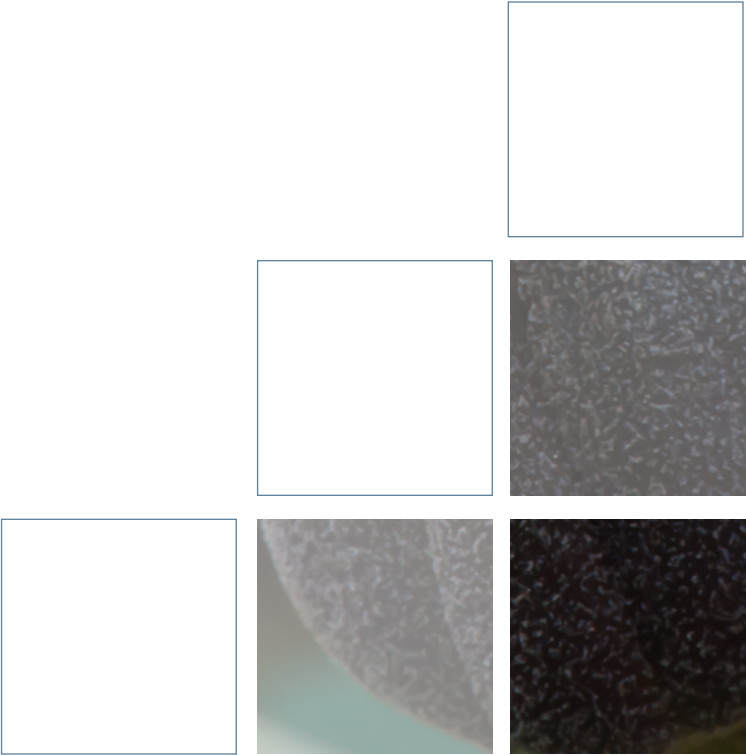


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WEALTH

**The Human Epoch:
A World Without End**

October 2017



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Human Epoch



- “Let there be Light” - Energy, a measure of human civilization or .5 Zj per annum

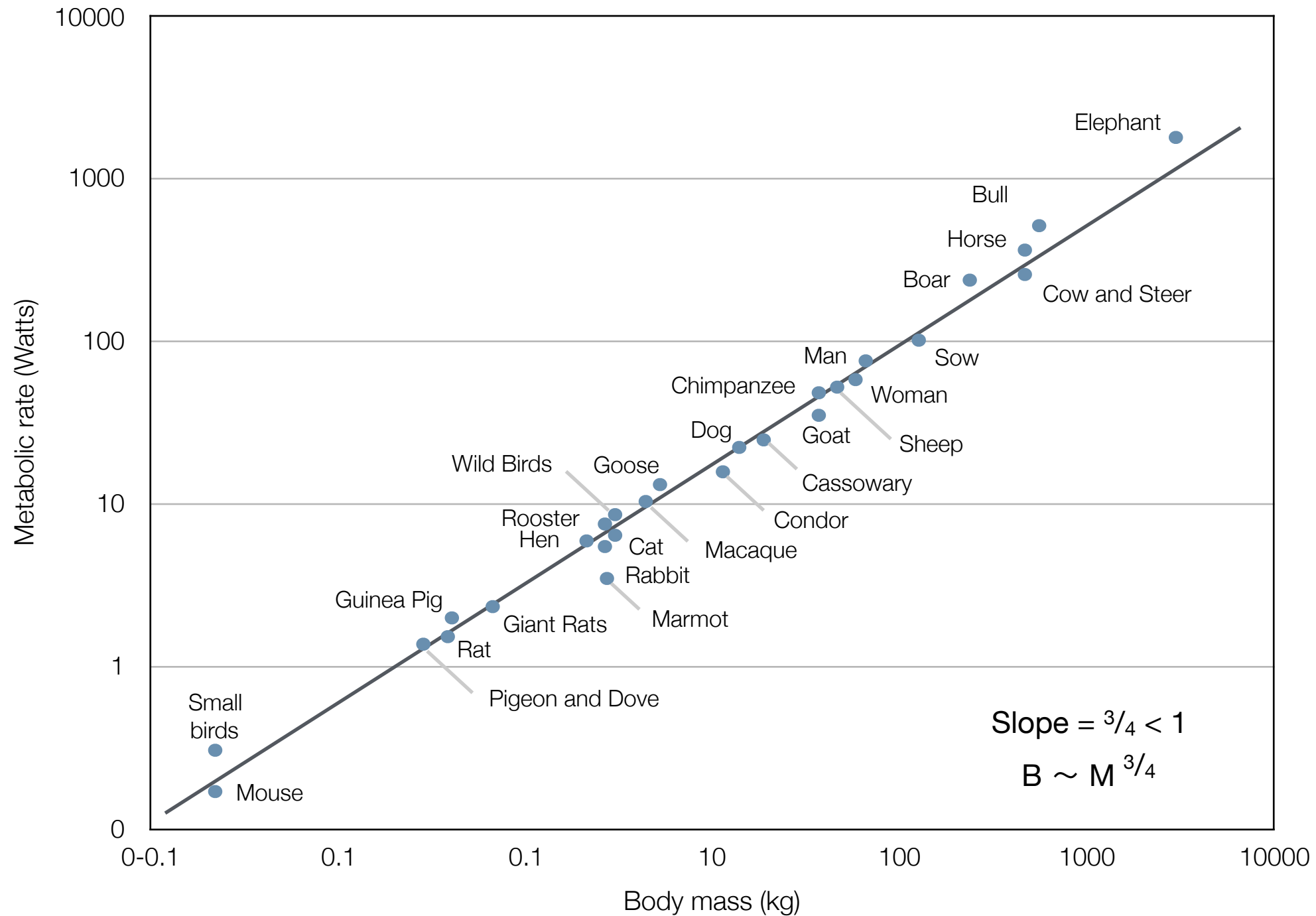
Sources:

* NASA - *The Earth at Night*

Biological life and socio-economic life

- Relationship between biological life and socio-economic life is based on two varying curves: biological curve is sub-linear, that gains efficiency in size, and finite. Socio-economic curve is exponential, open-ended, and infinite.
- Our open-ended infinite growth paradigm is based on a continual growth of consumption and credit, effectively an exponential function.
- This model is based on a surplus energy system that is amplified by a global monetary system based on credit, which is the means for delaying payment, servicing the borrowed principal and allowing us to scale up our consumption today. This combination has massively speeded up economic growth giving us our current standard of living.
- It is the imbalance between the growth curves of biological life and socio-economic life that we need to address.

Biological life's slope of life sub-linear

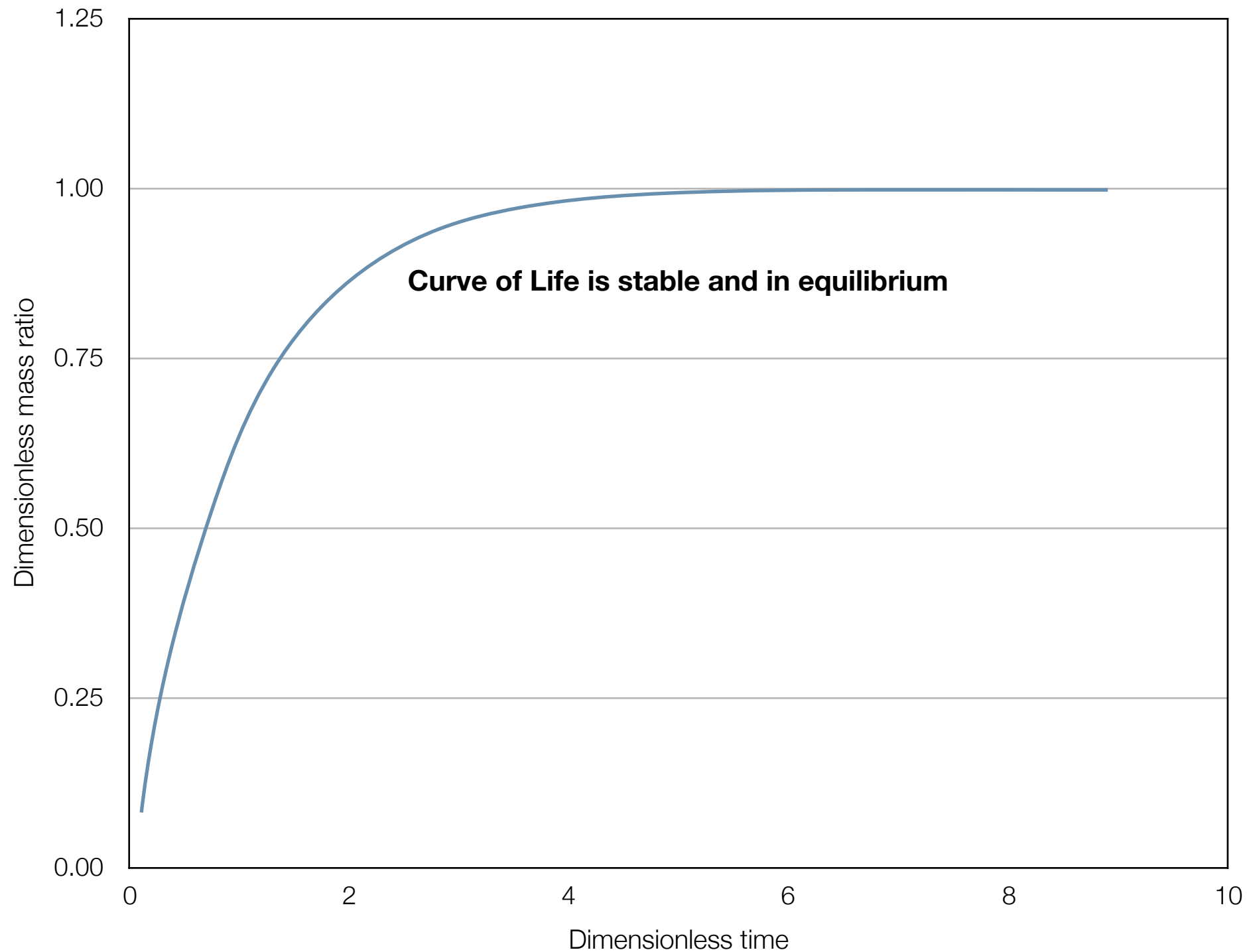


Sources:

1. Scale by Geoffrey West

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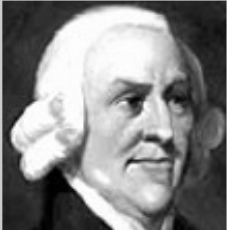


Biological life's finite lifespan



Sources:

1. Scale by Geoffrey West

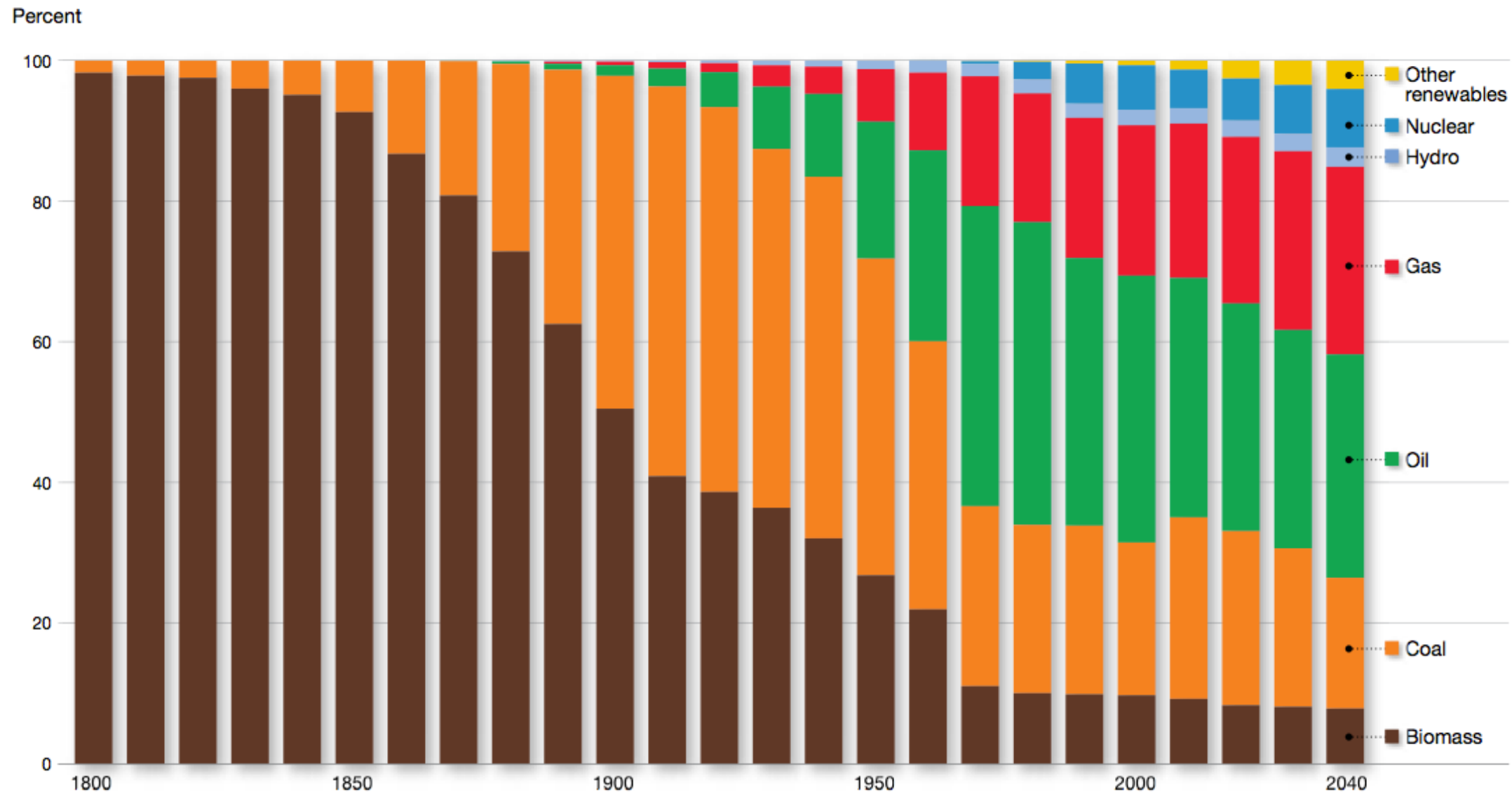
Definitions of socio-economic growth

		Growth	Components	Formula
	Adam Smith	Classical Economic Growth (Factors of Production)	<ul style="list-style-type: none"> • Land • Capital • Natural resources 	$FP = f(L, C, N)$
	Simon Kuznets	Economic Growth (Gross Domestic Product)	<ul style="list-style-type: none"> • Consumption • Investment • Government Spending • Net Exports 	$Y = C + I + G + NX$
	Mike Milken	Current Economic Growth Model	<ul style="list-style-type: none"> • Financial Technology • Human Capital • Social Capital • Real Assets 	$P = Ft \times (HC + SC + RA)$
	Clarmond	Internal Model	<ul style="list-style-type: none"> • Total Primary Energy Surplus • Monetary System 	$Output = f(TPES, MS)$

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The Fossil Fuel Age

- There have been three surplus energy transitions in the last 150 years, from biomass to coal, from coal to oil and from oil to natural gas ... each energy upgrade resulted in a change in energy leverage.



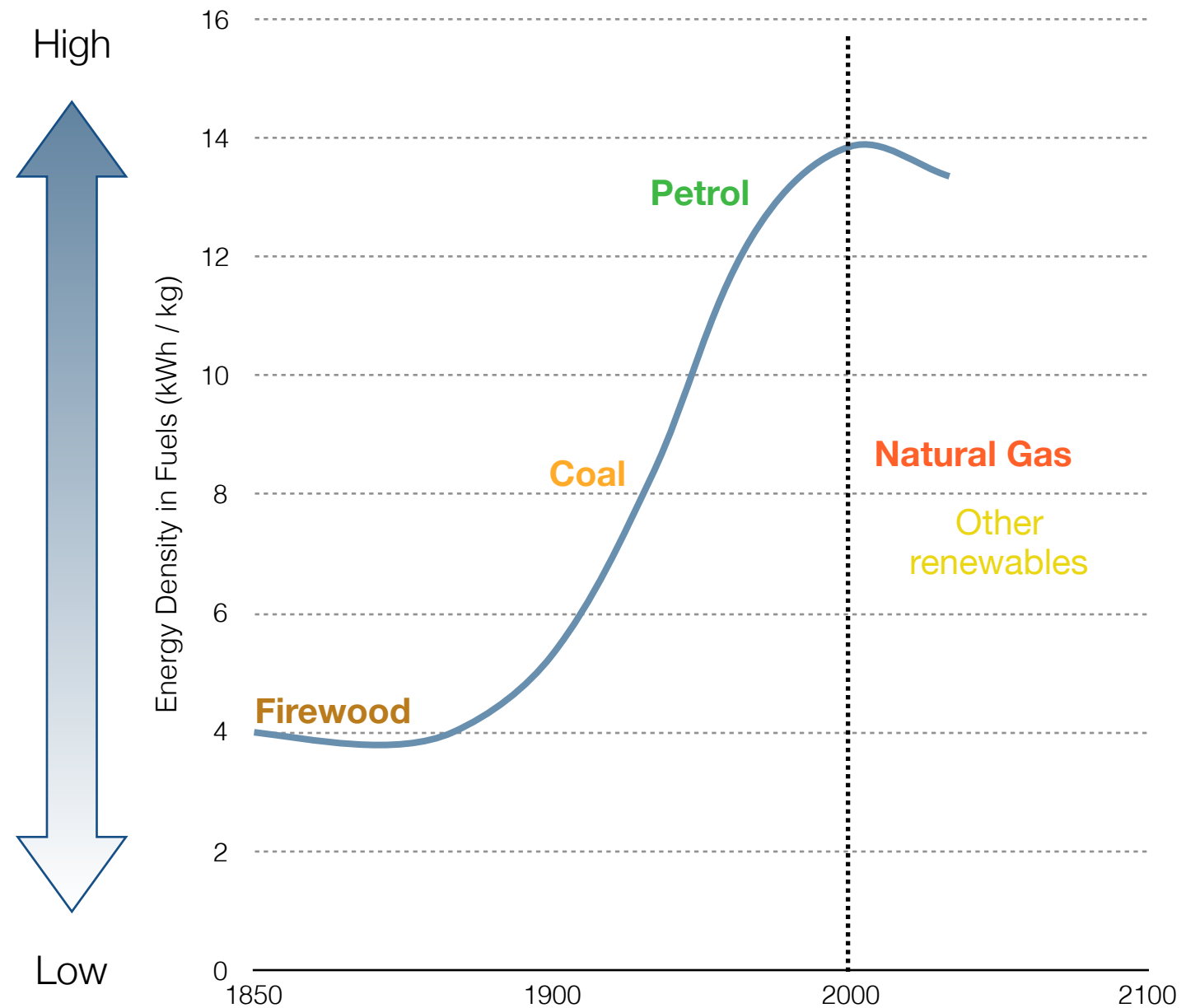
Sources:

1. Vaclav Smil - "Energy Transitions, History and Requirements" (2010).

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Energy System Leverage

Energy Carrier	Calorific value (kWh/kg)
Propane	13.8
Petrol	13.0
Diesel oil	12.7
Kerosene	12.8
Heating Oil	12.8
Natural gas	10.6
Coal	8.0
Firewood	4.4
Hydrogen	2.4



Sources:

1. *Energy Densities: Why they matter for sustainable transitions* by Andres Bucio, Noel Longhurst, Jeppe Graugaard.
2. *Biomass Energy Centre*

Monetary System Leverage (4th and 5th)

	1945-1971	Post-1971
International Money	Gold	HQC (US Treasury)
Money	USD (backed by Gold)	USD
Credit	Bank-based	Market-based
Capital Account	Closed	Open
Trade	Managed	Global

- International Money: The means of final payment (Reserve)
- Money: The means of domestic settlement
- Credit: The means of delaying payment
- Capital Account: The flow of money
- Trade: The flow of goods and services

- Monetary System: there have been five monetary systems in the Fossil Fuel era - we are currently in the 5th. The 5th monetary system, is based on globalized credit, with a high quality collateral at its core, acts as an amplifier to the surplus energy system.

Sources:

1. "Inherent Hierarchy of Money" Perry Mehrling, Jan. 2012.

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5th Monetary System (1971-present)

	1971 - 1985	1985 - present
Credit	Hybrid (Bank & Market)	Dominant Market Finance
Constraint	Reserve ratios	Margin
Regulation	Insured	Non-insured
Funding	National banks	Global money market
Price of Credit	Interest rates	Collateral values

- The means of credit creation
- The liquidity constraint
- The backstop of money
- The access to money
- The price of money

- The 5th monetary system, is based on globalized credit, with a high quality collateral at its core, acts as an infinite amplifier to the surplus energy system.

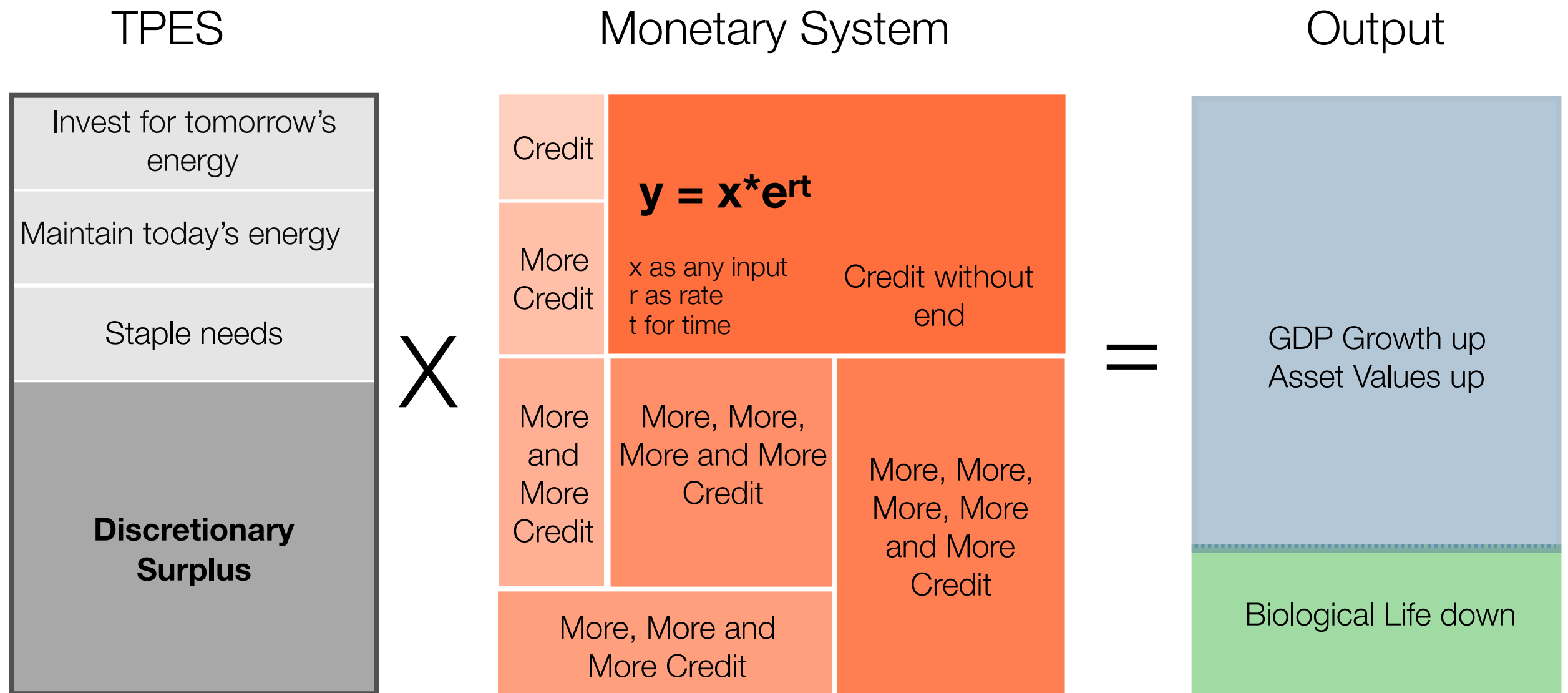
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Money View

- **Credit** reflects **promises to pay** at specific times in the future
- **Finance** is the mechanism for **setting daily valuations** of these credit commitments: **signaled by asset prices**
- **Hierarchical Money** is the means of payment, or **settlement** of credit commitments: **elasticity/discipline constraint**
- The interplay between **promises/valuations/settlements** are the **core relationships** between individuals and institutions globally

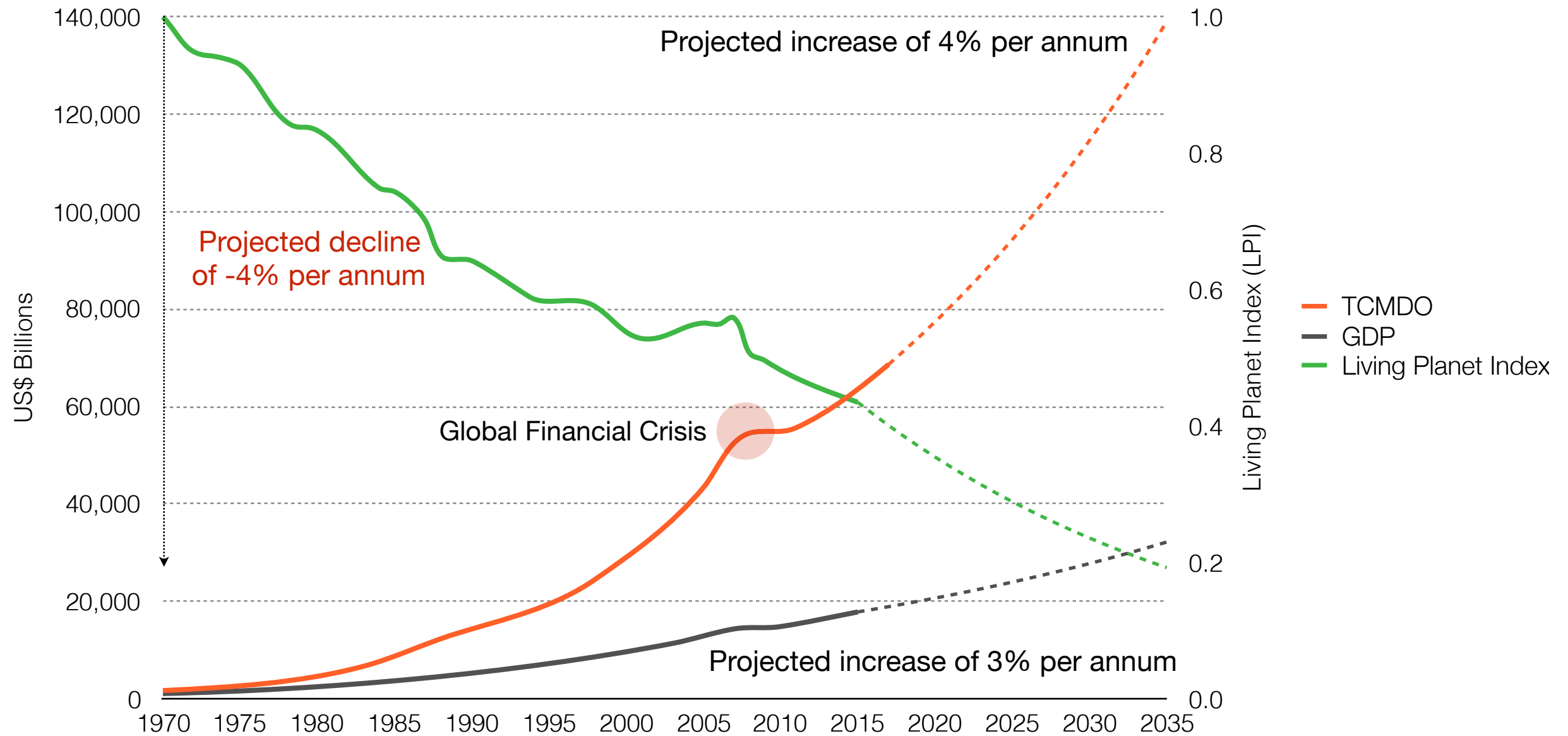
Sources: 'Money and Power,' Perry Mehring 2016

Internal Credit Model of socio-economic Growth



- Humanity aspires to live in a society where all measures of material consumption grows yearly...credit without end.

Credit, Economic Growth and Biodiversity Loss - 75 yrs



Notes:

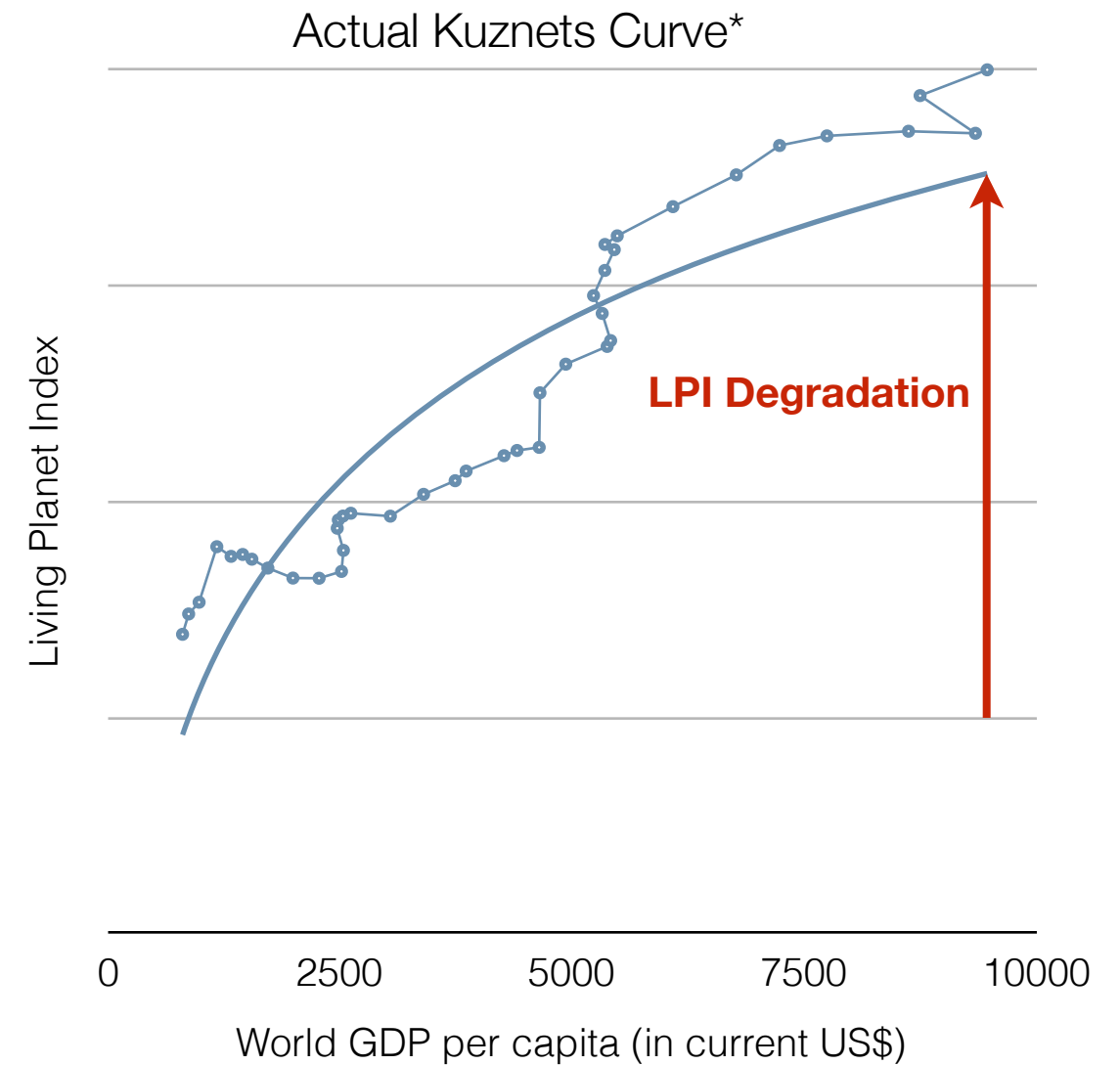
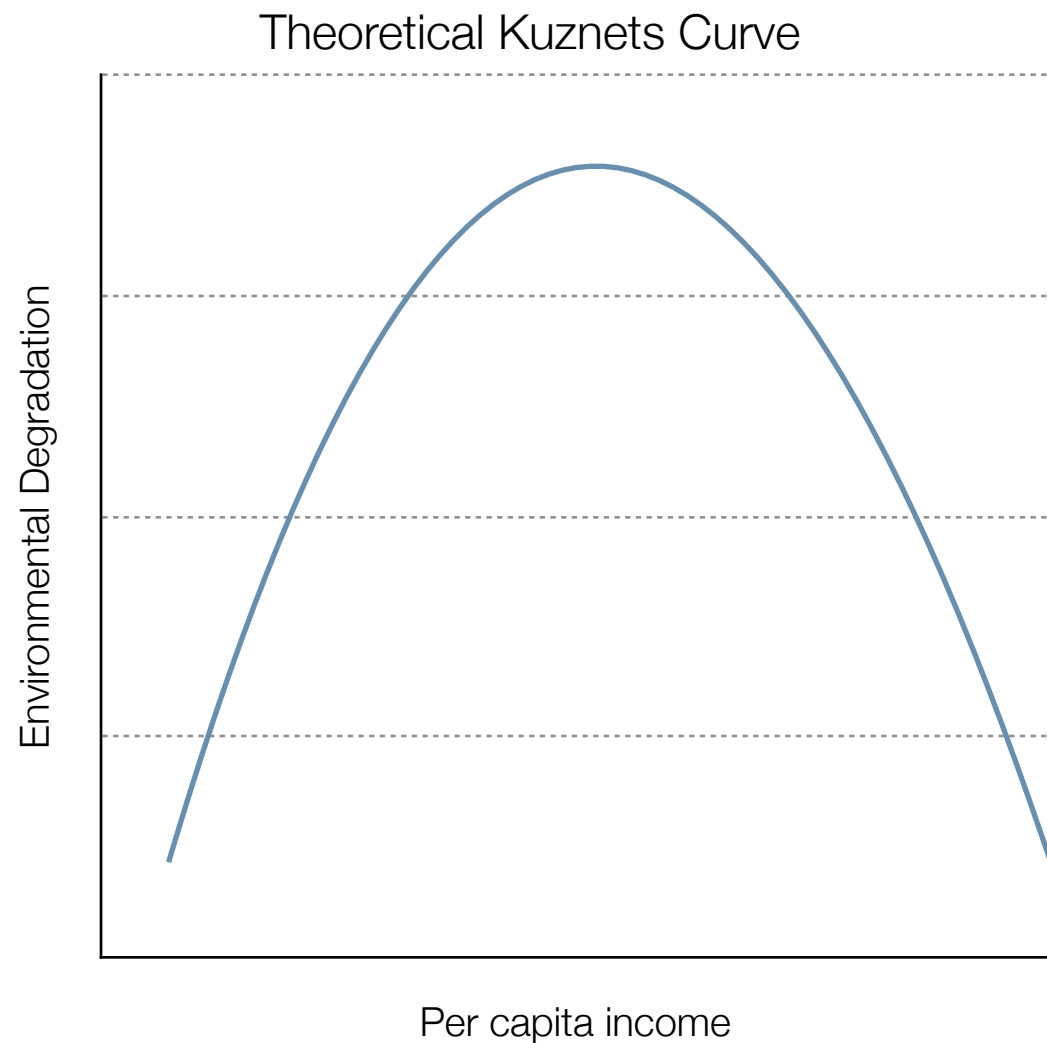
* Total Credit Debt Market Owed Annually since 1970, not seasonally or inflation adjusted. Projected growth rate of 4% from 2016.

Gross Domestic Product since 1970, Fiscal years since 1970, not seasonally or inflation adjusted. Projected growth rate of 3% from 2016.

Sources:

1. Federal Reserve Economic Data - FRED - St. Louis Fed

Waiting for Kuznets Environmental Economic Curve

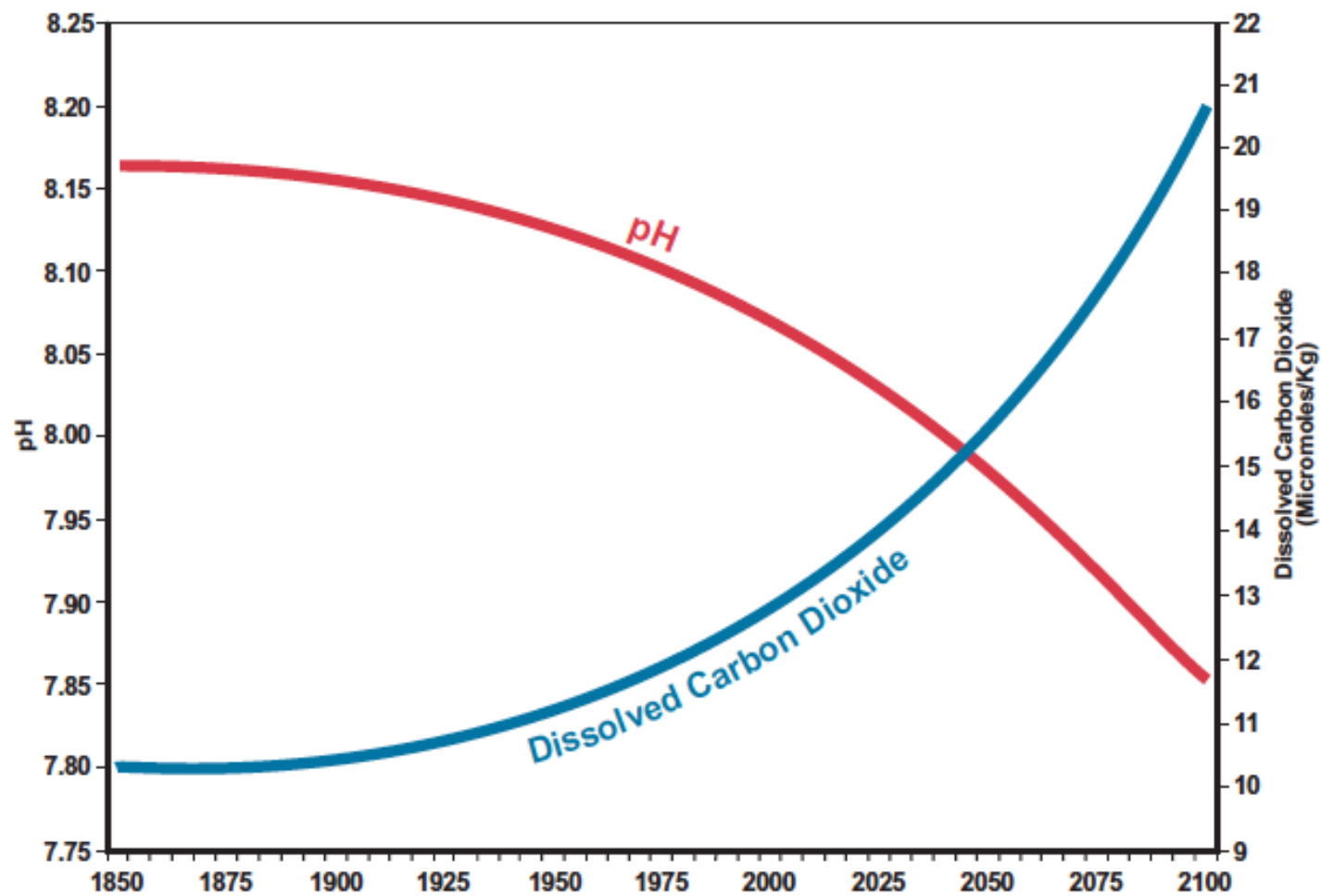


- 2nd Law of Thermodynamics: Entropy - order creates disorder our in our socio-economic model - waste

Sources:

1. *The Environment Kuznets Curve* by James van Alstine and Eric Neumayer
2. *World Bank Data*

Biodiversity Declines - Ocean Acidification



Heat-damaged Coral

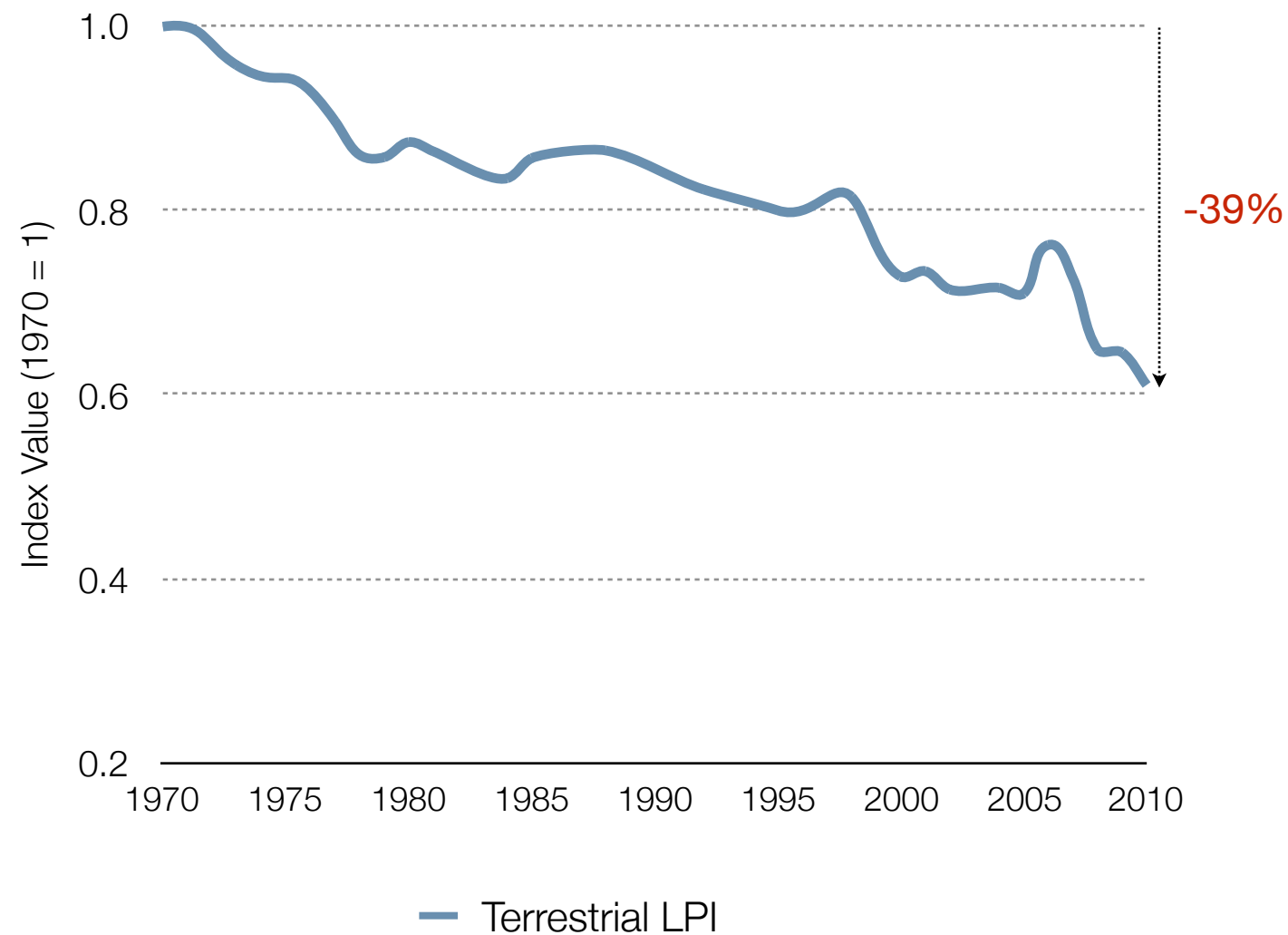
Image by National Geographic (Picture by Peter Essick)

Sources:

1. *Carbon Dioxide and Our Ocean Legacy* by Richard A. Feely, Christopher L. Sabine, and Victoria J. Fabry

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Biodiversity Declines - Terrestrial



Deforestation

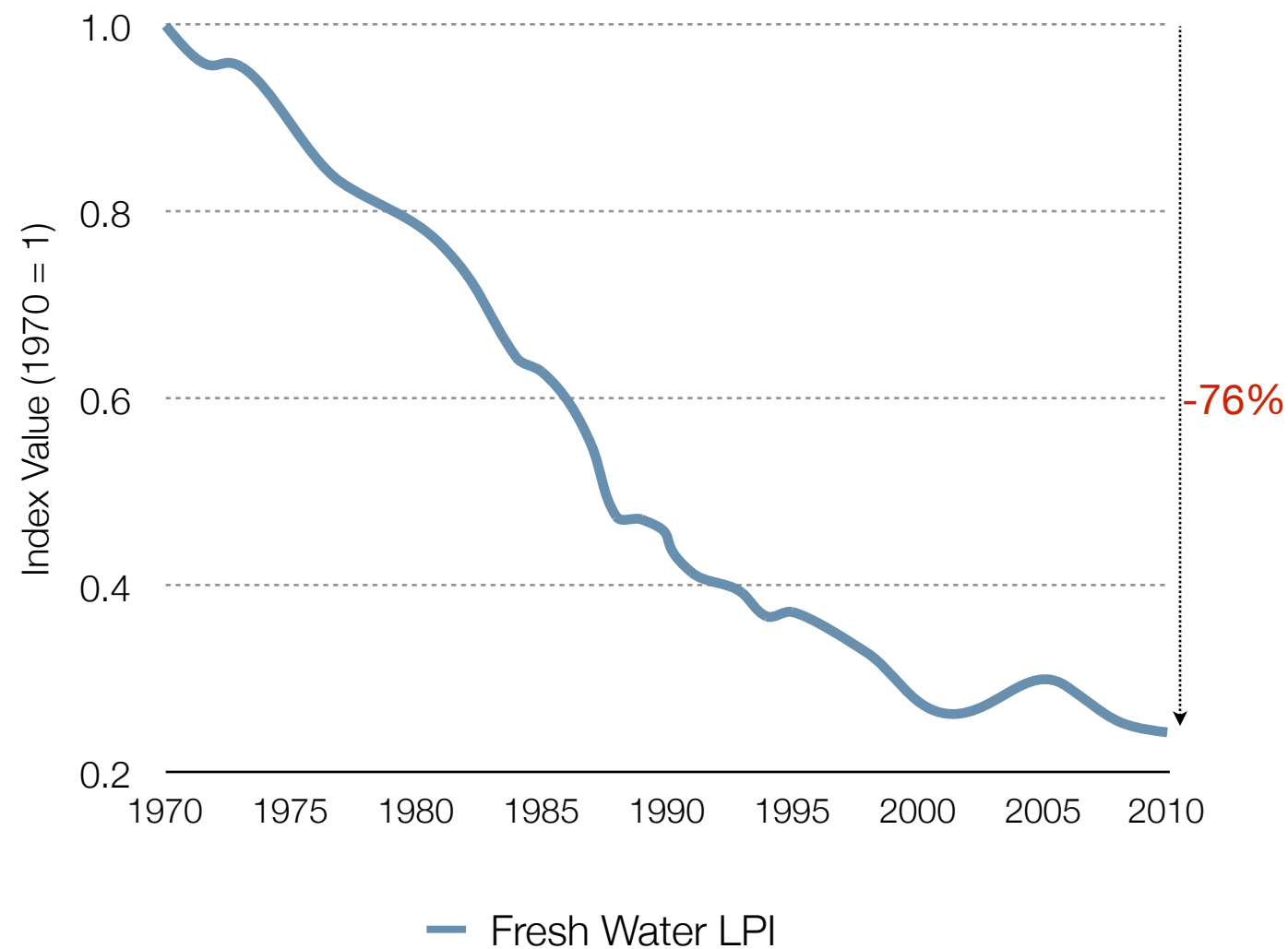
Image by National Geographic (Picture by Mark Moffett)

Sources:

1. Zoological Society of London and WWF

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Biodiversity Declines - Fresh Water



Algae Outbreak Threatens Aquatic Life

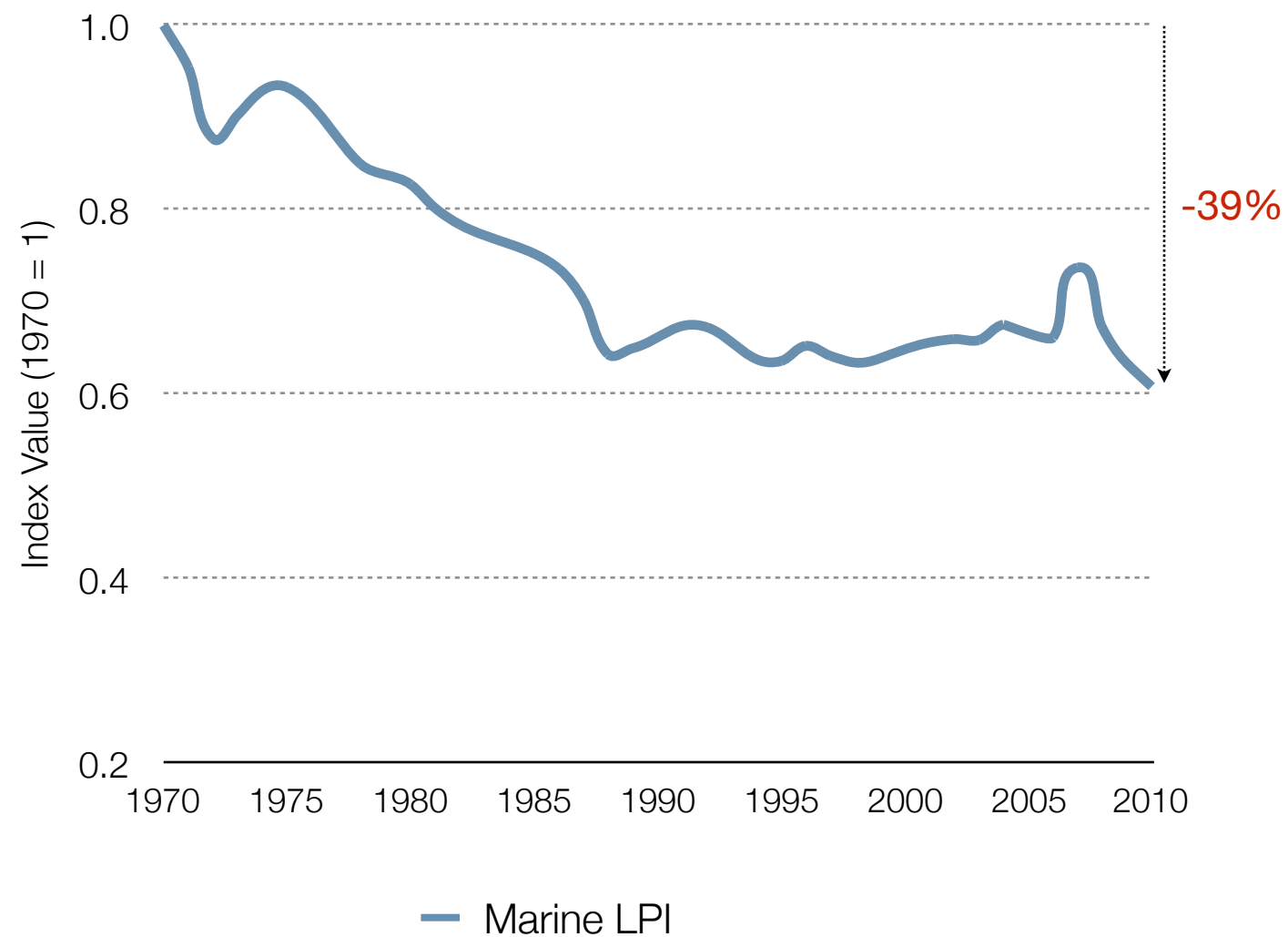
Image by Reuters/Jianan Yu

Sources:

1. Zoological Society of London and WWF

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Biodiversity Declines - Marine



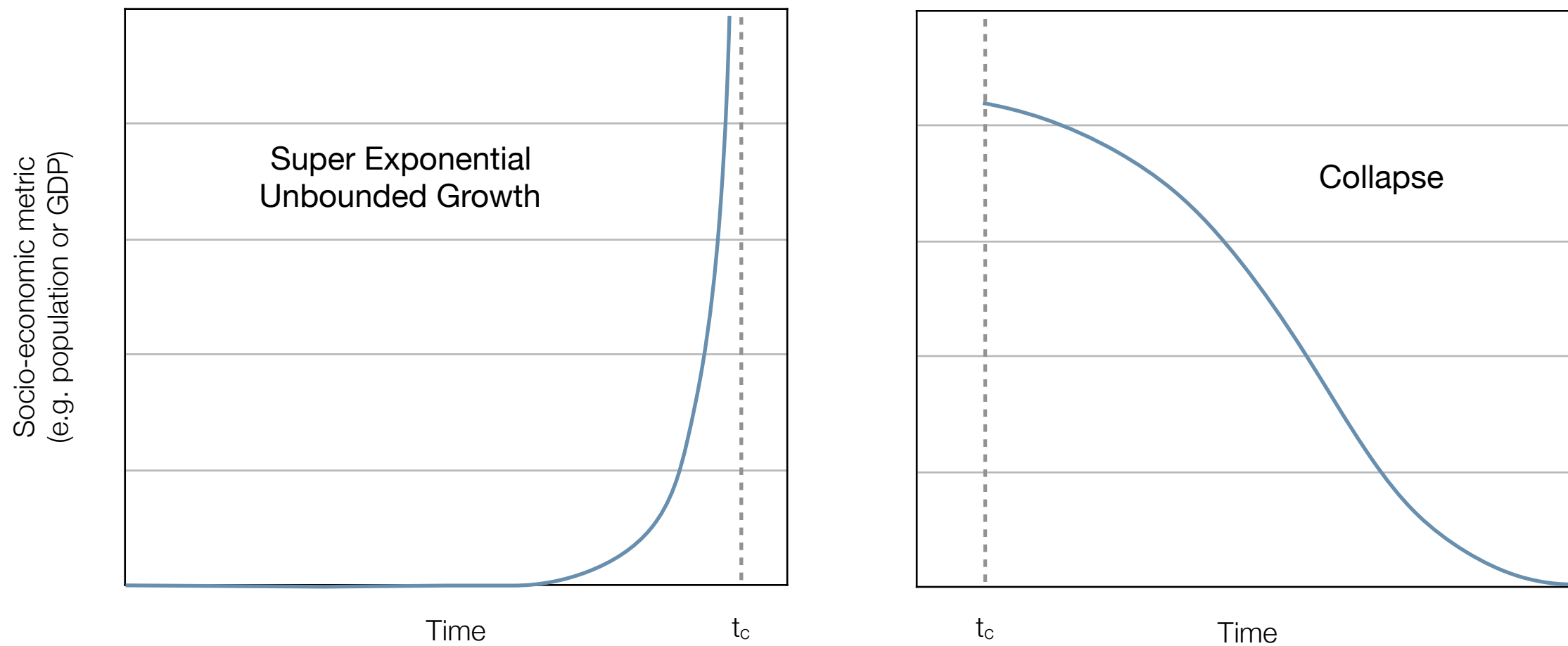
Overfishing

Image by National Geographic (Picture by Jose Luis Roca)

Sources:

1. Zoological Society of London and WWF

Socio-economic exponential curve

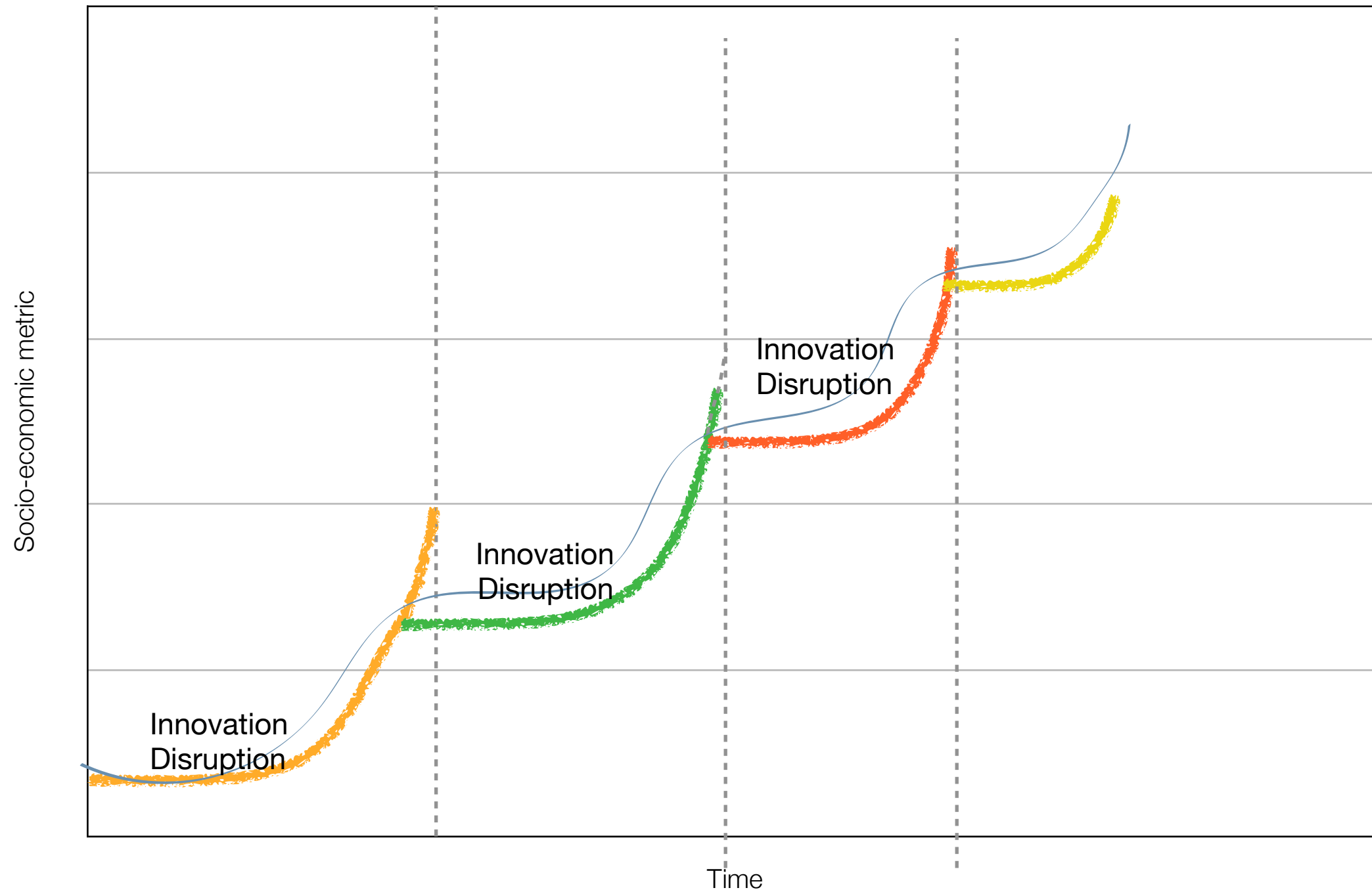


- An unbounded growth curve is one of a virus that ends in collapse

Sources:

1. Scale by Geoffrey West

Series of socio-economic J-curves



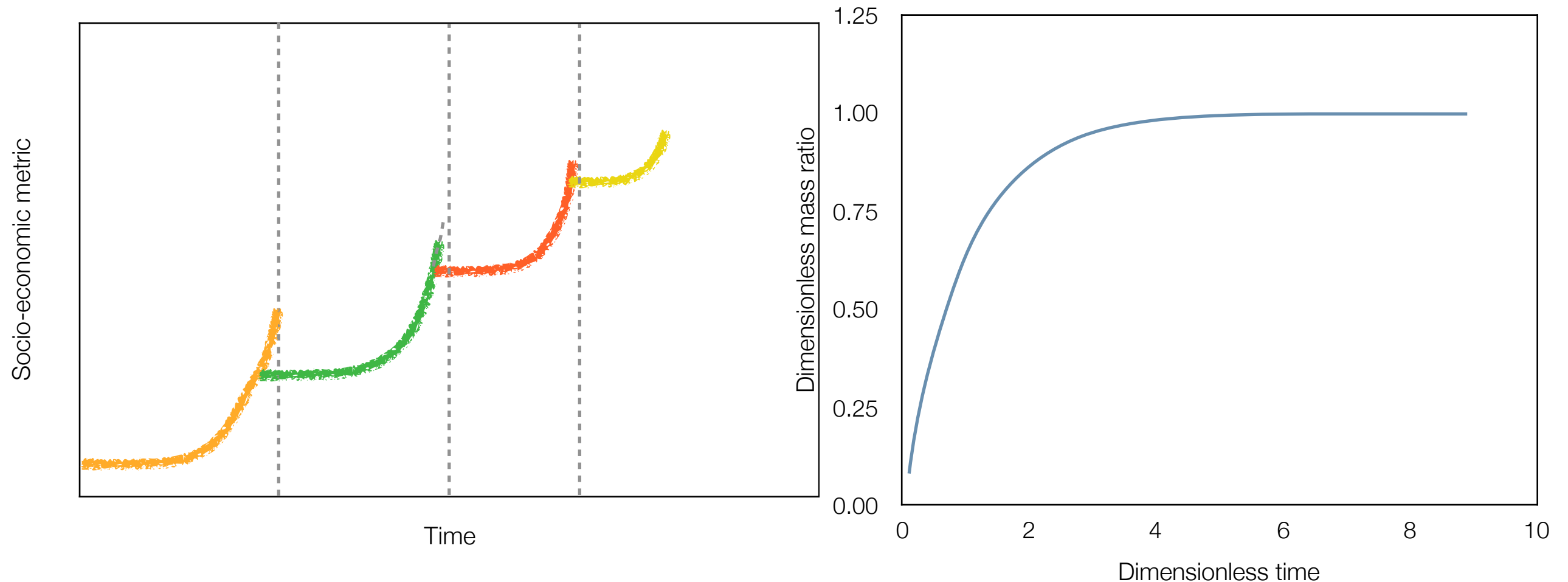
- We are driving a F1 without brakes (credit), with foot on the accelerator, and then leaping into a faster going F1.

Sources:

1. Scale by Geoffrey West

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Balancing the exponential with the sub-linear



- Humanity aspires to live in a society where all measures of material consumption grows yearly...credit without end.

Sources:

1. *Scale* by Geoffrey West

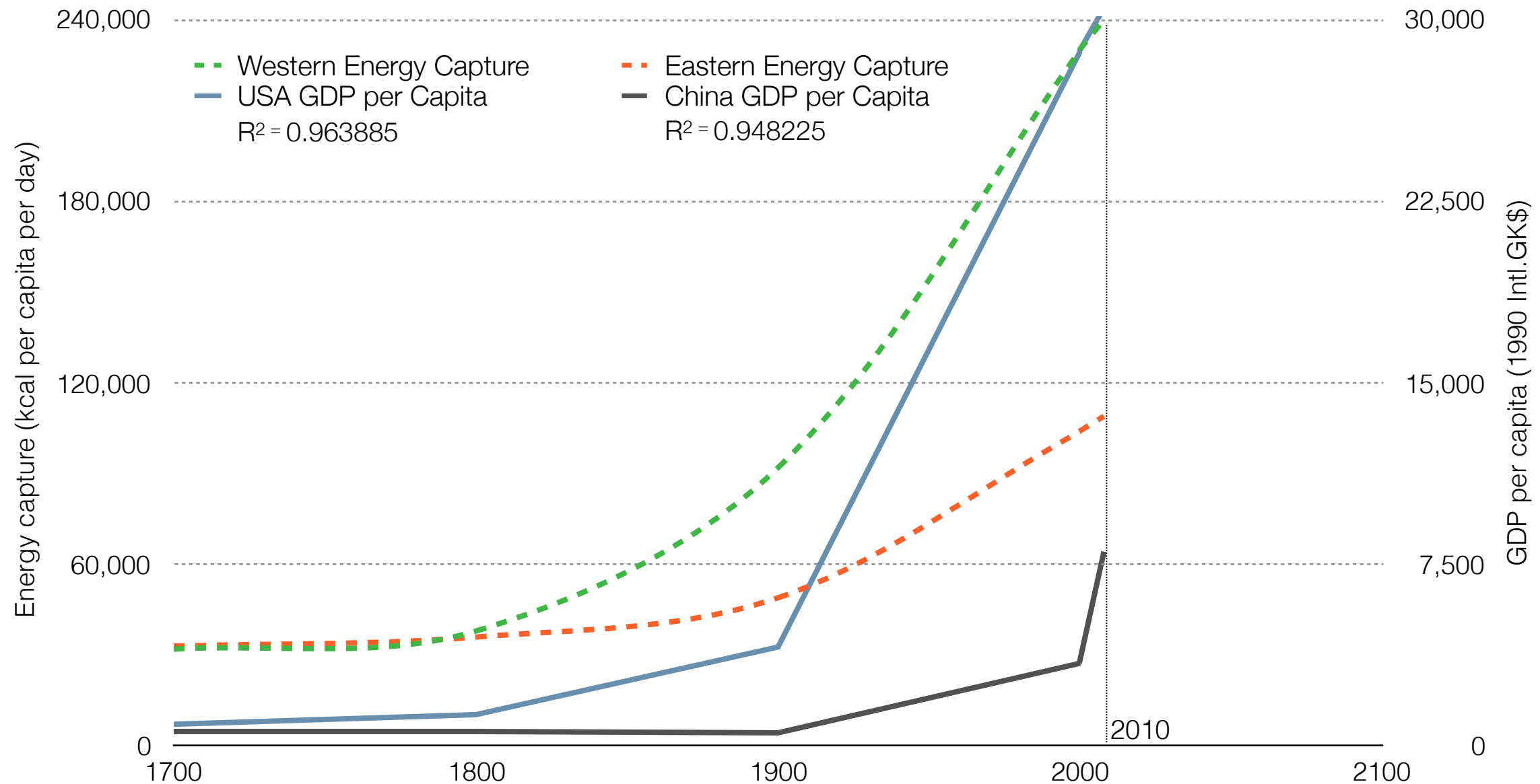
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Conclusion

- If the growth models remains on the path of credit and consumption with innovation moving up in an accelerating manner we shall remain on the path of World without End, leaving chunks of society behind and eliminating much biological life
- The angst of the others left behind is already being reflected in the political realm
- We need to reassess what socio-economic growth means for the future from super-exponential to sub-linear, focusing on efficiency not accelerating growth and credit; we need to mimic biological systems
- This means tackling the infinite part of the socio-economic equation - the denominator - credit. This has consequences on the current growth paradigm and asset values.

Appendix

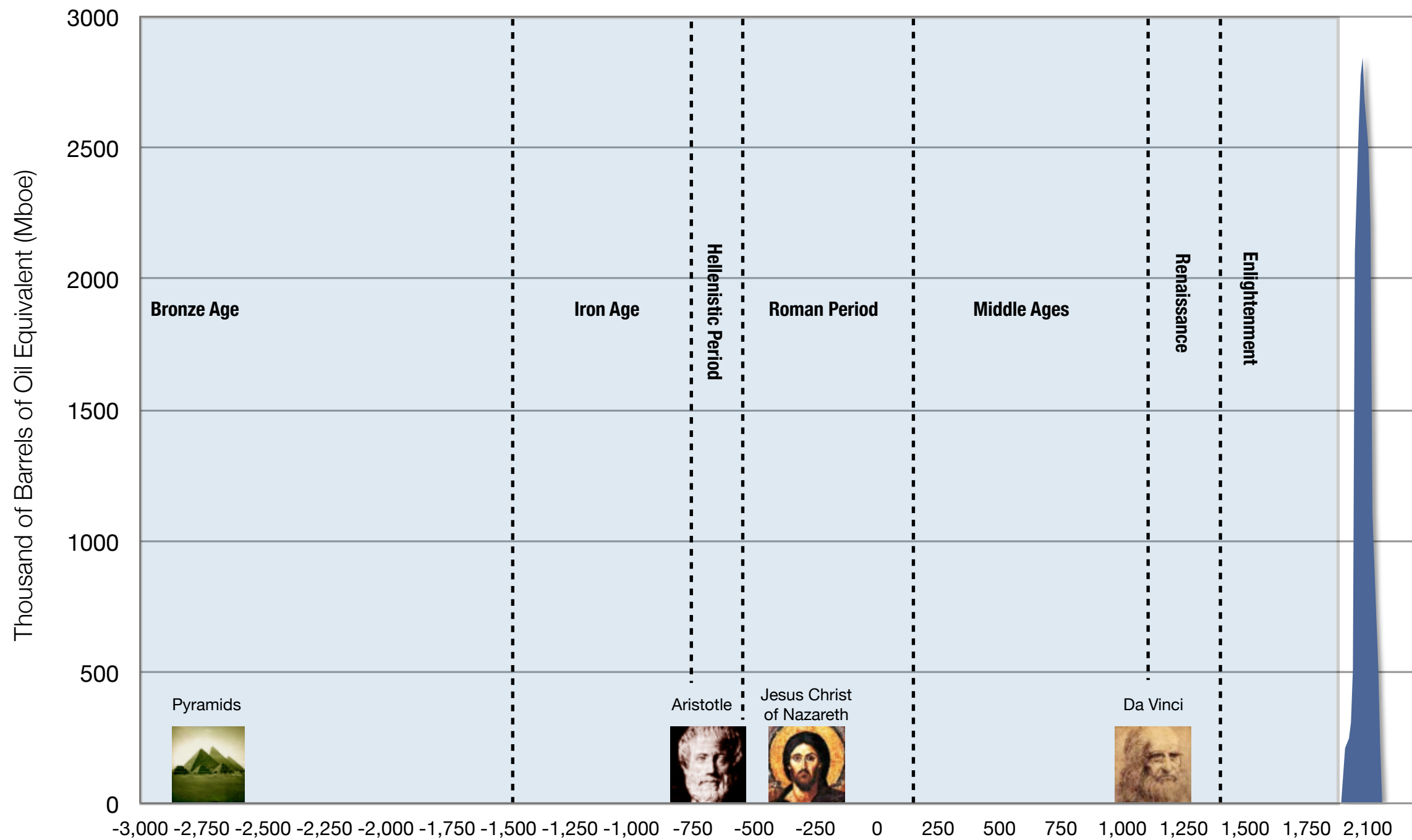
Energy central to Economic Growth

**Sources:**

1. *Social Development by Ian Morris, 'Measure of Civilization'*
2. *Maddison Project Database*

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Historical Blip - A Tail Event



Sources:

1. Tullett Prebon. "Perfect Storm". Timeline Index.

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Our socio-economic size is a multiple

Average Household Energy Consumption Monthly 1000 kWh		
1 gallon gasoline (\$2.5)	33 kWh	28,000 Kcal
30 gallons gasoline (\$75)	990 kWh	850,000 Kcal

Hourly pay	\$0.5	\$1	\$5	\$10	\$100	\$1,000
Monthly pay	\$100	\$200	\$1,000	\$2,000	\$20,000	\$200,000
Global Population	1 billion	3.0 billion	2.5 billion	870 million	120 million	10 million
Energy % Monthly pay	75%	37.5%	7.5%	3.75%	0.375%	0.0375%

- Global energy use 75 billion BOE or .5 Zettajoules
- Bulk of energy used by 1 billion ranging from 100,000-400,000 Kcal a day, so billion are a factor of 2x to 4x version; this is the modern standard of living.
- We are a socio-economic unit not just a metabolic unit, need to measure accordingly

Sources:

1. World Bank

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The Fossil Fuel Age

- Hyman G. Rickover, the four Star American Admiral and ‘father of the nuclear naval fleet’ gave a speech nearly sixty years ago (1957) titled ‘Energy Resources and Our Future’ in which he stated:
- *“We live in what historians may some day call the Fossil Fuel Age...fossil fuels, being coal, oil, and natural gas, resemble capital in the bank. A prudent and responsible parent will use his capital sparingly, a selfish and irresponsible parent will squander it in riotous living.”*



Admiral Hyman G. Rickover

Sources:

1. Clarmond Market Comments: The Devil's Excrement

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