



Institute
and Faculty
of Actuaries

Financial Implications of Resource Limits to Growth

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Introduction

- In January 2014 the Institute and Faculty of Actuaries established a Resource and Environment (R&E) Board
- Why? The IFoA has identified resource depletion (e.g. high oil price) and environmental issues (e.g. climate change) as being important issues for investigation.
- Research was commissioned on limits to economic growth, reporting in January 2013.
- The IFoA does not assert that growth/discount rates need to be changed now – just this is an area for investigation.

Resource constraints: Sharing a finite world

Oliver Bettis, Chair of IFoA's Resource and Environment Board

- Resource and environmental constraints: Including extracts from the IFoA's research report from January 2013

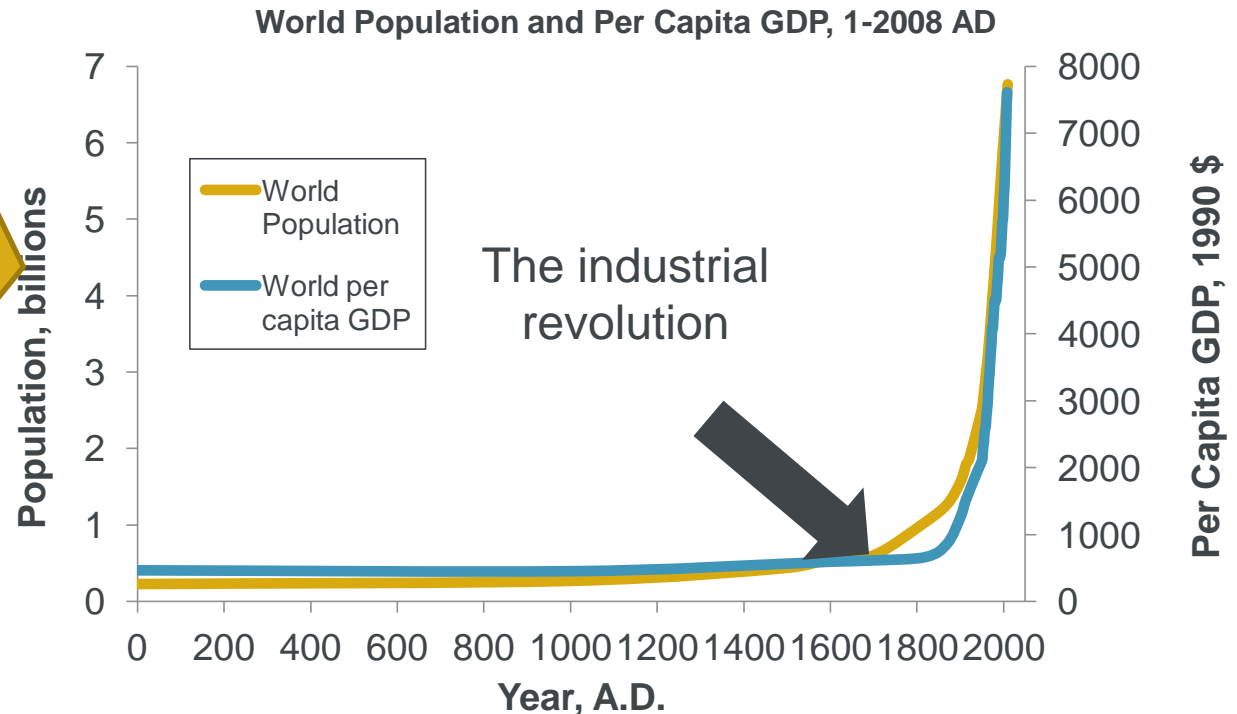


Exponential Growth

Exponential Growth

Until recently, global population has exhibited exponential growth.

Likewise the per capita GDP has been growing exponentially.

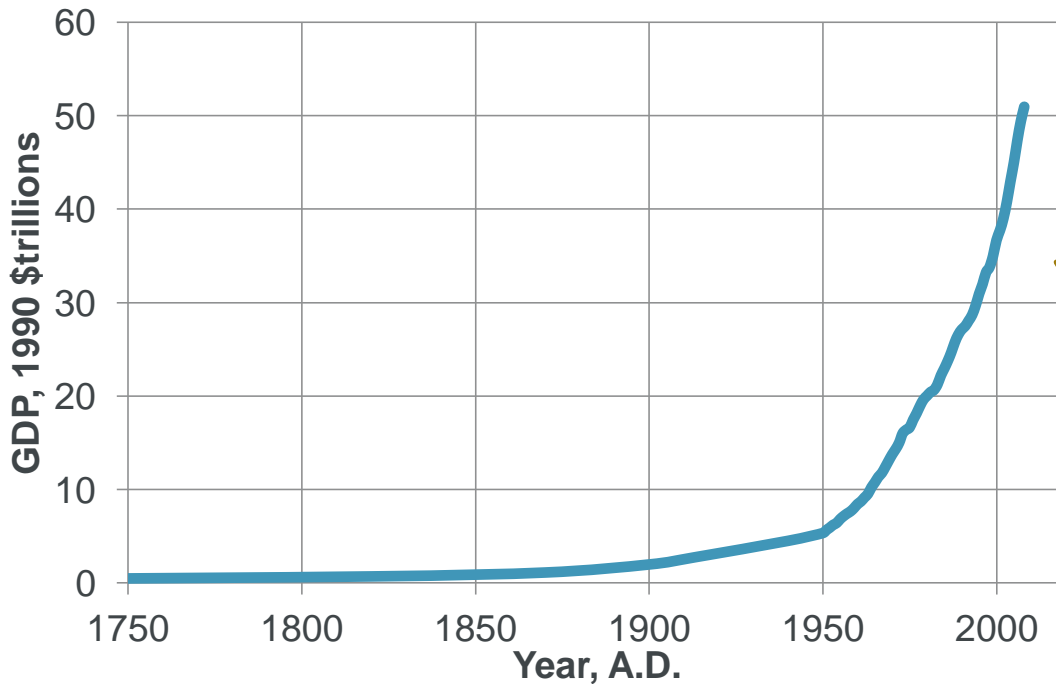


Source: <http://www.albartlett.org>

There is a great presentation about exponential growth at this web address.

Exponential Growth

World GDP, 1750-2008 AD



Exponential Growth

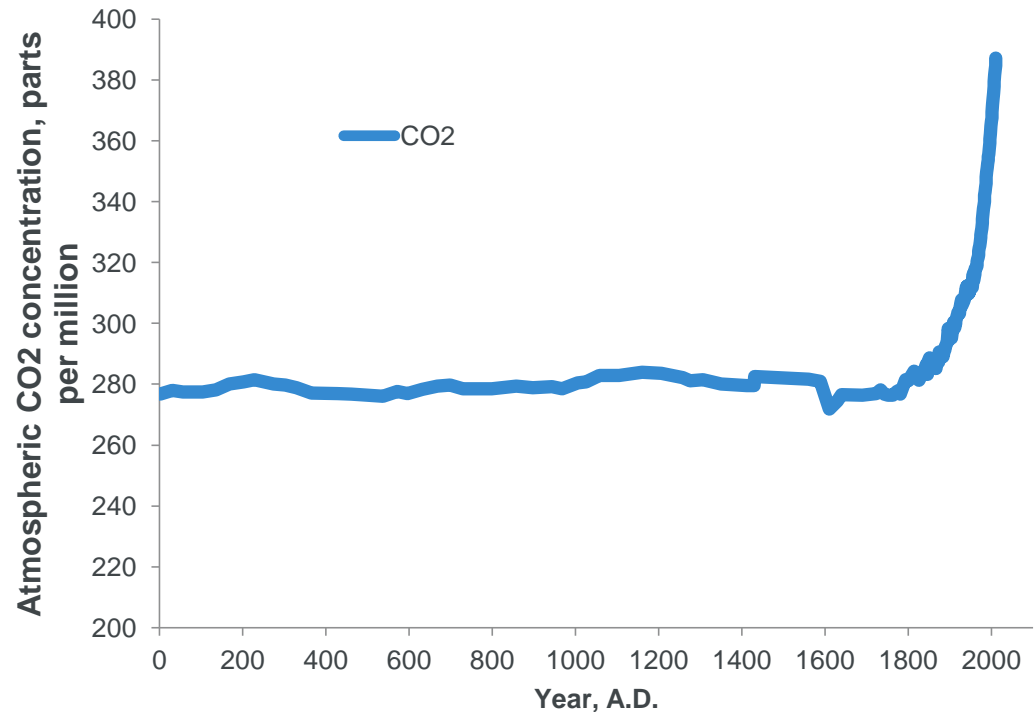
World GDP growth has been exponentially growing.

- In real terms world GDP has grown at average rate of c.3% per year in recent decades = doubling time 23 years.
- 2012 to 2100 is almost 4 doubling periods.
- If 3% growth continues, world economy would grow 14 times as large in 2100 as it is now.

Growth has a downside

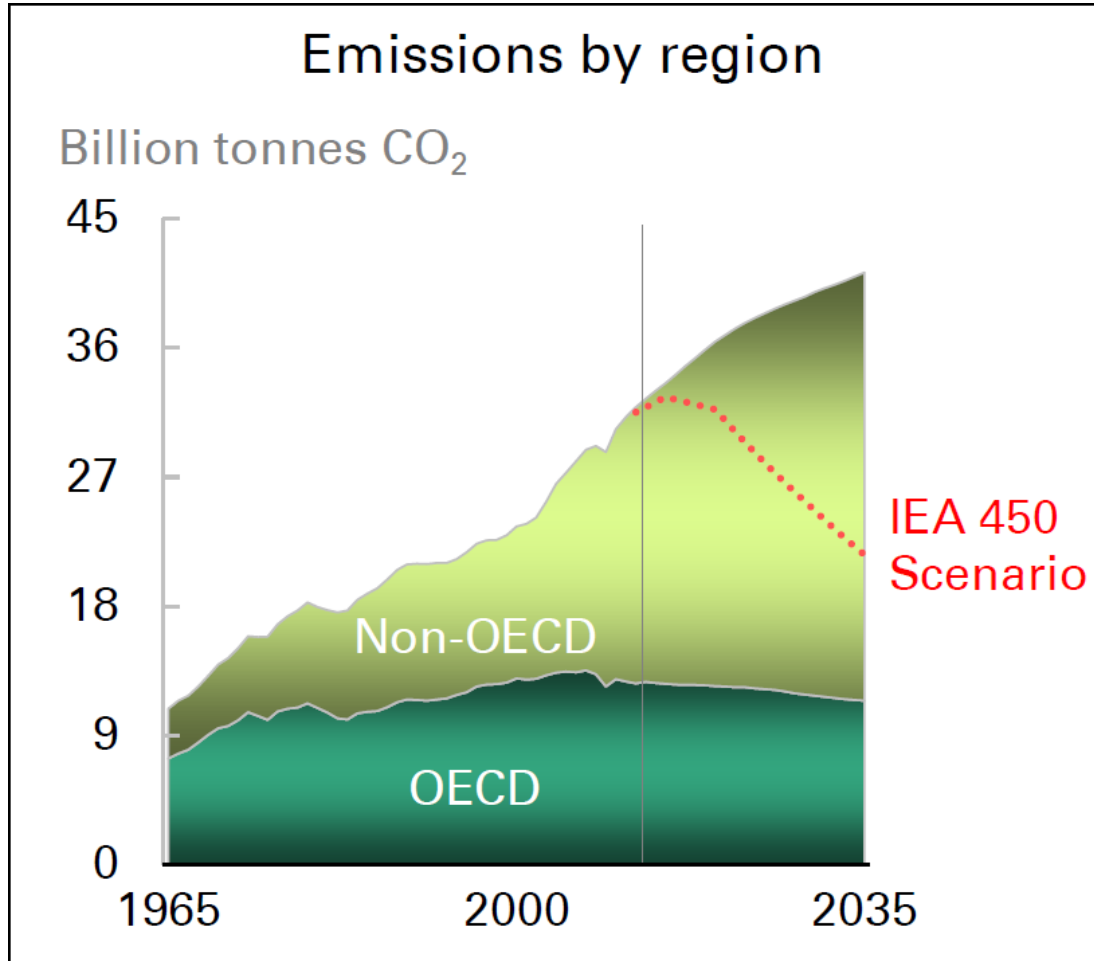
Carbon Dioxide

Not everything that grows exponentially is that great.



Source: Scripps Institution of Oceanography (SIO) CO2 Program <http://scrippsco2.ucsd.edu> R. F. Keeling, S. C. Piper, A. F. Bollenbacher and S. J. Walker

CO₂ Emissions not on a sustainable path



Physical Limits to Growth?

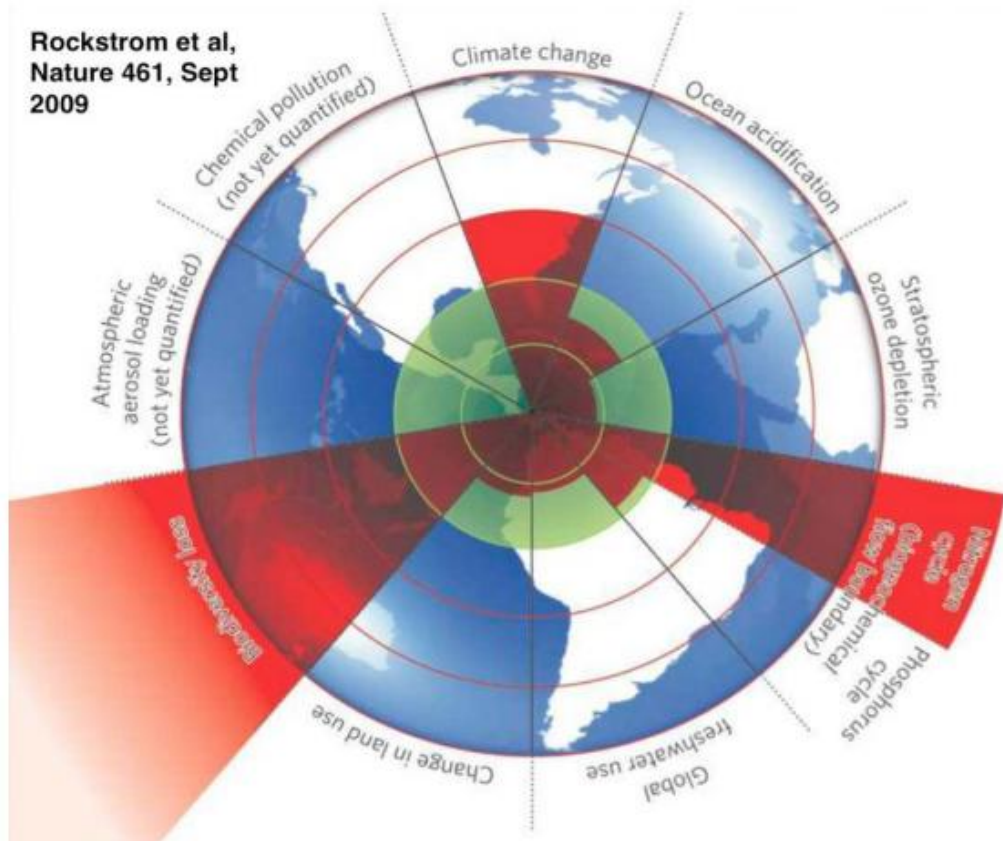


Figure 50: The 9 planetary boundaries of the Stockholm Resilience Centre. ⁶¹⁹

Stockholm University Resilience Centre (Planetary Boundaries)

This is the info-graphic (from 2009) showing the planetary thresholds and boundaries.

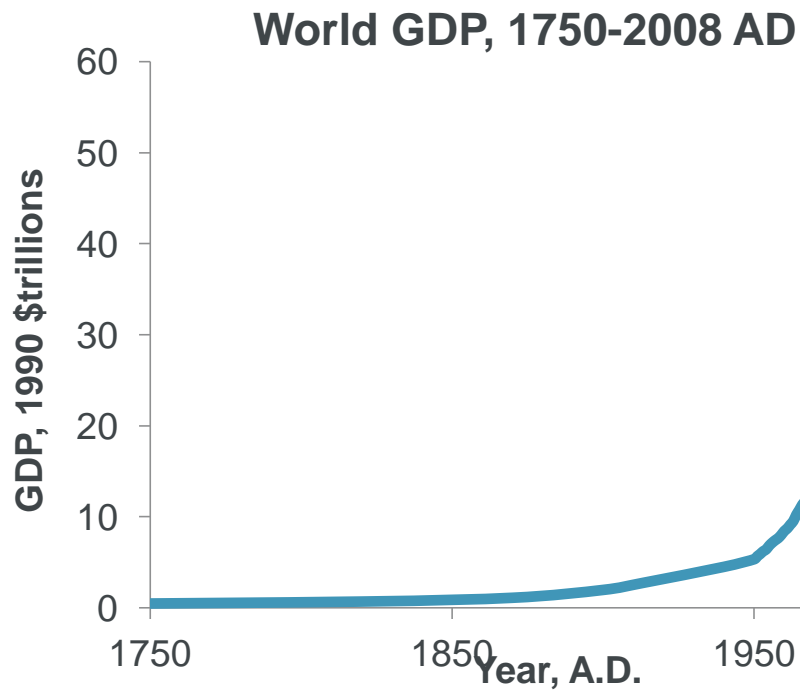
Beyond Boundary

- Climate Change

Beyond Threshold

- Rate of Biodiversity Loss
- Changes in Nitrogen Cycle

Future Growth?



Growth is the Solution

Green Growth

End of Growth

Beyond the Limits

Opinions: Growth is the Solution

Growth is the Solution

Madison (Contours of the World Economy) predicts 2003-2030 will be the fastest growing period in history – 2.25 fold increase in GDP.

Ridley (The Rational Optimist) speaks of the ability of humankind to adapt to new challenges – i.e. inventiveness and innovation will ensure growth.



Opinions: Green Growth

Green Growth

UNEP International Resource Panel says costs of growth now outweigh benefits. **Global resource usage grew 2x fast as population but not as fast as GDP – so some decoupling of GDP observed.**

OECD Towards Green Growth Framework calls for a move to green growth will foster economic development and continue to provide natural resources. Follows Green Growth Declaration signed by 34 ministers in June 2009.

Resource Revolution (McKinsey Global Institute). **Price falls over 20C wiped out by last 10 years of price rises.** Next 20 years we will have 3bn more middle class consumers . They offer two scenarios. productivity static (supply expansion) + productivity response (most demand met by productivity). Latter scenario needs a good deal more investment but neither avoid 2 degree warming. Third scenario “climate response case” – move to low carbon energy, reforestation, land restoration, carbon capture,

Shell have two scenarios Scramble (energy efficiency left until supplies tight + greenhouse gas emissions cut when climate change happens) and Blueprint (local actions to ensure growth, deliver energy security and mitigate environment). 2011 updates suggests messages mixed whether we are following Scramble or Blueprint . **Shell actively supports Blueprint**

IEA produced scenarios “Current Policies”, “New Policies” and “450” – the former two suggest significant global warming – the latter one. **Advocate increasing nuclear, gas and renewables.** In 450 scenario - 4/5 of carbon allowed until 2050 is locked in already.

Opinions: End of Growth

Limits to Growth stressed (reiterated) that humanity is on course to overshoot.

Based on a systems dynamics world view – interconnections, feedback loops, delays, event interactions.

They conclude overshoot caused by...

- Rapid Change
- Limits / barriers to change
- Errors / delays in perceiving limits / controlling change.

Concludes that physical growth will ultimately cease completely whether we like it or not.

Limits to Growth – Predictions

Comparing 'Limit to Growth' scenarios to observed global data

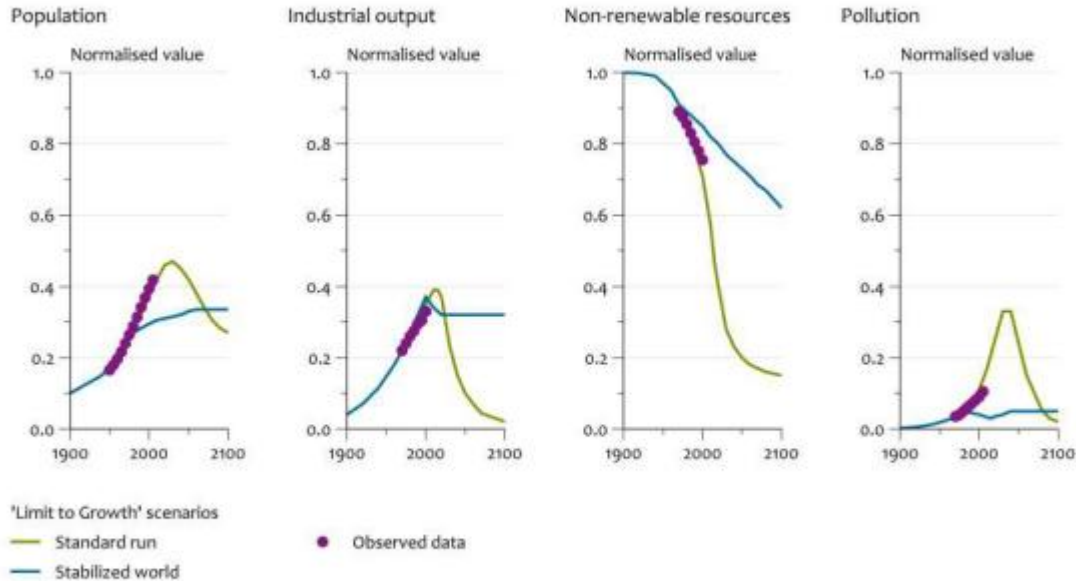


Figure 1: Comparison of World3 Limits to Growth scenarios to observed data. ¹³

Limits to Growth (30 Year Update)

The 1972 LtG paper used a systems dynamics model (World 3) to explore the feedback between;

- Population
- Industry
 - Food
- Non-renewable resources
- Pollution system.

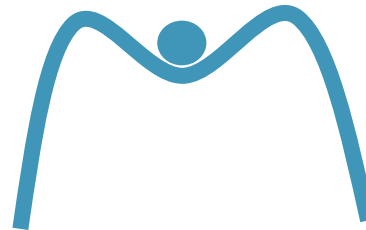
The green lines represent the “standard scenario” – which is a business as usual (growth agenda).

The purple observations show the realised observations.

Netherlands Environmental Assessment Agency / Turner (2008)

Why so many views?

Fatalistic	Hierachic
Individualistic	Egalitarian



Cultural Theory of Risk

Anthropology has something to say about this.

That there are 4 *social constructions* of risk that affect the way people perceive risk taking.

Evidence for Resource Limits



- Fossil fuels ((Oil, coal and gas))
- Land, soil and food
- Fresh water
- Uranium
- Commodities (e.g. copper, iron, zinc, rare Earth metals)

Oil

This graph from the IEA (International Energy Agency) 2008 World Energy Outlook – shows significant dependence on fields yet to be developed.

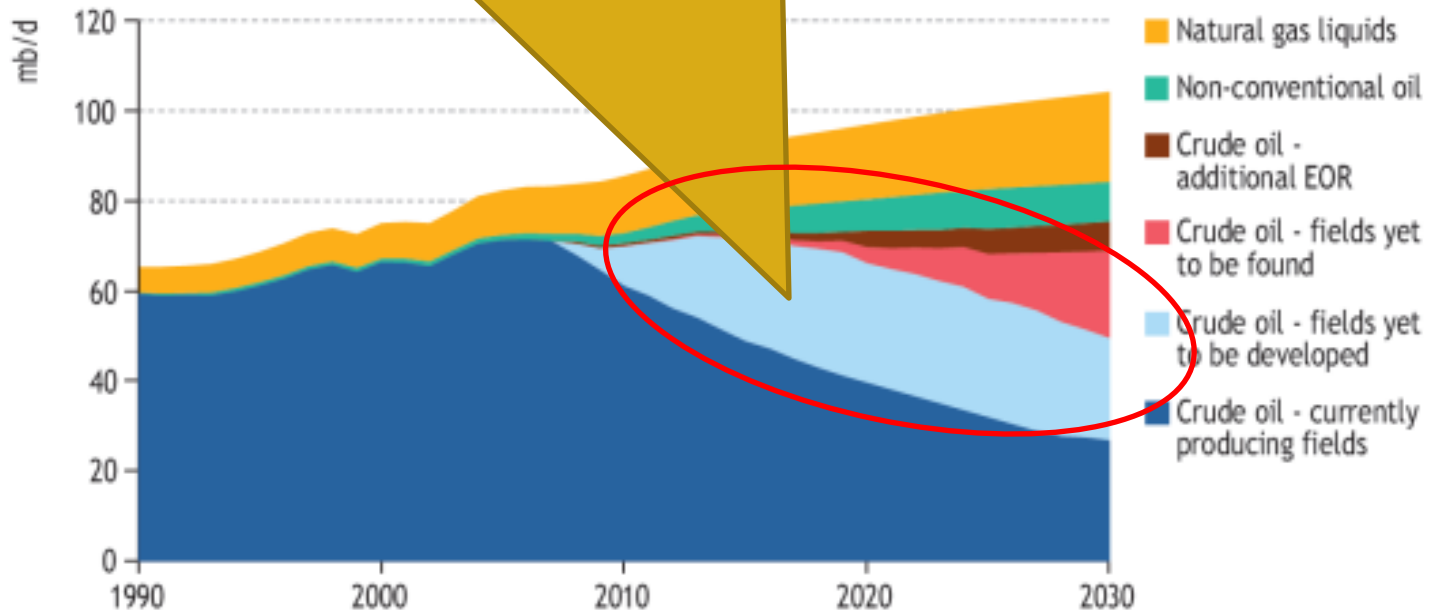


Figure 7: World oil production by source in the 2008 Reference Scenario²²⁴

Oil

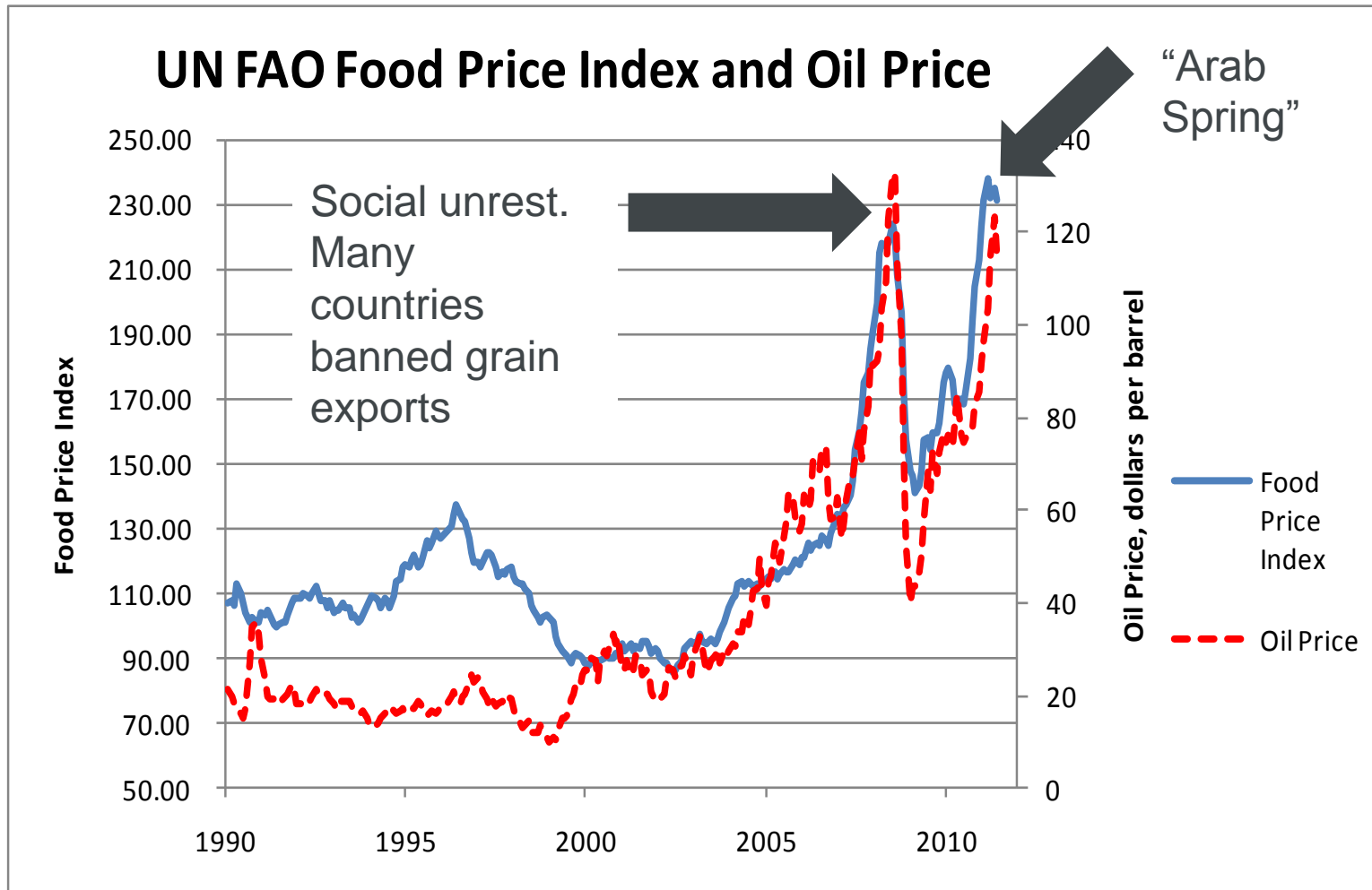
Issues

- New fields are smaller – and therefore run off faster.
- EROEI (energy returned on energy invested) is falling.
- Many national oil companies – oil set to become more of a political issue

When will Peak Oil occur?

According to some it has occurred already (e.g. Macquarie Group) – according other others it is a long way off (e.g. Exxon Mobil).

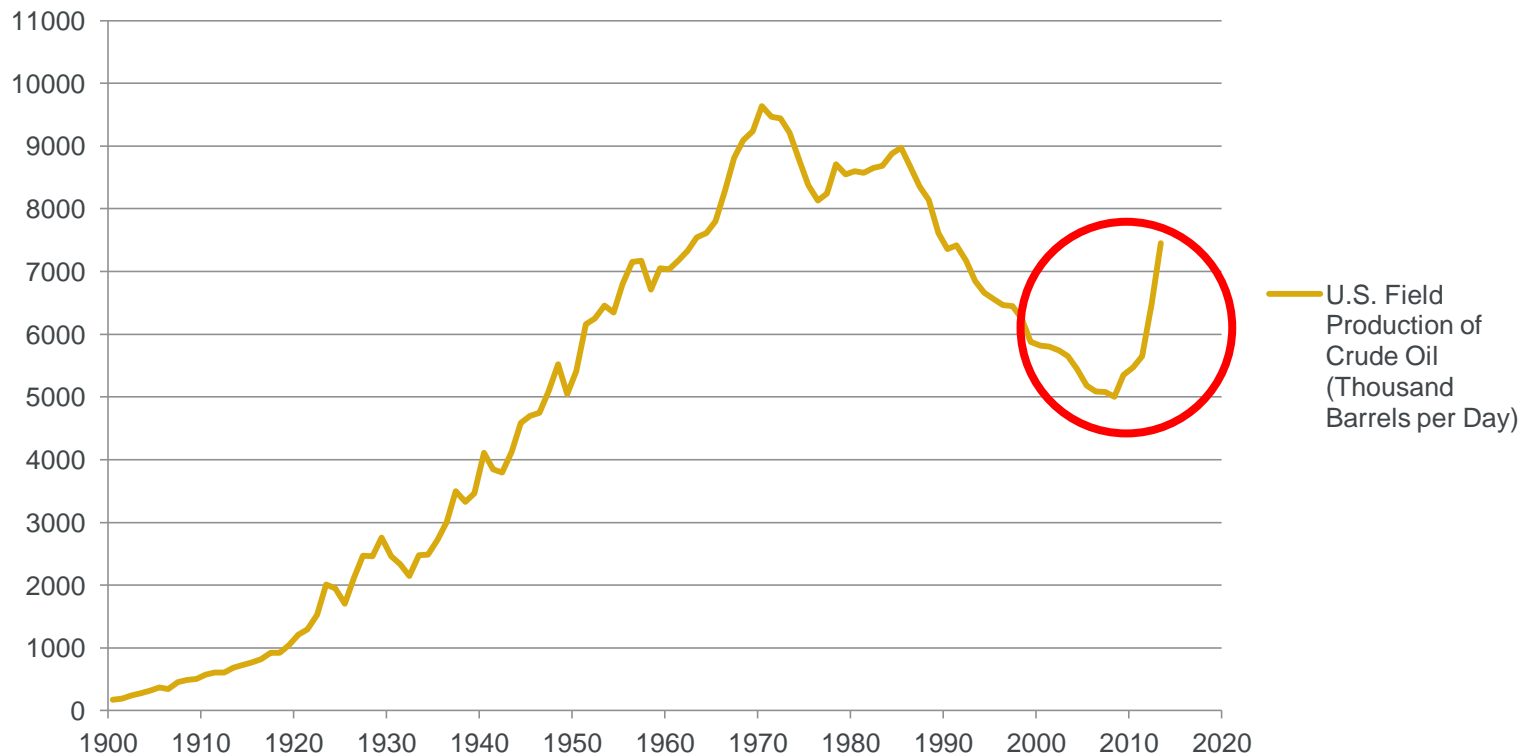
Limits interact e.g. oil, food prices and civil unrest



Sources: <http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/>
<http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rbrte&f=m>

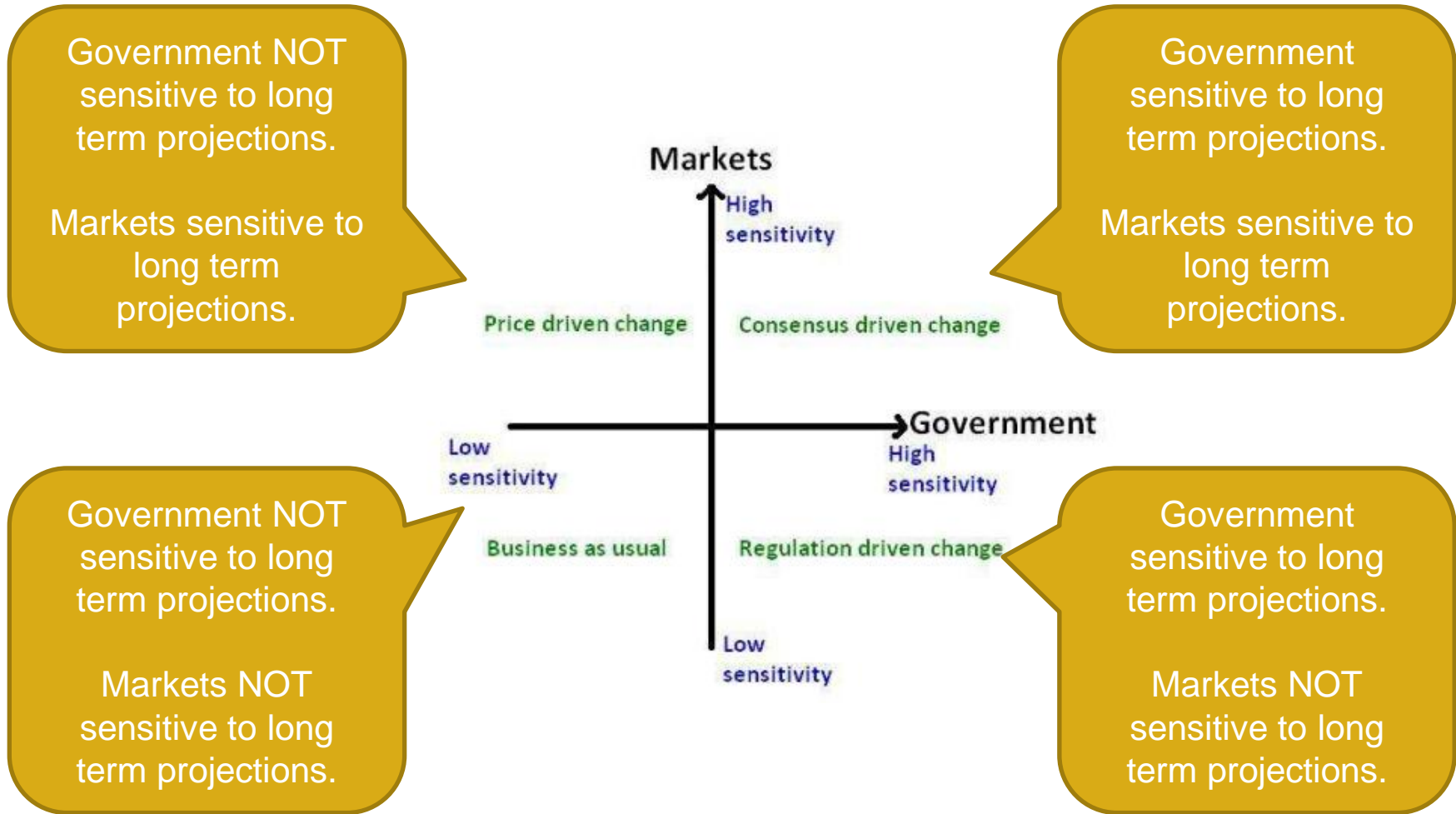
Counter argument – High oil price leads to higher production

U.S. Field Production of Crude Oil, 1900-2013

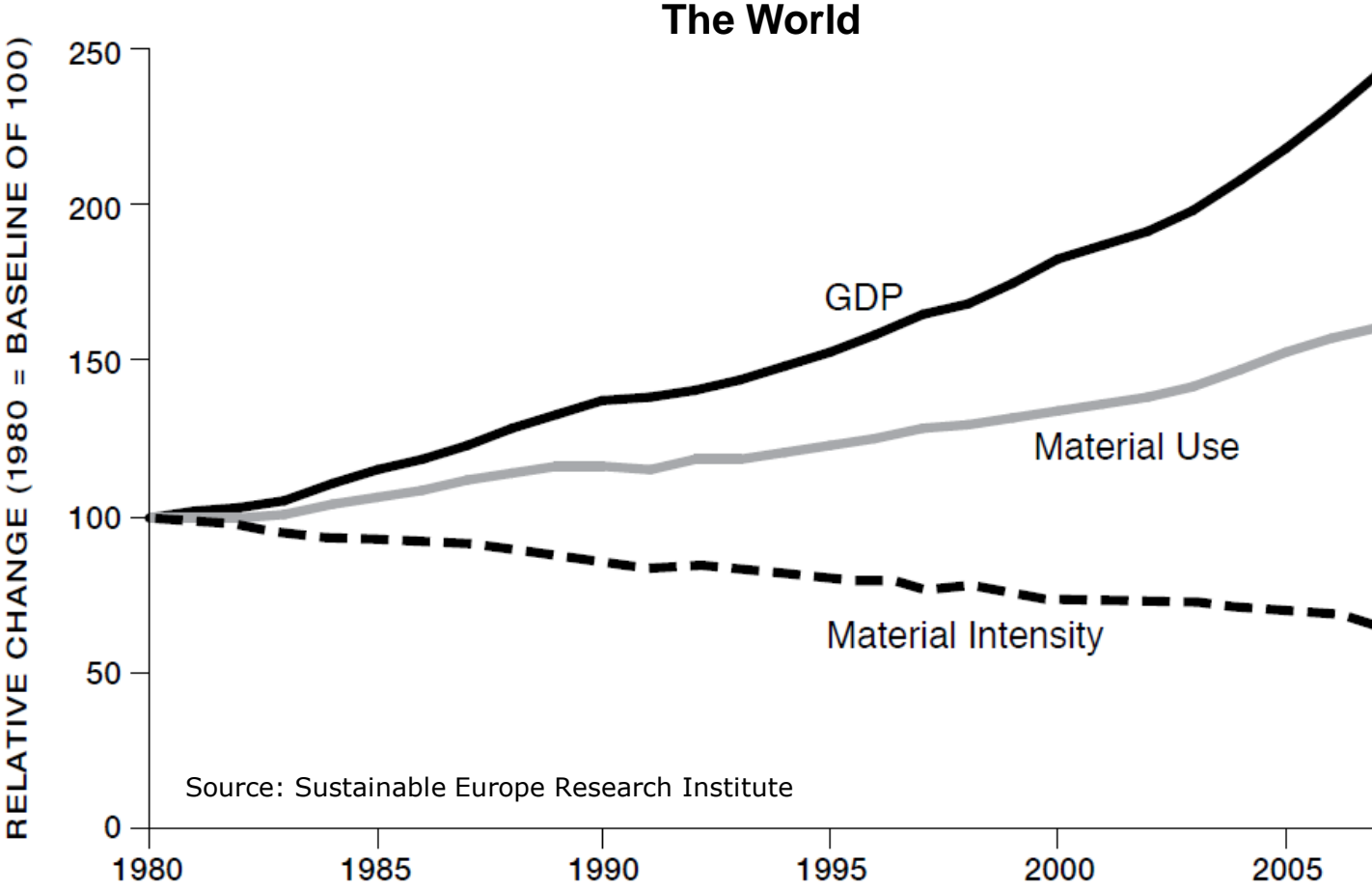


Source: US Energy Information Administration <http://www.eia.gov.htm>

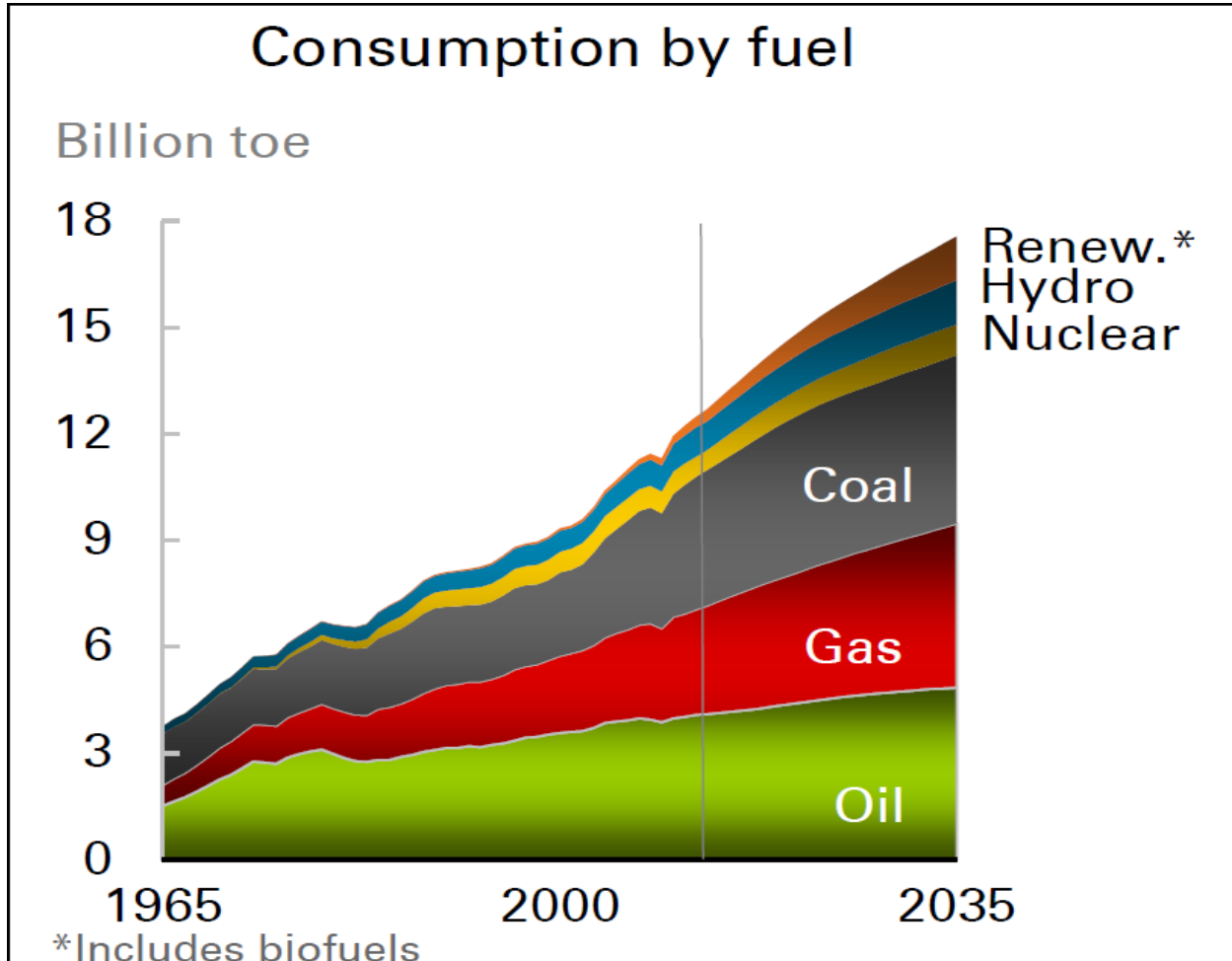
Actuarial – Scenarios in the Paper (Briefly)



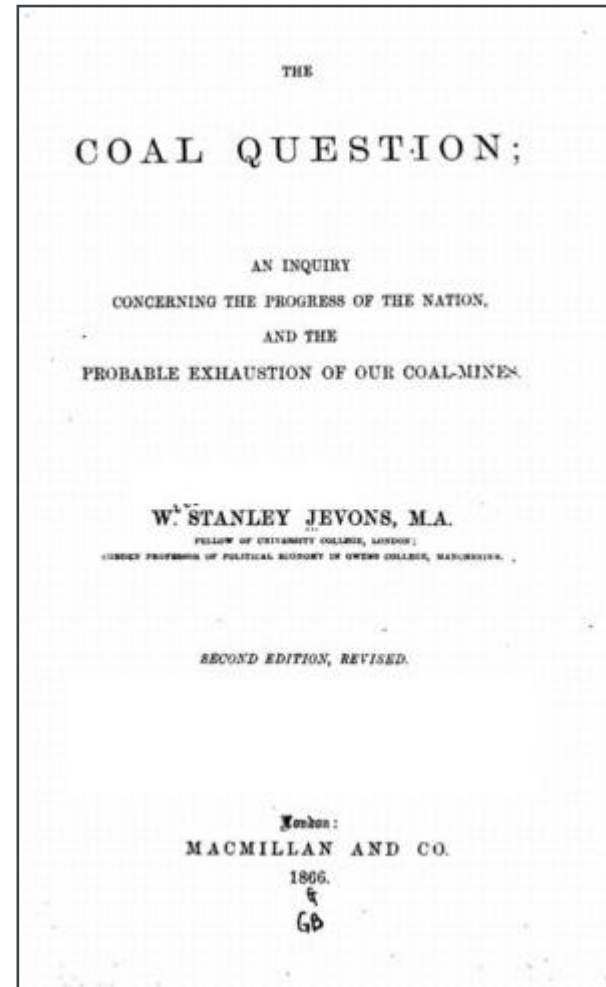
Can Technology Save Us?



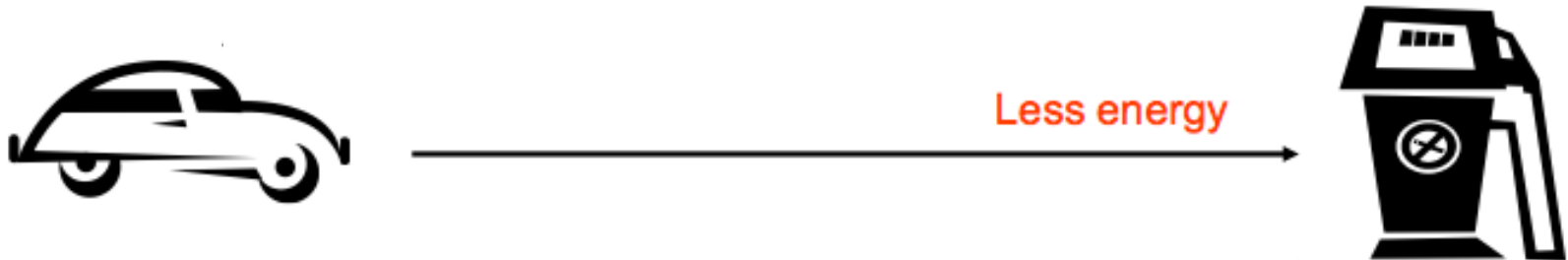
Projected Energy Demand to 2035



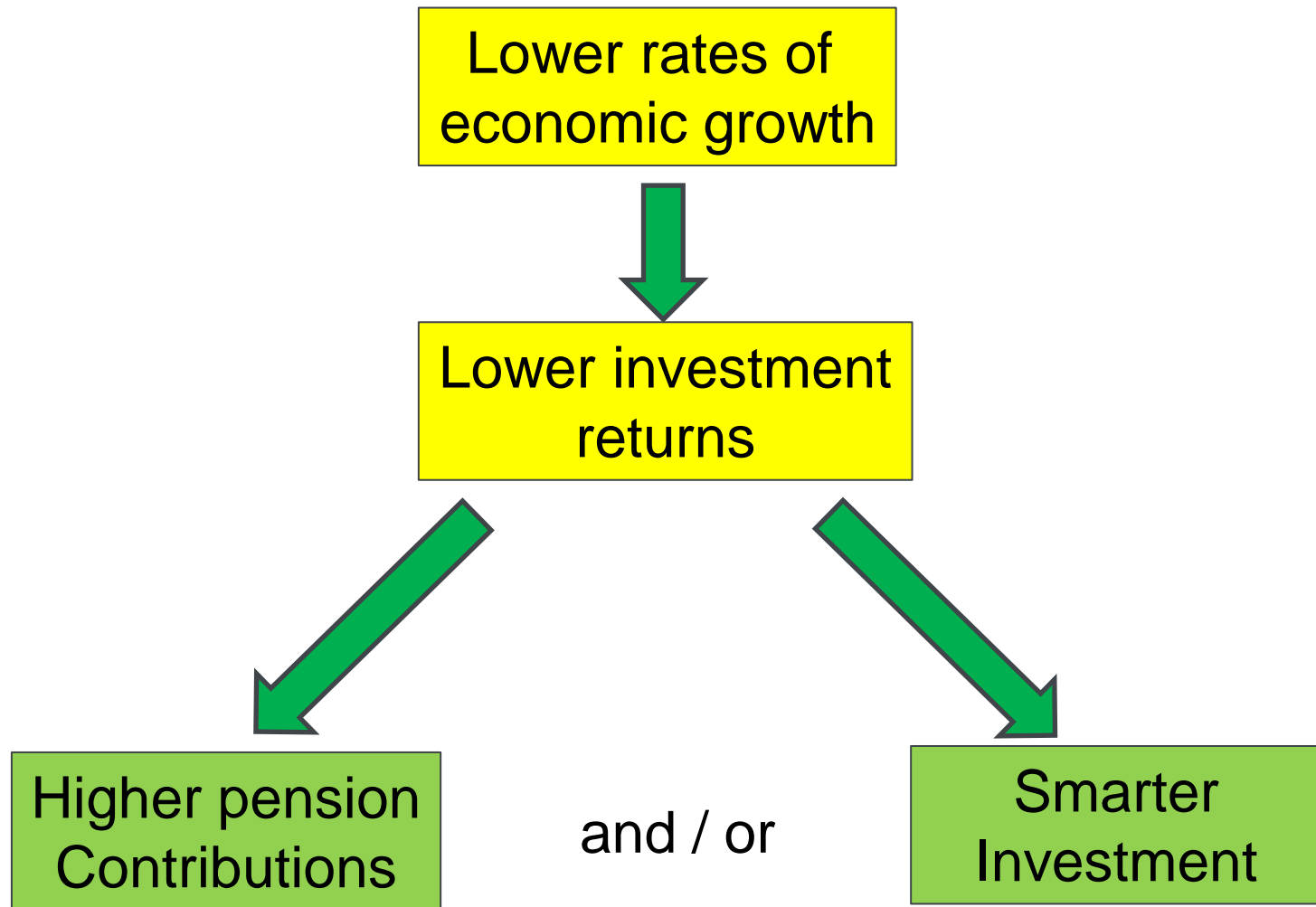
The Rebound Effect



The Rebound Effect



What Could This Mean for Pensions?



The Danger of Stranded Carbon Assets

- Many fossil fuel companies are valued assuming all resources will be extracted and consumed
- Consumption of proven fossil fuel reserves could yield over 5 times the safe level of carbon emissions
- If governments act faster on climate to hold temp, the value of these assets will decline sharply
 - 60-80% of coal, oil and gas reserves are potentially unburnable and therefore of no value
- This “carbon bubble” has not been widely recognised by investors



See: <http://www.smithschool.ox.ac.uk/research/stranded-assets/>

And <http://www.carbontracker.org/carbonbubble>

Investment Opportunities in a constrained World

- Renewable energy
 - £300 billion required between now and 2030 in the UK (Blyth and McCarthy)
 - Large scale wind
 - Locally distributed generation
 - Energy efficiency improvements (e.g. Green Deal)
 - \$35 trillion required globally (IEA)
 - Sustainable transport technologies
 - Hybrid and electric vehicles, bus rapid transit
 - Sustainable agriculture
 - Ecosystem protection
 - Ecosystems provide tens of trillions of dollars worth of services to the world economy
-



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Thank you!

Expressions of individual views by members of The Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

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