

1.- We are not running out of hydrocarbons (but there are serious limits to its use)

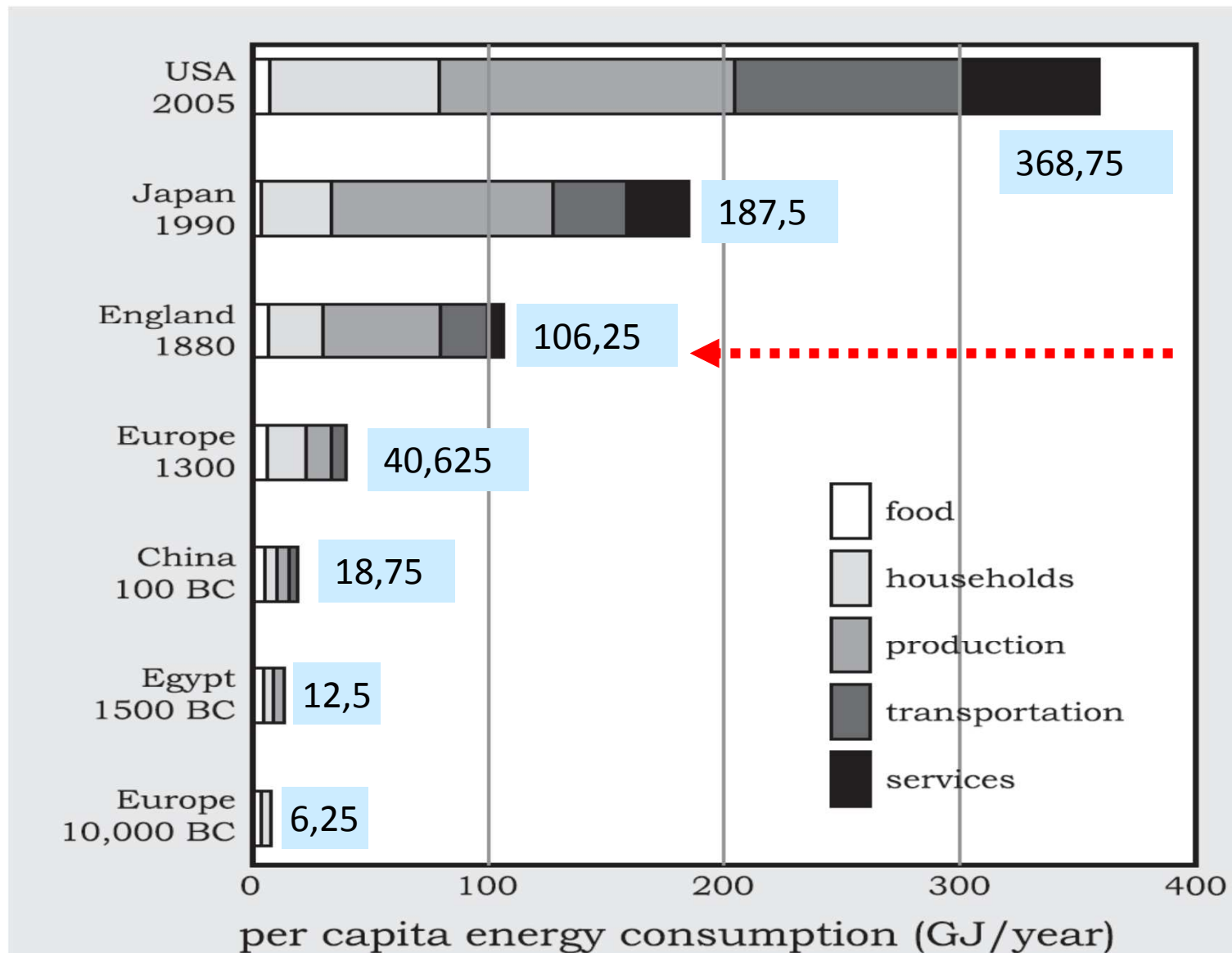
2.- Do not blame hydrocarbons for climate change (who is the culprit, the bullet or who pulls the trigger?)

3.- We not only are talking about an urgent transition (revolution?) in the field of energy....

4.- Are we living in the Anthropocene?

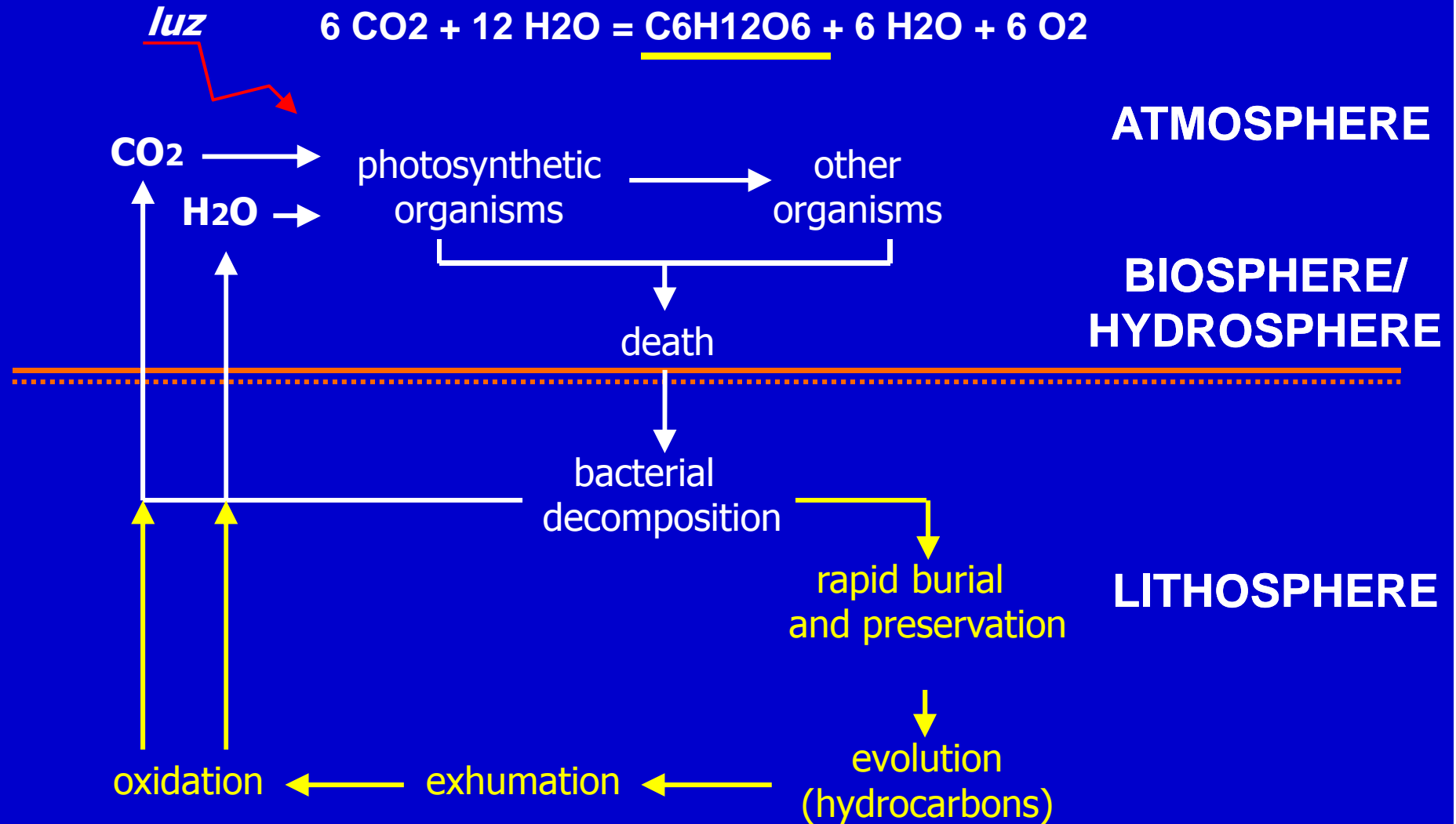
5.- The Great Acceleration: can it be continued?

Evolution of per capita energy consumption (GJ year) in the last 10,000 years



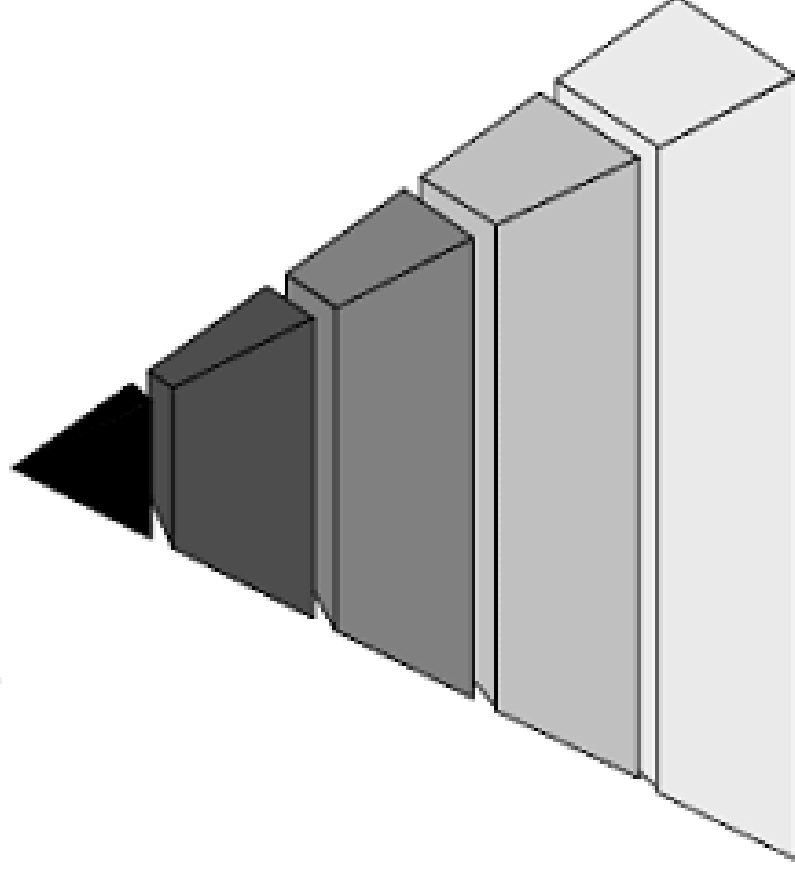
The solar legacy

Origin of organic matter and hydrocarbons



Resource Pyramid (for minerals)

Highly concentrated
Easy extraction/access



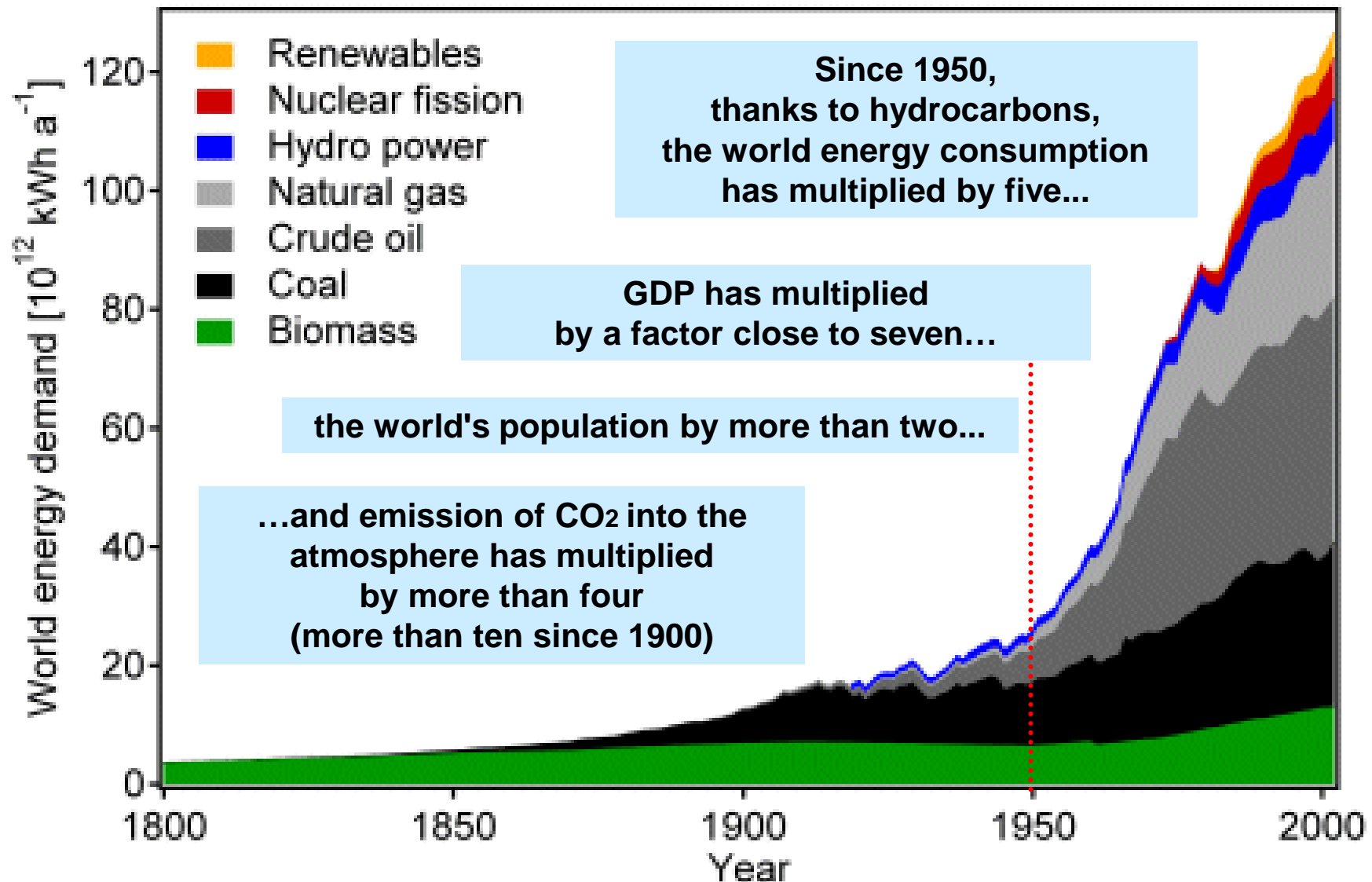
Better quality
resource

Increasing cost
of extraction
(including
MORE
ENERGY)

Low concentration
Difficult extraction/access

The hydrocarbon Man

Oil, natural gas and coal (2008) = 81, 25% TPES



The Kaya Identity

$$\text{Net F} = P \left(\frac{G}{P} \right) \left(\frac{E}{G} \right) \left(\frac{F}{E} \right) - S = P_{\text{gef}} - S$$

Where:

Net F is the magnitude of net carbon emissions to the atmosphere

F is global CO₂ emissions from human sources

P is global population

G is world GDP and $g = \frac{G}{P}$ is global per-capita GDP,

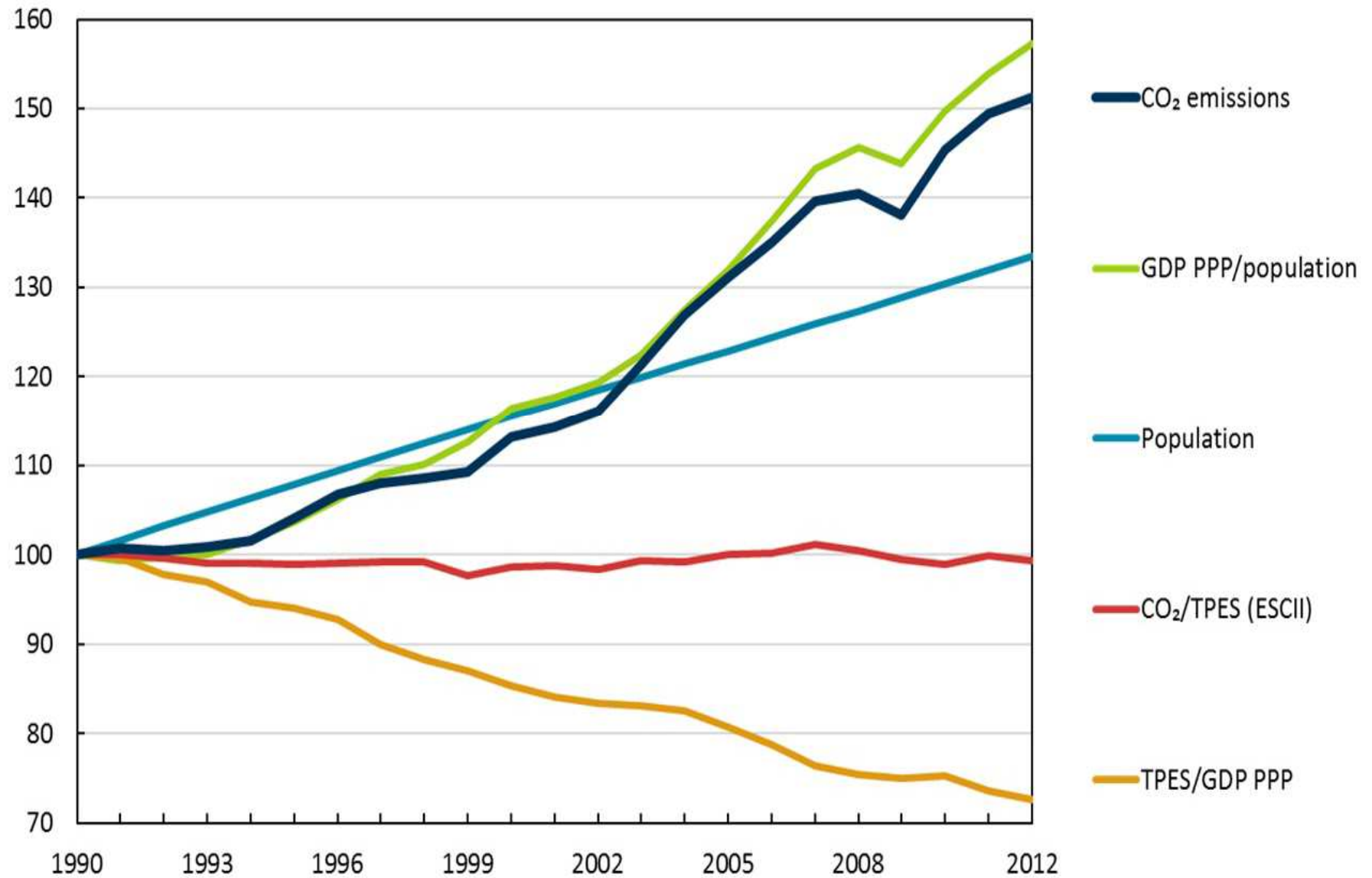
E is global primary energy consumption and $e = \frac{E}{G}$ is the energy intensity of world GDP,

and $f = \frac{F}{E}$ is the carbon intensity of energy,

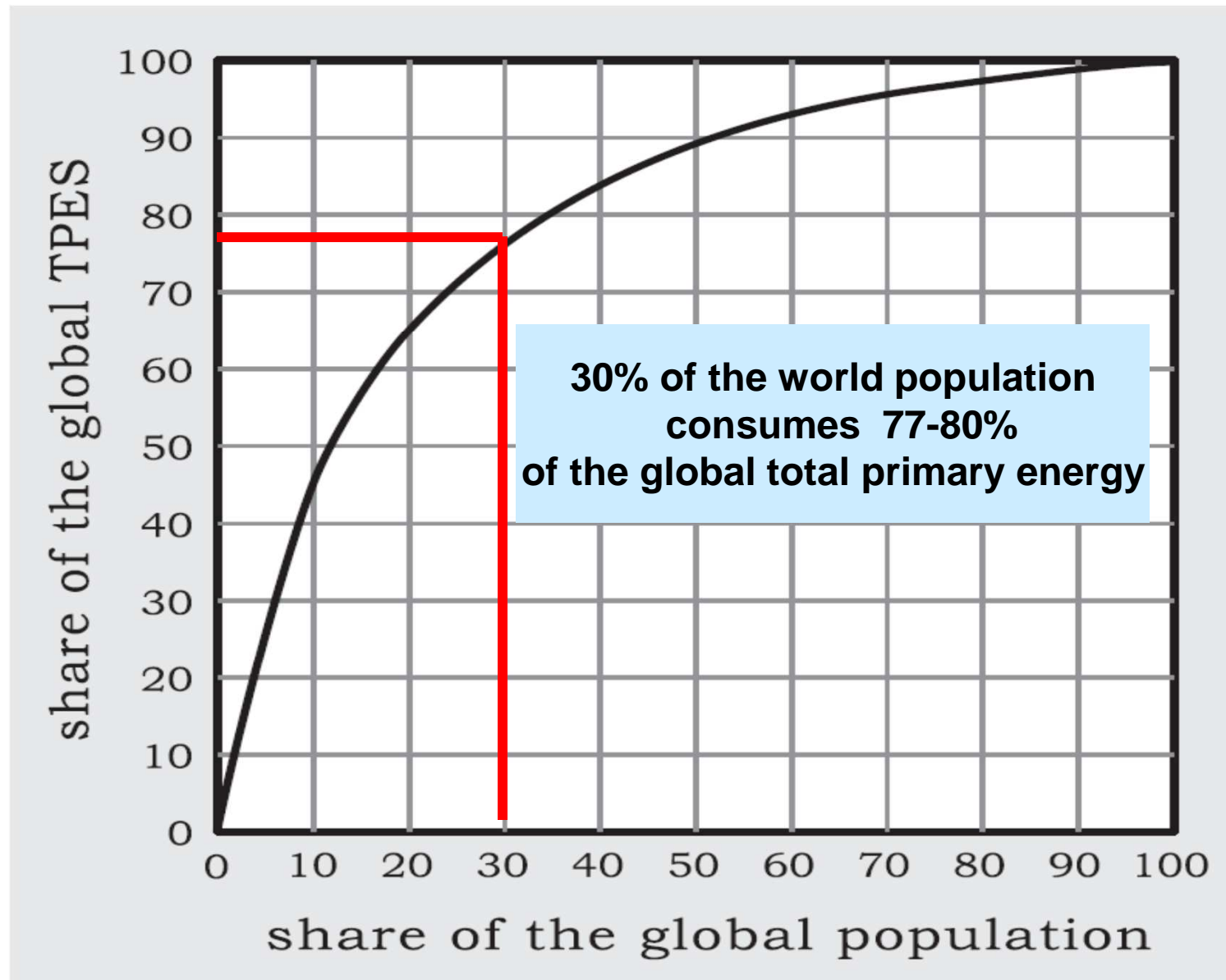
S is the natural (or induced) carbon sink.

Which factors have driven the increase in CO₂ emissions between 1990 and 2012?

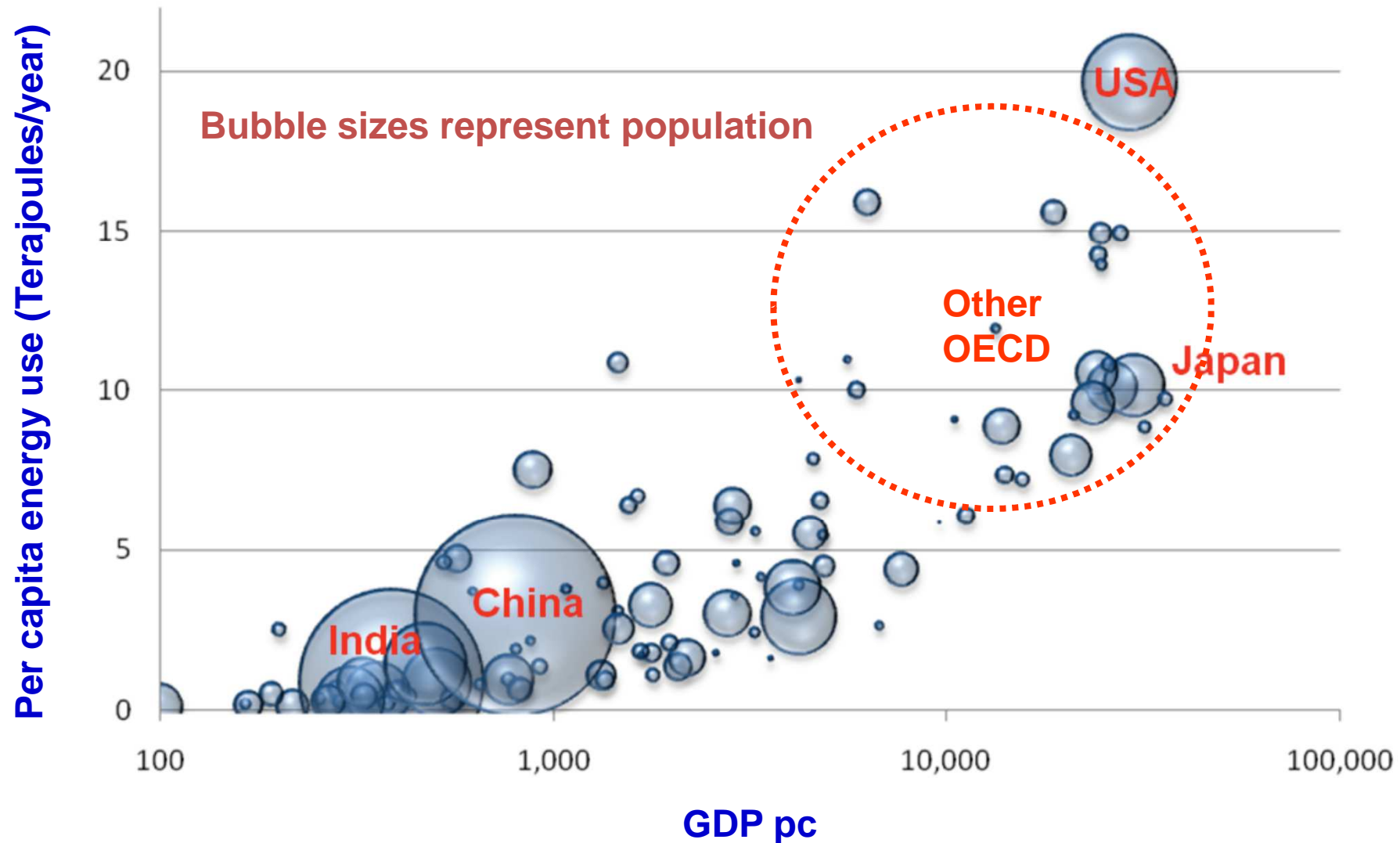
1990 = 100



energy consumption % vs. global population %



Per capita income and energy use, 2006 “the demonic bubble bath”

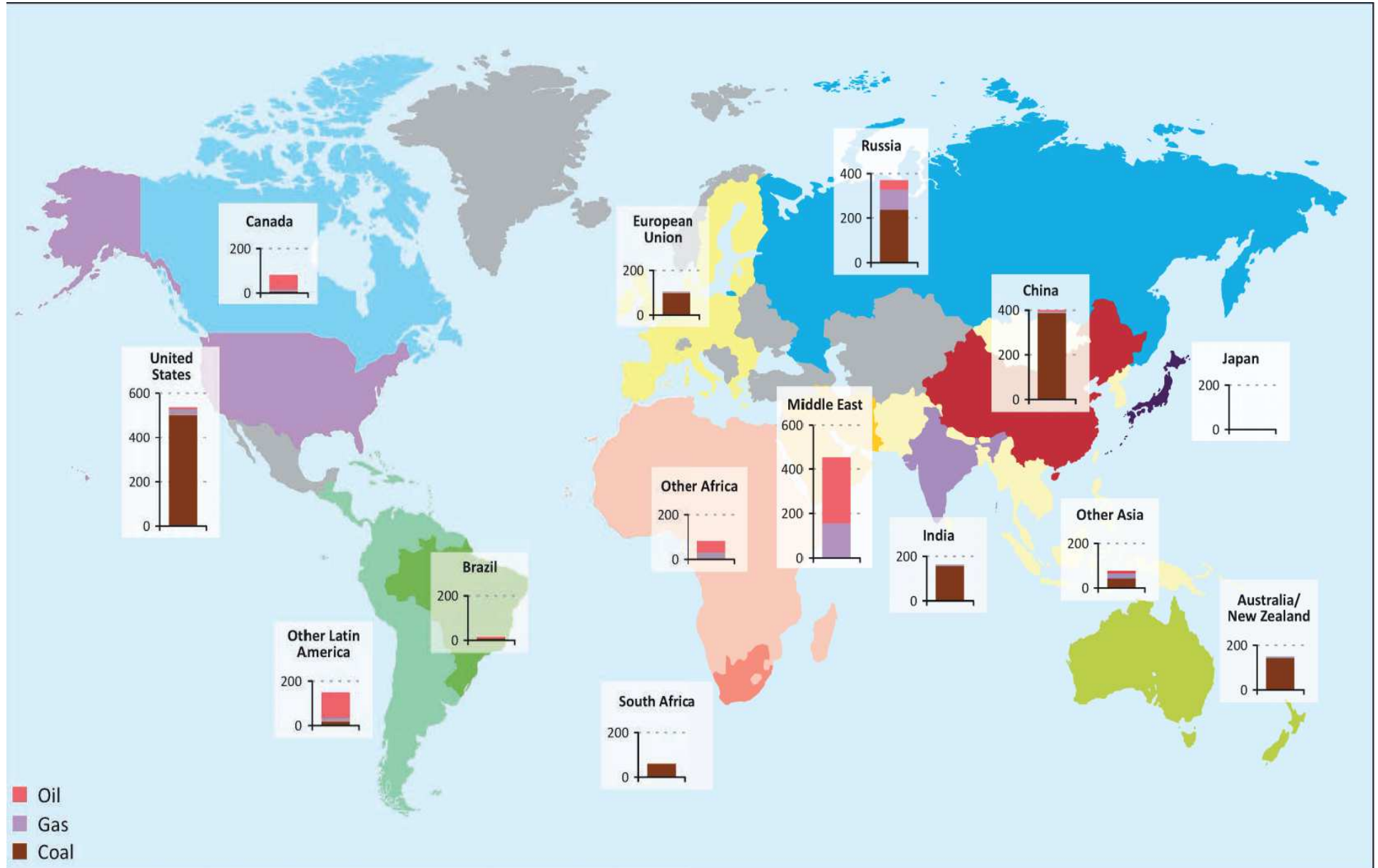


Climate change is largely due to an unprecedented economic and demographic development made possible by the massive use of hydrocarbons



IT IS A DYSFUNCTION OF THE CURRENT SOCIOECONOMIC MODEL

Potential CO₂ emissions from proven fossil-fuel reserves at the end of 2011 by region (Gt CO₂)



Potential CO₂ emissions from proven fossil-fuel reserves at the end of 2011 by region (Gt CO₂)

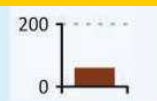
Less than 900 Gt CO₂ can be emitted up to 2050 in a 2°C world, meaning that, in the absence of significant deployment of CCS, more than two-thirds of the current fossil-fuel reserves could not be commercialised before 2050

About two-thirds of today's total carbon reserves of 2860 Gt CO₂ (fossil-fuel reserves expressed in terms of their equivalent CO₂ emissions when combusted) are concentrated in only four regions:

North America, the Middle East, China and Russia.

Of these carbon reserves, 74% are publicly-owned.

Oil
Gas
Coal



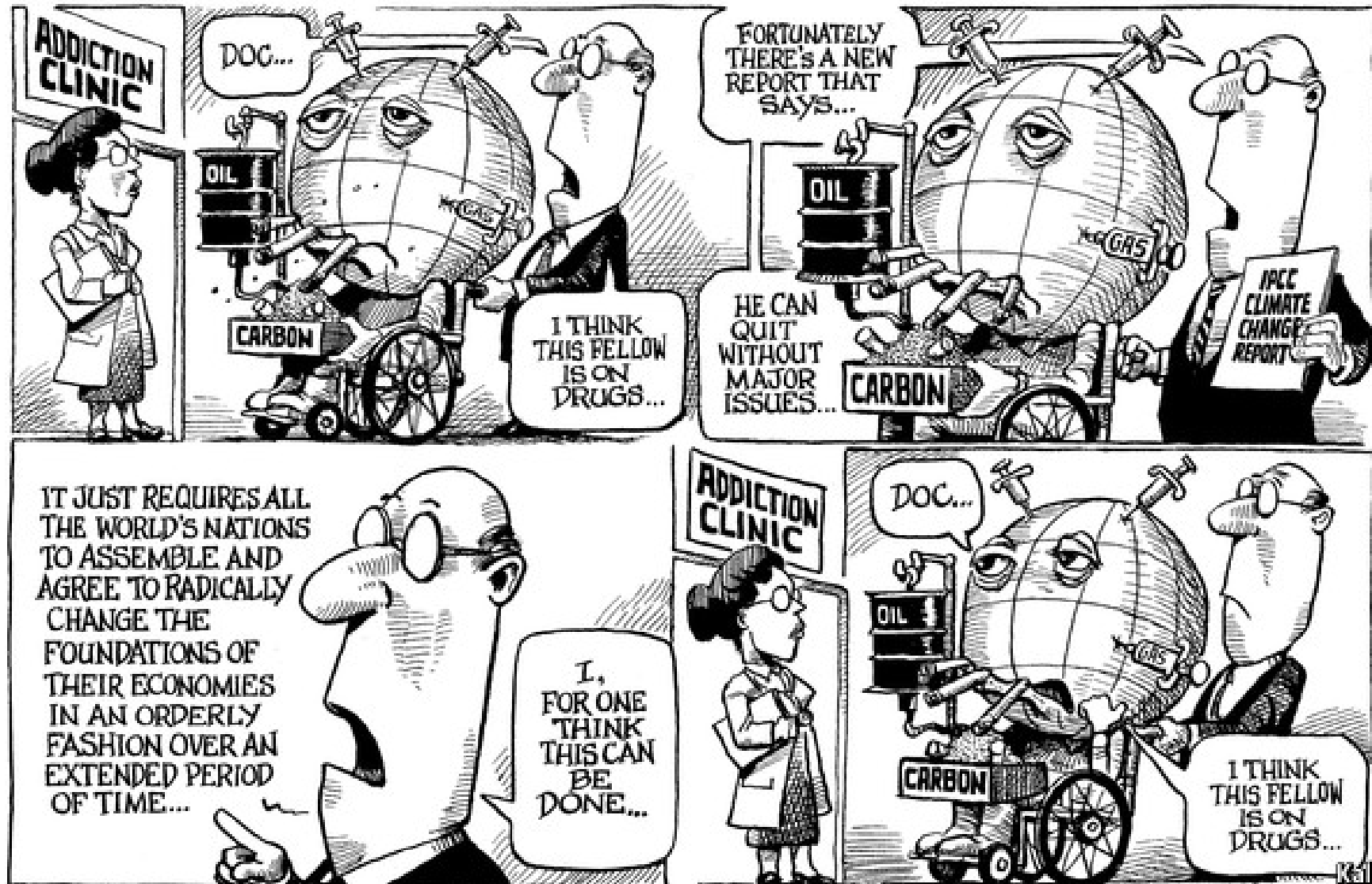
Energy firms and climate change

Unburnable fuel

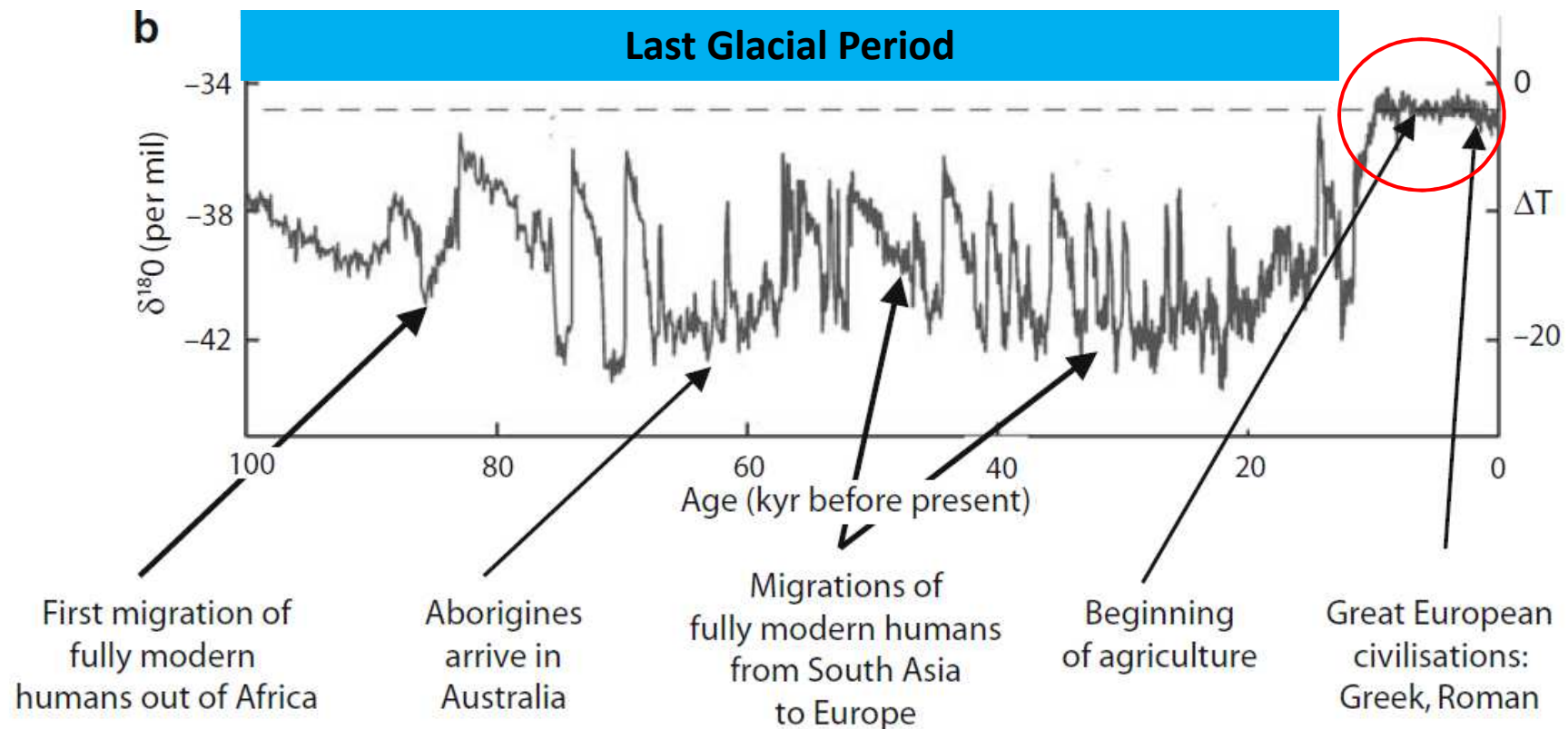
Either governments are not serious about climate change or fossil-fuel firms are overvalued



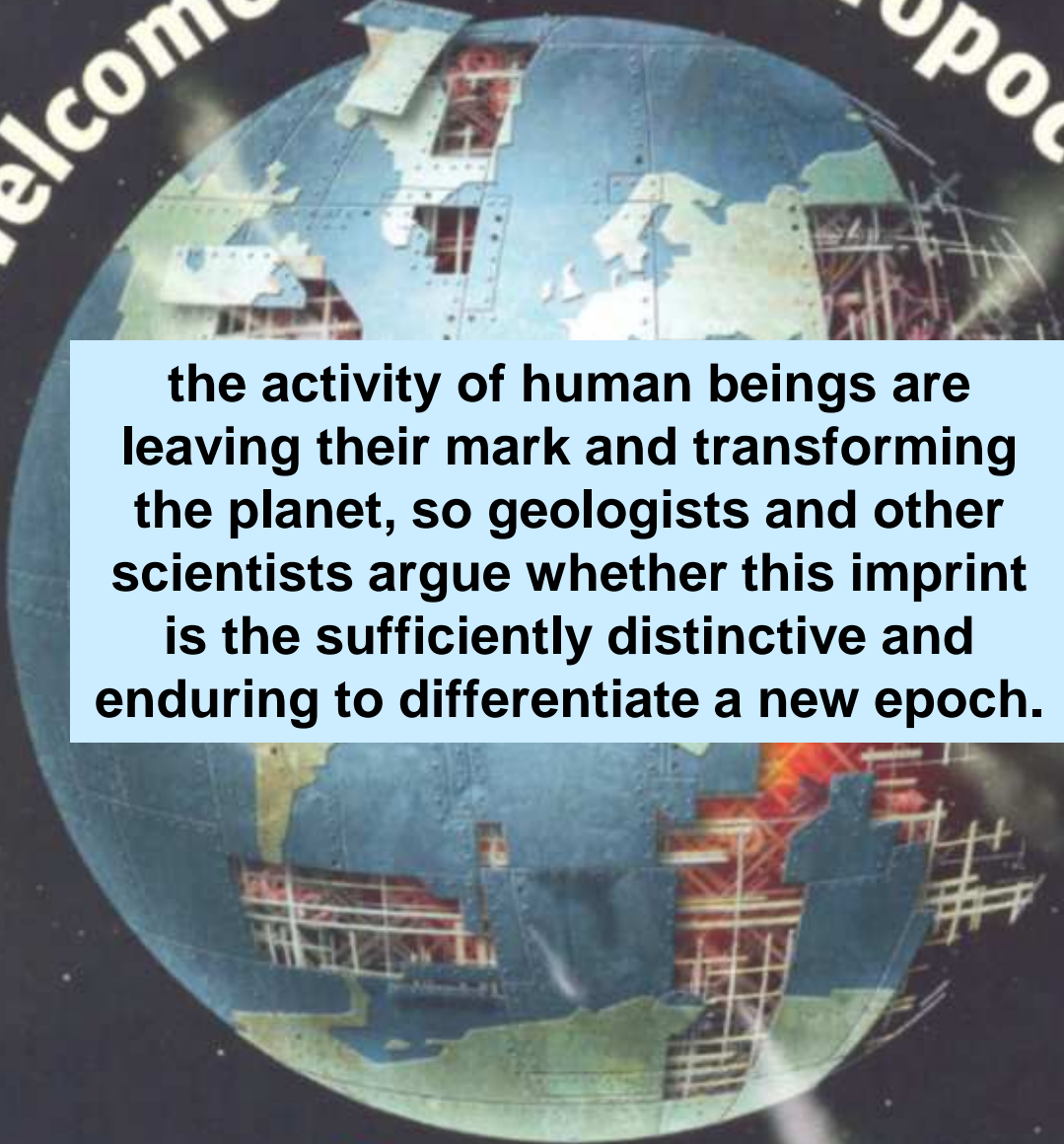
**We not only are talking about an urgent transition
(revolution?) in the field of energy....**



The Holocene: an abnormally stable period in recent geological history. We have been very fortunate in the past 11,700 years!



Welcome to the Anthropocene



the activity of human beings are leaving their mark and transforming the planet, so geologists and other scientists argue whether this imprint is the sufficiently distinctive and enduring to differentiate a new epoch.

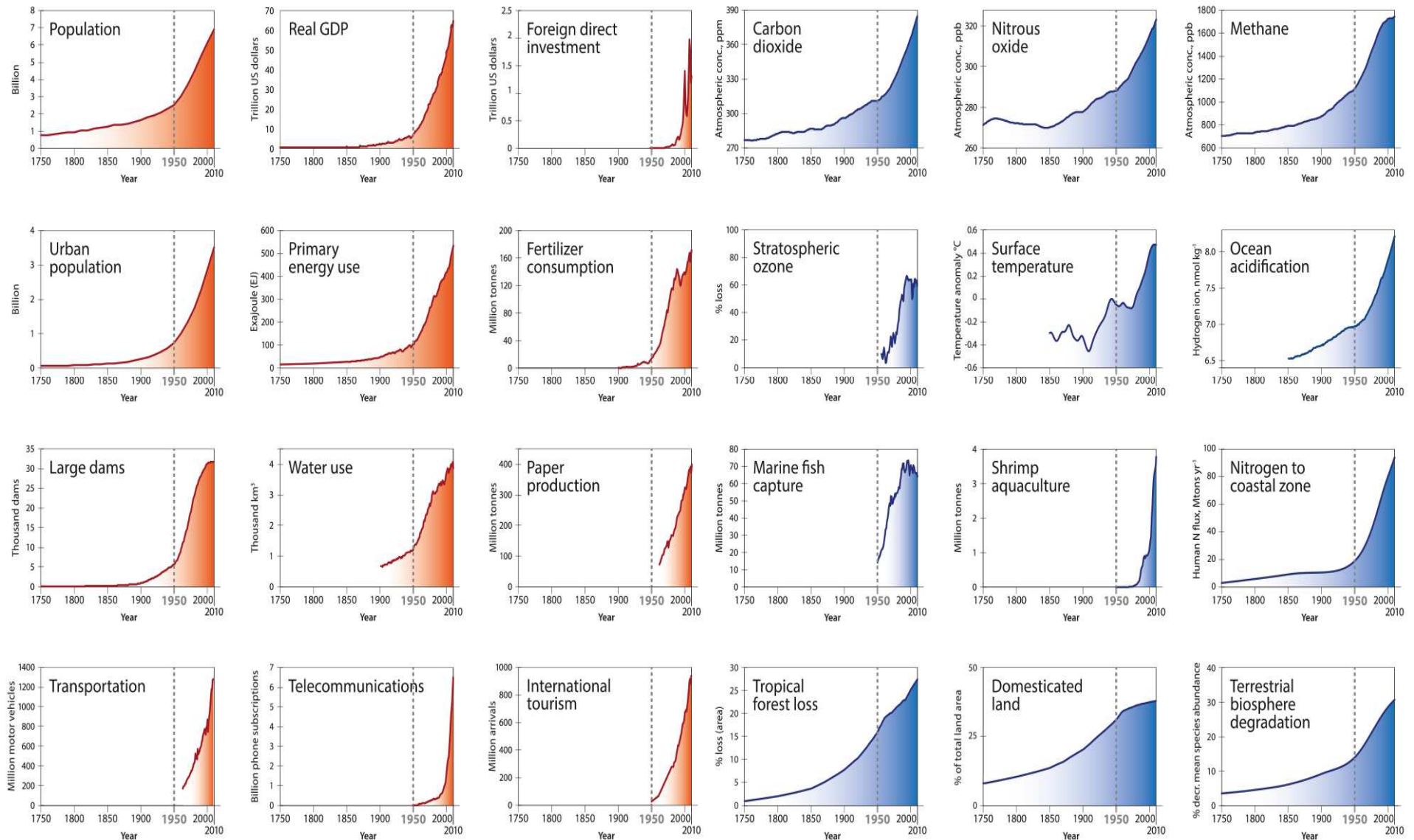
Geology's new age

is not just about climate change: the great acceleration

Steffen et al. (2015), The Anthropocene Review

Socio-economic trends

Earth system trends



“Think globally, act locally“

**Do we think globally, in terms of the whole Earth System,
when we talk about sustainability?**



We need to develop a planetary mindset

The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day we were aware of only one Earth'

Sultan Bin Salman al-Saud, astronaut, 1985