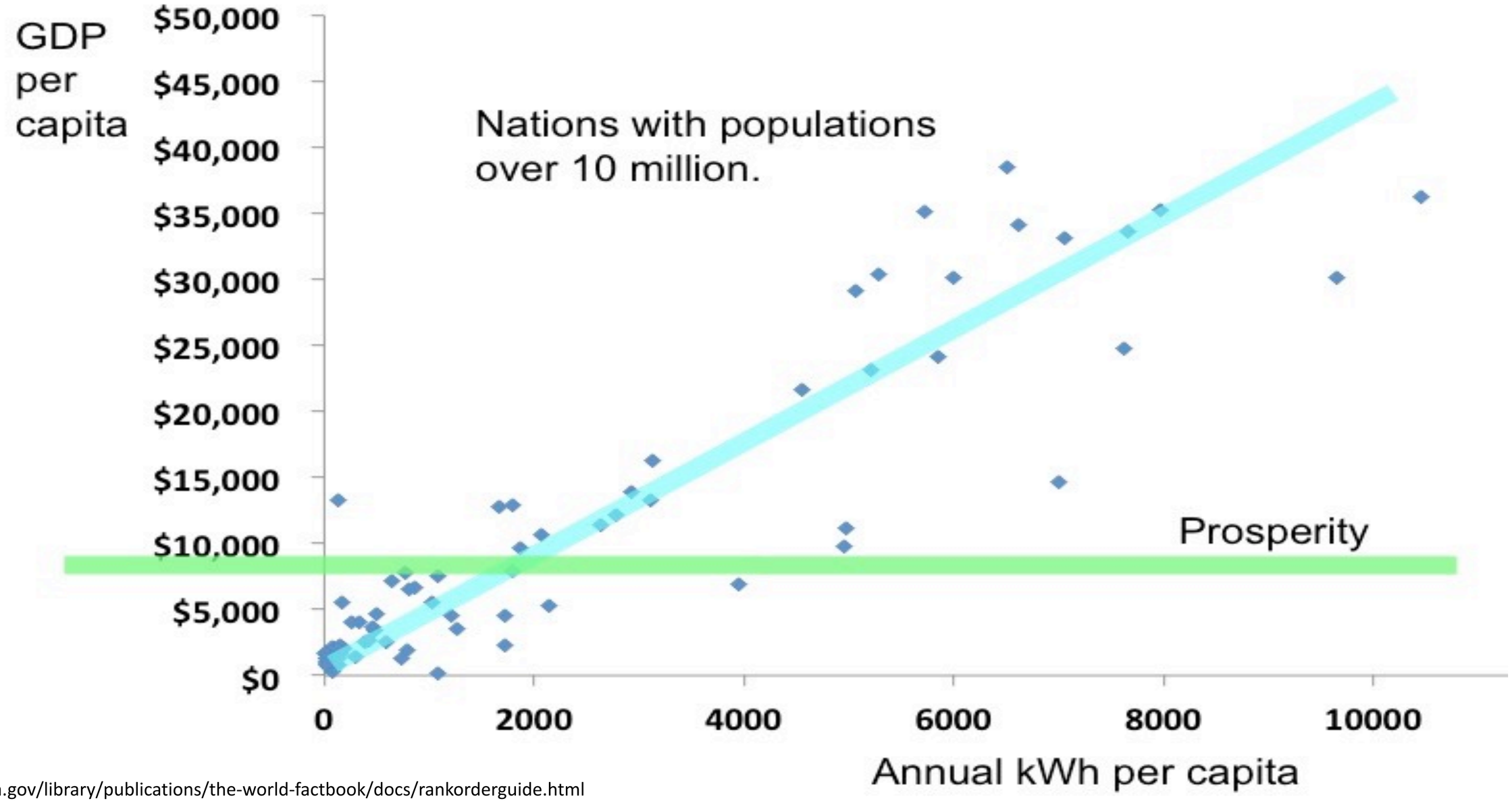
By 2030, 122 million more electric vehicles travel 12,000 miles per year at 4 miles/kWh.

Desalination of 87 million cubic meters of water per year is growing at 8% annually, demanding 3 kWh per cubic meter.



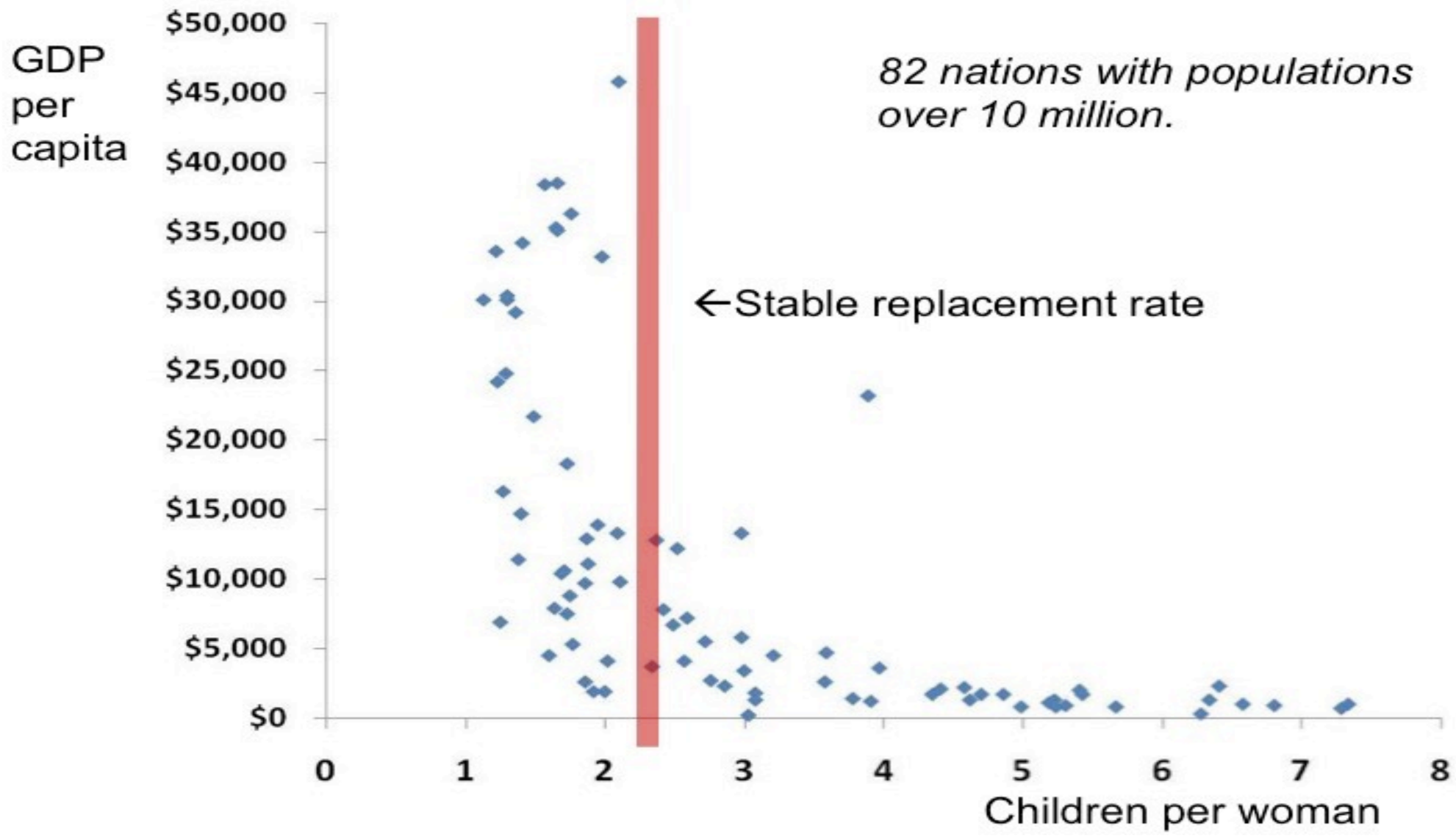
Data centers, the internet, and consumer electronics will demand 300 GW more by 2030.

Nations achieve prosperity with electricity over ~250 watts per person.

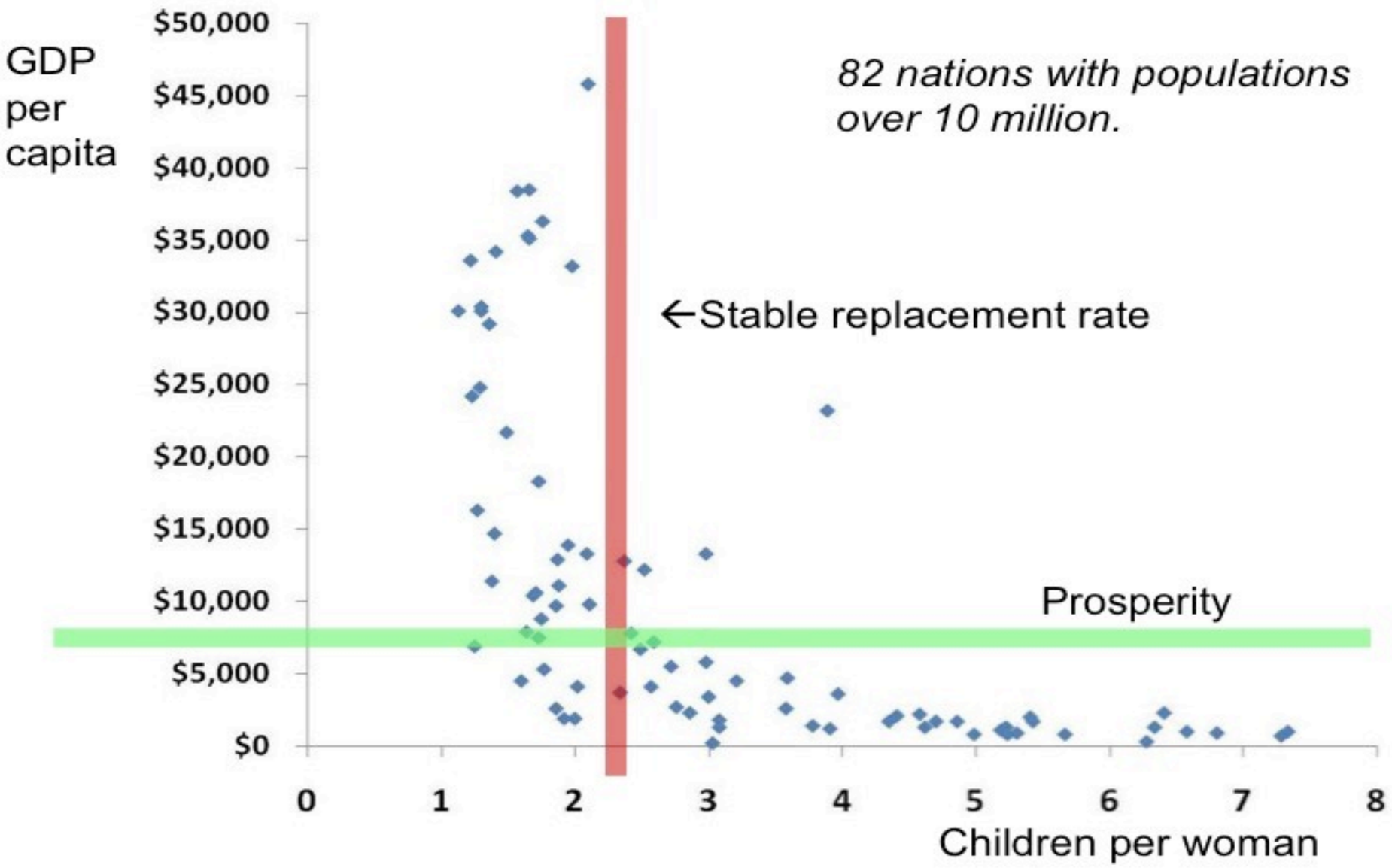


https://www.cia.gov/library/publications/the-world-factbook/docs/rankorderguide.html

Prosperous people have fewer children.



Fewer birthed people, with adequate energy, compete for finite world resources.



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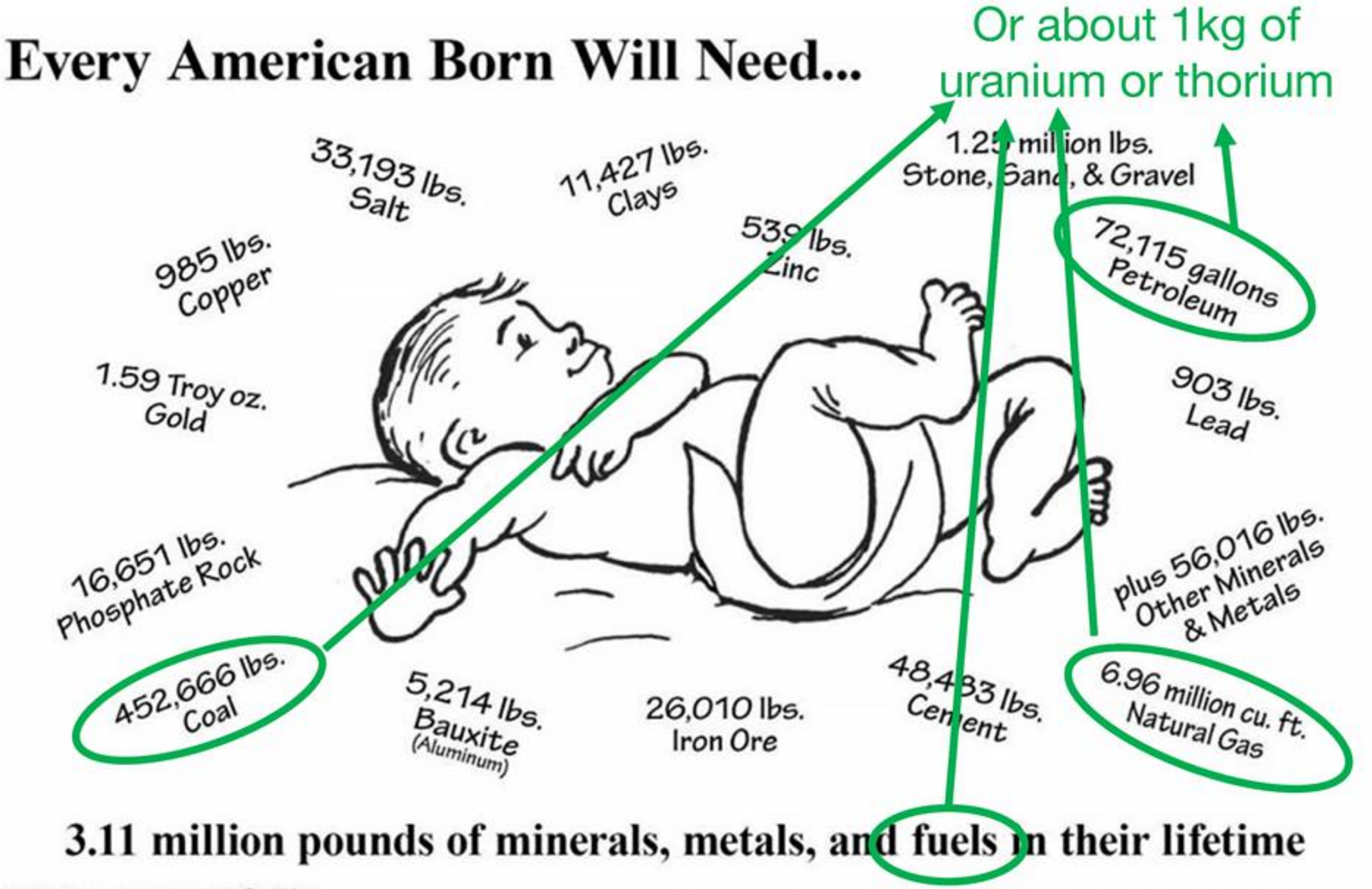

1 Energy role in the evolution of civilization

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Wealth

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Wealth dependence on energy

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