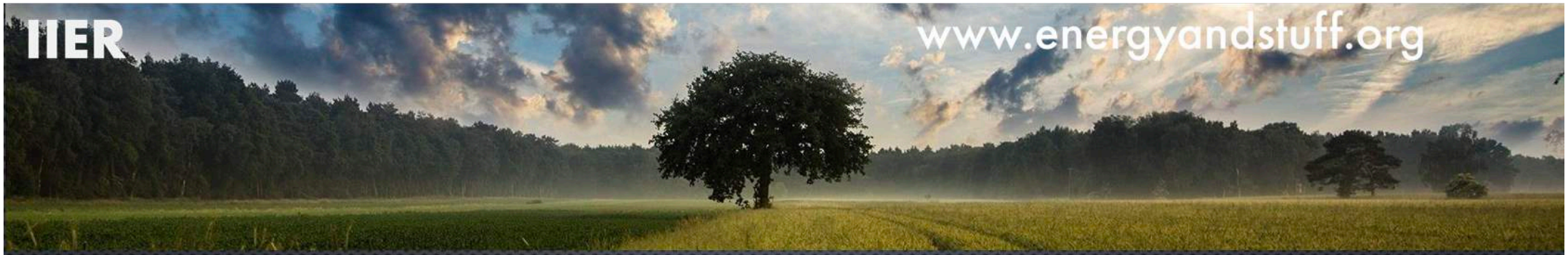


Wake-up call

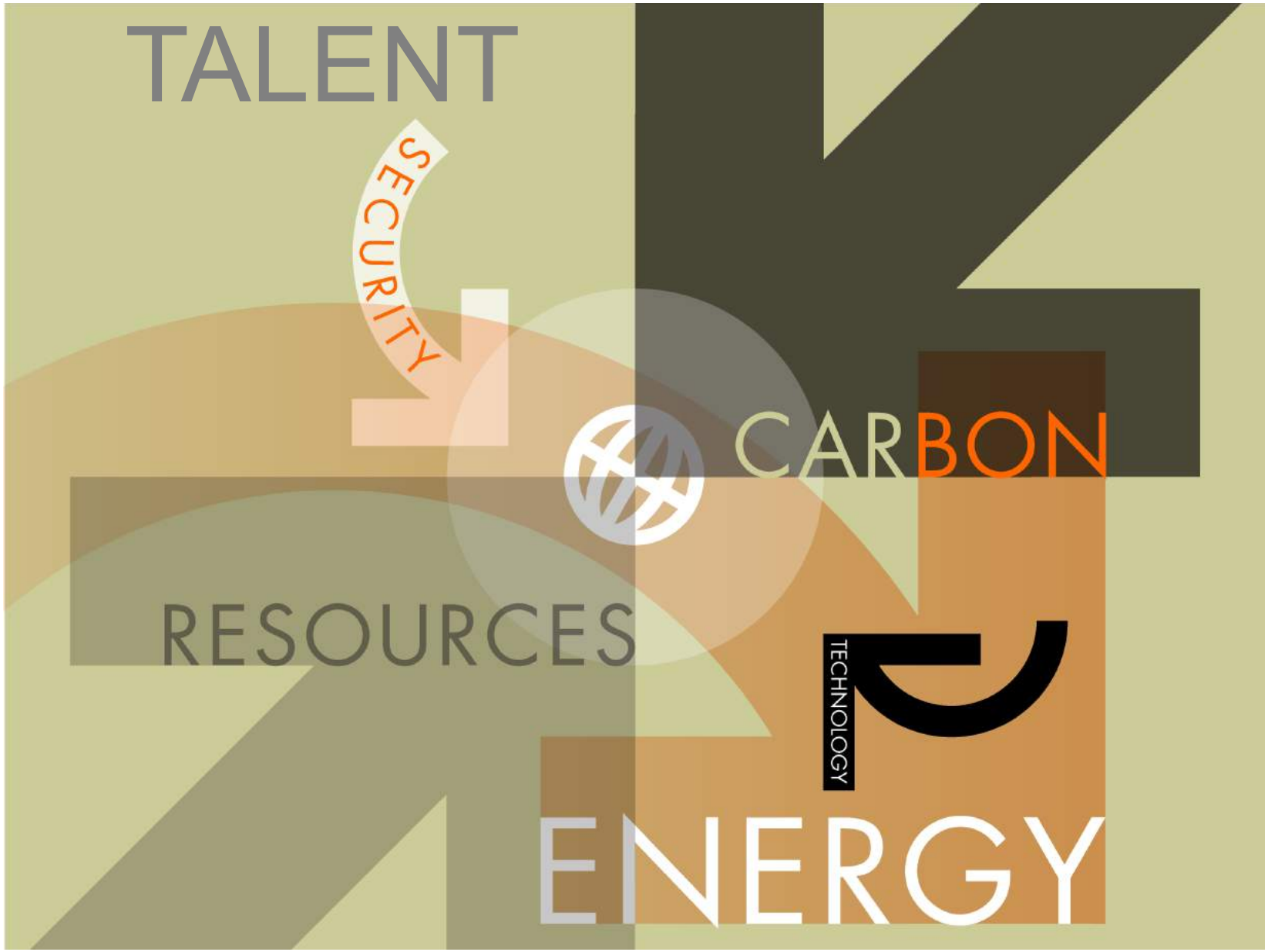
Are you ready for the exponential era?

Hans van der Loo

Chairman Advisory Board
Institute for *Integrated* Economic Research

Bruges, 12 June 2019

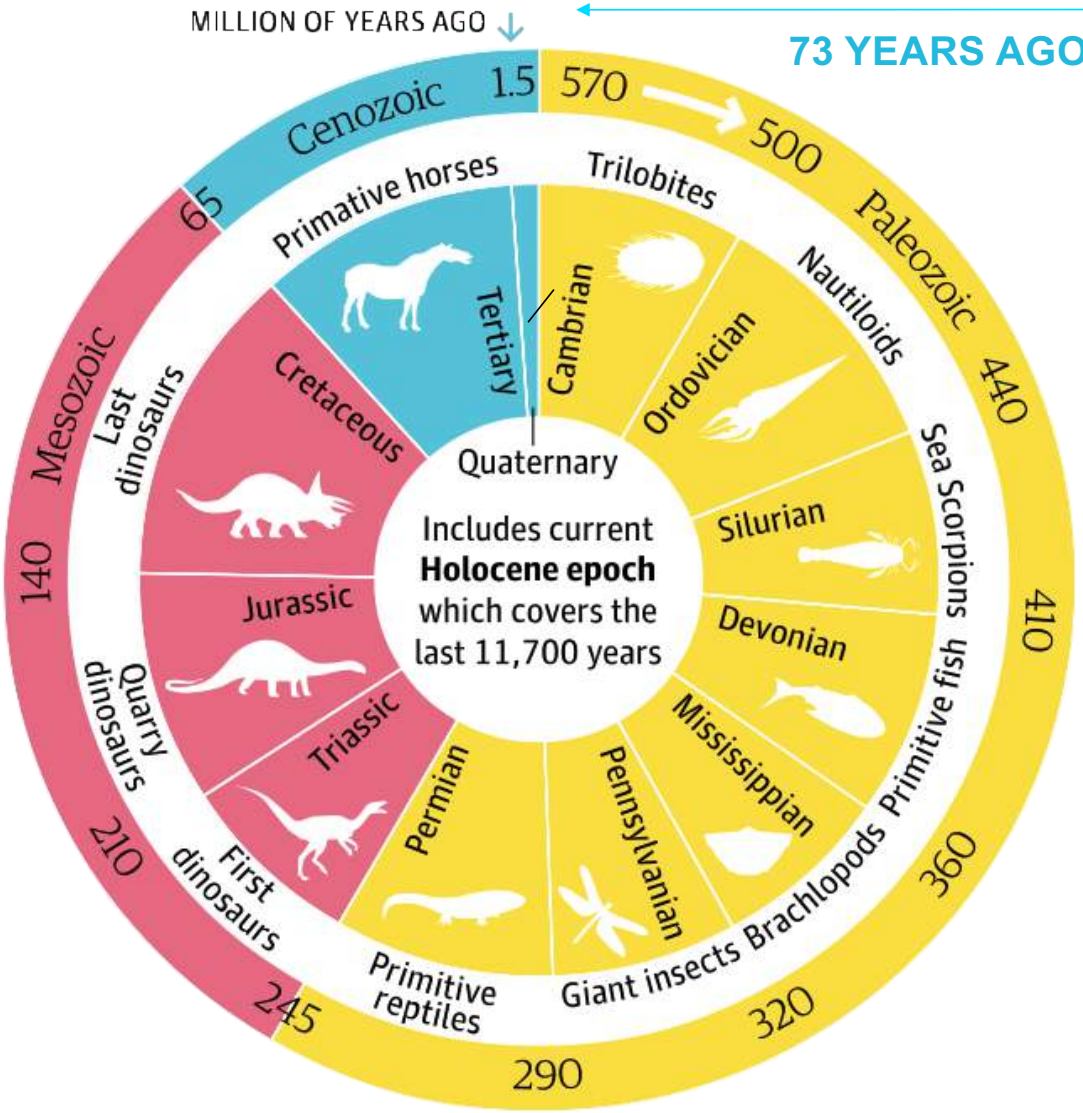
EUREKA 2019


TALENT
SECURITY
CARBON
RESOURCES
TECHNOLOGY
ENERGY

https://www.youtube.com/embed/0yBzxC9eoog

- When did Oxygen begin to develop ?
- When did Photosynthesis / Plant life start
- How long did Dinosaurs last ?
- How long has our species been here ?

Geological periods 570m years ago to the present



73 YEARS AGO

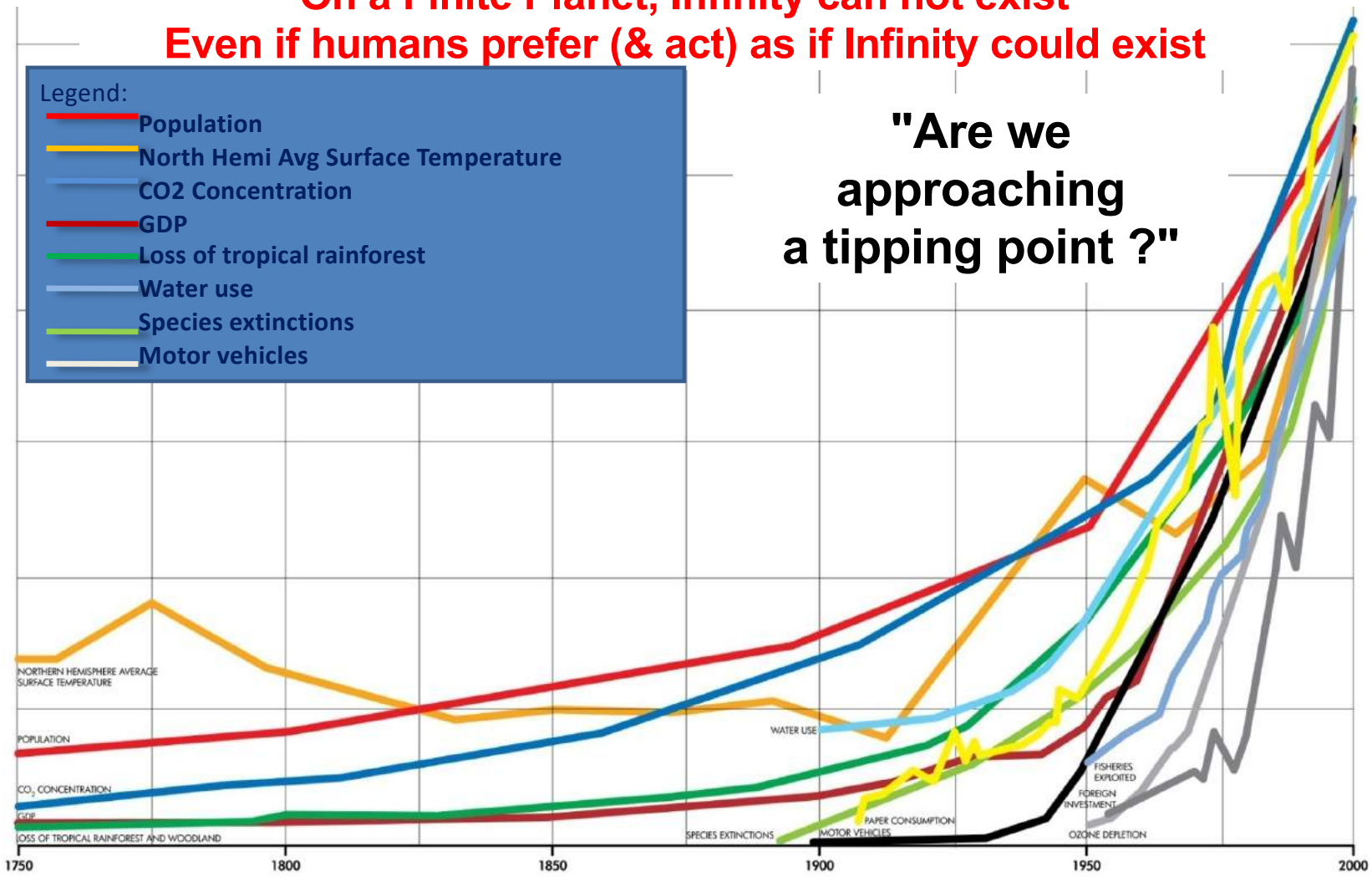
Los Alamos
16 July 1945:
start of
Antropocene

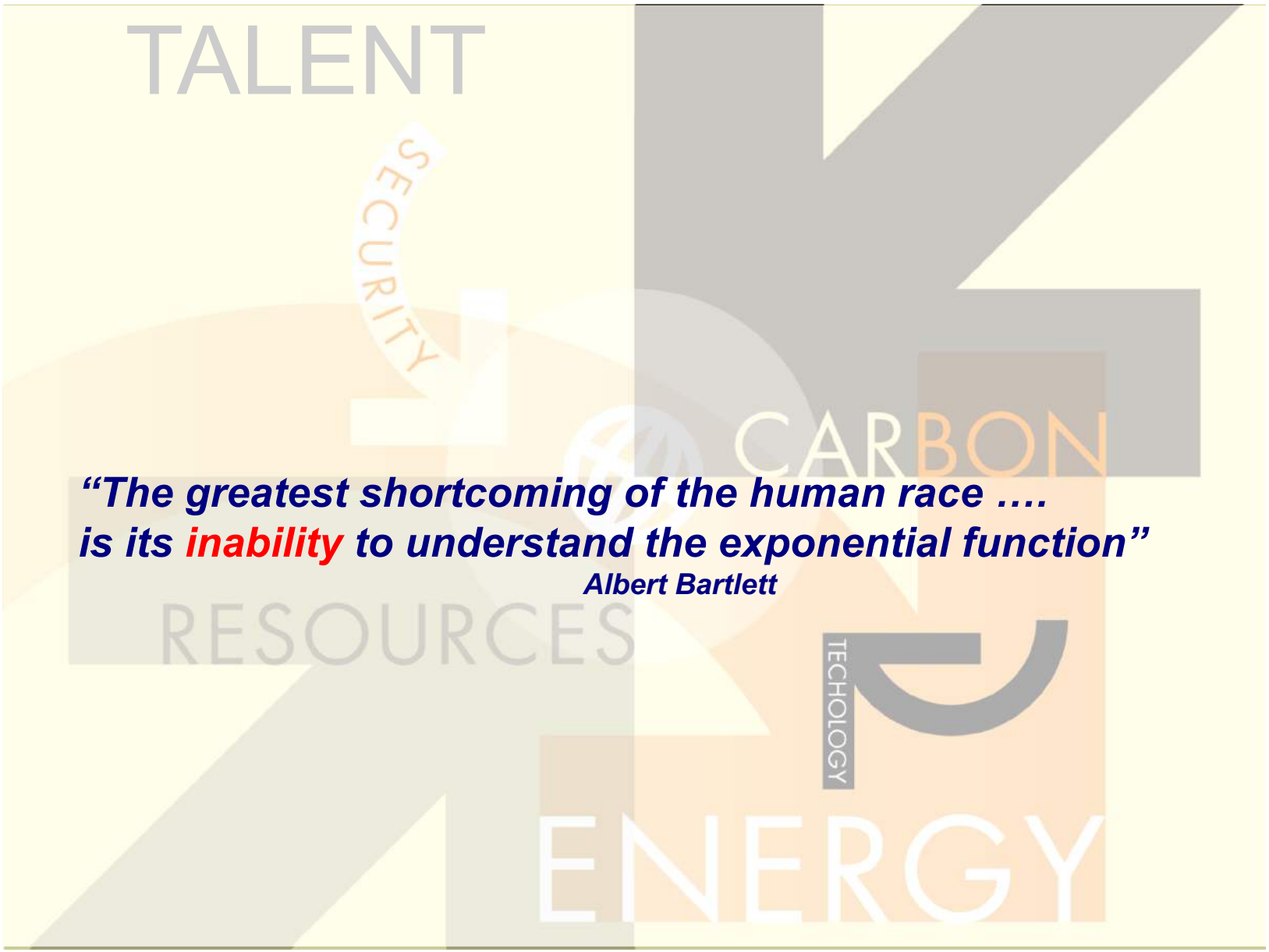
Accelerating & Fundamental Change

J-curves only exist in theoretical mathematics

On a Finite Planet, Infinity can not exist

Even if humans prefer (& act) as if Infinity could exist





"The greatest shortcoming of the human race ….
is its inability to understand the exponential function"

Albert Bartlett

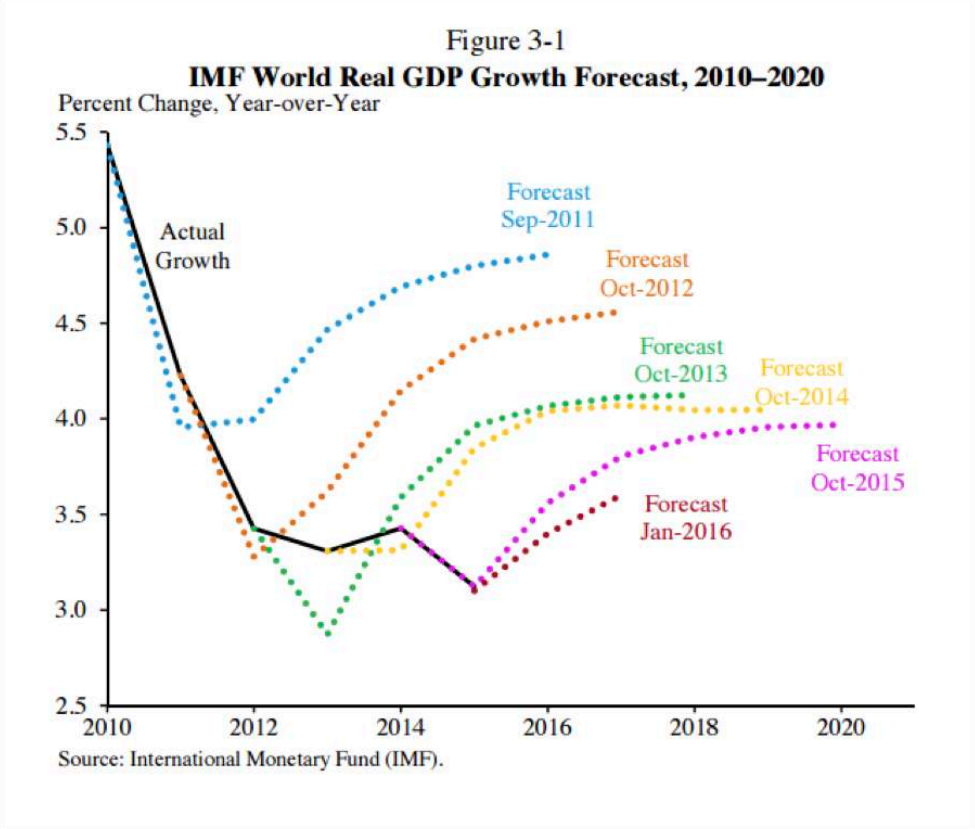
The tale of the Persian King

$2^{63} = 9,223,372,036,854,775,808$

The Shape of Exponentiality


Today the Dashboard of Spaceship Earth looks like this
tippingpoint
Houston, we've got a problem !

Growth Predictions vs. Reality

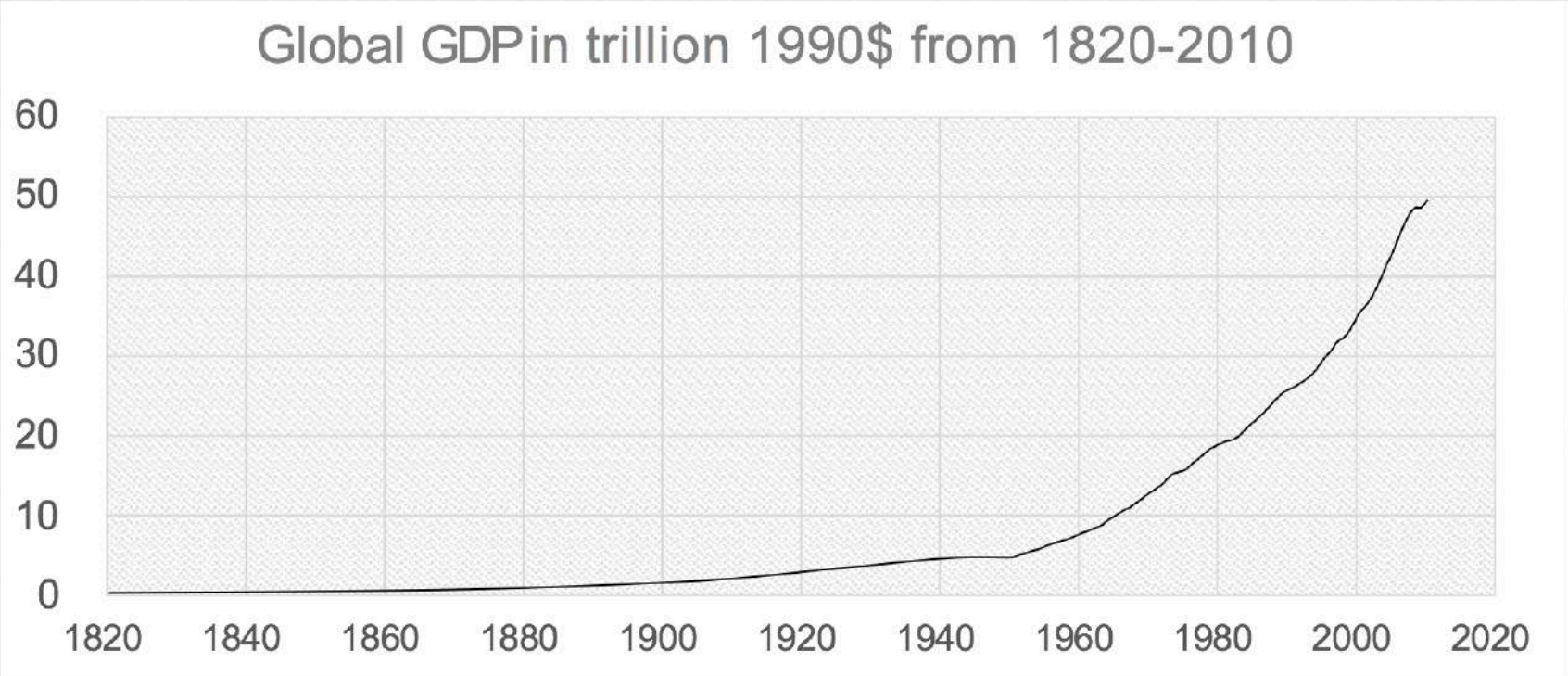


During the past years, growth prediction for almost all economies – and on global level – were constantly overoptimistic, and most countries grew at a slower pace than anticipated during the recovery since the 2008/9 crisis

Keeping up growth gets tough !

The past 200 years were just amazing

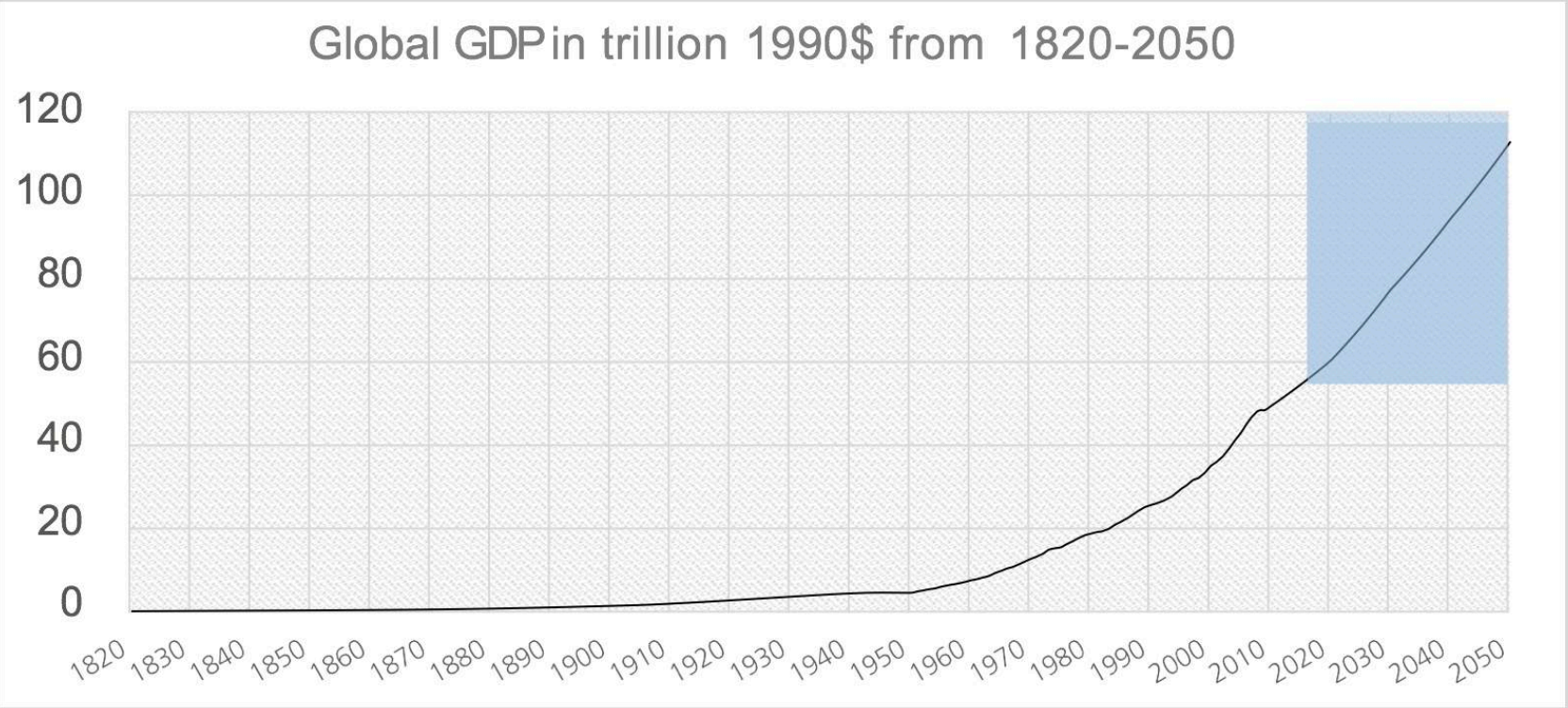
Between the years 1820 and 2010, the global economy grew 77-fold, with only very few (short) interruptions



*Sources: Angus Maddison, World Bank, IIER

This is what macroeconomics expects

Even most conservative macroeconomic forecasts project more than a doubling of global GDP between 2015 and 2050 in real (inflation-adjusted) terms



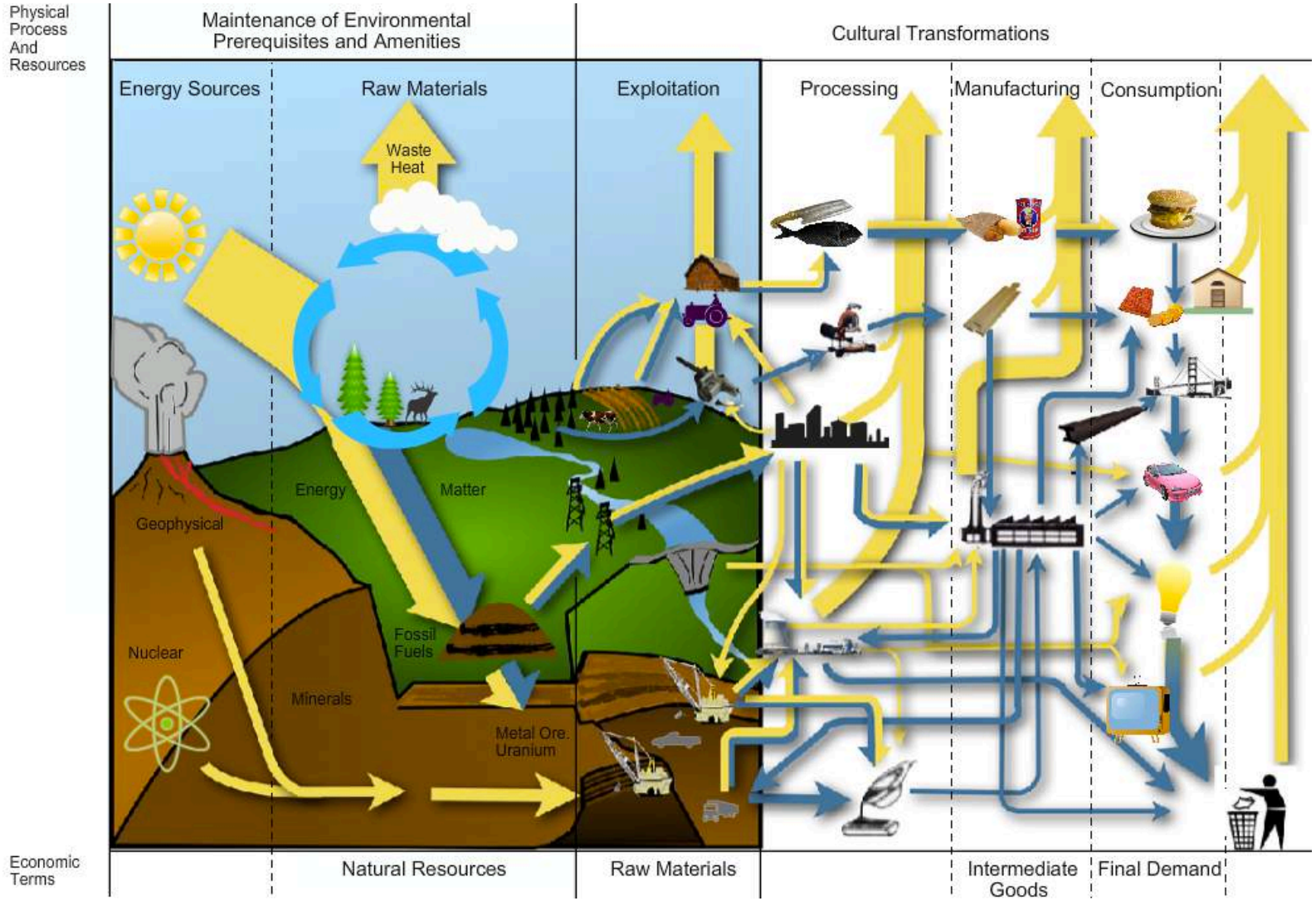
*Sources: Angus Maddison, World Bank, IIER, OECD, The Economist Intelligence Unit

…but at one point, there are limits

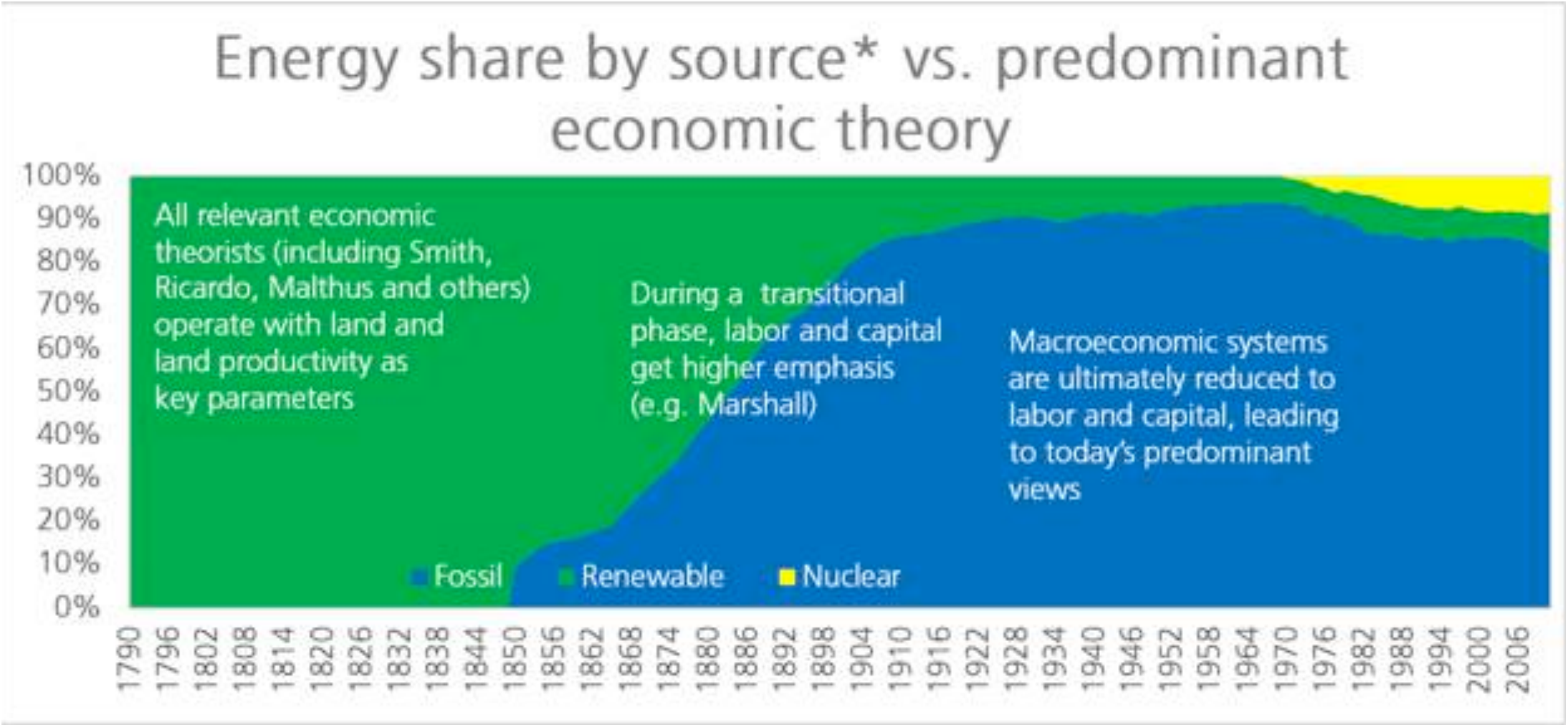
Global GDP patterns from 0 A.D. Source: Angus Maddisson, IIER calculations

Overview of Bio-physical Reality

Energy enable process to convert Natural Resources into Cultural Transformations



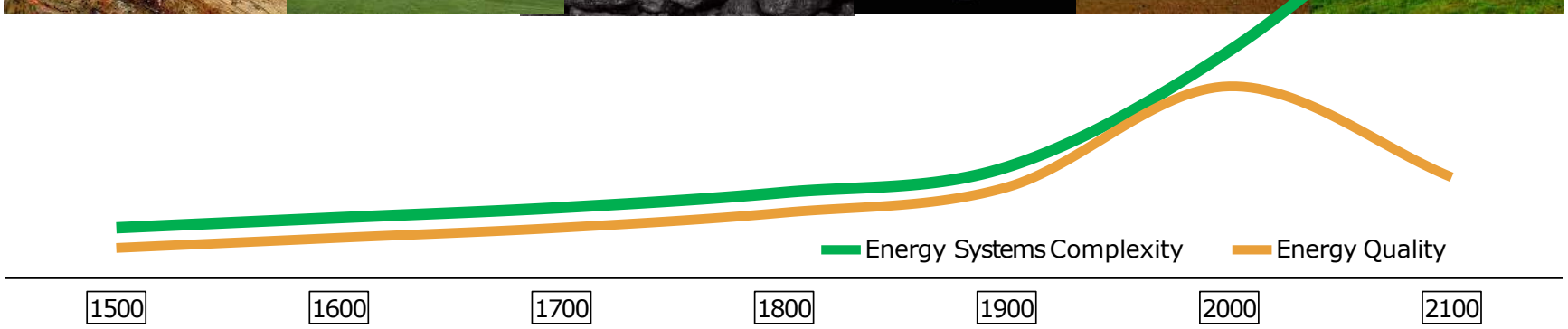
INSIGHT : our Energy Supply influences our Perception of Reality & Predominant Economic Theory



The Key Property of Renewables : Intermittency

- Variable Supply
- Adaptation of Demand
- Storage of Finished Goods

A SYSTEMS VIEW REVEALS GAPS



Economics vs. ecosystems science

Economic science

- Simplified models
- No integration of natural science
- Looks at recent history (200 years)
- Little to no interconnection between elements
- No/weak feedback loops outside supply/demand view
- No inclusion of breakpoints

Ecosystems science

- Complex systems
- Integrates physics, chemistry and biology
- Includes long-term human ecosystem history
- Highly interconnected components
- Strong feedback loops
- Systemic failure risks accepted and integrated

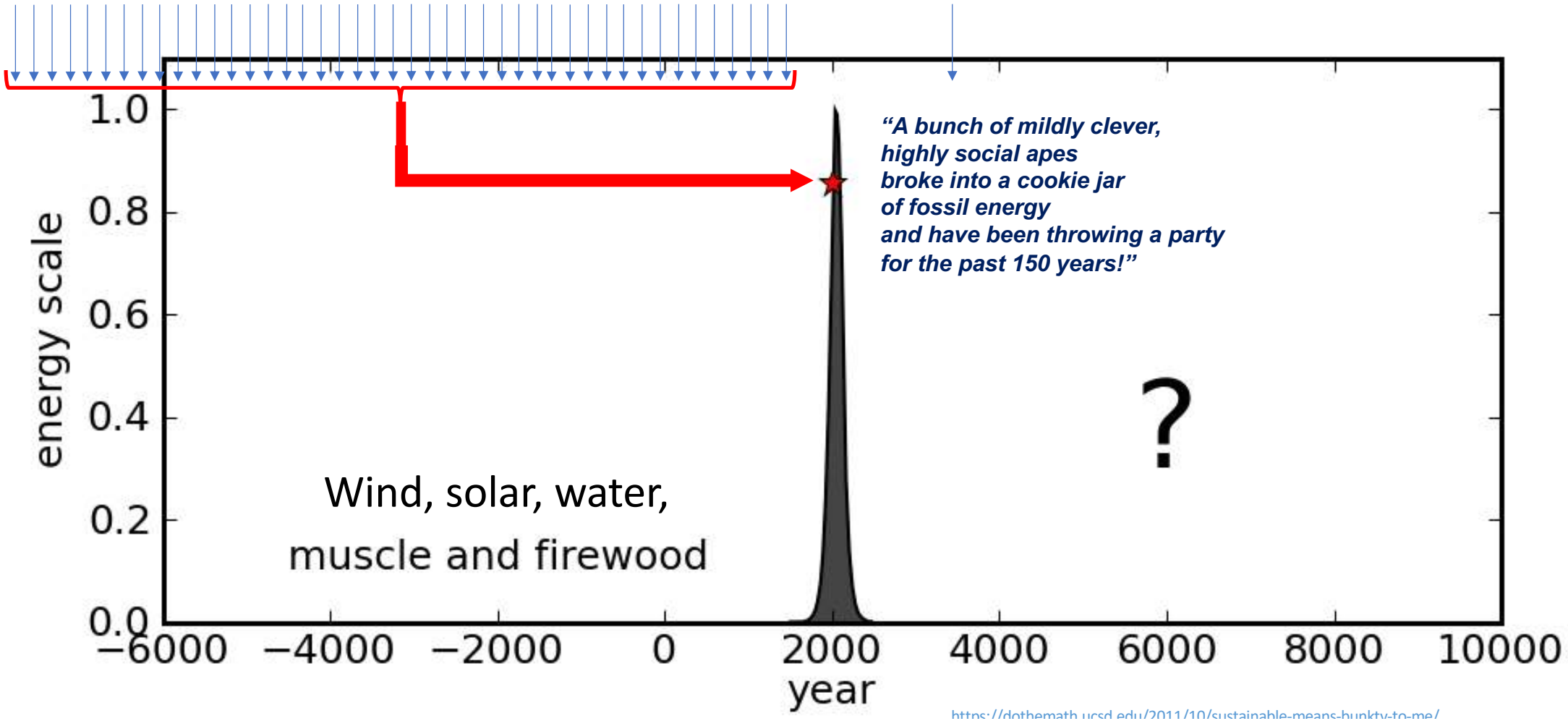
In reality, our human economic system is nothing but a (very complex) ecosystem with many more parameters

Energy quality matters a lot

For all energy (and resource) extractions, it matters what arrives on societal level

The higher the net benefit, the larger our economy

Simplified overview of our Reality : Current Solar vs Past Solar



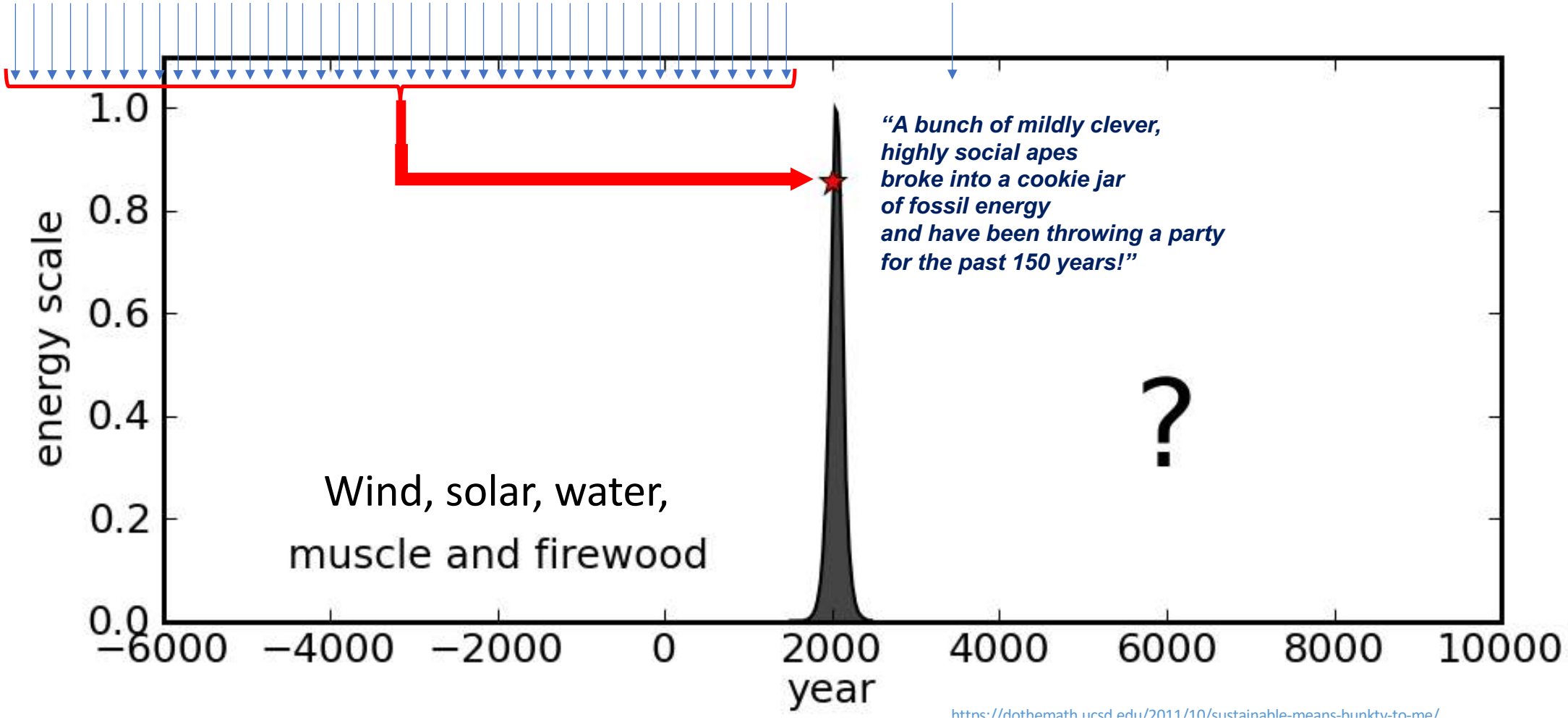
https://dothemath.ucsd.edu/2011/10/sustainable-means-bunkty-to-me/

Simplified overview of our Reality : Current Solar vs Past Solar

PAST SOLAR (=fossil) is 500 mio years of condensed prehistoric photosynthesis / solar power – Half now consumed!

Average ANNUAL Consumption : 250 mio years reserves / 250 years = 1 mio year past solar production / per calendar year

2016 consumption = 4.5 mio years prehistorische productie (= 22x the time humans roam this planet)



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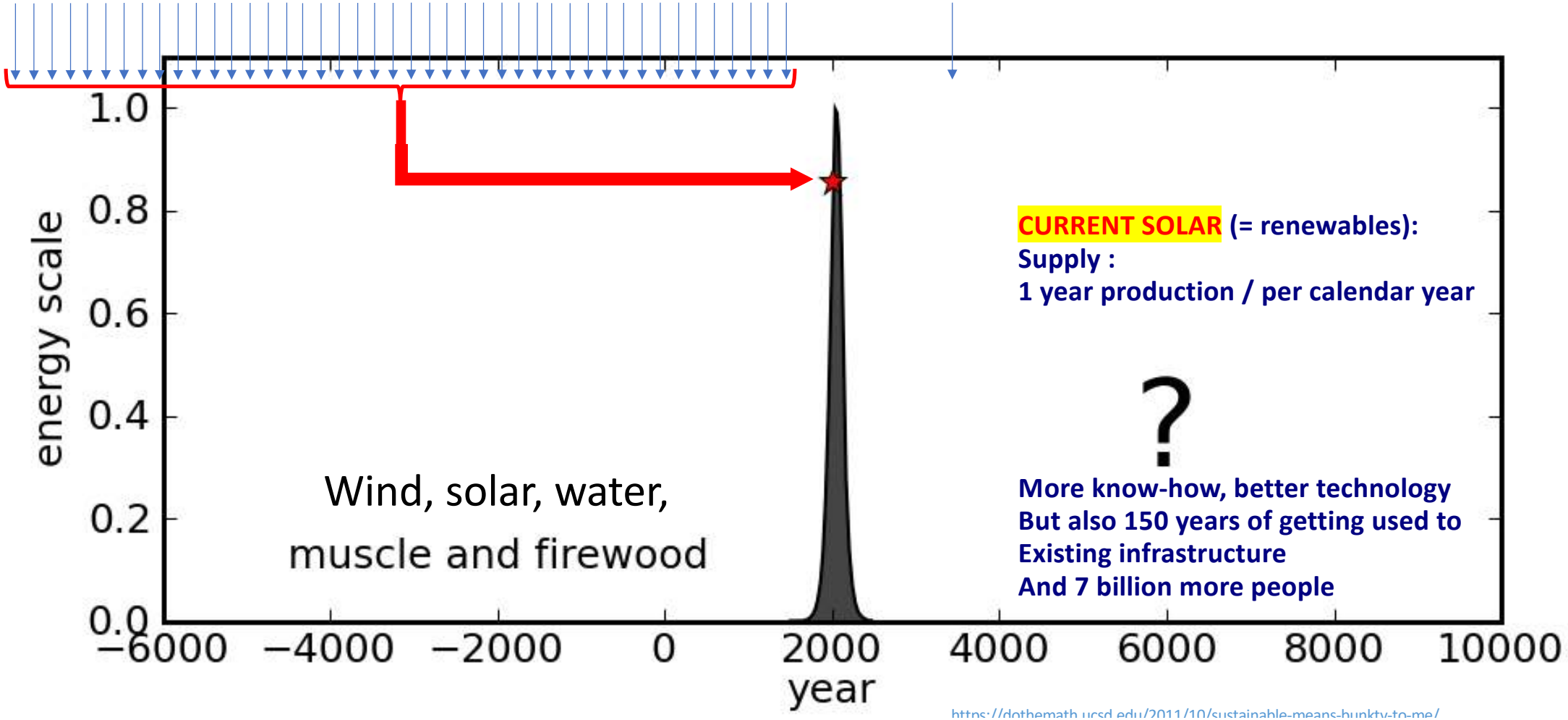


CURRENT SOLAR (= renewables):
Supply :
1 year production / per calendar year

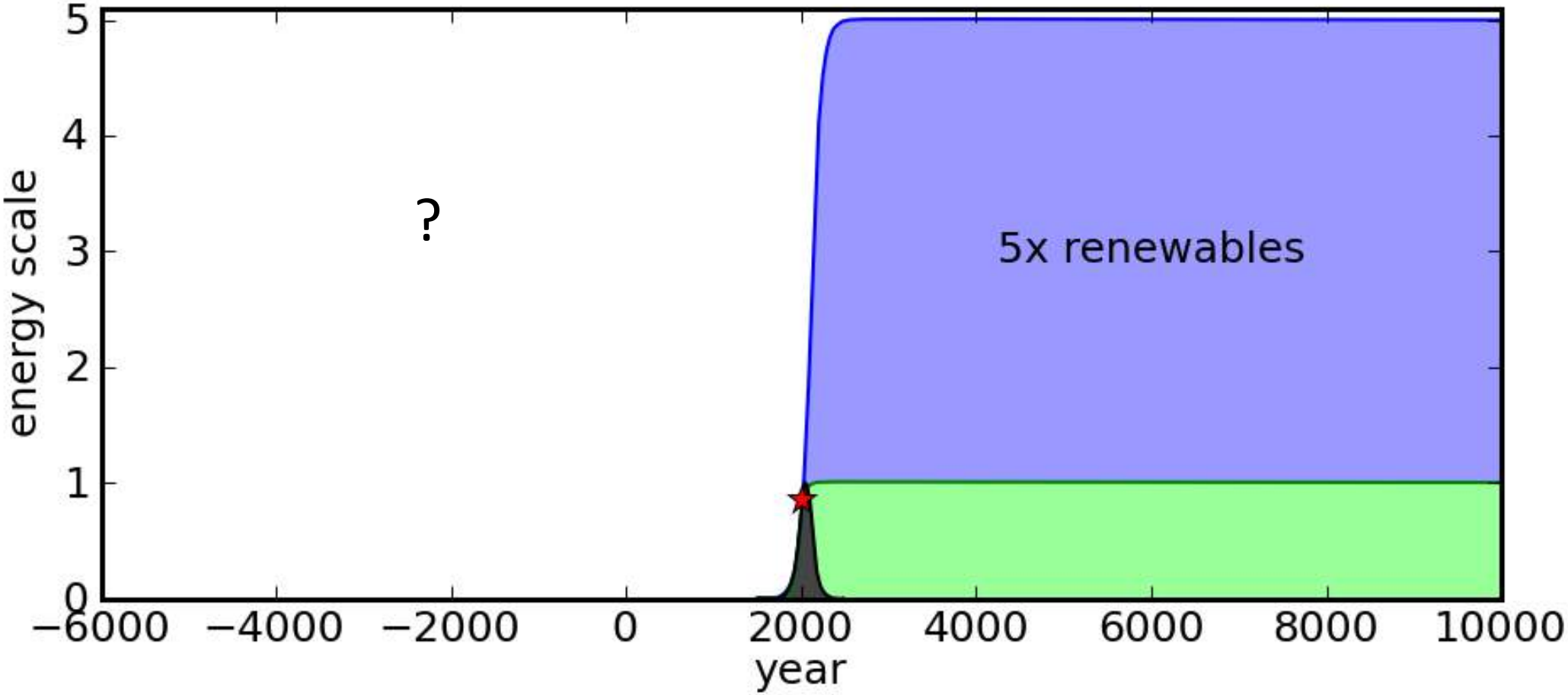
?

More know-how, better technology
But also 150 years of getting used to
Existing infrastructure
And 7 billion more people

https://dothemath.ucsd.edu/2011/10/sustainable-means-bunkty-to-me/

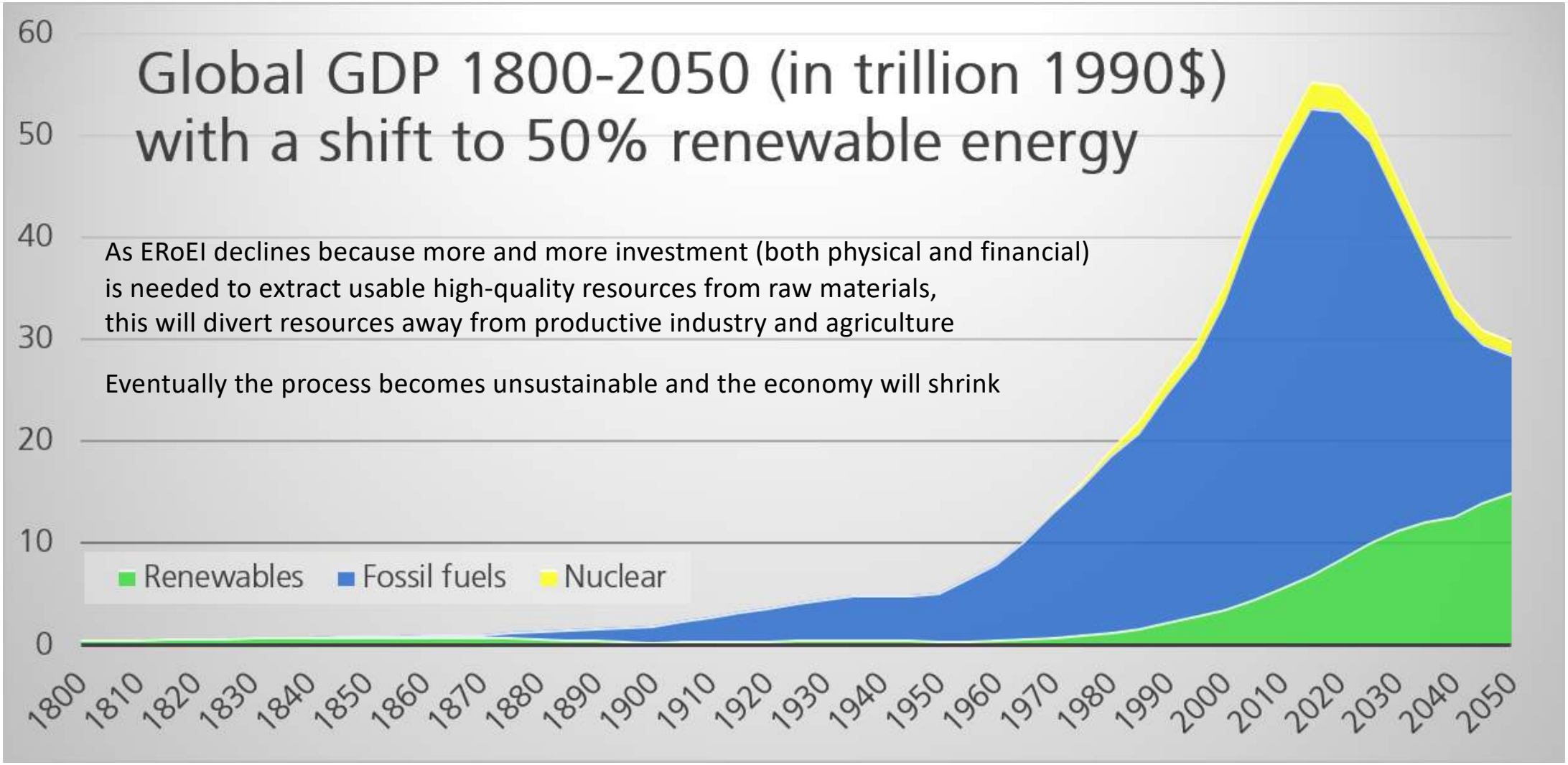
3 *Existentially important* Insights, currently missing in public policy discourse about Way Forward

1. **Capacity & Production** is *not* the same – Renewable Energy is stochastic. Requires 5-10 units capacity for 1 unit produced output.
2. **Presence & Density** is *not* the same : Density determines economic availability (recycling requires energy too (cobalt, koper, etc)
3. **Chemical & Electric Storage :** is *not* the same. Not just 24 hours, but weeks/months. (*Batteries: Resource intensive / Power2Gas ignored*)



Mother Nature, over 500 mio years **conveniently stored** the *prehistoric solar energy* **for free** in various fossil molecules. With *current solar energy* **we** have to **arrange** & **pay for the storage**. This should be included in the energy scenarios, which many tend to forget.

Davos Consensus for 21th Century: long term 2% growth
INSIGHT : our Leaders are wrong by a factor of 4!



From 3 R to 10 R

How can the HVAC-R Industry contribute to achieving the SDG's ?

- Reduce
- Reuse
- Recycle
- Repair
- Refurbish/ Recondition
- Re-purpose & up/down cycle
- Re-design products, service, business model & system
- R& D, new materials, process, technology and innovation
- Re-Skill People
- Reverse Supply Chain and Value chain

https://www.youtube.com/embed/WmVLcj-XKnM

This (y)our only home …

… use (y)our Talent to preserve it!

EUREKA 2019