October 23, 2024 · John Peach and Erik Michaels

Burning Man

The Failure of the Green New Deal

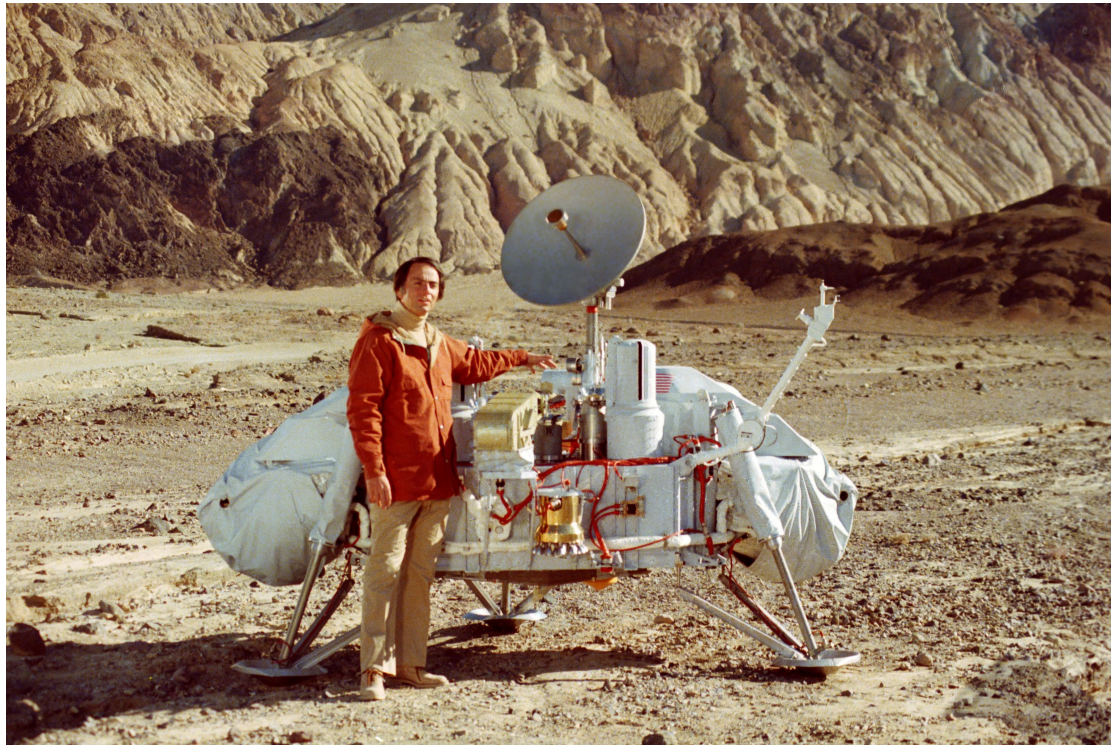
Outline

- Carl Sagan’s ECREE
- Three questions
- Thermodynamic and geophysical constraints
- Biophysical economics and Jevons Paradox
- Side effects and unintended consequences
- Summary

Extraordinary Claims Require Extraordinary Evidence

- Learn to distinguish between **claims** and **evidence.**

- **Verify, don’t trust:** Prefer independent confirmation and reproducible evidence over claims, anecdotes, or single sources.
- **Debate the evidence, not the people:** Authority isn’t proof; prioritize informed, adversarial review and “steelman” the best opposing case.
- **Generate alternatives:** Don’t stop at one explanation—list plausible competing hypotheses and compare them.
- **Quantify end-to-end:** Use numbers, rates, and constraints; check that *every step* in the argument holds together (no weak links).
- **Keep it falsifiable and simple:** Ask what would disprove the claim, and prefer the least-complicated model that still explains the data.



Carl Sagan with a Viking lander

Three Questions

- Do we have the technology to replace fossil fuels with alternative sources?
- What is the expected response from society to alternatives?
- What side effects and unintended consequences might occur?

Does technology exist?

Claim: “We know how to build renewables. We just need to make the transition happen more quickly.”

- Imagine our civilization without any fossil fuel inputs:
  - Is it possible to mine, refine, transport and construct alternative energy systems using only the energy derived from a similar system?
  - Is it possible to scale a proposed alternative to the energy rates currently used?
  - Many alternatives generate electrical energy, but electricity is only 20% of primary energy. How will systems and processes be transitioned?

Critical Minerals Becoming Expensive to Extract

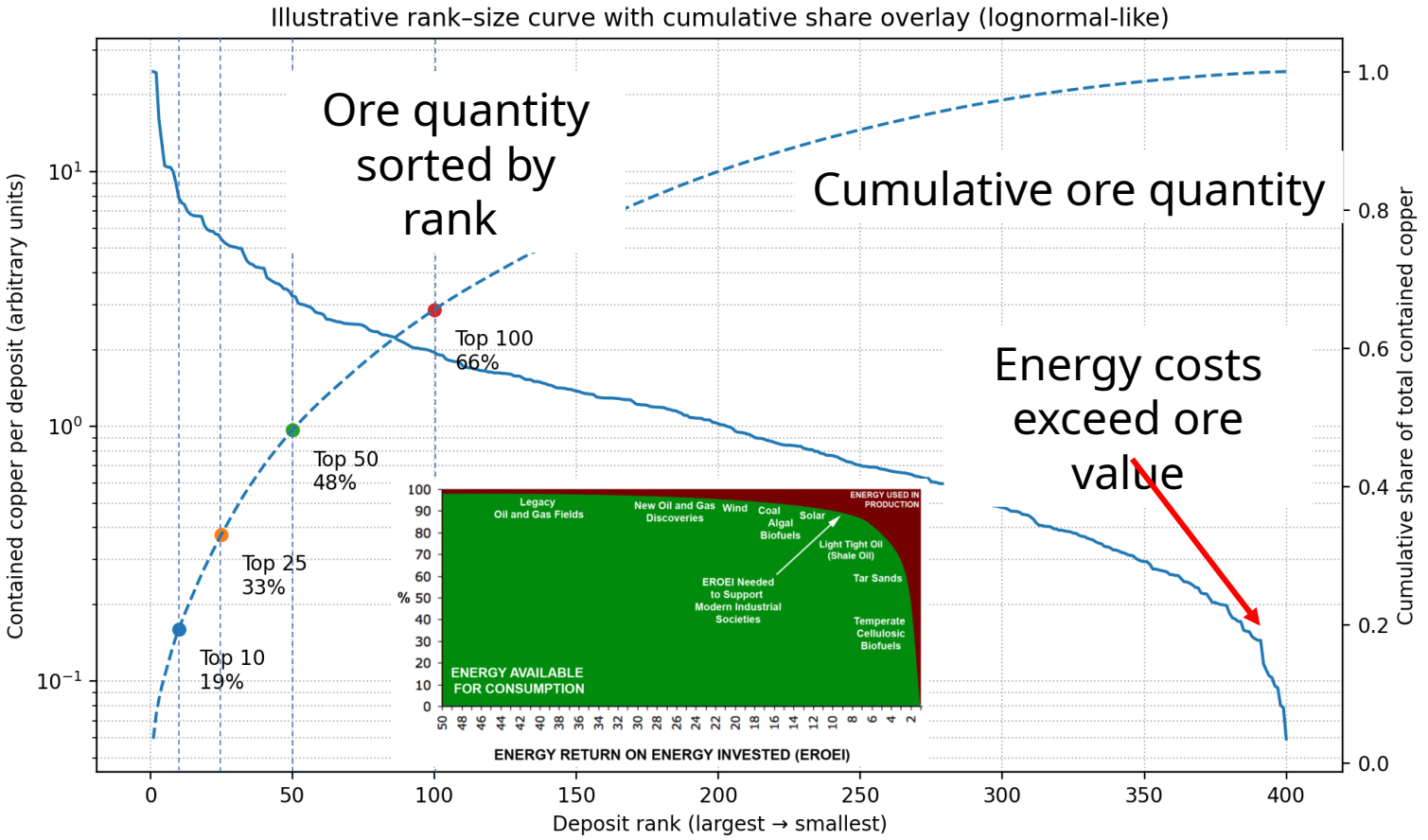
- Deposit sizes and grades are heavy-tailed, often modeled as lognormal
- We’re moving to lower grades and paying more energy per unit metal
- We’re increasingly reliant on expanding old discoveries, and finding fewer big new ones
- Discoveries are trending deeper, harder to find / develop

Approaching the Resource Cliff

Top 50

Top 25

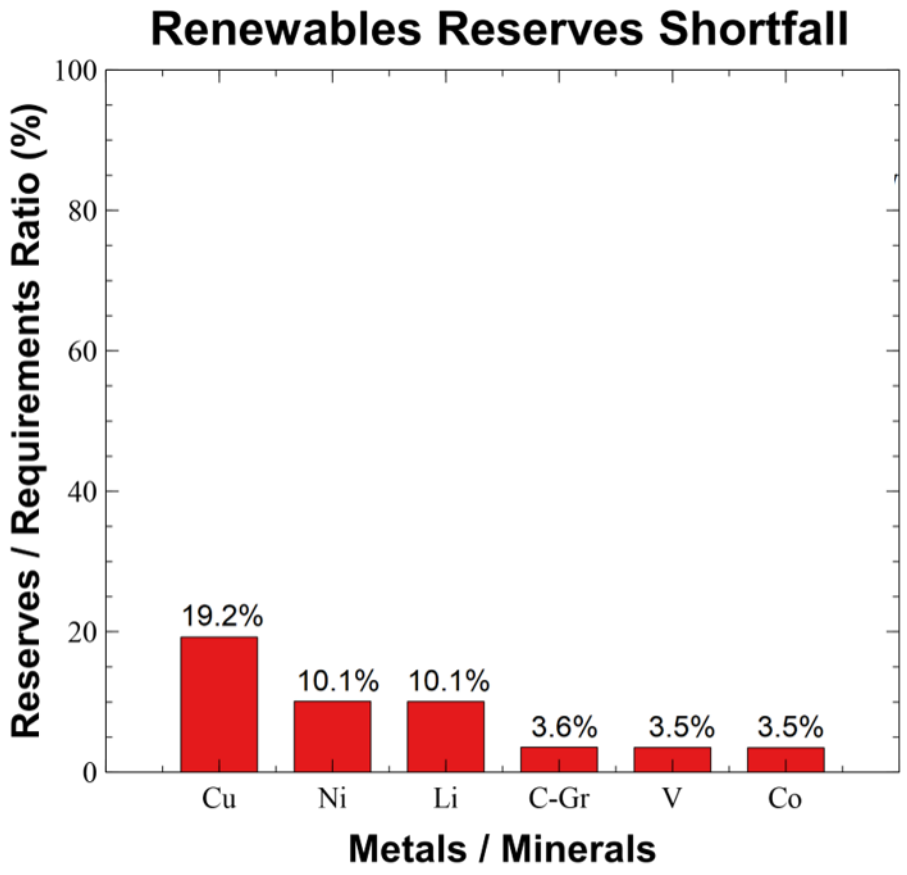
Top 10



Biggest, easiest deposits mined first, everything that remains is smaller, harder, or lower grade.

Ref: *Approaching the Energy Cliff*, Dave Rollo, Resilience, Feb. 7, 2024.

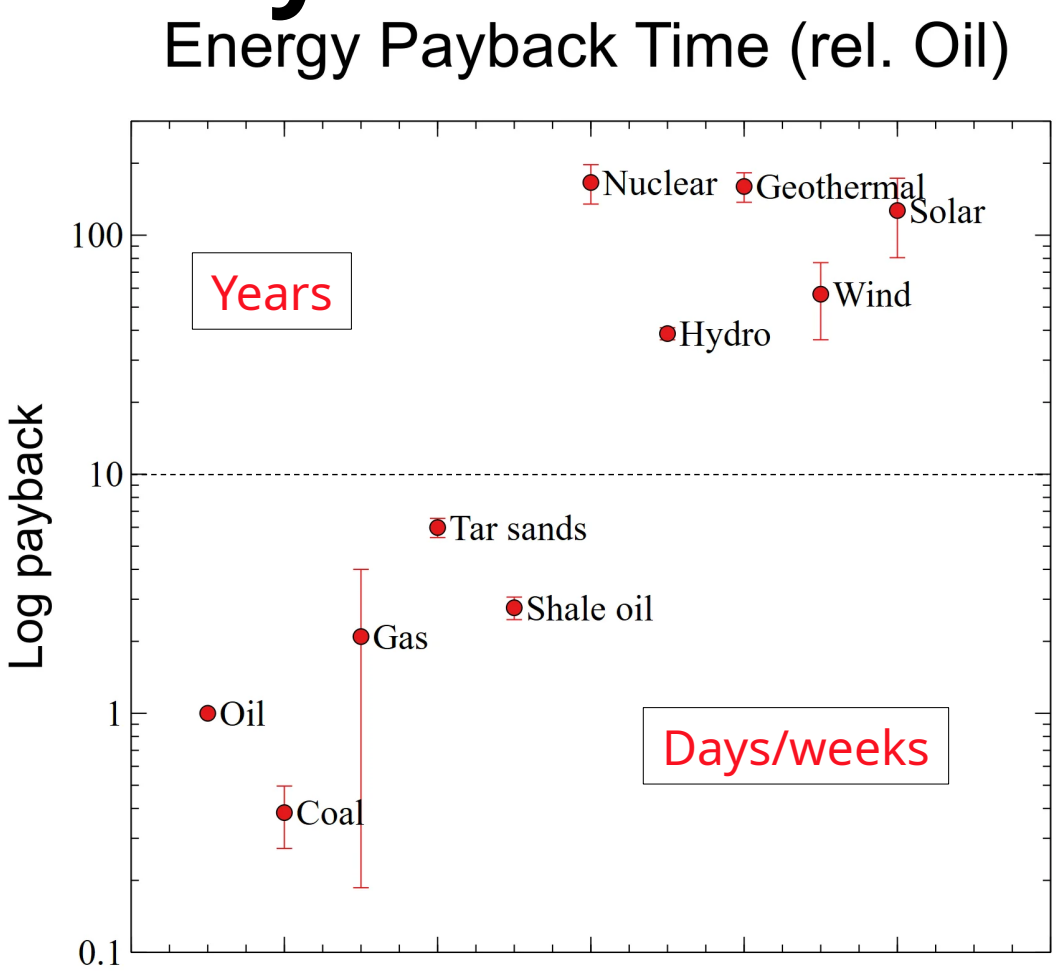
Insufficient Reserves, Low Mining Rates



Metal	Element	Global Metal Production 2019 (tonnes)	Years to produce metal at 2019 rates of production (years)
Copper	Cu	24 200 000	189,1
Nickel	Ni	2 350 142	400,2
Lithium	Li	95 170 *	9920,7
Cobalt	Co	126 019	1733,0
Graphite (natural flake)	C	1 156 300 ♦	3287,9
Graphite (synthetic)	C	1 573 000 ♦	-
Silicon (Metallurgical)	Si	8 410 000	5,9
Vanadium	V	96 021 *	7101,2
Rare Earth Metals	-		
Neodymium	Nd	23 900	40,4
Germanium	Ge	143	29113,0
Lanthanum	La	35 800	166,8
Praseodymium	Pr	7 500	31,4
Dysprosium	Dy	1 000	196,2
Terbium	Tb	280	59,9

Ref: The Mining of Minerals and the Limits to Growth. Simon Michaux, Geological Survey of Finland, Jan 3, 2021.

Energy Return on Input (EROI) and Payback Time

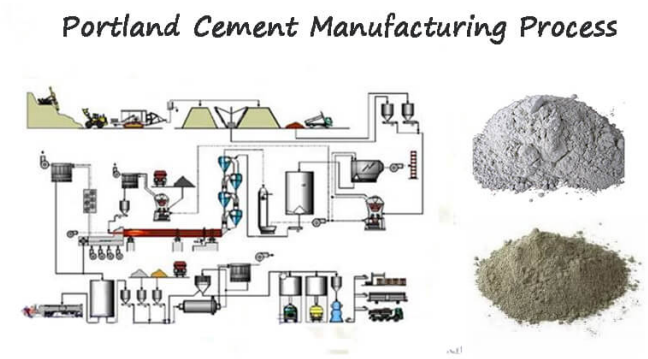


- Payback times for non-fossil energy sources are orders of magnitude longer
- EROI comparisons miss energy rates of return
- Alternatives require high up-front energy costs
- Many EROI estimates overlook energy storage costs

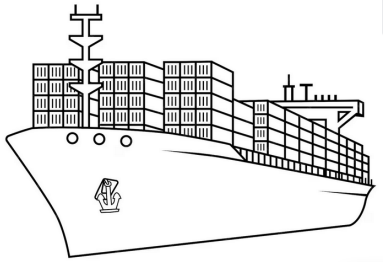
Ref: EROI of different fuels and the implications for society – ScienceDirect, Hall, Lambert, Balogh

Systems Requiring Fossil Fuels

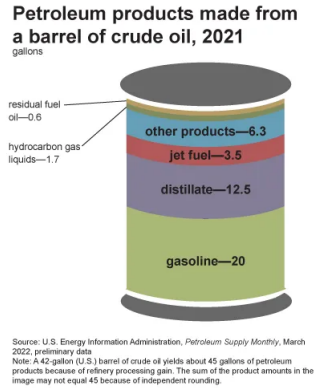
Steel



Cement



Trans-oceanic Shipping



Long-haul Flights

Ammonia Fertilizers

Plastics

Trucking

Over 6000 products:

- Plastics
- Soaps, cleaners
- Pharmaceuticals
- Asphalt, tires

Ref: Halfway Between Kyoto and 2050 - Zero Carbon Is a Highly Unlikely Outcome, Vaclav Smil, 2024.

Evidence Required

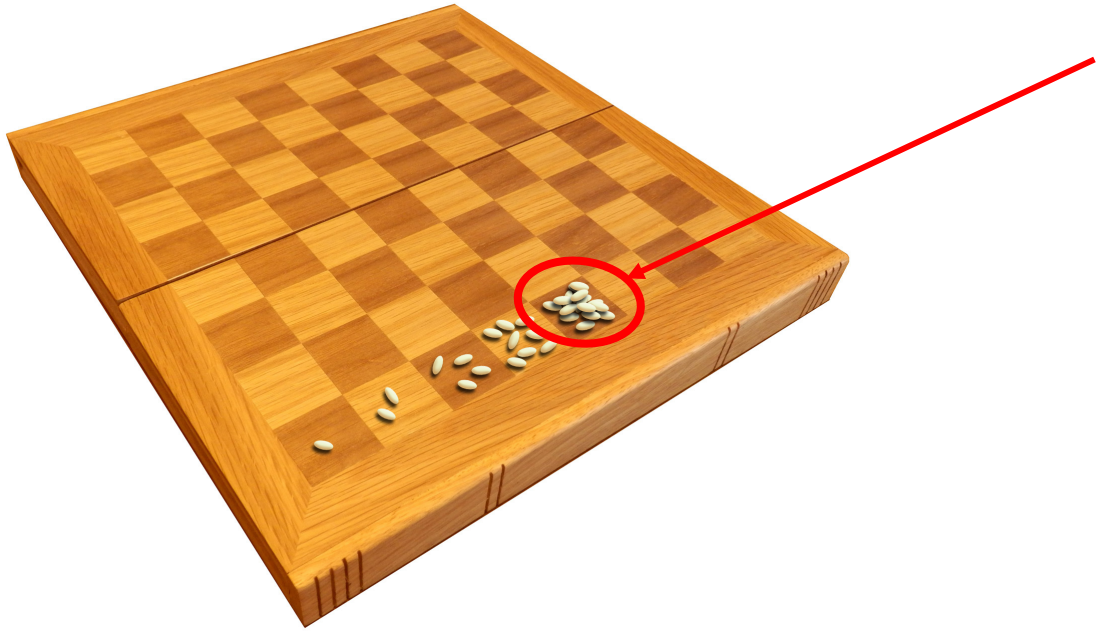
- An alternate source delivering energy reliably and continuously with an EROI rate comparable to fossil fuels.
- Demonstration of the availability of metals and minerals required.
- Increased rates of mining to meet energy transition needs.
- World-scale continuous production of an alternate energy source without fossil fuel inputs.

Expected Response from Society

Claim: “The cost of solar and wind are cheaper than fossil fuels. We’re rapidly transitioning to renewables.”

- How much energy is used worldwide, and what are the primary sources?
- How does energy relate to GDP?
- Understanding Jevons Paradox and Exponential Growth

Economic Growth and the Exponential Function

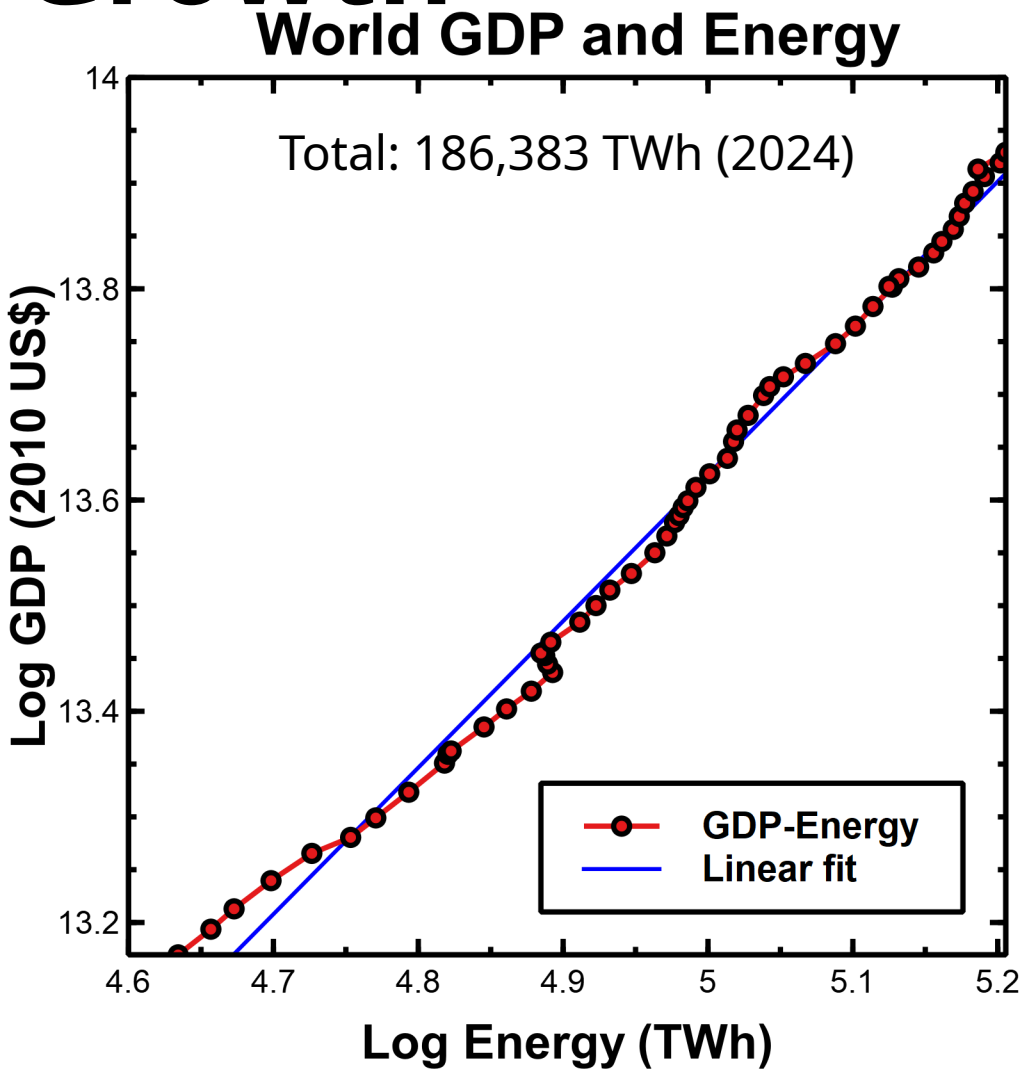


Efficiency gains only move the grains forward

- Half of fossil fuel consumption happened in the last 25 years
- Doubling time ~72/annual growth rate
- Desired economic growth is 2% - 3%
  (24 – 36 years)
- Number of grains of rice on the last square is 1 more than the total of all previous squares

“The greatest shortcoming of the human race is our inability to understand the exponential function.”
— Albert Bartlett

World Energy Use and Economic Growth

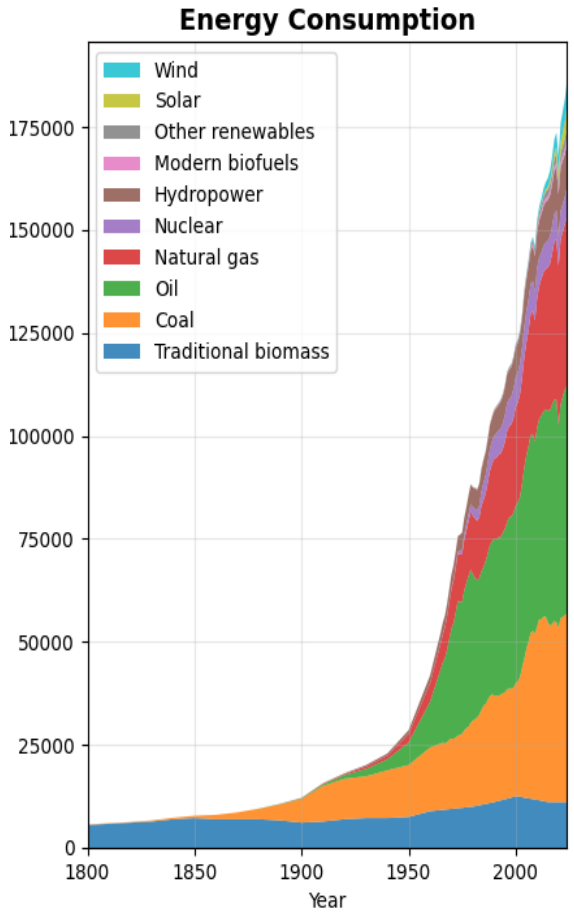


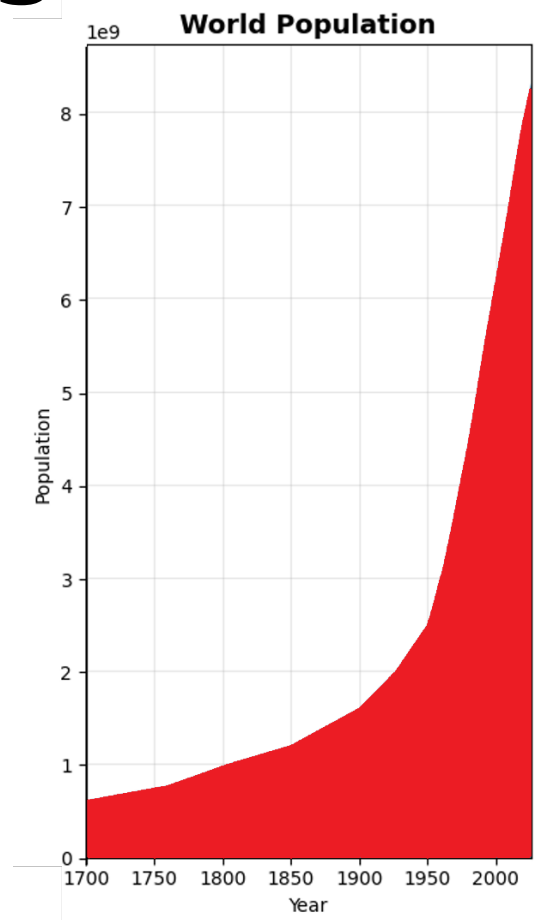
A simple calculation:

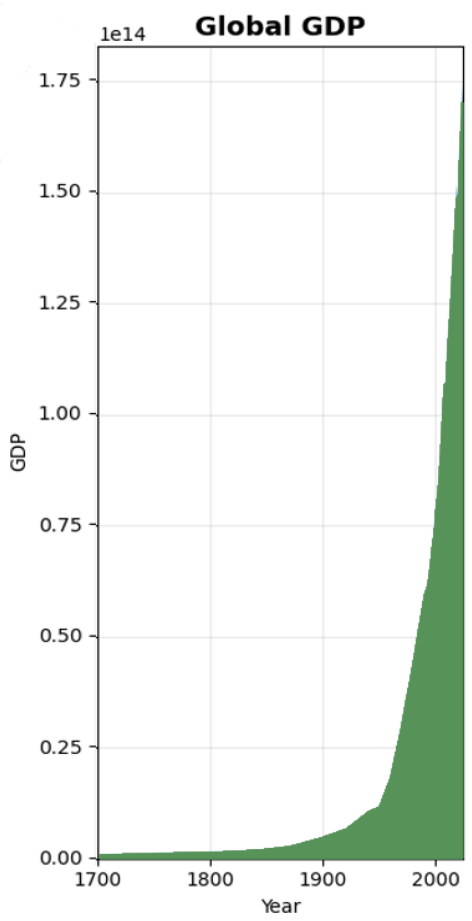
- Continuous human output ~ 100 Watts
- 10 hours/day = 1 KWh
- 200 days/year = 200 KWh
- 5 billion physically able people = 1000 TWh
- Less than 1% of energy consumed from other sources

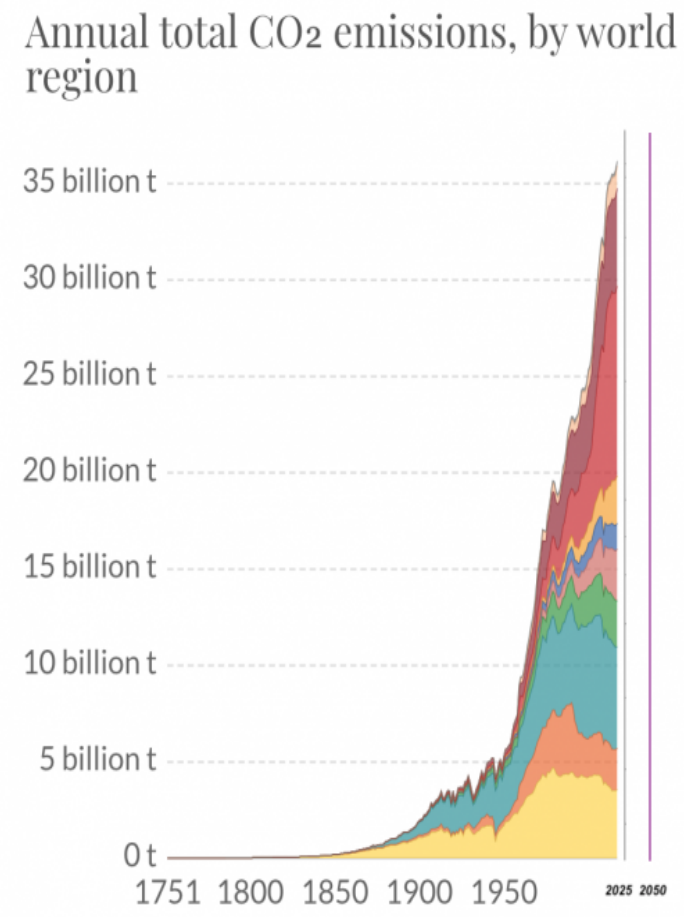
Society doesn't transition from one energy source to another because energy is too valuable in any form.

Energy, Population, GDP and Emissions

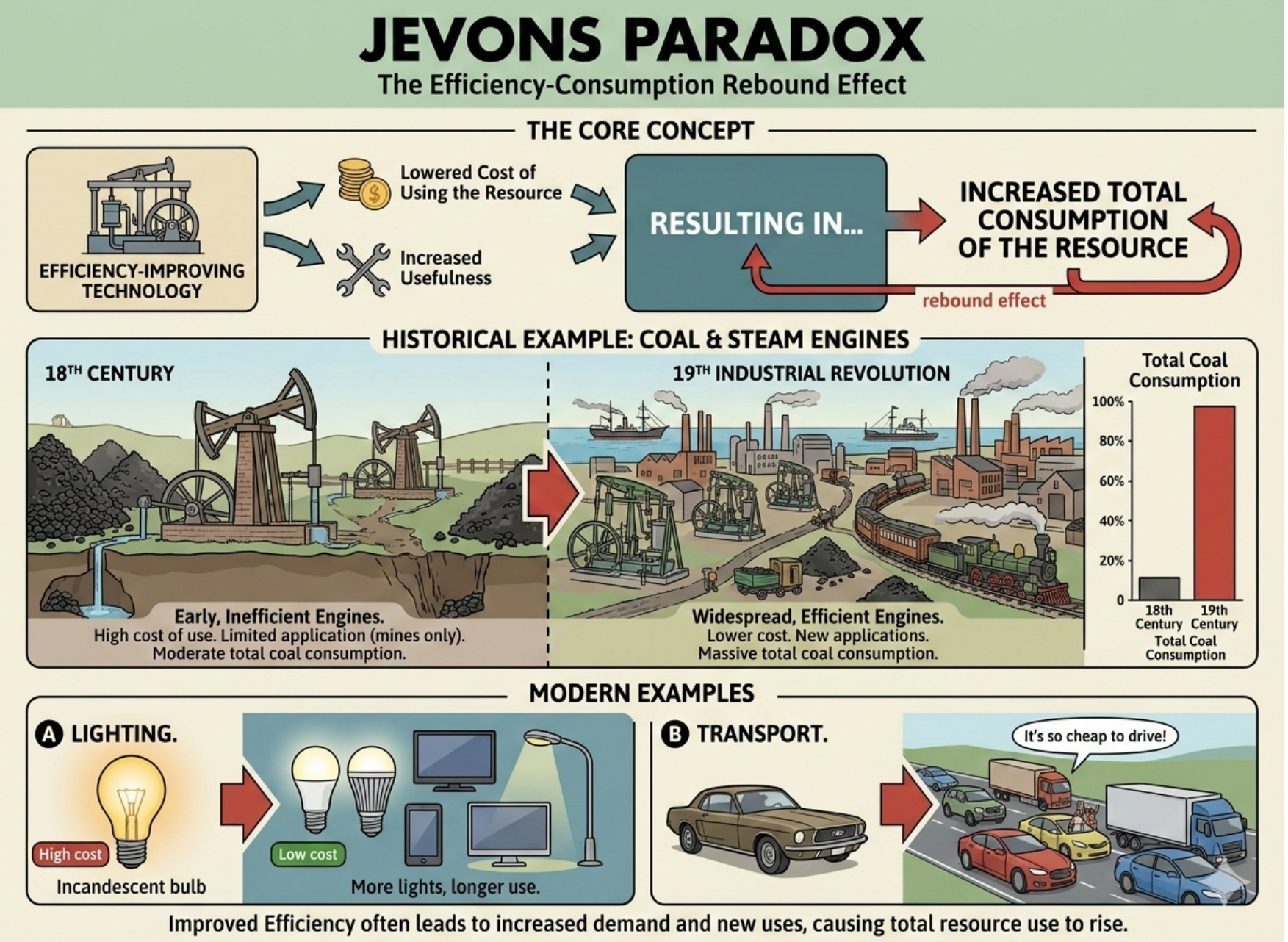








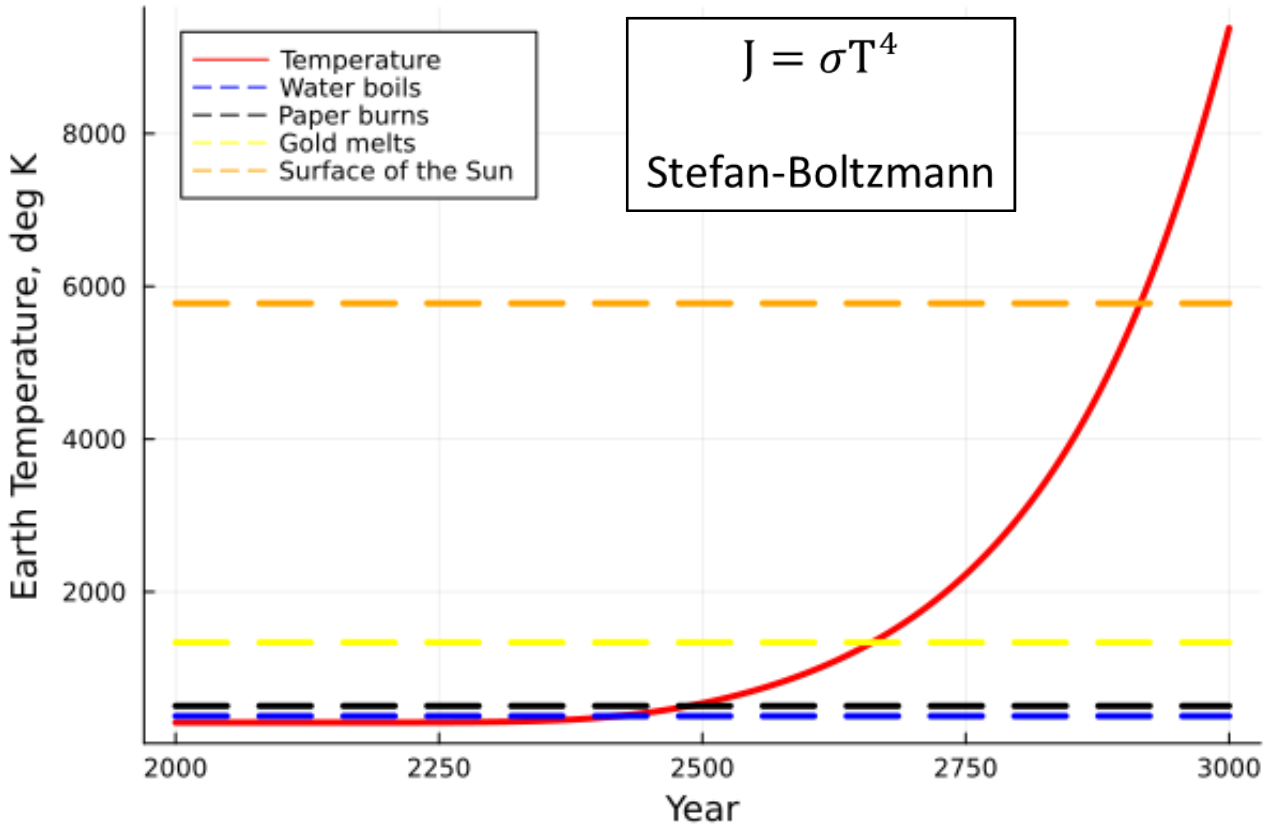
Exponential Growth follows Energy Consumption



- When civilization expands it also increases its ability to access reserves of primary energy and raw materials
- Increased access to energy reserves allows civilization to sustain its newly added circulations.
- If efficiency is sustained, it can also expand further.
- In a positive feedback loop, expansion leads to greater energy inputs and therefore even more work and more rapid expansion.

Energy consumption increases despite improved systems efficiency

Exponential Energy Growth = Exponential Heating



- All energy becomes heat
- Earth energy imbalance requires higher temperatures (Stefan-Boltzmann Law)
- Energy accounts for ~4% of global warming
- Atmospheric CO_2 will not decrease near-term
- Even “green energy” systems contribute to heating

Evidence Required

- Continued exponential increase in non-fossil fuel energy sources.
- Demonstrated substitution of an alternate energy system for fossil fuels.
- Jevon’s Paradox is no longer valid.
- The economy can continue to grow at an exponential rate without adding heat to the Earth’s system.
- The economy can be “decoupled” from energy consumption, or a “circular” economy is possible.

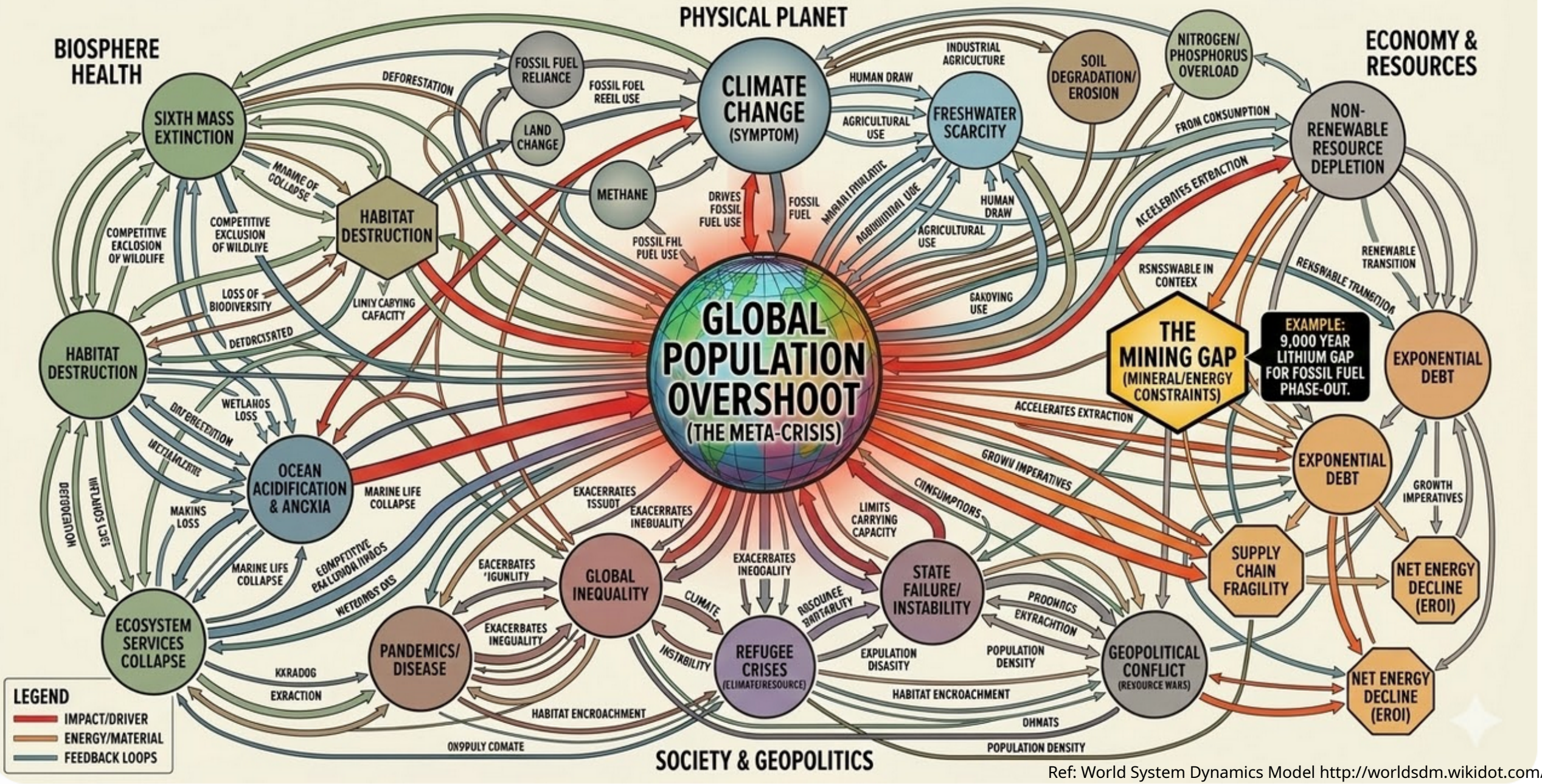
It’s The Ecology, Stupid

- Claim: “We need energy. Without energy, billions of people will die.”

- Continued destruction of the biosphere likely to lead to even greater loss of human life
- Adopting alternate energy sources has not demonstrated greater environmental awareness
- Humanity is following Odum’s Maximum Power Principle

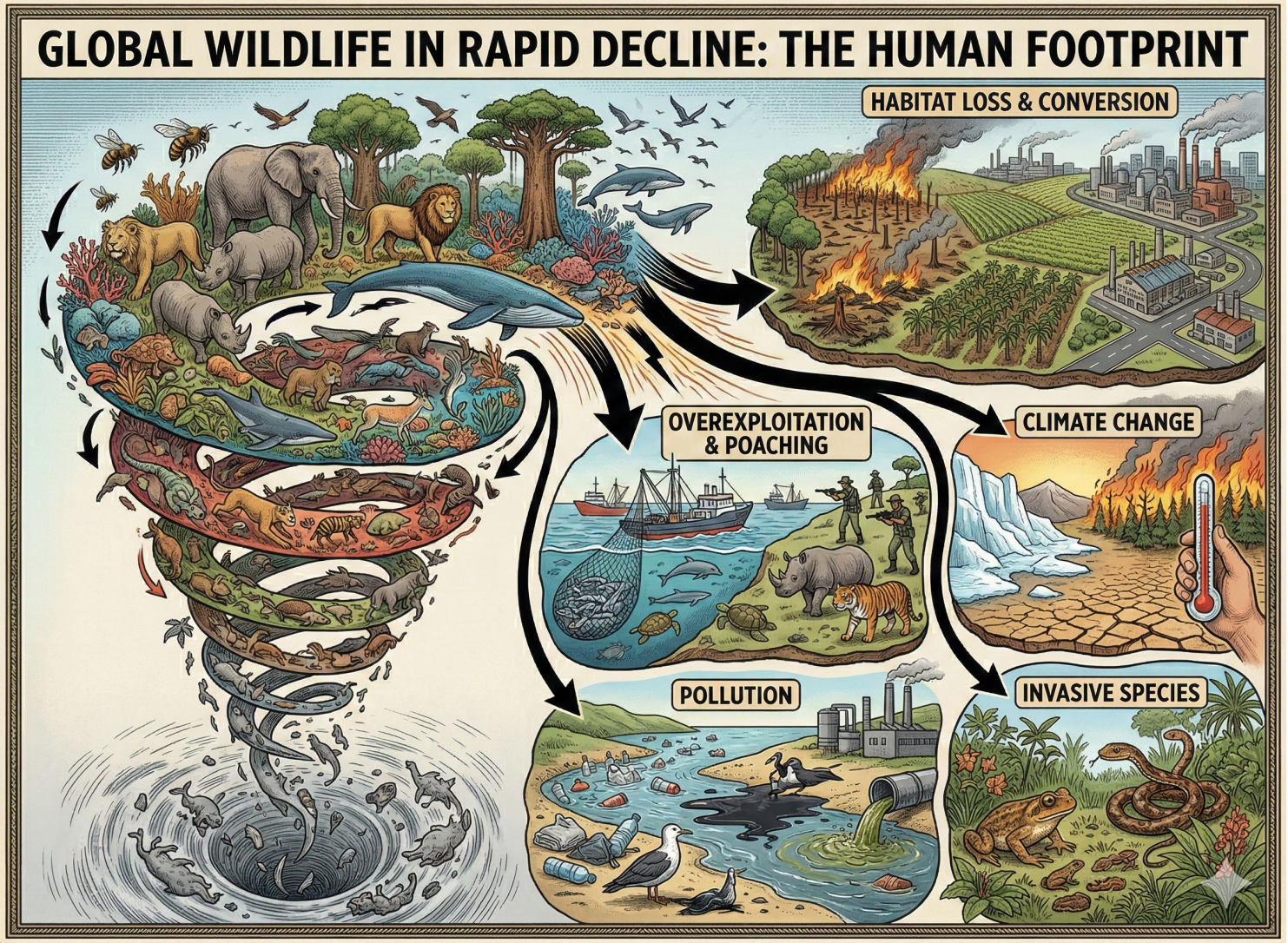
SYSTEMS DYNAMICS OF THE POLYCRISIS: POPULATION OVERSHOOT AS THE CENTRAL DRIVER

Synthesized from the framework of 'Twenty-four reasons why we are hooped' and 'Burning Man'.



Ref: World System Dynamics Model http://worldsdm.wikidot.com/

Human Causes of Biodiversity Loss



- **Catastrophic Population Declines:** Average relative decline of **73%** in 50 years.
- **Severe Regional Impacts:** Losses concentrated in highly biodiverse areas; 95% in Latin America Caribbean.
- **Vulnerable Ecosystems:** Freshwater species populations dropped by **~85%**.
- **Accelerating Extinction Risk:** Approximately **1 million** plant and animal species are currently threatened with extinction—a rate unprecedented in human history.

Twenty-four reasons why we are hooped

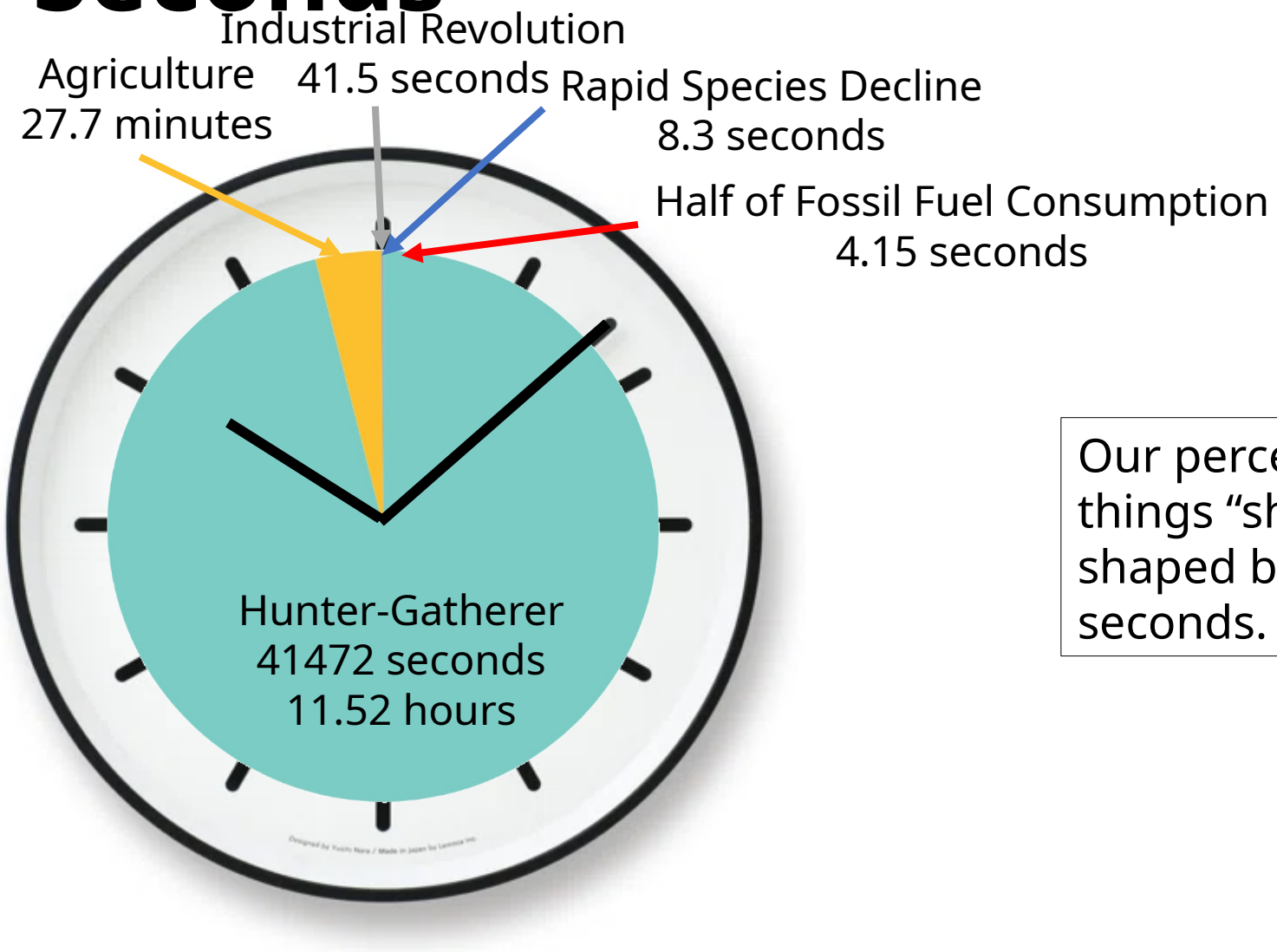
William E. Rees

- Biological and Evolutionary Constraints: *Homo sapiens* have an innate tendency to expand into all available habitat and consume all available resources.
- The Fallacy of Technology and "Green" Solutions
  - Renewable Energy Limitations.
  - Efficiency Paradox (Jevons Paradox).
  - The "Energy Transition" Illusion.
- Cultural and Institutional Failures
  - Neoliberal Economics as Pseudo-Science.
  - Social Constructs vs. Reality: Humans live in "linguistic bubbles“.
  - Collective Denial: We are psychologically predisposed to ignore "inconvenient truths“.
  - Cultural Maladaptation: Our current "Modern Technological Industrial" (MTI) culture is behaving like a "mega-psychopath“.
- Ecological Overshoot and Collapse
  - Overshoot as the Meta-Crisis: Climate change is merely a *symptom* of overshoot.
  - We are living on "natural capital" rather than "natural interest“.
  - The Sixth Mass Extinction: Human biomass now dwarfs that of all other wild mammals/birds combined.

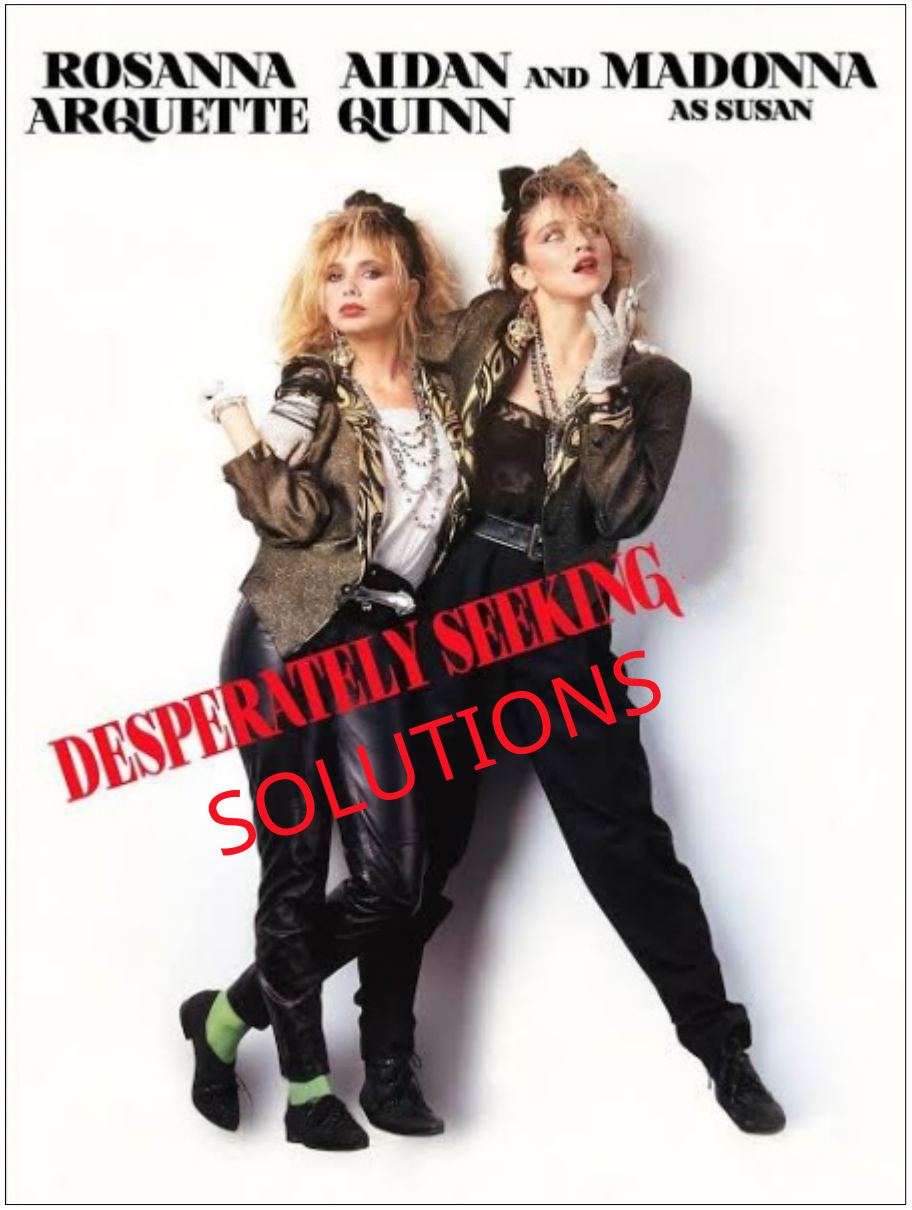
Evidence Required

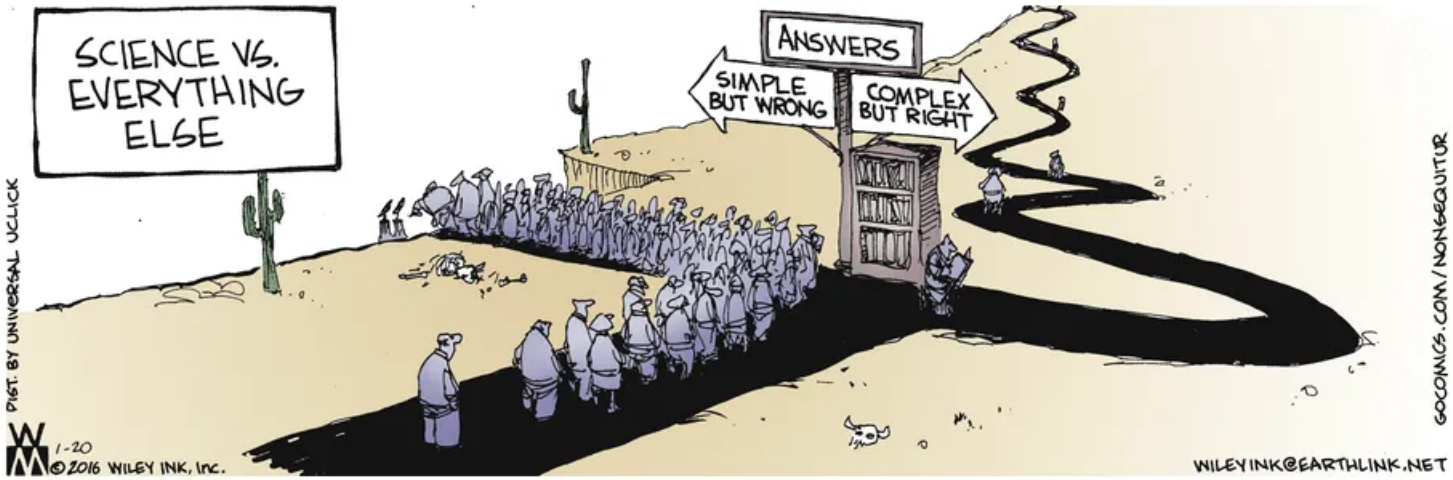
- Society recognizes the dangers of the polycrisis and actively responds.
- World leaders become convinced that growth cannot continue.
- People reduce consumption to ~1% of current levels.
- Biodiversity restored.

Human History in 12 Hours = 43200 Seconds



Our perception of the way things “should be” has been shaped by the last 10 seconds.





“The real problem of humanity is the following: We have Paleolithic emotions, medieval institutions and godlike technology. And it is terrifically dangerous, and it is now approaching a point of crisis overall.”

— Edward O. Wilson

Summary

- Physical Constraints
  - Renewables deliver usable energy ~100–300× more slowly than fossil fuels (rate limit).
  - Minerals + mining throughput don’t scale: at current rates, meeting projected needs would take centuries–millennia.
  - No renewable pathway has shown fossil-free self-replication (build/maintain/replace itself end-to-end).
- Economic Realities
  - Despite claims of cost competitiveness, renewables provide only 5% of total global energy.
  - Last decade fossil growth exceeds all historical renewable output.
  - Efficiency gains often raise total energy use (Jevons/rebound).
- Ecological Impact
  - Humanity is in deep overshoot across multiple planetary boundaries.
  - Wildlife populations have declined 73% since the 1970s.
  - Today’s energy use equals ~200× what human labor alone could supply.
  - Both continued fossil fuel use and attempted renewable transition will further damage Earth’s life support systems.

References

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- Sagan - *The Demon-Haunted World: Science as a Candle in the Dark*
- Michaux - *The Mining of Minerals and the Limits to Growth*
- Garret - *Rebound, Backfire, and the Jevons Paradox*
- Murphy - *Energy and Human Ambitions on a Finite Planet*
- Rees - *Twenty-four reasons why we are hooped*
- Surendran - *The Limits to the Energy Transition*
- Jacobson – *Choking on Hope*
- Smith - *We Want One Solution, But One Solution Can't Solve Our Polycrisis*

[Consciousness of Sheep](https://consciousnessofsheep.co.uk/)
[Post doom](https://postdoom.com/)
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