Ecological economics

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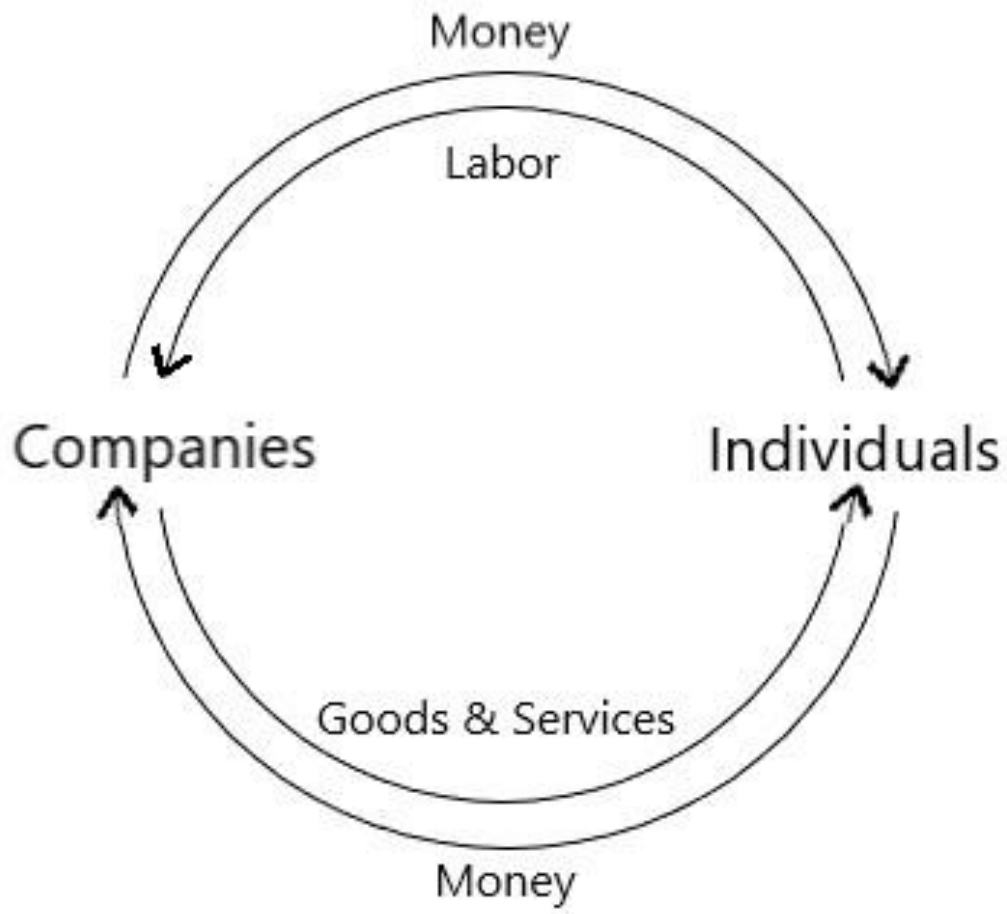
Circular model of neoclassical economics



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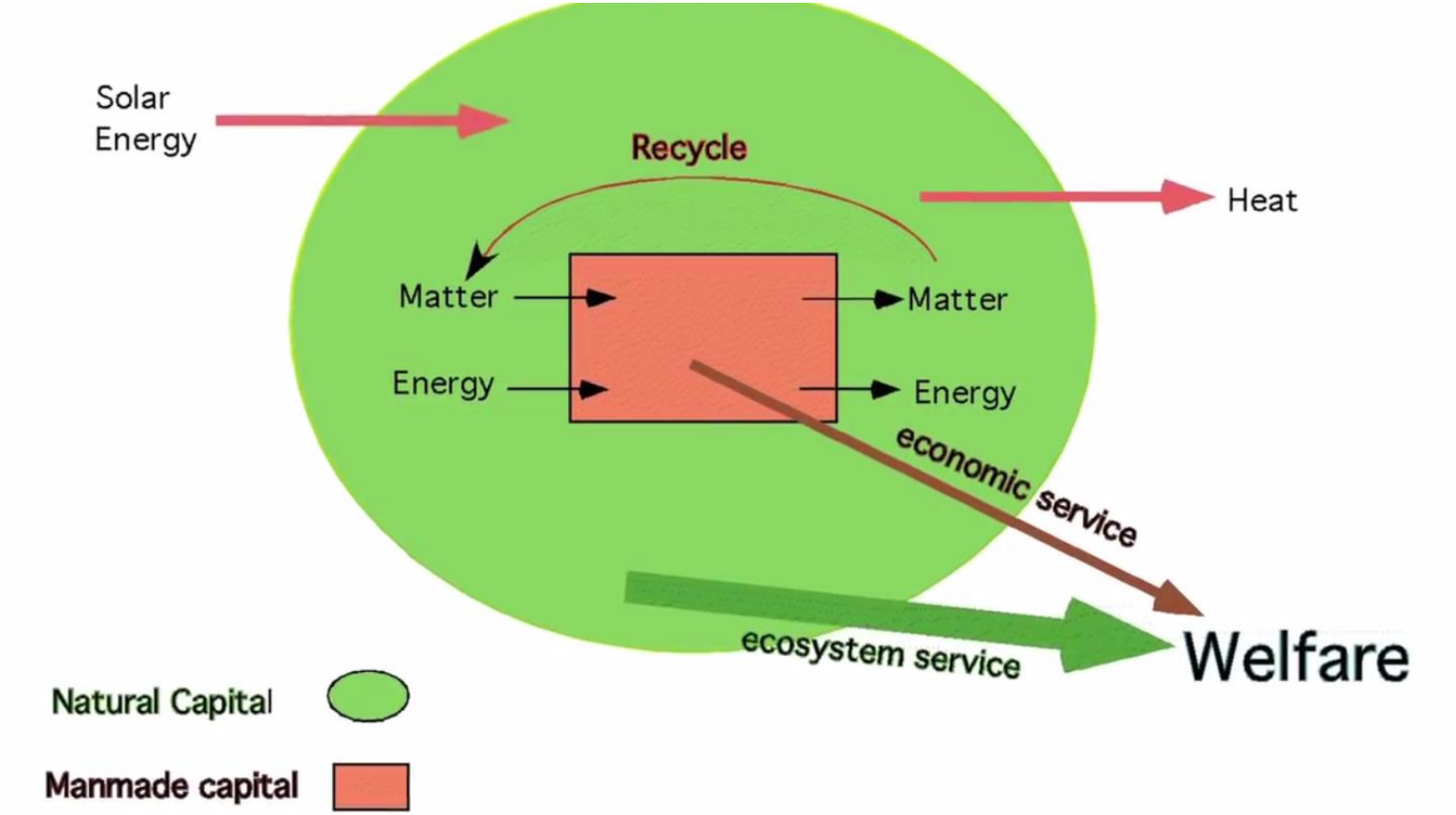
Mindset of traditional economics



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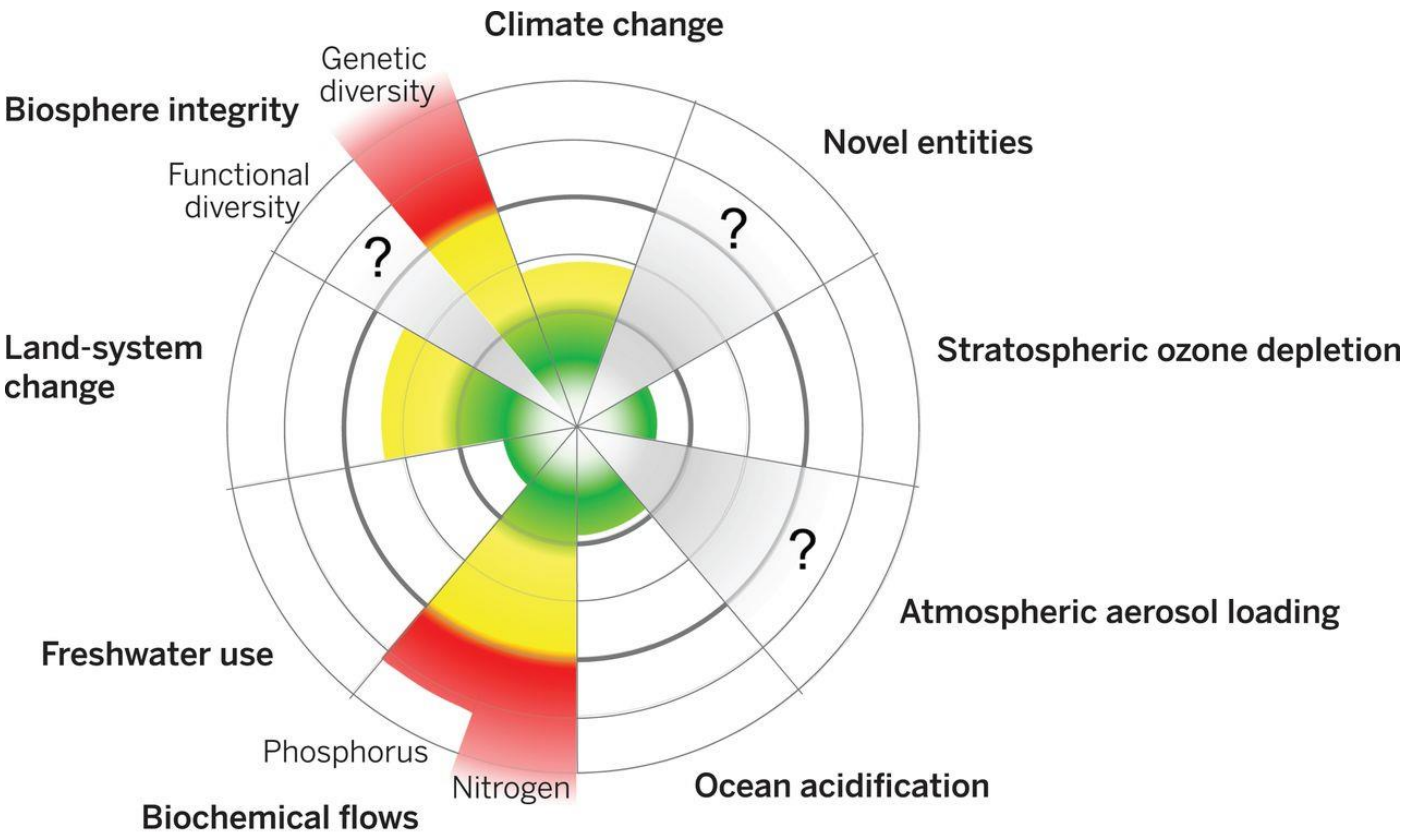
Planetary boundaries



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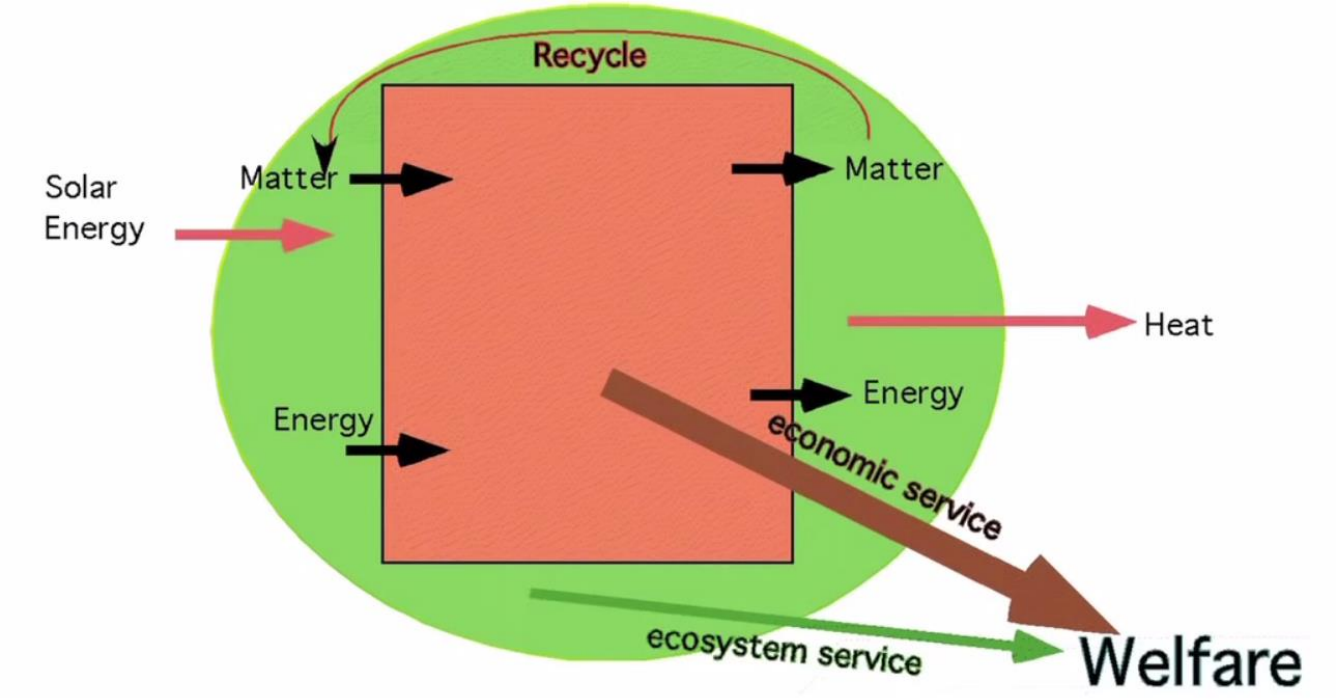
Modern 7bn people world – economy embedded in the nature



=> Ecological economics as an (less homogenous) interdisciplinary normative approach integrating environment and economics, emphasizing physical limits of our planet.

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System theory

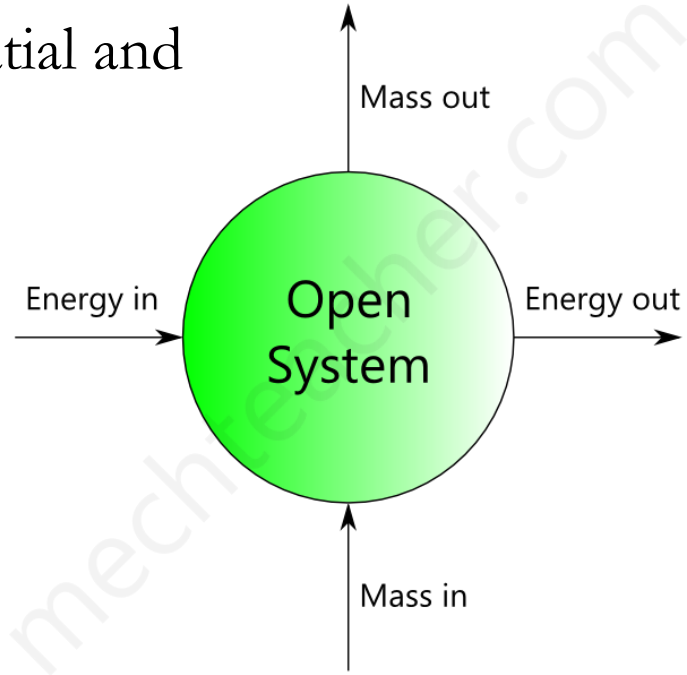
= An interdisciplinary theory about the nature of complex systems in nature, society, and science, and is a framework by which one can investigate and/or describe any group of objects that work together to produce some result.

= A framework to study the (complex) systems.

= Study of the imputs, outputs and changes in a system under various conditions

System theory

- System = a cohesive conglomeration of interrelated and interdependent parts that is either natural or man-made
- Separated from the environment by spatial and temporal boundaries.
- Matter or energy is exchanged among components of the system and its environment.
- Reservoir – storage of material.
- Inputs – outputs = net flux



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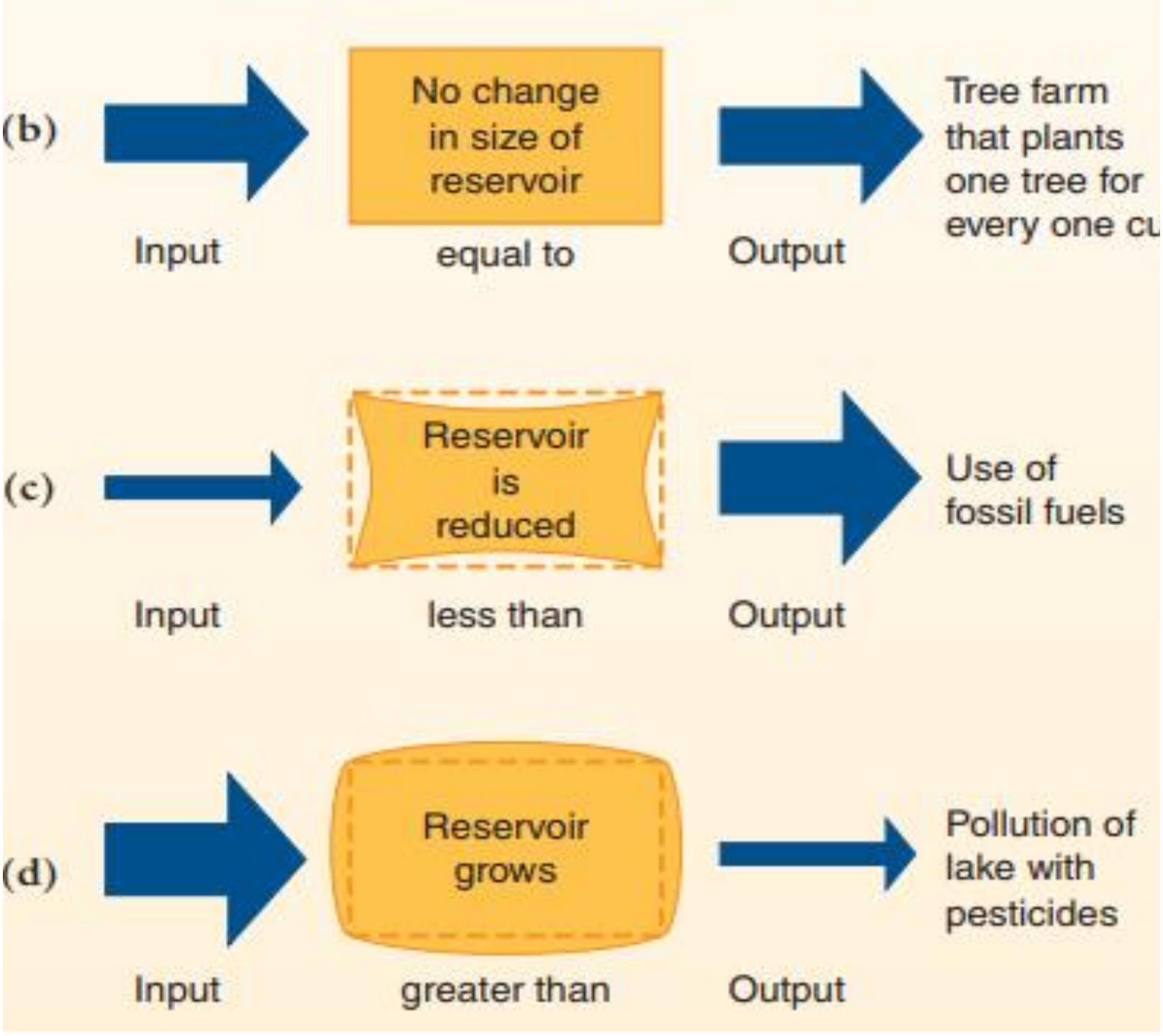
System theory

- Steady state - when net flux = 0
- Mean Residence Time (MRT) – average time a typical molecule remains in the systém (volume of the pool/flux in or out).
- Resilience – tendency of the system to return or remain in the steady state.
- A tipping point – a treshold where the system cannot return to the steady state.
- Natural or man-made.
- Open vs. closed systems.
- Earth as a system.

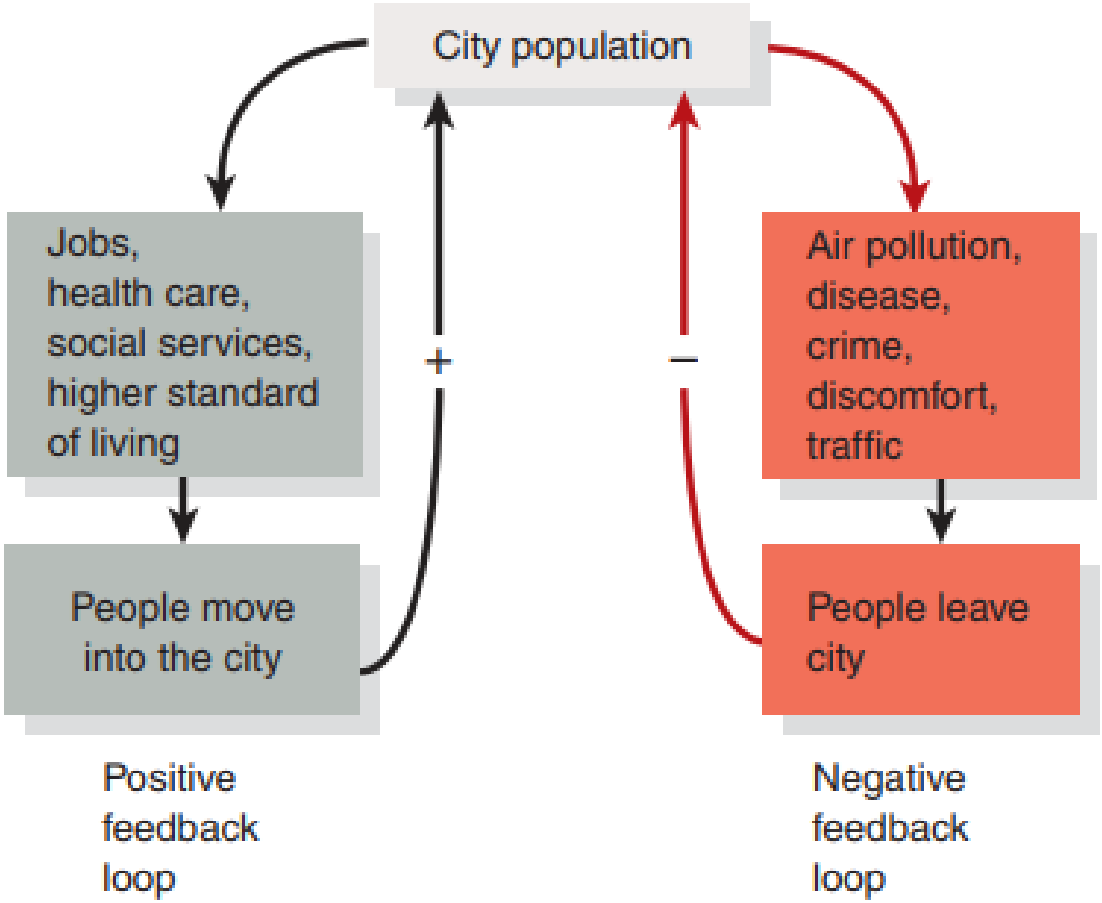

(b)
No change in size of reservoir
Tree farm that plants one tree for every one cu
Input
equal to
Output
(c)
Reservoir is reduced
Use of fossil fuels
Input
less than
Output
(d)
Reservoir grows
Pollution of lake with pesticides
Input
greater than
Output


1986
2013

Human population in large cities (feedbacks)

- Systems tend to dynamic equilibrium, from time to time disrupted by natural and human-induced disturbances → changes over time.
- Feedback – adjustments in input or output rates caused by changes to a system.
- Positive – amplifies change by causing further increase or decrease
- Negative – resists change by returning to original state/slowing rate of change.

Human population in large cities (feedbacks)



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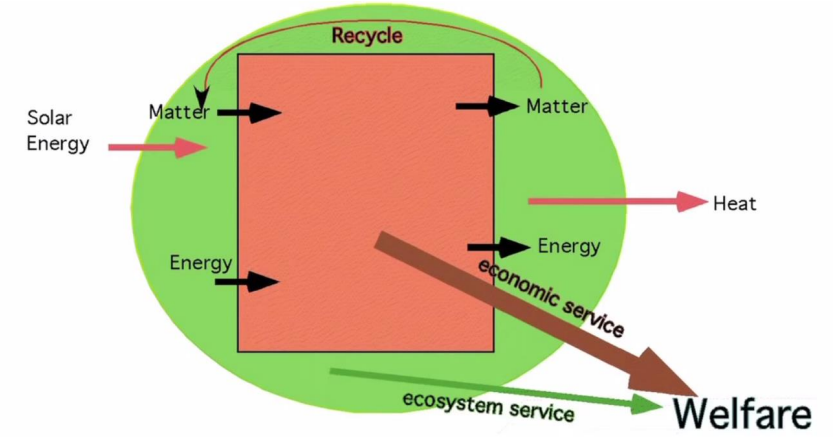
Modern 7bn people world



= Natural resources and solar energy provide essential imput to economic processes -> society is ultimately dependent on these resources.

= Laws of thermodynamics overrule economic laws.

= Economic system is not unbounded and cannot grow indefinitely, it is limited by the availability of natural resources and ability of environment to assimilate wastes.

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Law of thermodynamics

- Conservation of energy – total energy of an isolated system is constant, energy (and matter) can be transformed but neither created nor destroyed.
- As energy is transferred or transformed, more and more of it is wasted (= increasing entropy).

1) Technology cannot compensate for resource depletion

- Man-made capital can replace all types of natural capital (weak sustainability view) VS
- Natural resources and services are irreplaceable (strong sustainability).

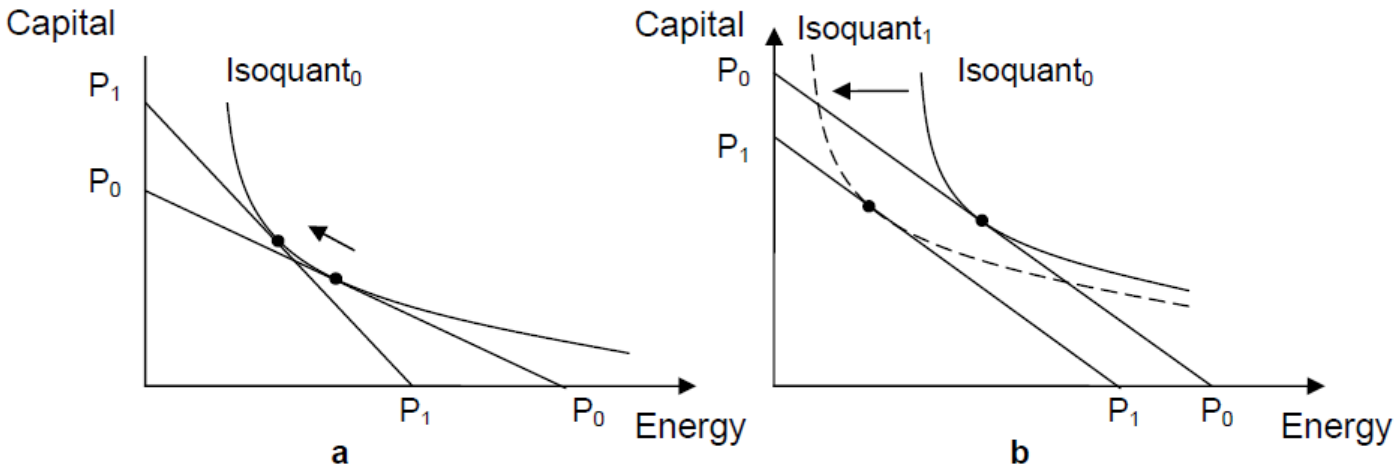

Figure 1 (*a*) Energy efficiency–improving substitution versus (*b*) energy-saving technological change.

Energy efficiency of engines

- Internal combustion – gasoline (around 50%), diesel (55-60%)
- External combustion – steam turbine (up to 60%).

- Modern thermal power plants usually ranges between 35 – 50%.

2) New energy discoveries cannot satisfy increasing demand

- New (unconventional) sources of energy.

VS

- EROEI = usable energy output/energy consumed. Global EROEI is declining (= you need to produce more gross energy to satisfy the same consumption).

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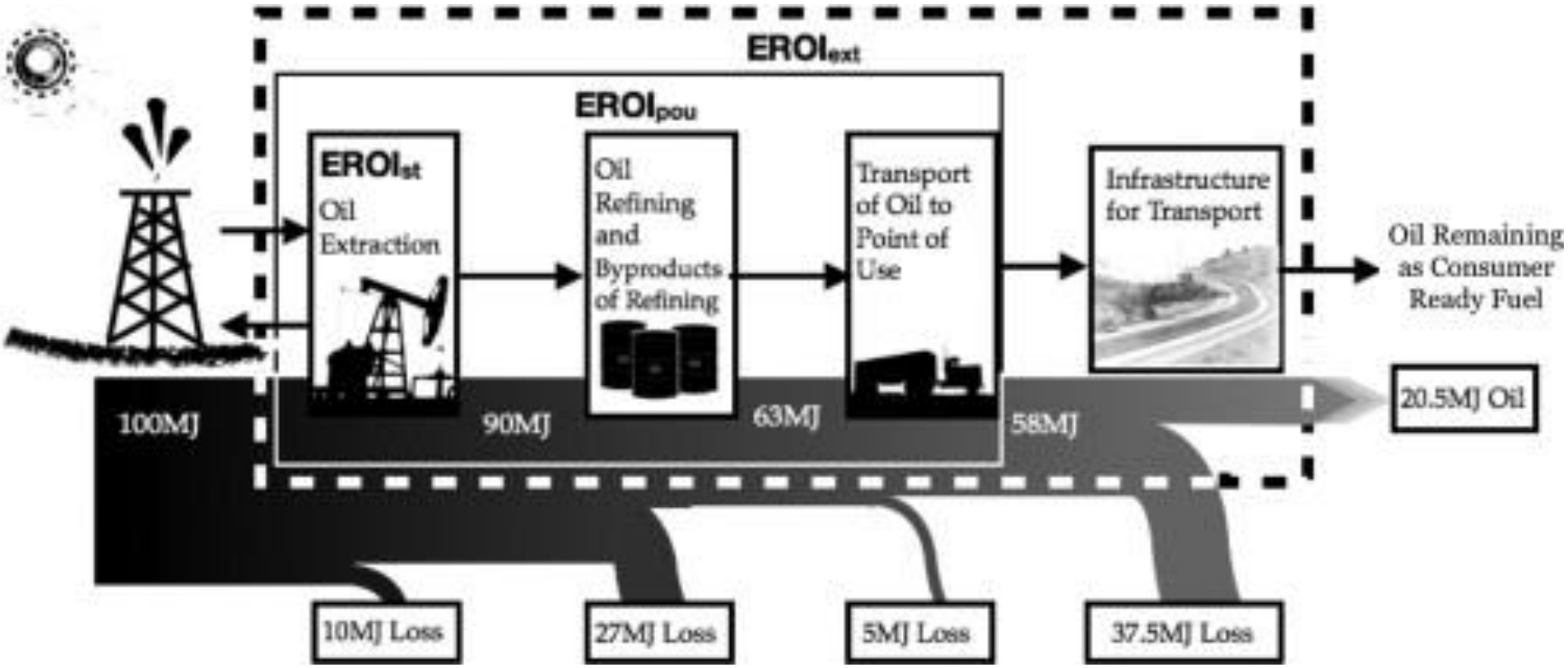
ERoEI

- Energy returned on energy invested – ratio of the amount of usable energy delivered from a particular energy resource to the amount of energy used to obtain that energy resource.
- Less then one – energy sink, net energy loss.

ERoEI


EROIext
EROIpou
EROIst
Oil Extraction
Oil Refining and Byproducts of Refining
Transport of Oil to Point of Use
Infrastructure for Transport
Oil Remaining as Consumer Ready Fuel
100MJ
90MJ
63MJ
58MJ
20.5MJ Oil
10MJ Loss
27MJ Loss
5MJ Loss
37.5MJ Loss

ERoEI

- Standard ERoEI – divides the energy output for a project (region, country) by the sum of the direct and indirect energy used to generate that output.
- Point of use ERoEI – includes additionally the costs associated with refining and transporting the fuel
- Extended ERoEI – considers the energy required not only to get but also to use a unit of energy.
- Societal ERoEI – all gains from fuels and all costs of obtaining these fuels.

EROEI of different sources of energy

Oil in the beginning of oil business	100
Oil in Texas around 1930	60
Oil in the Middle East	30
Other oil	10-35
Natural gas	20
High quality coal	10-20
Low quality coal	4-10
Water power plants	10-40
Wind power plants	5-10
Shale oil	5
PV power plants	2-5
Nuclear energy	4-5
Oil sands	max. 3
Shale oil	max. 1,5
Biofuels (in Europe)	0,9 - 4

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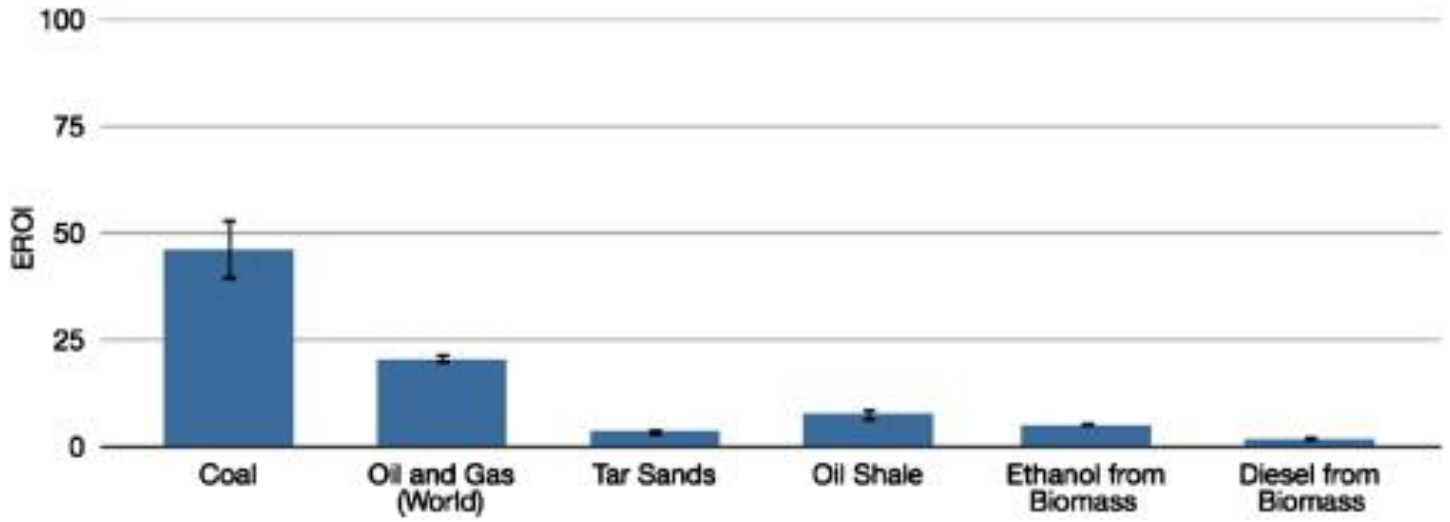
EROEI of different sources of energy



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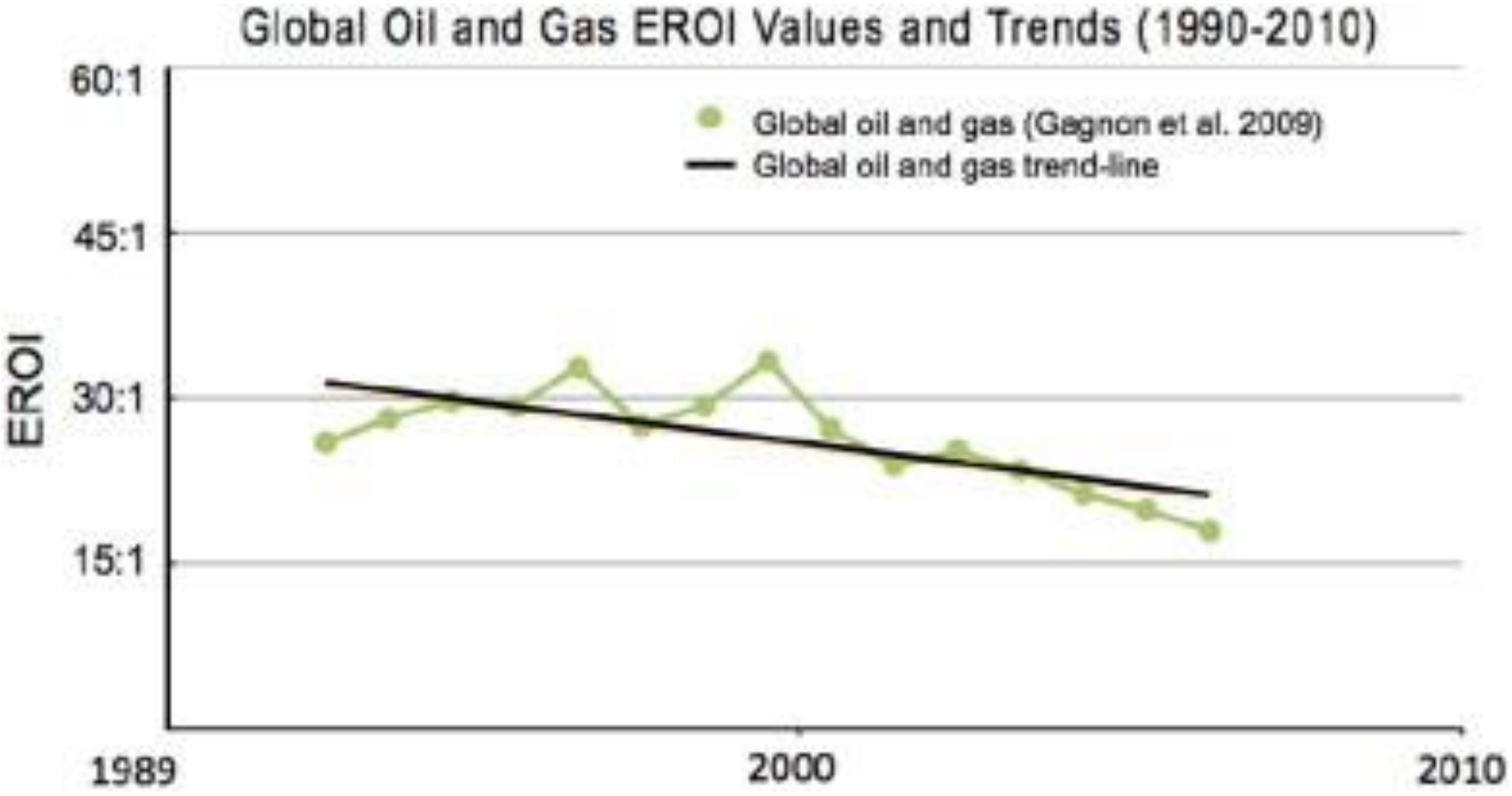
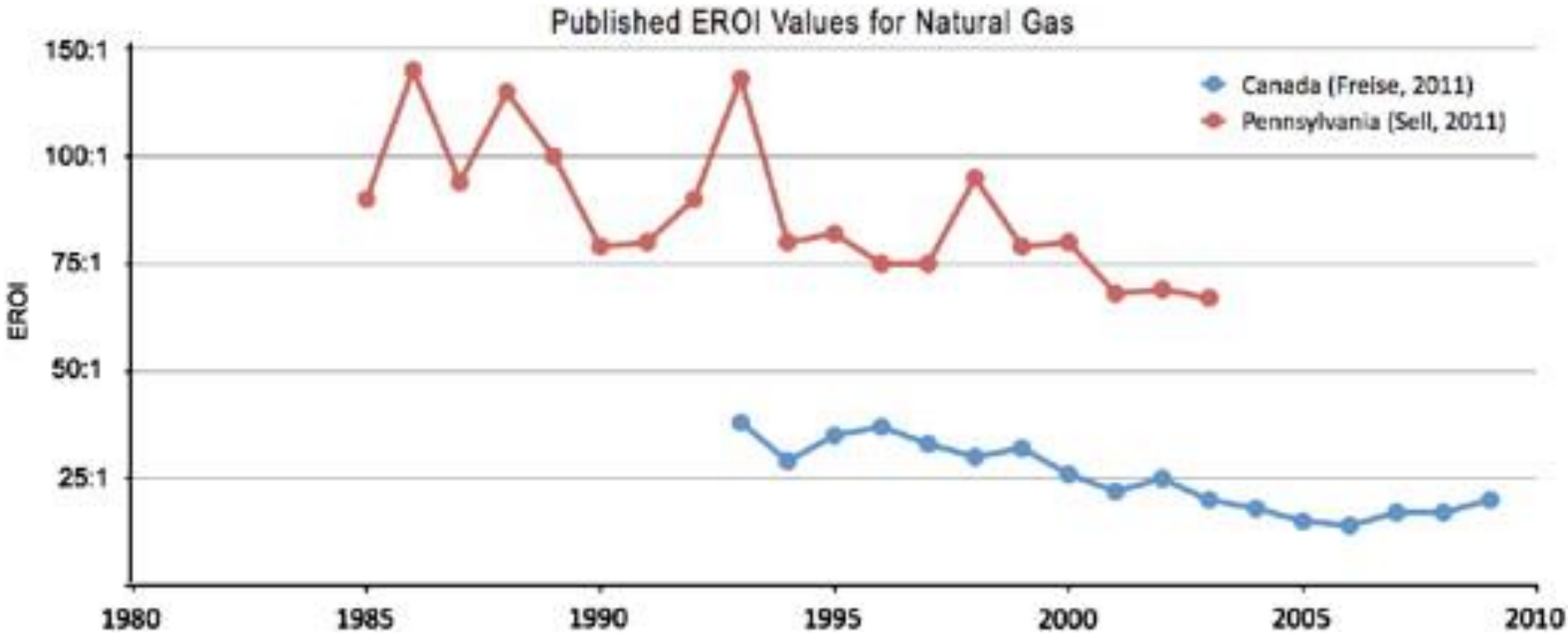

Global Oil and Gas EROI Values and Trends (1990-2010)
60:1
45:1
30:1
15:1
EROI
Global oil and gas (Gagnon et al. 2009)
Global oil and gas trend-line
1989
2000
2010



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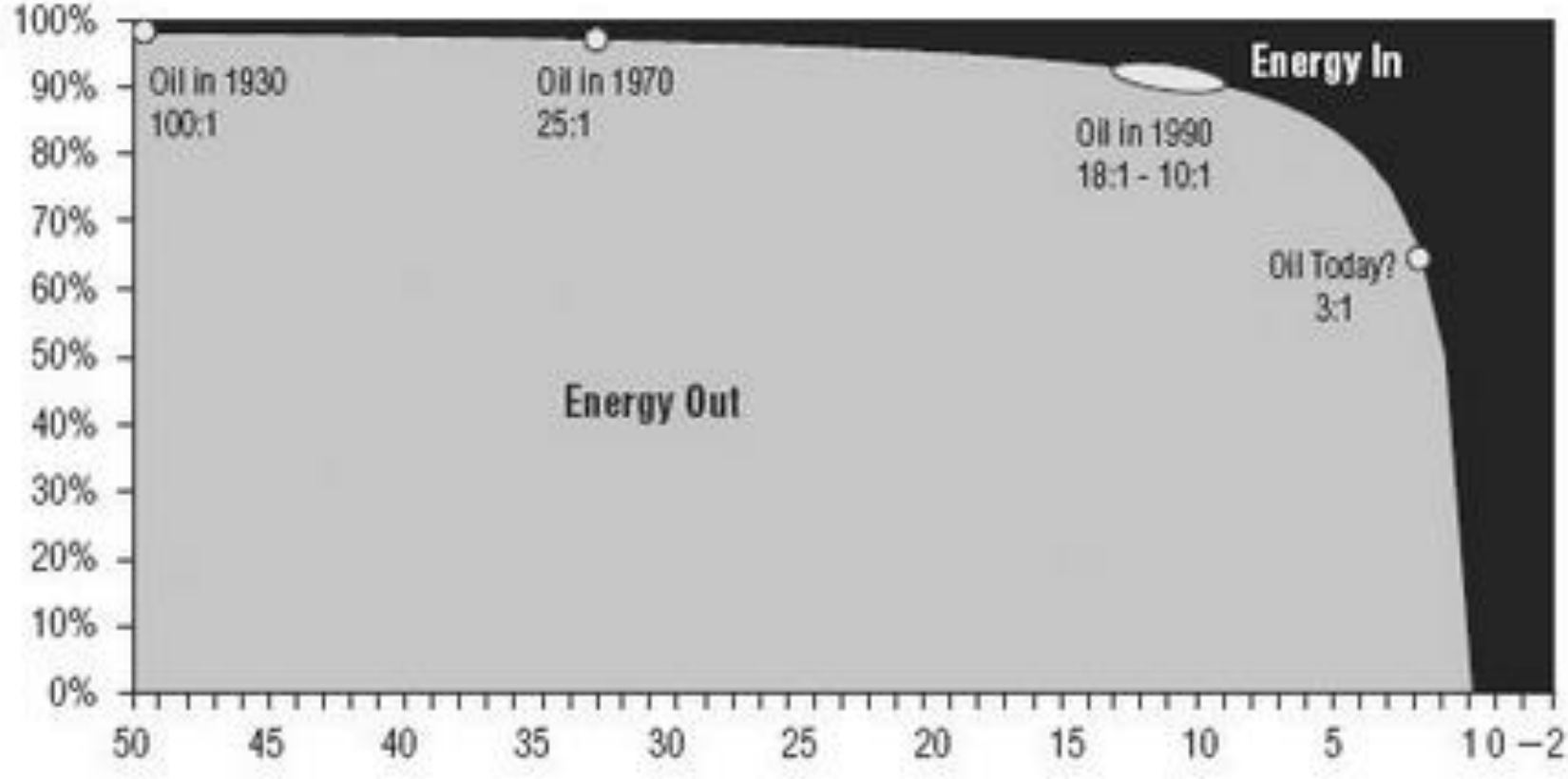

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3) Society cannot relly on techno-optimism

- New energy sources/technologies.

VS

- „Are there any?“

- Beginning of modern petroleum industry in 1859 (E. Drake in Pennsylvania).
- Beginning of modern natural gas industry around 1820s in Ohio and Pennsylvania.
- Nuclear energy – 1930s (E. Fermi).

- Combustion engine 1872, steam engine 1698, electric engine 1832, solar panel 1883.

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Is steady-state economics/degrowth possible? (Polemic)

- People would never voluntarily walk away from competitive consumerism.

VS

- People over-consume not because of their inner values but because they feel compelled to do so and because our economy is structured to incentivize consumption.
- Our political system defends the interests of capital.
- There is an increasing demand for change.

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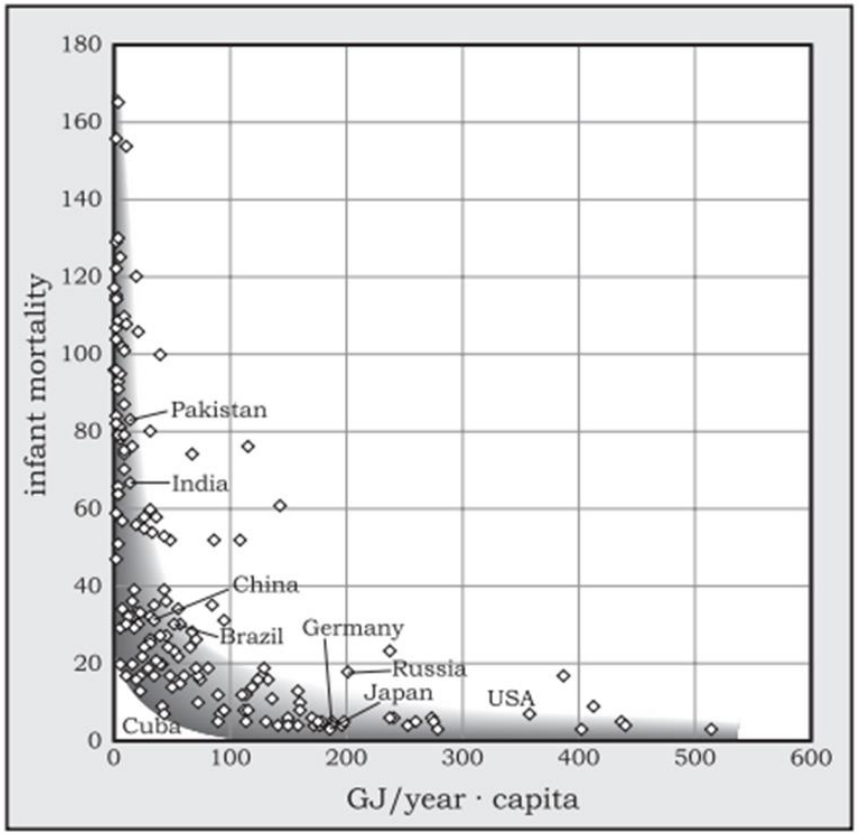
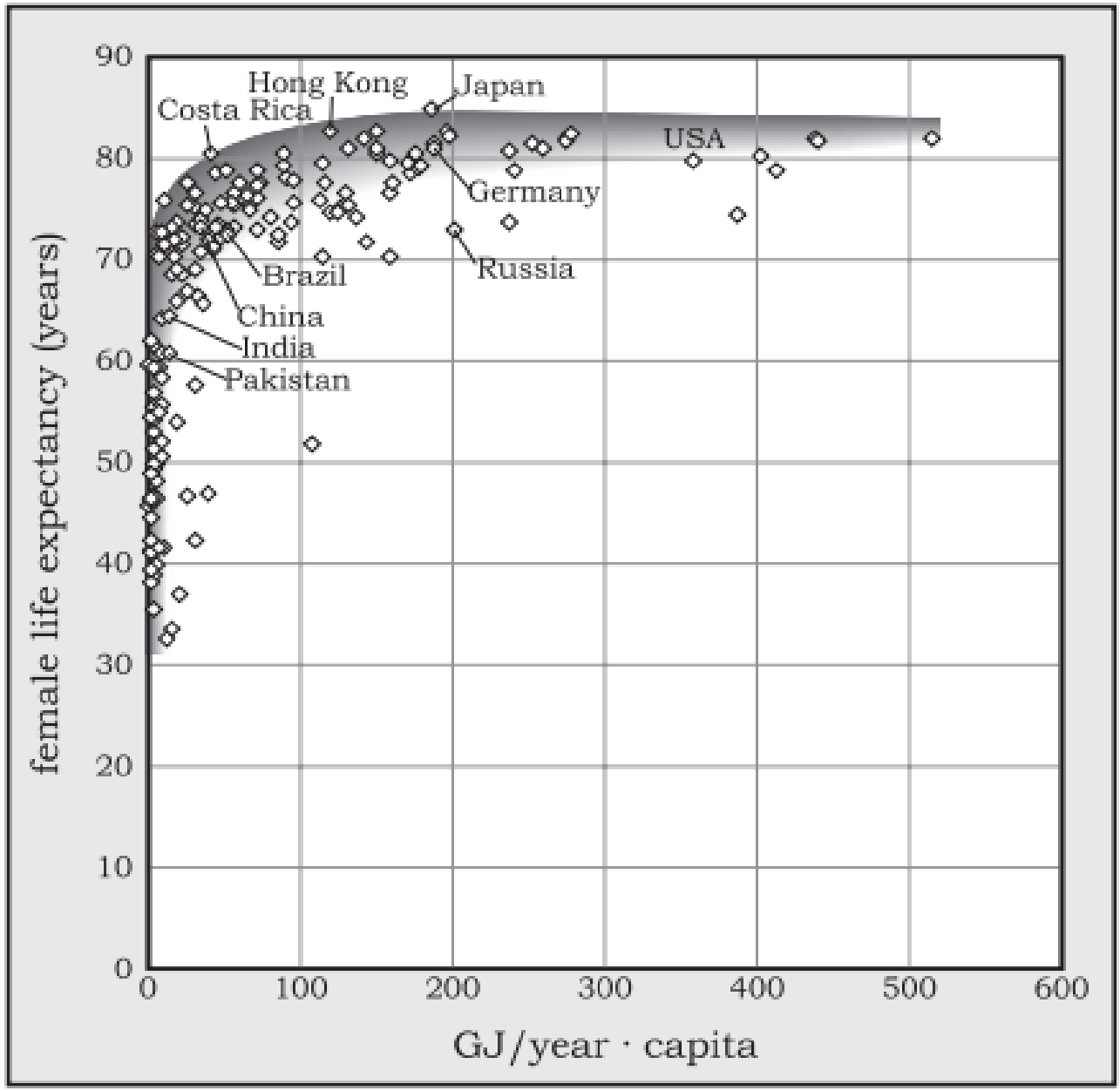
Ecological economics

- Simple growth (increase in output, GDP) vs. development (improvement of the quality of life).



Per capita energy use and infant mortality.



Per capita energy use and female life expectancy at birth.

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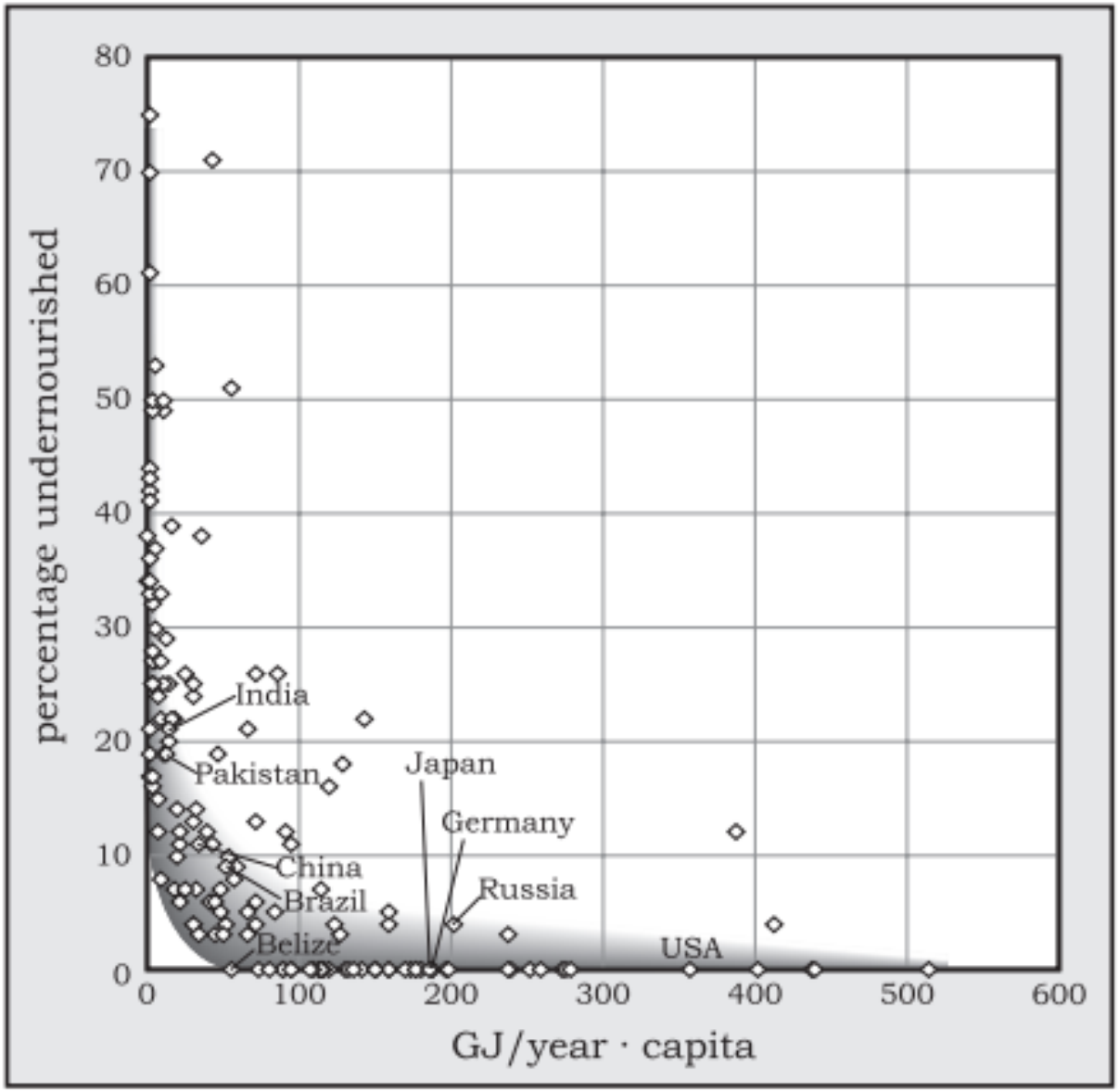

Per capita energy use and malnutrition.

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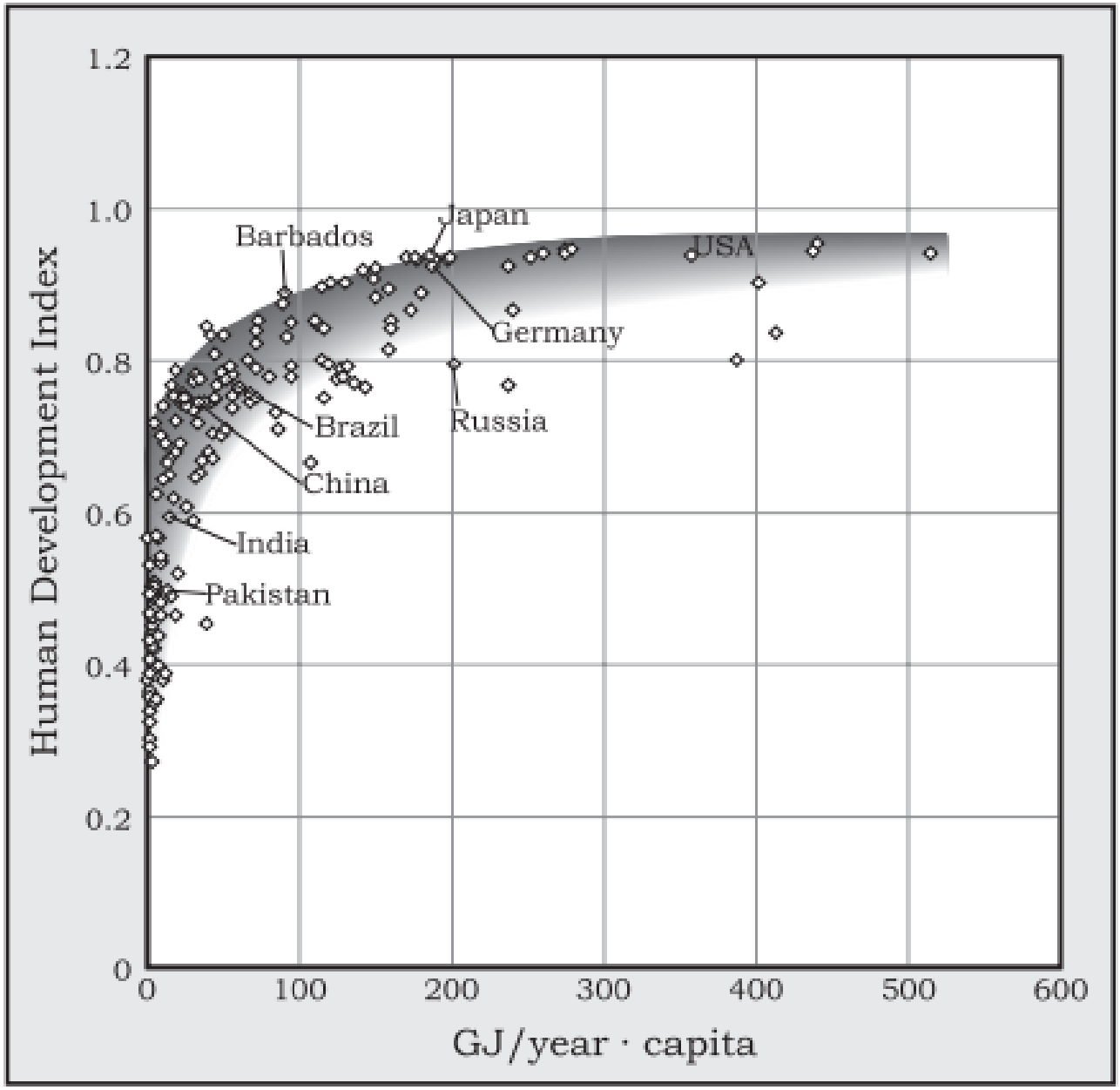

Per capita energy use and HDI.

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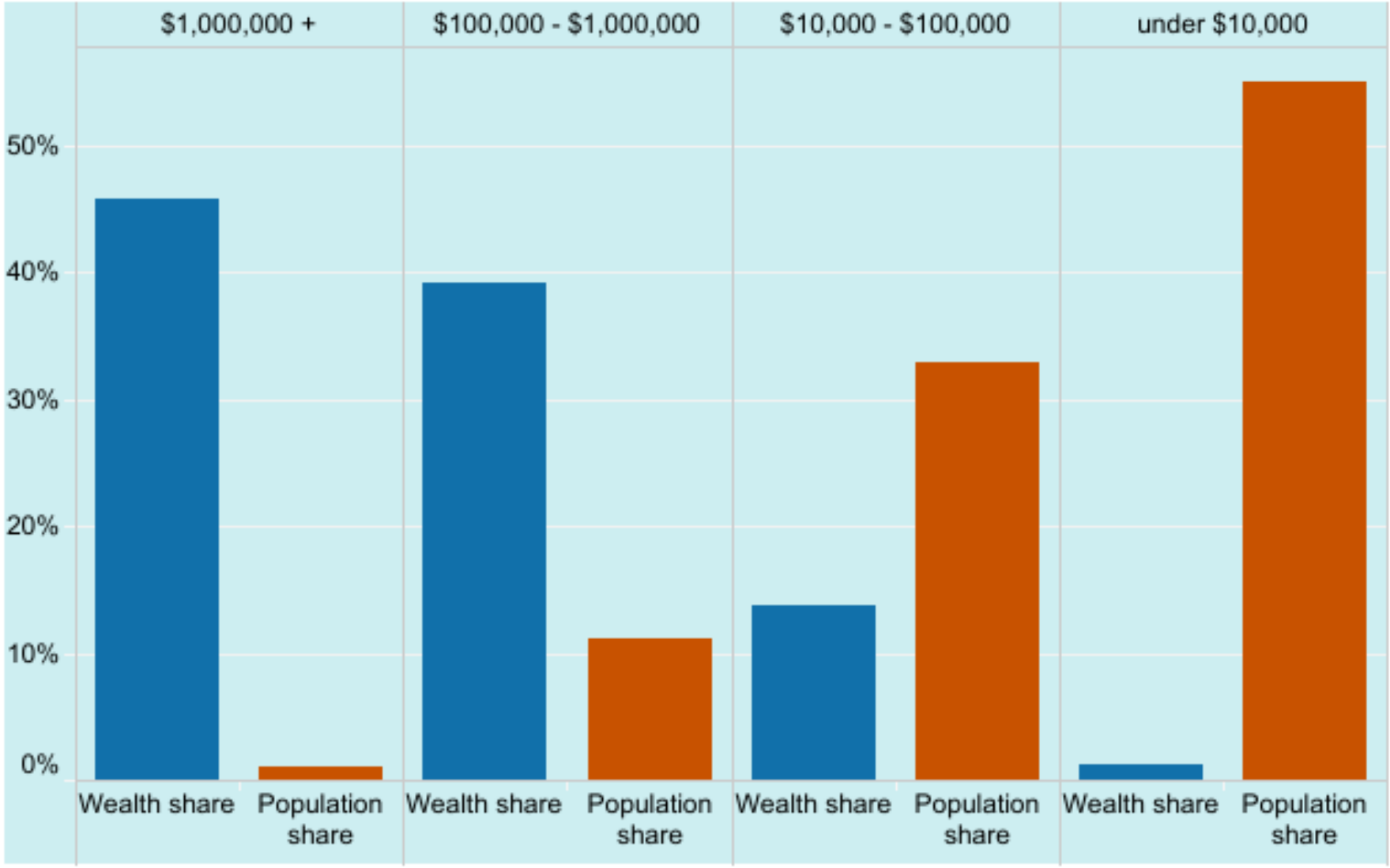
The Richest 1% Own Almost 46% of the World's Wealth

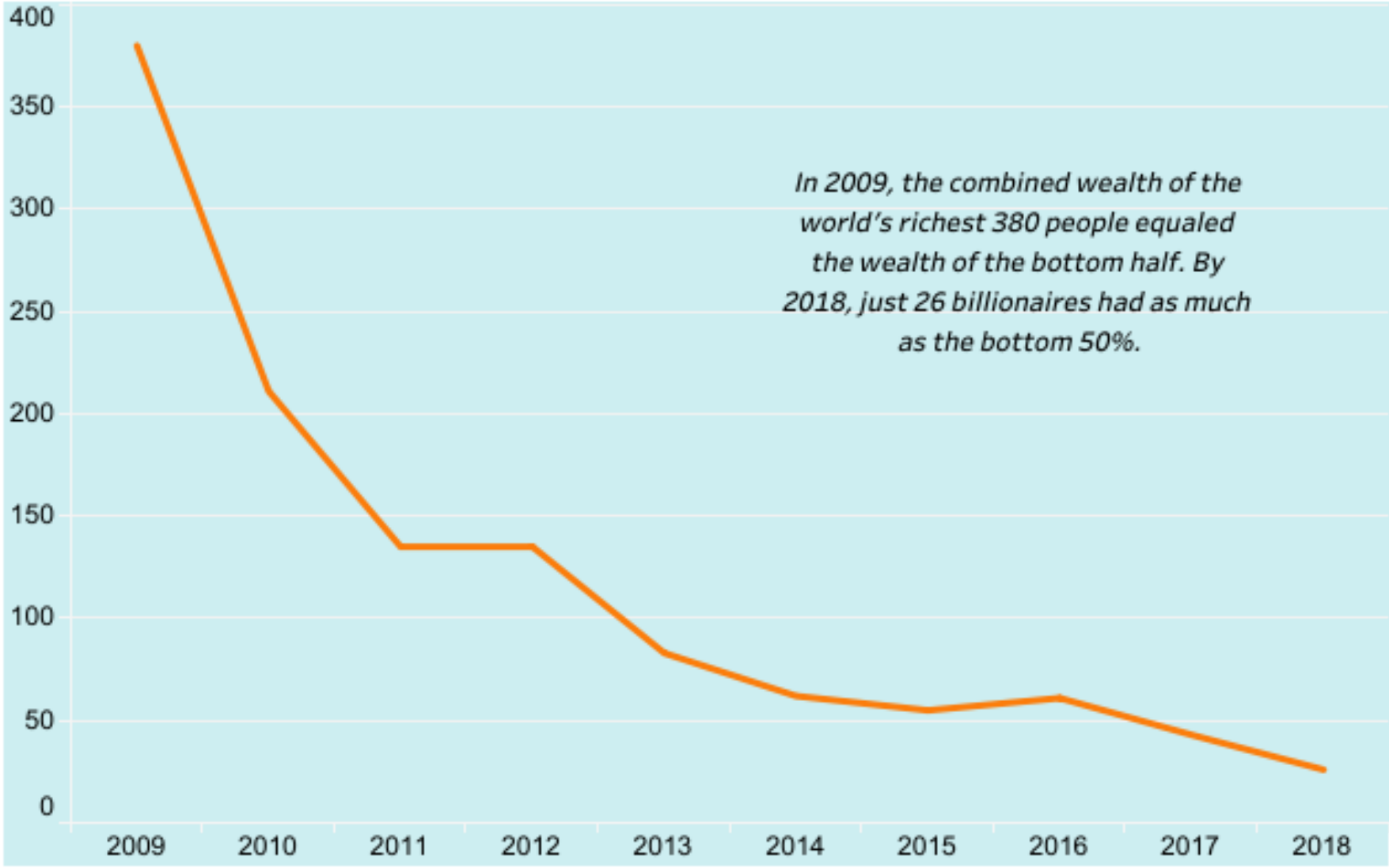
Global adult population and share of total wealth by wealth group, 2020



Source: Credit Suisse Global Wealth Databook, 2021

Wealth of the World's Poorest Shrinks Relative to Billionaires

Number of billionaires it takes to equal the wealth of bottom 50% of the global population



Source: Oxfam, 2019

Green growth as a response?

- Green growth (2012, more efficient technology + right incentives = continuous economic growth while reducing environmental impact) vs. empirical evidence.
- Hard cap on resources use, different measurement of improvement (DP replaced by other tools).

Ecological economics

- Emphasis on nature, justice, time (sustainability). Highly normative (prescriptive).
- Technological scepticism (vs. mainstream economists optimism).
- Economics is contained within the ecosystem of the planet; boundaries of the economy must remain within the boundaries of the ecosystem.
- Carrying capacity of the environment.
- Scarcity of resources, limited supply of environmental services. Firstly to focus on maintaing the environment, then assesing its costs in dolar terms.
- Laws of thermodynamics apply (we cannot create the matter or energy, we need to work with what is available).
- Claimed to be more appropriate framework for today´s world.

Main differences between environmental and ecological economics

Question	Viewpoint of Environmental Economics	Viewpoint of Ecological Economics
How is the value of the environment determined?	Using economic value, based on people's willingness to pay.	Economic value may be useful, but also recognizes inherent values.
How are values measured?	Convert all values to monetary terms if possible.	Some values, particularly inherent value, cannot be expressed in monetary terms.
Advocate market-based solutions to market failures?	Yes, in the majority of cases.	Perhaps, but micro-level market solutions may fail to address macro-level issues.
Consideration given to future generations?	Some, with weights inferred from market activity.	More weight given to future generations based on ethical considerations.
Is value neutrality desirable?	Economics aims to be value neutral (objective).	Values are acceptable in a pluralistic framework.
What is sustainable development?	Maintaining the well-being of humans across time.	Maintaining ecological functions across time.
Are there ultimate limits to economic growth?	Perhaps not, at least in the foreseeable future.	Very likely, based on the limited availability of natural resources.

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