The Limits to Growth: Climate Change and Other Sustainability Issues

Casualty Actuaries of Europe 22nd June 2010

- The exponential function
- Climate change is one of many problems
- Making sense of it all - the “Limits to Growth”
- Why are we in this situation?
- What are the solutions?

Why actuaries need to know about sustainability issues

Climate Change

- Natural Catastrophe implications
- Inflation - Claims
- New markets
  - Existing products
  - New products

Oil and Resource Depletion

- Economic impacts:
  - Interest rates
  - Inflation – Raw Materials
  - Asset prices
- Impacts on global relations

Exponential Growth

"The greatest shortcoming of the human race is our inability to understand the exponential function" – Professor Albert Bartlett

$$x(t) = x_0 e^{ti}$$

The exponential function arises whenever a quantity grows or decays at a rate proportional to its current value.

Refer: http://www.albartlett.org

Exponential Growth - Doubling Time

- Doubling time

  Approx. doubling time = 70/Growth Rate %

  Reason: $70 \approx 100 * \ln(2)$

- Every time you hear a growth rate, think doubling time:
  - “Crime Doubled in a Decade!”
  - “Growth in GDP”

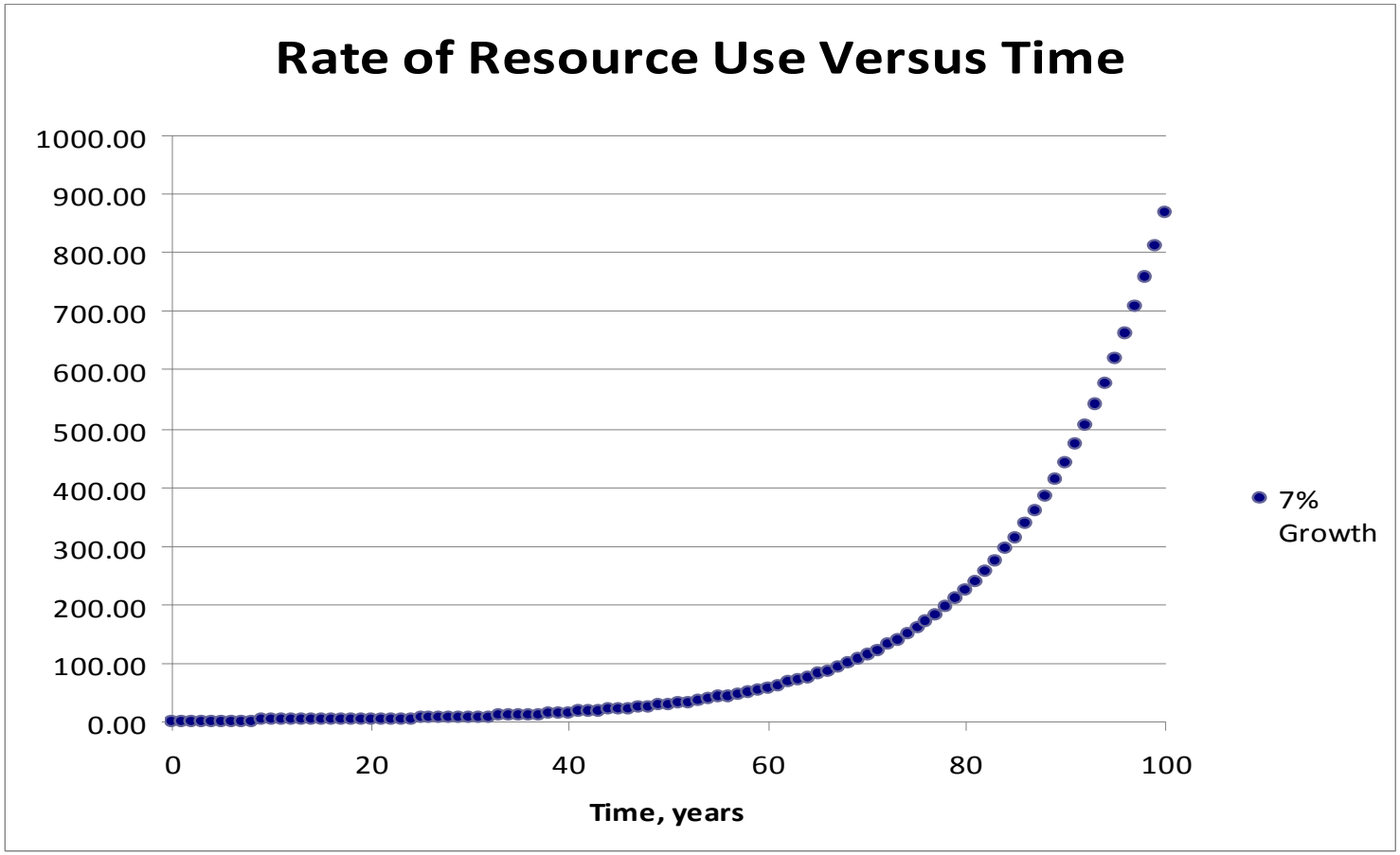
Exponential Growth – Resource Use

For a resource which is used up at a constantly increasing rate:

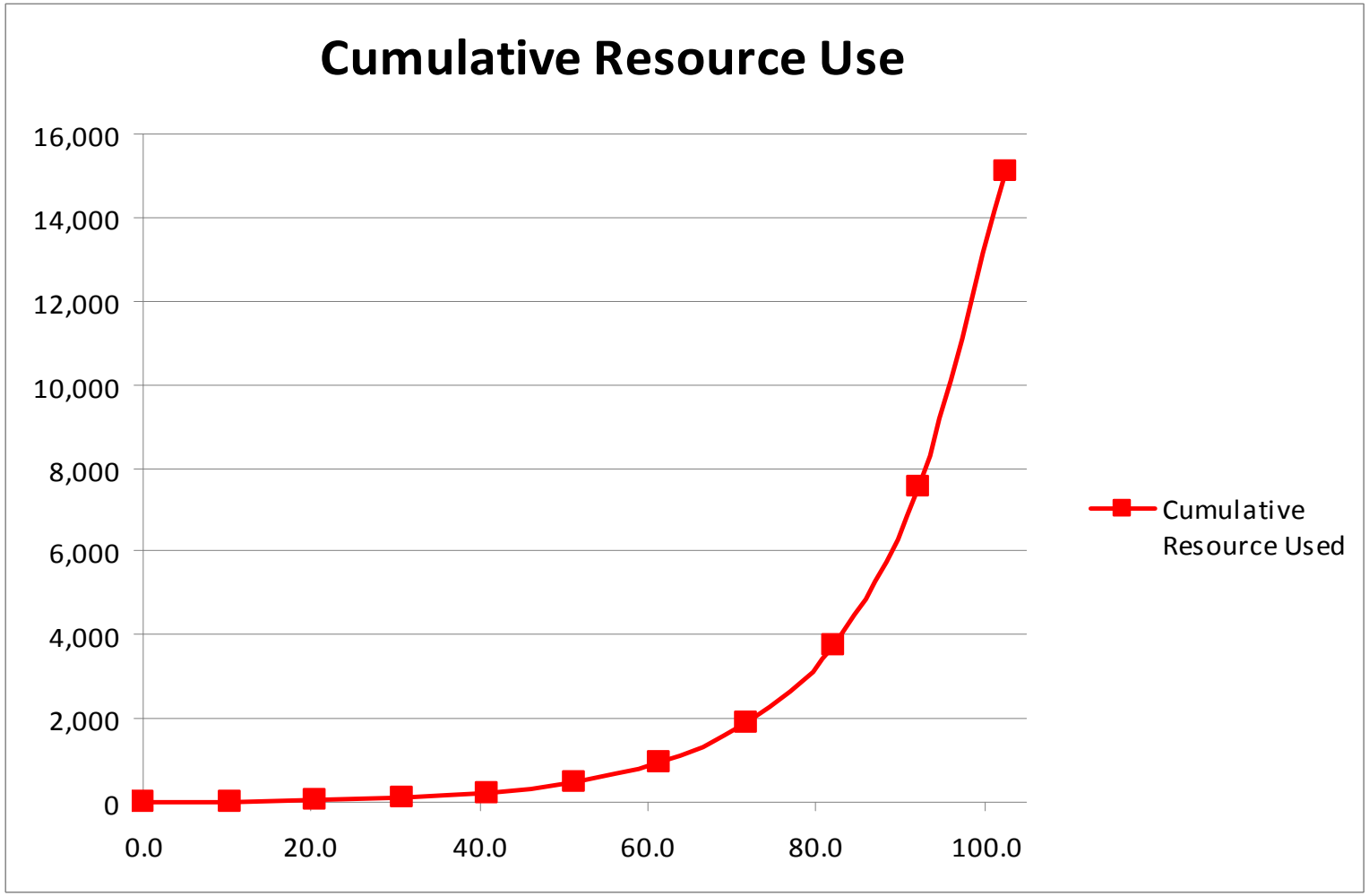
- In the time it takes to double the rate of use, the amount of resource used will be the same as THE RESOURCE USED IN ALL PRIOR DOUBLING PERIODS COMBINED.

Exponential Growth – Resource Use

Example: 7% p.a. growth



Exponential Growth – Resource Use



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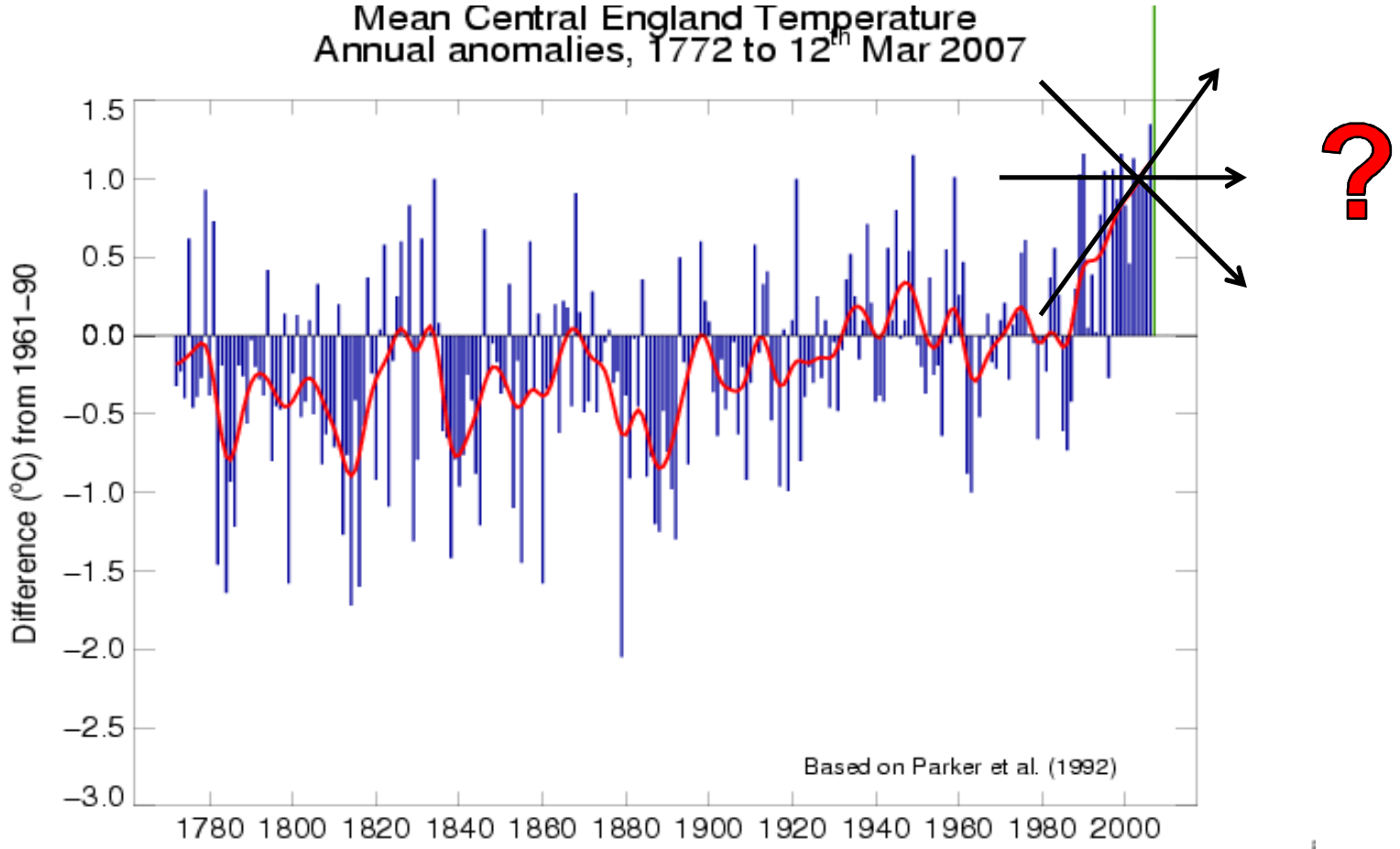
British Summers Getting Warmer?? My Wakeup Call.



Met Office

Hadley Centre for Climate Change

bs 13/03/2007 1131

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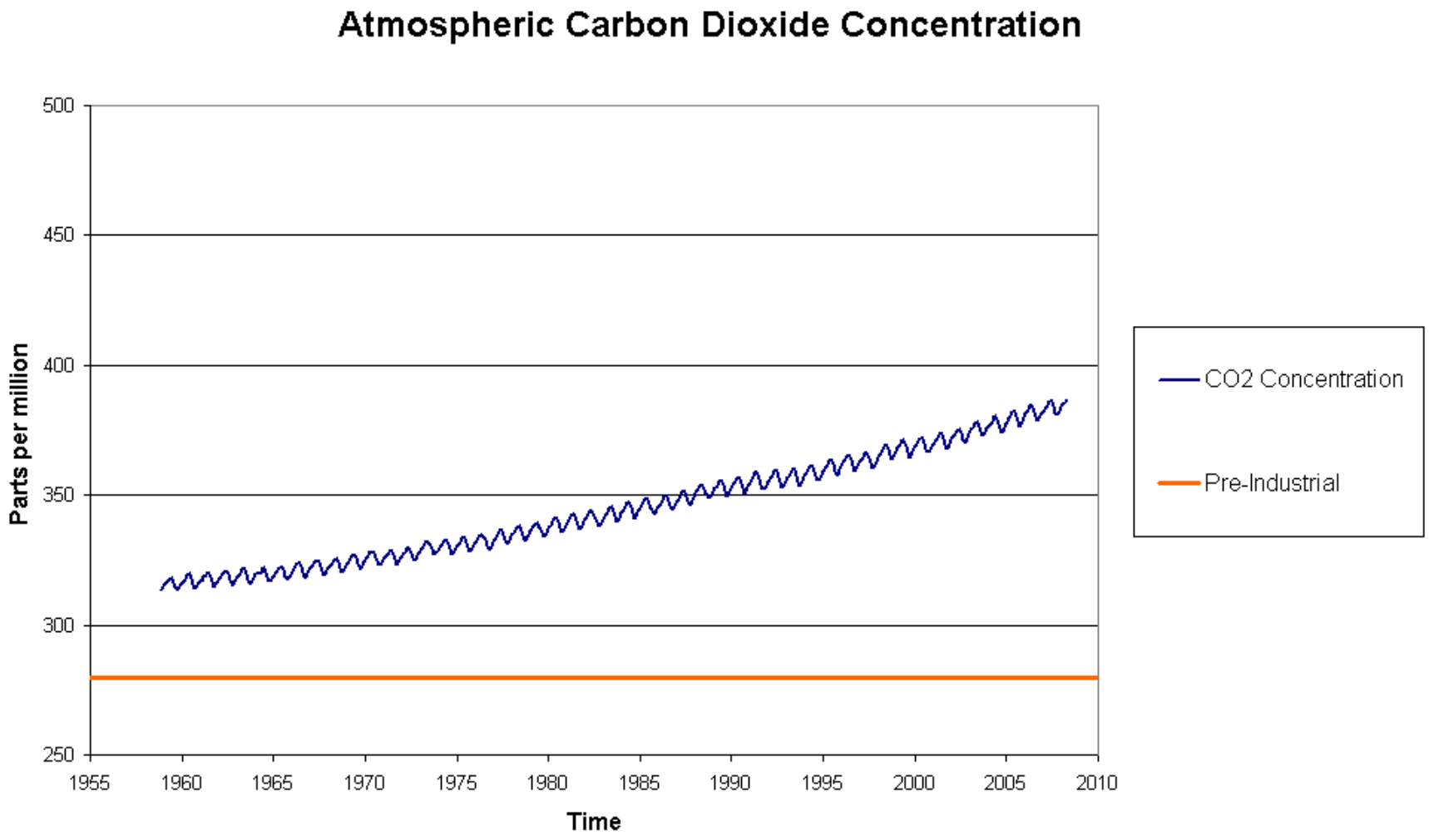
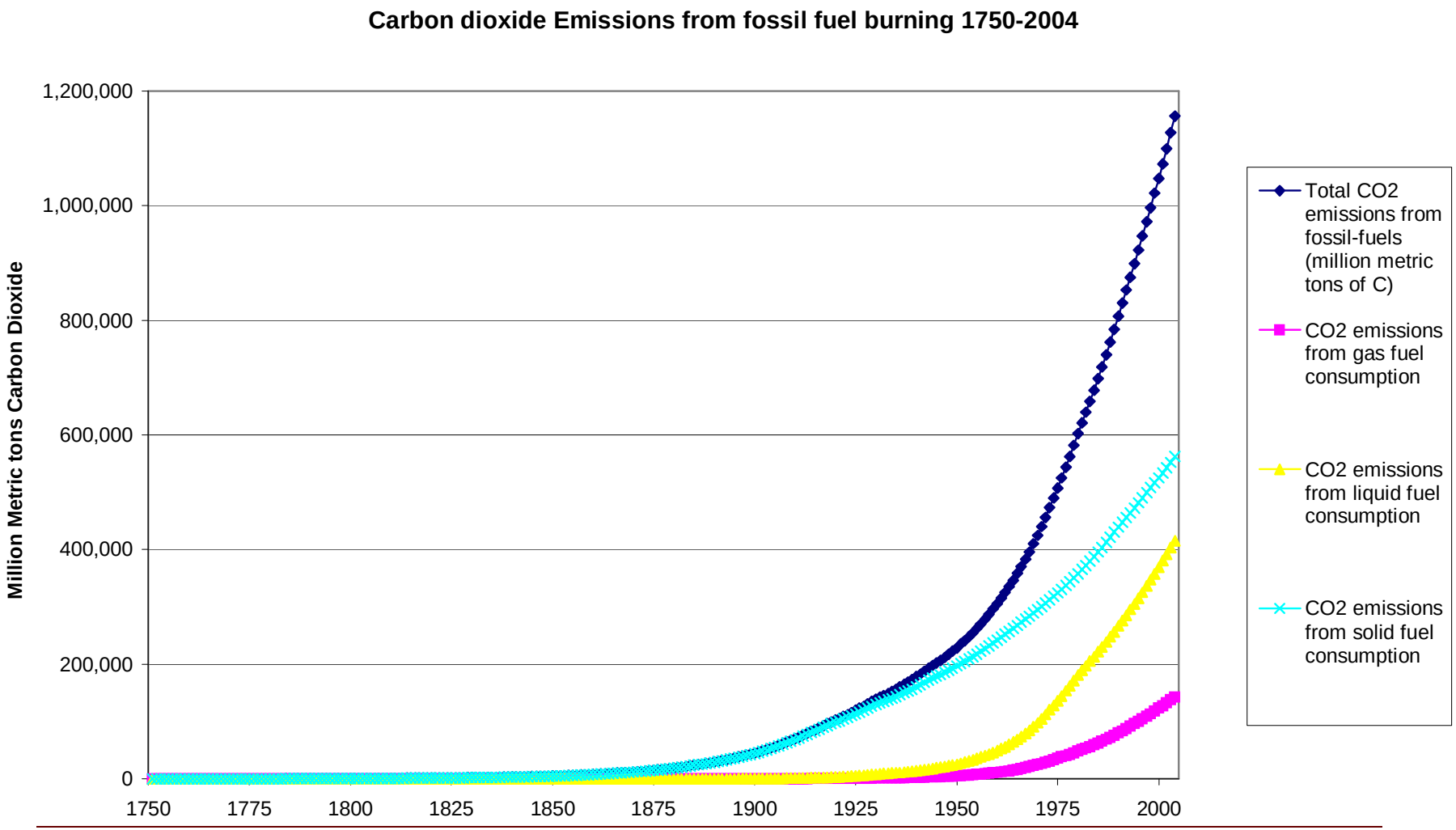
making financial sense of the future

Atmospheric Carbon Dioxide Versus Time



Cumulative CO_2 emissions from fossil fuels From the beginning of the industrial revolution



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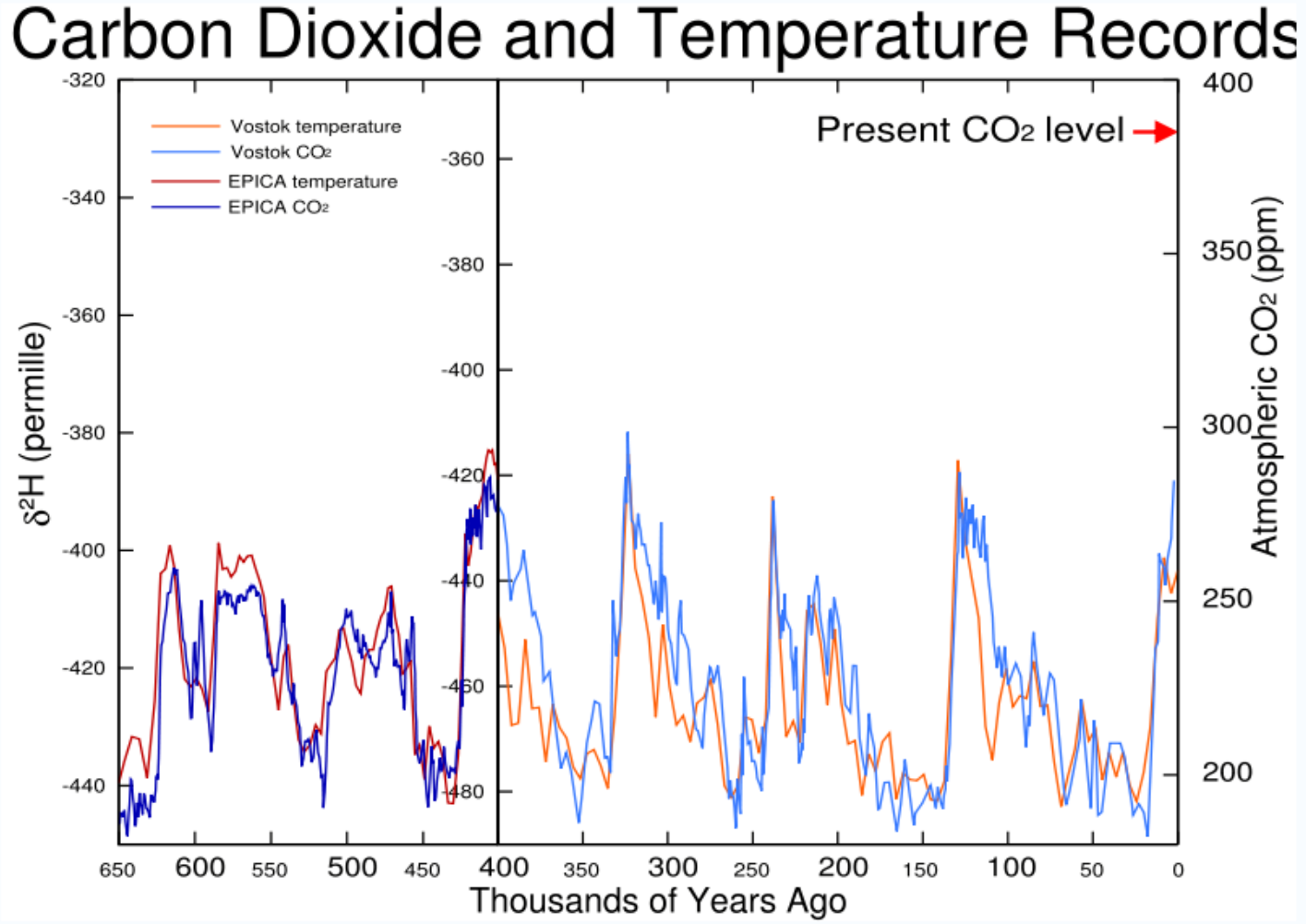
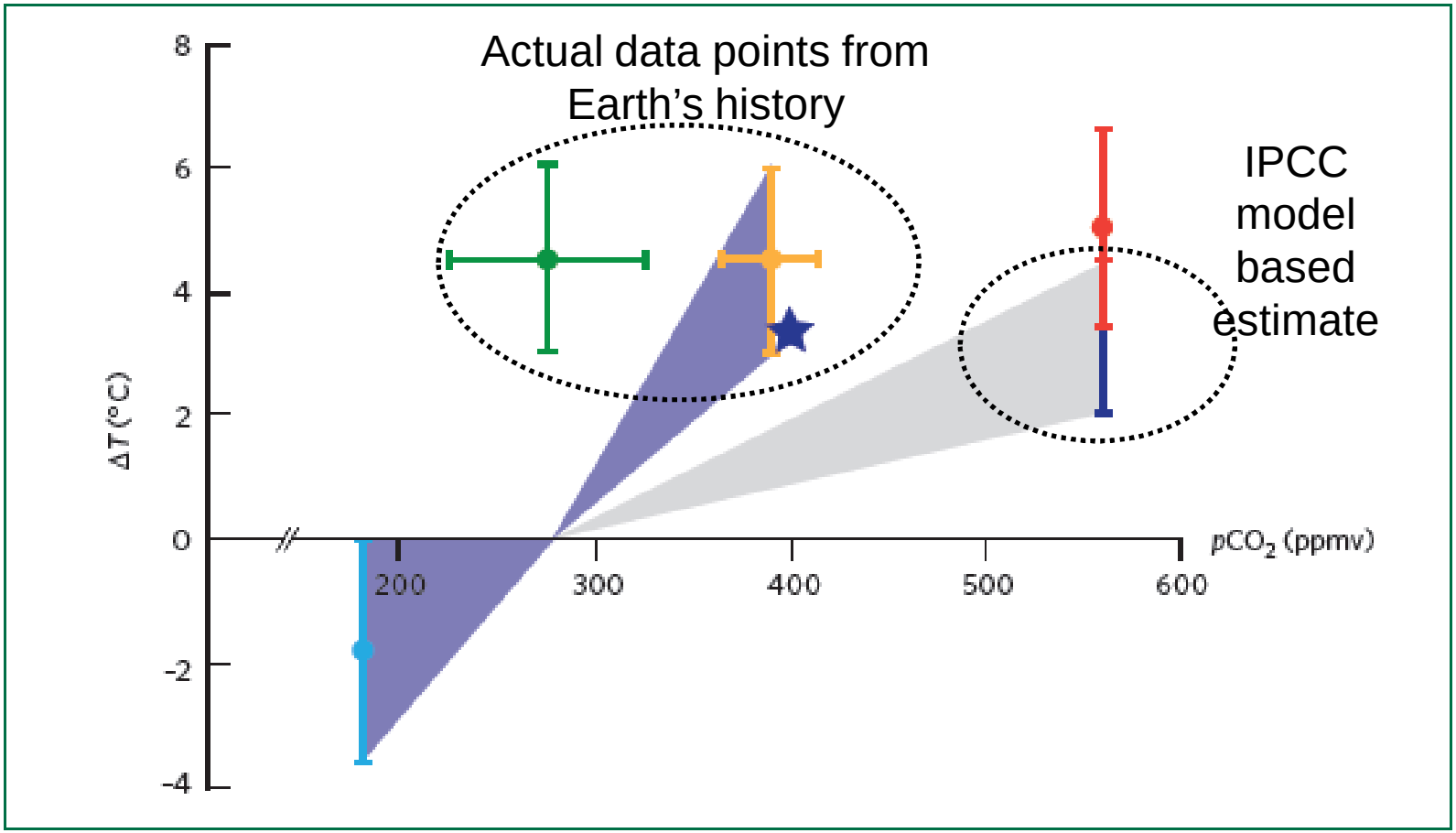
The “Smoking Gun”
Temperature versus CO_2 concentration



IPCC Estimate vs climate record



Important: It is technically possible to remove CO_2 from the atmosphere!

From Schneider B. & R., Nature Geoscience Jan 2010

Interpretation of Climate Science

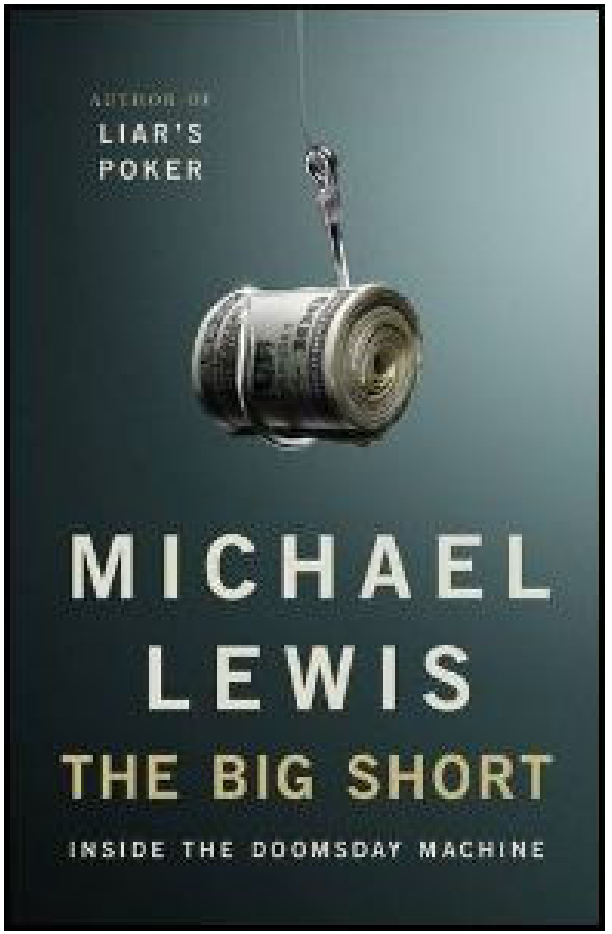
Q. Who has an incentive to recognise that the Earth has a high sensitivity to carbon dioxide?

Q. Is it possible that anchoring is occurring with climate sensitivity estimates?

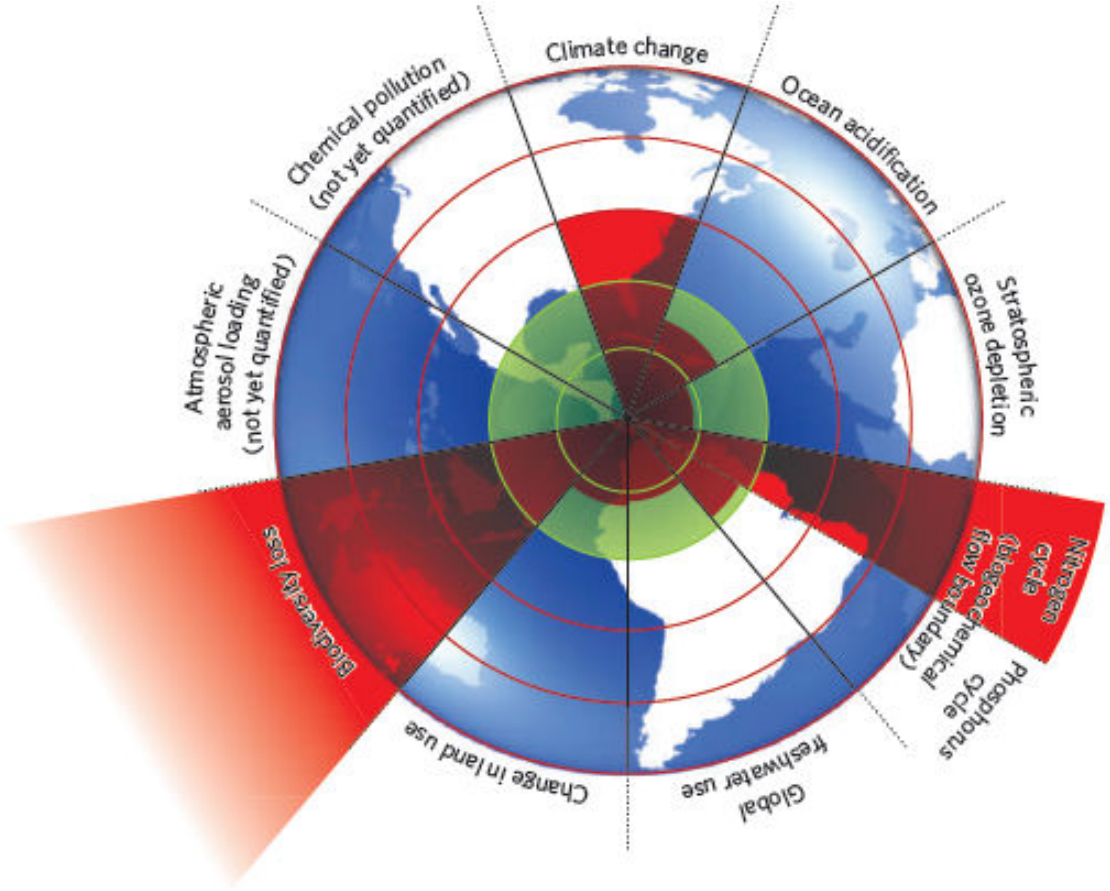
- Problem is not with climate science.
- Problem is with the interpretation of science.
- To understand what is going on, **look for the incentives.**

A Parallel with the Subprime mortgage bubble?

Recommend Michael Lewis's book "The Big Short" about the sub-prime debacle.



Climate change is 1 of 9 hard-wired environmental limits



From Rockstrom et al “A safe operating space for humanity”, Nature 2009

The Deepwater Horizon Oil Spill

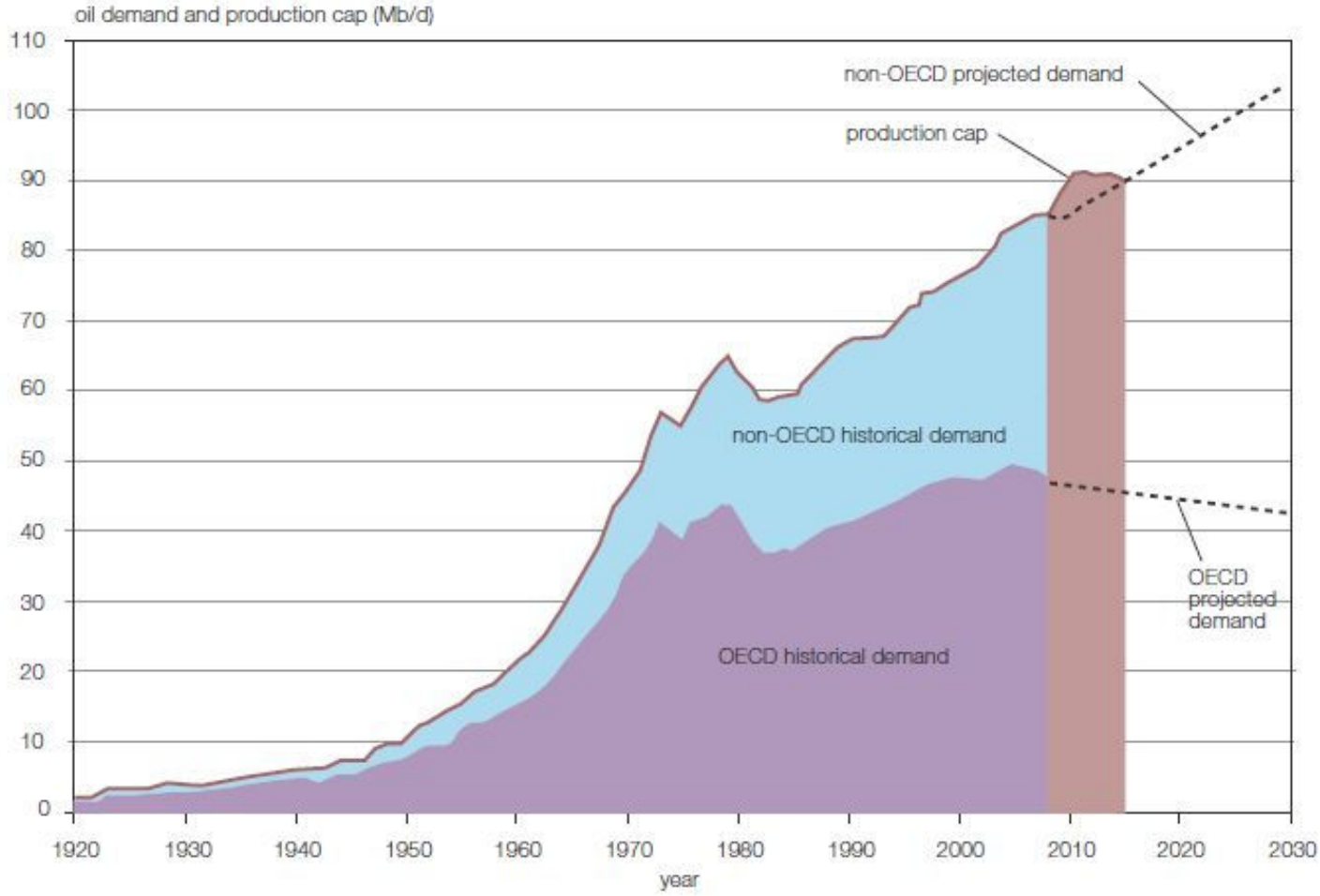
Questions Raised by Deepwater Horizon

- Proximate cause of the oil spill was a blowout.
- Deepwater Horizon rig was drilling through 1 mile of sea and 3 miles of rock.
- Operating at limit of current technical capability.

Questions:

- Why drill in such deep water?
- What is the real cost of fossil fuels?
- Where does our wealth come from?

Global Oil Production Since 1920



From “The Oil Crunch”; Second report of the UK Industry Taskforce on Peak Oil & Energy Security (ITPOES) , February 2010

Conclusion of the ‘Oil Crunch’ report

February 2010

“The credit crunch of 2008 … stress tested the responses of governments, policy-makers and businesses to the extreme…

The next five years will see us face another crunch - the oil crunch. This time, we do have the chance to prepare. The challenge is to use that time well. As we reach maximum oil extraction rates, the era of cheap oil is behind us.”

Our message to government and businesses is clear. Act now.

Don’t let the oil crunch catch us out in the way that the credit crunch did.”

Richard Branson,
Founder, Virgin Group

Ian Marchant,
CEO, Scottish & Southern Energy

Brian Souter,
CEO, Stagecoach Group

Philip Dilley,
Chairman, Arup

Jeremy Leggett,
Chairman, Solarcentury

Decline in Oil – effect on actuaries

- Energy underpins economic activity. It is the "master resource".
- Transport needs liquid fuel – no easy substitutes*.
- Sudden change to asset prices is possible when world becomes "peak oil aware"
- Interest rates and inflation rates greatly affected
- Timescale: <5 years. Perhaps soon as 2011 or 2012.

*Refer: Hirsch Report, 2005 for the US Department of Energy

What is going on?

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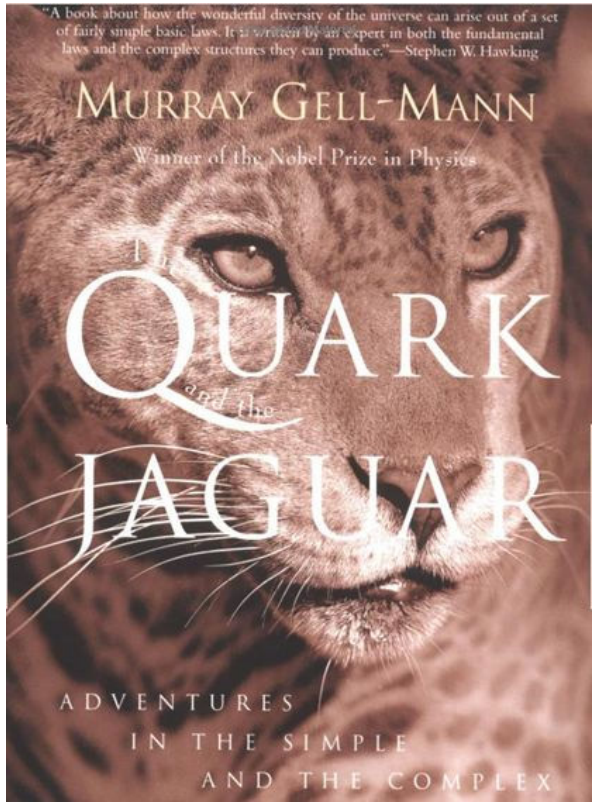
The CLAW Approach

The world is highly complex; full of non-linear systems.

Get a more realistic view of the world by taking a Crude Look At the Whole.

From Murray Gell-Mann, “The Quark and the Jaguar”



A CLAW for human impact on the Earth

$$I = P \times A \times T$$

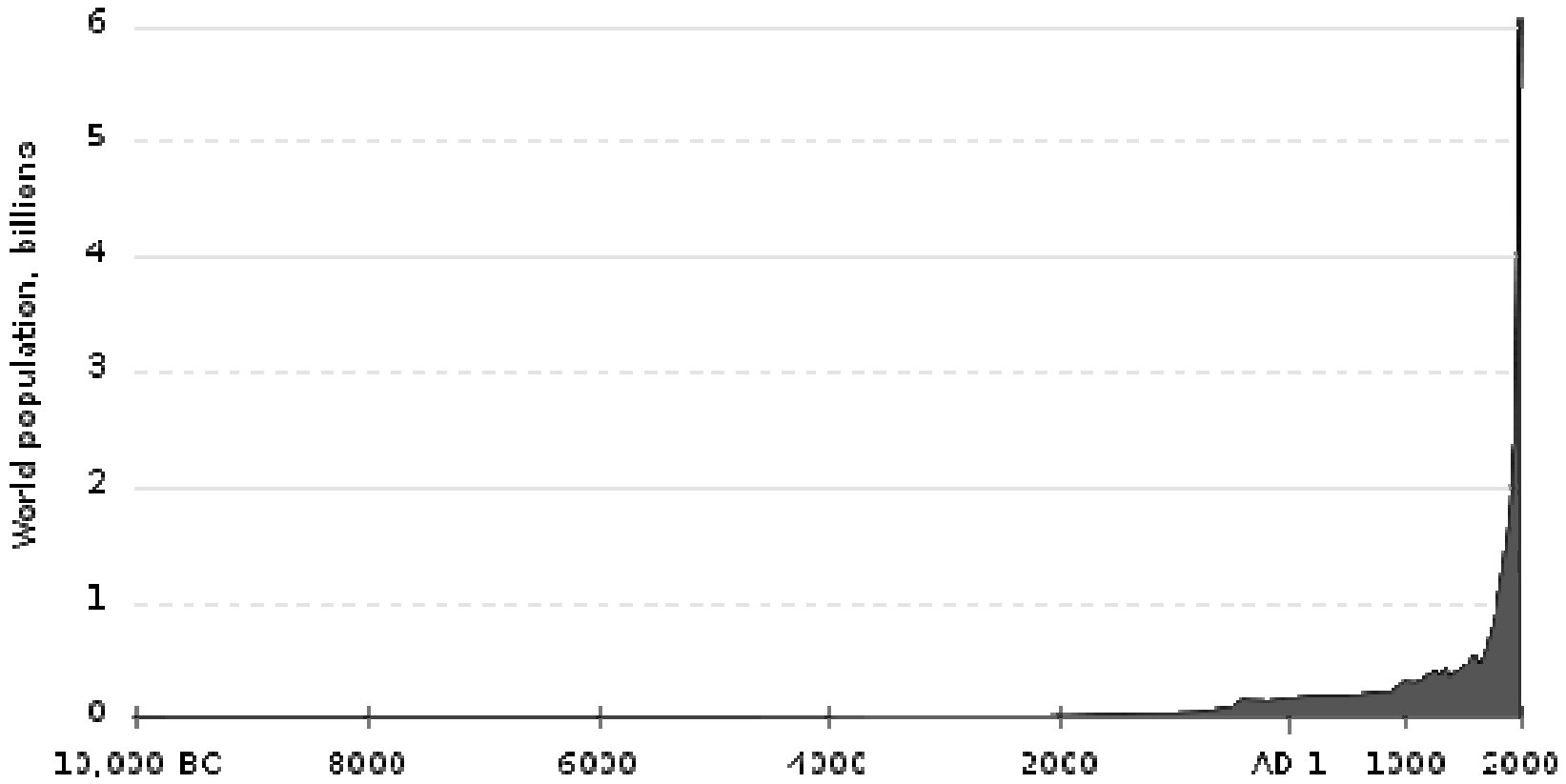
I = Impact

P = Population

A = Affluence (consumption per capita)

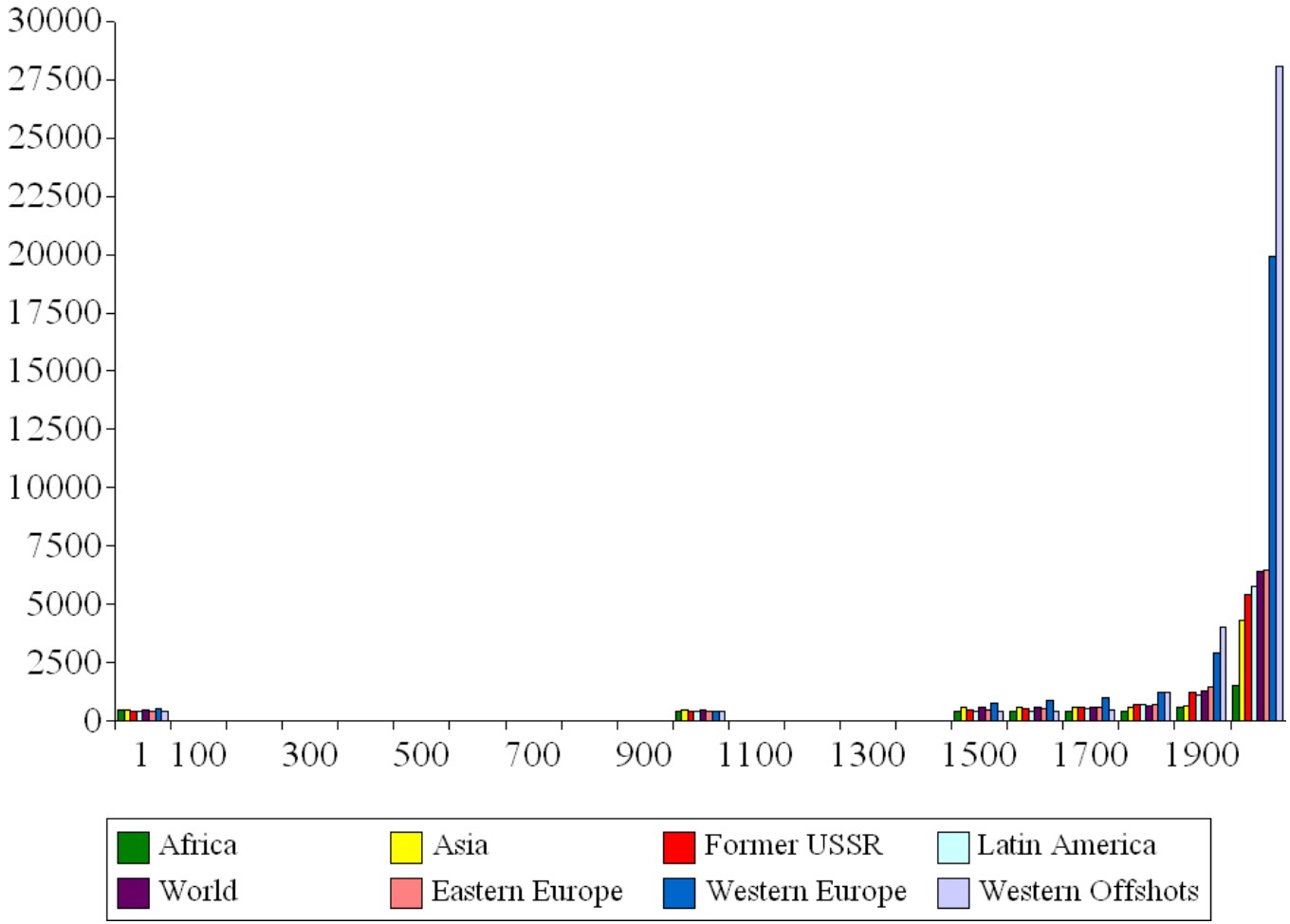
T = Technology (environmental impact per unit of consumption)

World Population



Affluence

World GDP/capita 1-2003 A.D.



Technology

$$I = P \times A \times T$$

- If affluence and population grow, for impact to stabilize or shrink, technology must improve.
- Up to the year 2000, carbon intensity of global GDP was reducing.
- Since 2000, this trend has gone into reverse, probably driven by increased coal use*.
- Technology might deliver radical improvements – but it hasn't happened yet!

*Reference: "Reframing the climate change challenge", Anderson & Bows 2008

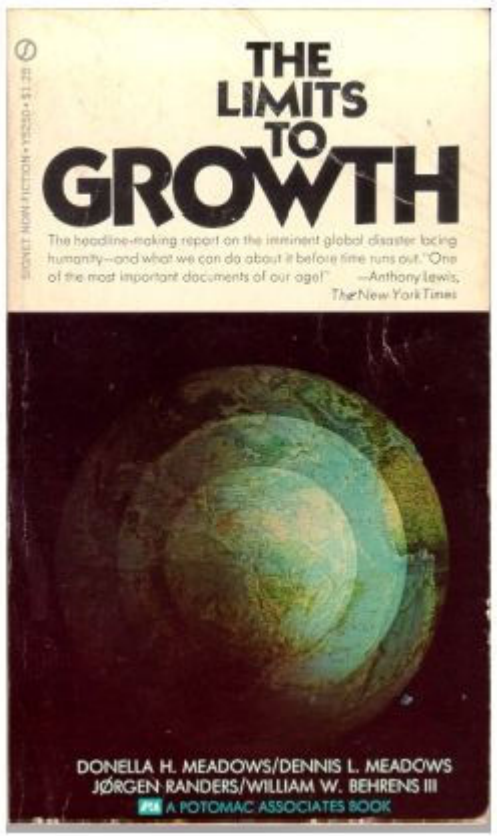
Link Between Problems

- Climate change
- Other environmental problems e.g. biodiversity
- Oil depletion
- Other resource depletion

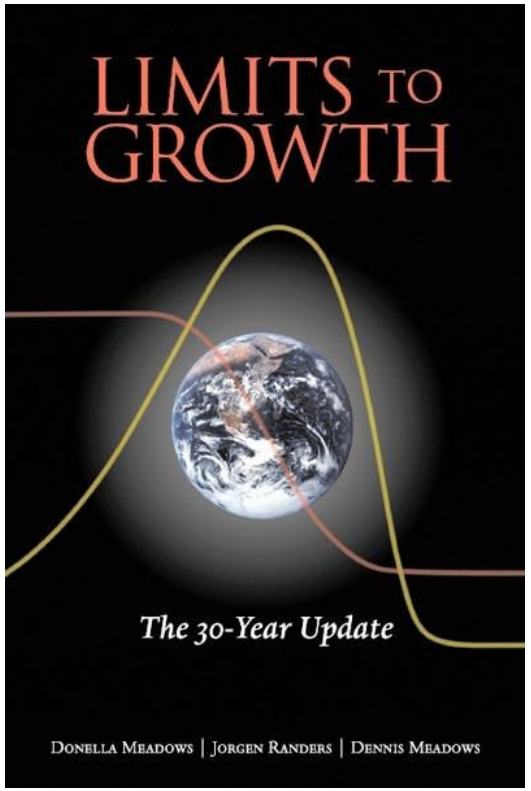
All driven by increasing consumption by humans – caused by exponential growth of population and the global economy.

Growth drives our problems!

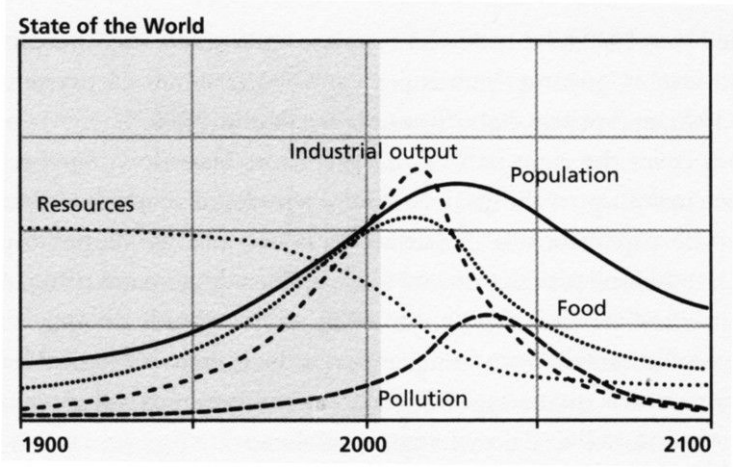
The “Limits to Growth” Study



The original 1972 study was updated in 2004



Example below of one of the indicative modelled scenarios (<u>not</u> a prediction)



The story of the “Limits to Growth”

- A group of systems scientists in MIT were commissioned by the Club of Rome.
- The book “Limits to Growth” was published in 1972. Sold over 20 million copies.
- Was controversial, attacked by “cornucopians”.
- 1970s oil shocks and “stagflation” appeared to confirm predictions.
- But, in 1980’s cheaper oil let economies grow again. The “Limits to Growth” was forgotten.

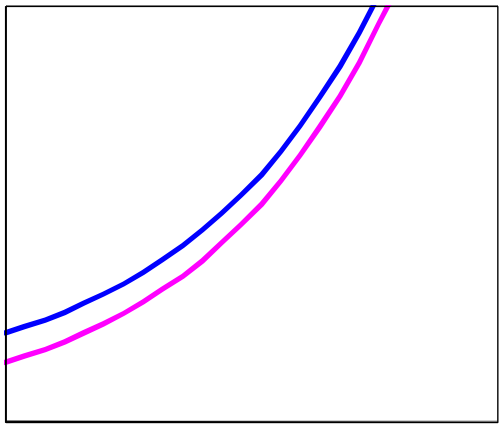
Time to rediscover the Limits to Growth?

The “Limits to Growth” Argument

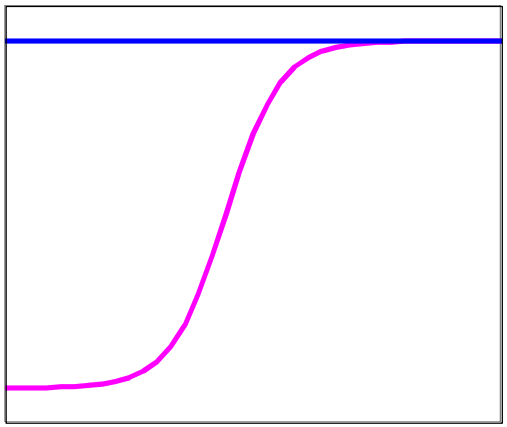
- Endless physical growth in a finite world is not possible.
- If growth in consumption is not contained, humanity will exceed the carrying capacity of the Earth.
- By exceeding the carrying capacity of the Earth, humanity risks sudden and uncontrollable collapse.

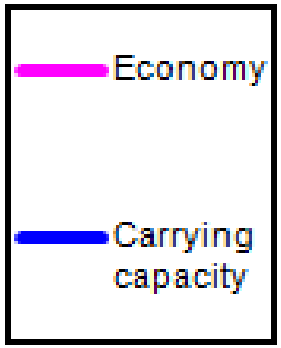
The 4 possibilities for exponential growth

Continuous growth

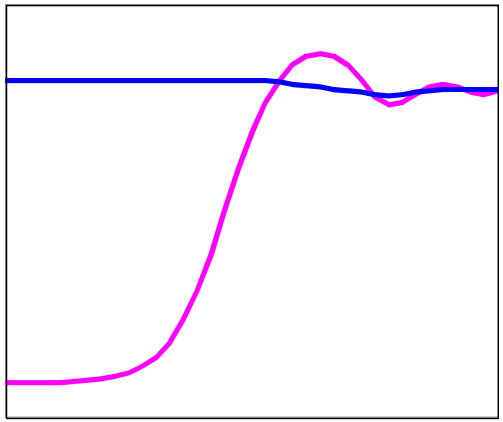


Sinusoidal Growth

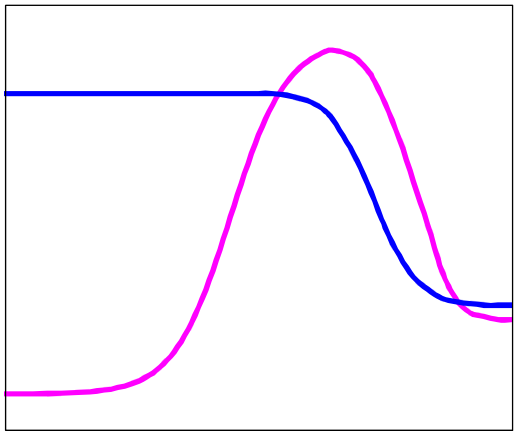




Oscillation



Collapse



Conclusion from the “Limits to Growth”

- The Limits to Growth study used systems science to develop models which indicate general behaviour.
- The models do not generate predictions.
- They are “what if” scenarios illustrating general systems behaviour.
- Humanity can avoid the collapse scenario if physical limits of the Earth are recognised.

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Fossil Fuels Are Just Too Good!

- Fossil fuels contain energy from sunlight, stored for millions of years.
- Since the industrial revolution, this energy has subsidized our economies.
- Energy content of 1 barrel of oil = manual labour of 30 people for 1 month.
- The world currently uses about 30 billion barrels of oil per year (= 1 cubic mile!)

We are addicted to oil*!

* As admitted by George W.Bush in his State of the Union speech, 31st January 2006

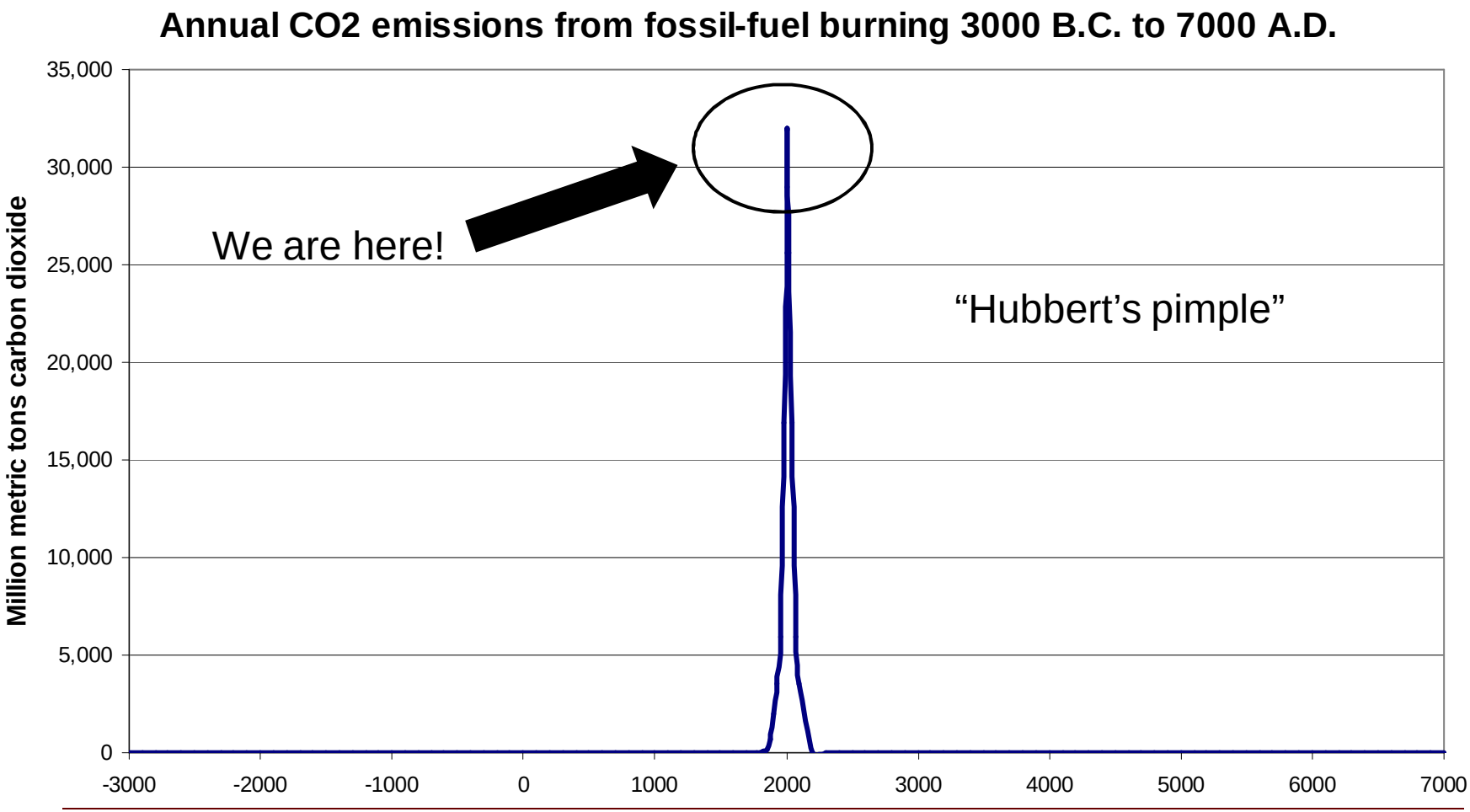
Fossil Fuel Gives Us Energy Slaves

- UK energy consumption per person = 125kWh per day*[1] (= 5.2kW per person)
- 1 person produces ~ 75 Watts sustained power
- UK citizens have ~ 70 “energy slaves”
- US citizens have double energy consumption*[2] ~140 energy slaves each!

*1 Refer: www.withouthotair.com - David MacKay, ‘Sustainable Energy Without Hot Air’

*2 Refer http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table1.html - US Energy Information Administration

A Long Term View of Fossil Fuel Use



Refer: M.King Hubbert

A Culture of Exponential Growth

- Some things we “know” without learning. E.g. We shake hands with our right hand.
- We “know” that economic growth is always good, for every nation, rich and poor.
- Analogy: An insurance company with a company culture of premium growth in all conditions. Would this make sense?

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Solutions

- First – face up to the real world, be curious.
- Don’t be optimistic – or fatalistic.
- Get the right answers (based on data) not the popular ones. A familiar task to all actuaries.

Technology is important e.g. Desertec

Refer: www.desertec.org

Technology is not sufficient

- Deep questions must be asked about society
- Some great thinkers knew this a long time ago

John Maynard Keynes, 1945

"**The day is not far off when the economic problem will take the back seat where it belongs, and the arena of the heart and the head will be occupied or reoccupied, by our real problems — the problems of life and of human relations, of creation and behaviour and religion.**"

GDP is outdated for wealthy countries

"Our gross national product … measures everything in short, except that which makes life worthwhile."

Robert Kennedy, 1968

ICAEW THE INSTITUTE OF CHARTERED ACCOUNTANTS IN ENGLAND AND WALES

Nobel Laureat Robert Solow
From Harper's Magazine, March 2008

"It is possible," says Solow, "that the United States and Europe will find that, as the decades go by, either continued growth will be too destructive to the environment and they are too dependent on scarce natural resources, or that they would rather use increasing productivity in the form of leisure. . . . There is nothing intrinsic in the system that says it cannot exist happily in a stationary state."

Solutions:

Examples:

- Reform of the money system – Move away from debt based money.
- Focus on non-monetary measures of well-being.
- Switch from consumption into investment in clean energy.

Solutions: Steady State Economy

http://steadystate.org/

What can actuaries do?

- Understand that climate change and peak oil will affect our professional lives. Learn more.
- Become aware of the invisible rules of our culture. Make up your own mind.
- Get involved with the CAS Climate Change Committee headed by Susan Woerner.
- Learn more about oil depletion at the website www.theoildrum.com – edited by a Casualty actuary; Gail Tverberg