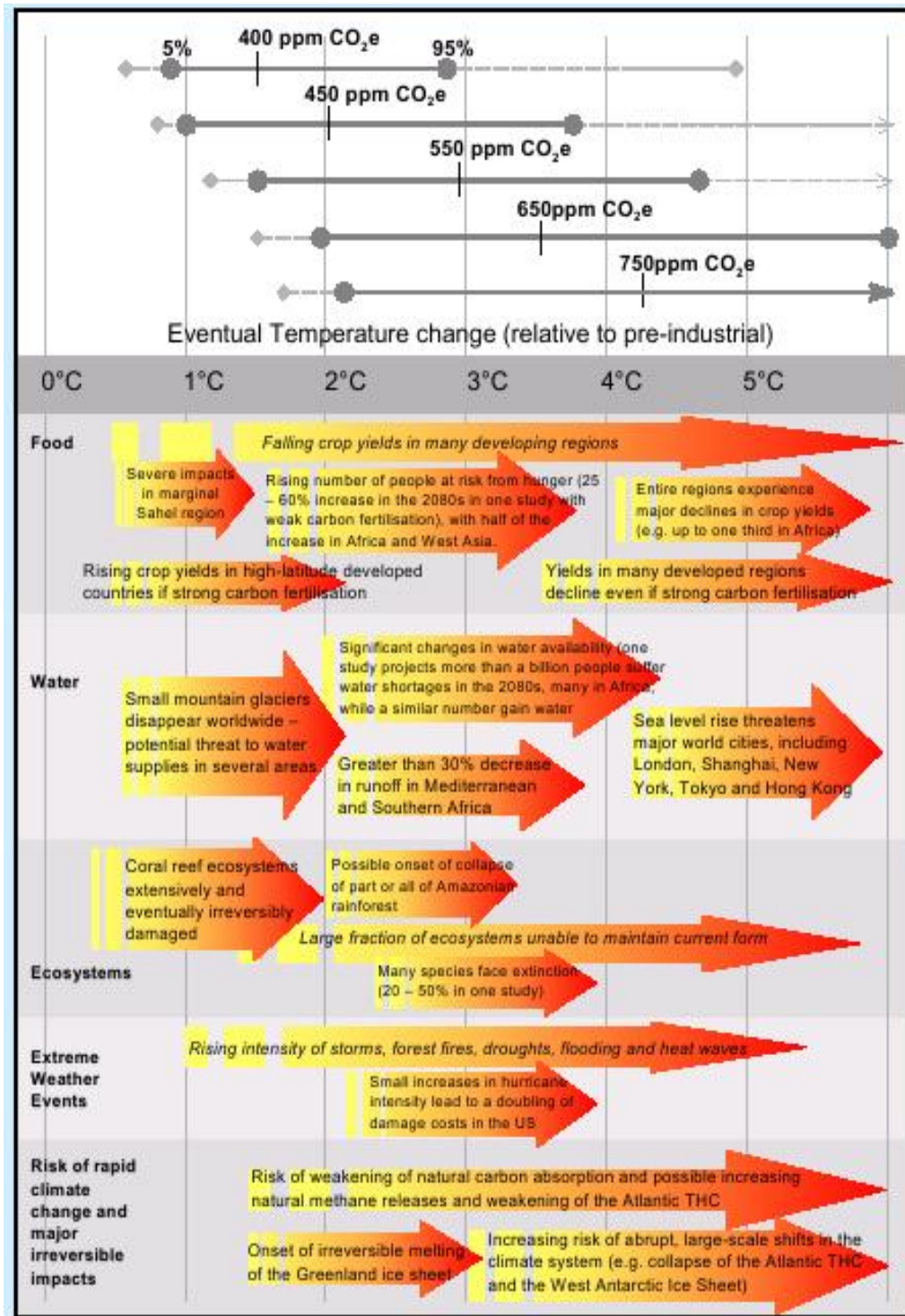


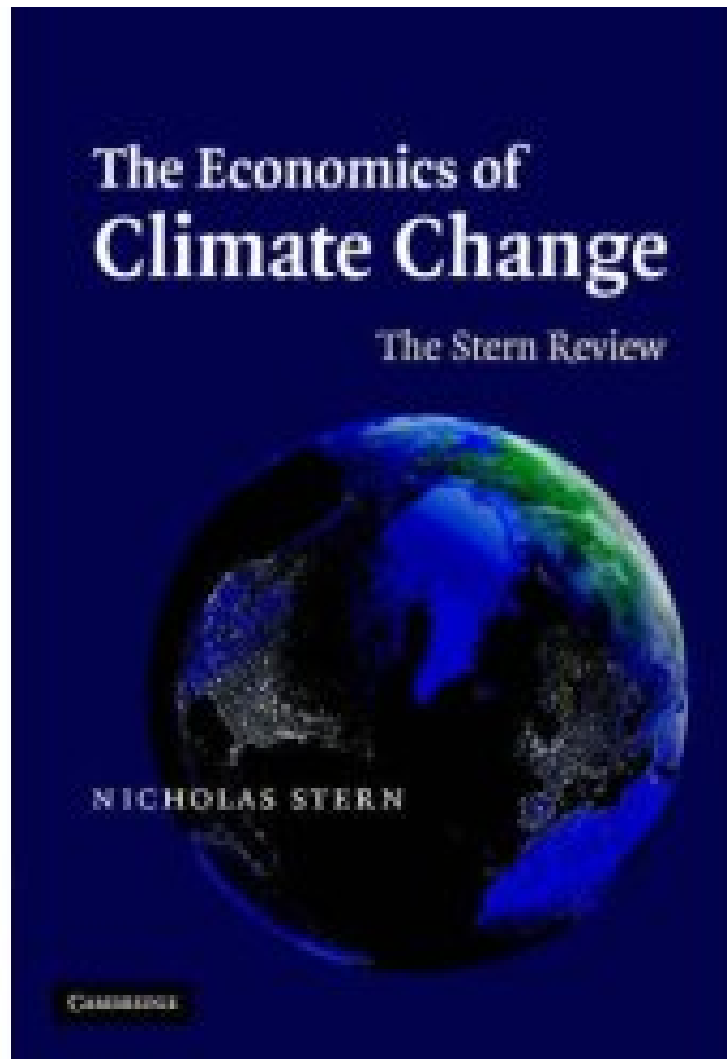
Climate Change Economics

Brian Davey



- ***The Stern Review (2007)***
- A range of probabilities of temperature rises is associated with successive rises of concentration of CO₂eq in the atmosphere
- For each increase in temperatures there is a range of impacts with a level of costs.
- The costs of mitigation to stabilise at each greenhouse gas concentration level is compared to the (discounted) costs of impacts at that level.

Stern's Conclusions 2007 and 2008



• Using this methodology (and a low discount rate) Stern concludes that a mitigation cost of 1% of gross world production is worth investing to prevent the loss of 5-20% of gross world production for ever.....Stern Review 2007

More recently Stern has been saying that “We underestimated the risk, we underestimated some of the effects” May 2008

This economics is out of date

The Stern Review is a massive piece of research and scholarship.

However it is flawed in the implicit assumption of “stabilisation levels” - the idea that a stabilised concentration of Greenhouse Gases means a stabilised level of global temperatures and costs.

This is outdated climate science.

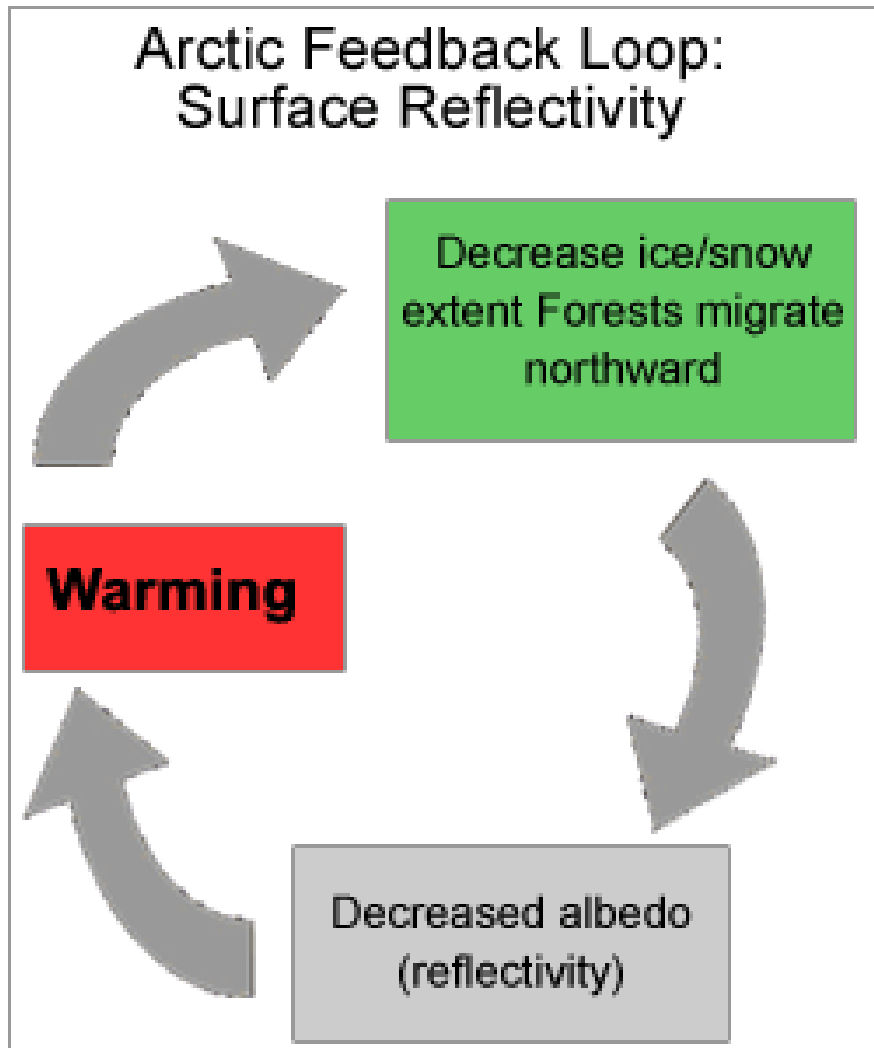


Current Climate Science uses system dynamics approaches and stresses “avalanche effects” The key idea - warming accelerates and becomes self perpetuating



- **Positive feedbacks** (self reinforcing or amplifying) appear to **predominate** over negative ones (dampening or braking feedbacks)
- *Hence tipping points beyond which*
- ***Accelerating climate change occurs with declining possibilities for human intervention and escalating mitigation costs***

Amplifying feedback - example 1



- Global warming melts ice, reducing the amount of energy and light reflected back into space so the earth gets warmer and yet more ice melts...
- Note that, once started, this continues, feeding on itself, even if CO₂ emissions have stopped increasing until all the ice and snow is melted.

Current Climate Science

The Earth's climate is remarkably sensitive to global forcings. Positive feedbacks predominate. This allows the entire planet to be whipsawed between climate states.... Recent greenhouse gas emissions place the Earth perilously close to dramatic climate change that could run out of our control, with great dangers for humans and other creatures.

James Hansen, Director, NASA Goddard Institute for Space Studies. 18th February 2007

Amplifying feedbacks – example 2

- Global warming leads to the release of more methane from under the permafrost and from ocean beds but methane is a greenhouse gas so this leads to more global warming
- Again, once started this would go on even if CO₂ emissions have stopped



These dangers are not getting the recognition that they deserve. The influence of the fossil fuel lobby in government has suppressed awareness of the emergency.

The latest Intergovernmental Panel on Climate Change Assessment Report's **Summary for Policy Makers** Report was watered down when governments became involved in writing it.

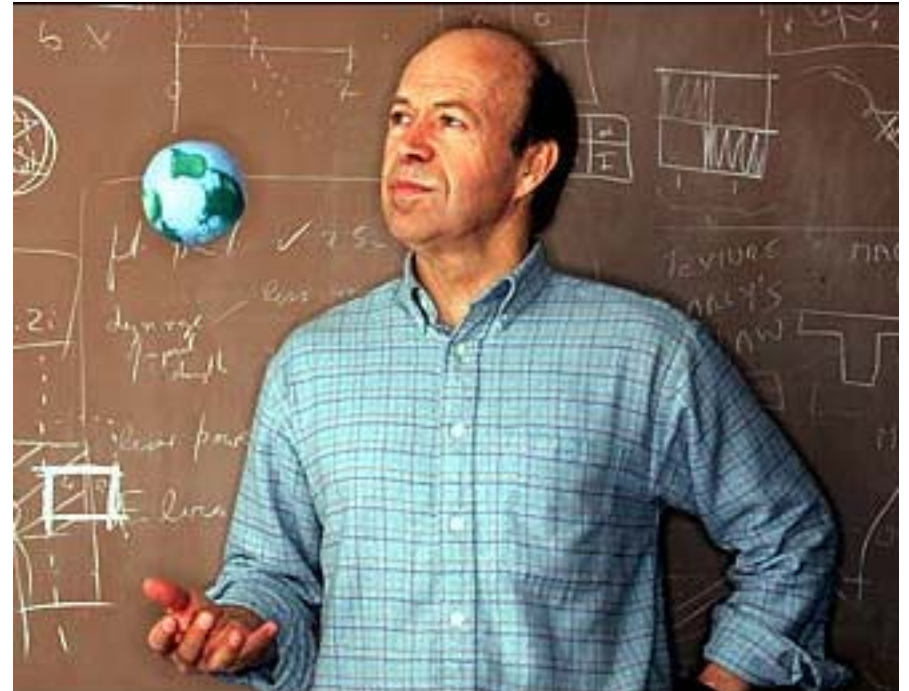
The preliminary version produced by scientists in April 2006 contained many references to the potential for climate to change faster than expected because of "*positive feedbacks*" in the climate system. Most of these references were absent from the final version.

However a PR manipulation doesn't change the facts..

This is why

***Climate scientists
are saying we may
already be over a
safe limit for
greenhouses gases
in the atmosphere***

***e.g. James Hansen
and research team***



A Safe Level of CO₂ according to James Hansen

350 ppm

'Hansen says the EU target of 550 parts per million of CO₂ - the most stringent in the world - should be slashed to 350ppm. He argues the cut is needed if "humanity wishes to preserve a planet similar to that on which civilisation developed"'. *Guardian* 7th April 2008

The Current Level of CO₂

385 ppm

**Which means we must find ways
to take CO₂ out of the atmosphere**

Oil and gas depletion makes this situation even worse..

- India, China and other countries are joining Europe, the US and Japan on a fossil fuel powered development path at that point in history when *global fossil oil and gas reserves are about one half exhausted* – these were the cheap and easy to recover oil and gas reserves. What is left are the expensive to recover oil and gas reserves.



Unfortunately current Oil and Gas Substitutes Damage the Climate More!

If the rising demand for oil and gas cannot be met with increased supply it spills over into increased demand for coal, biomass and bio-fuels.

But coal is a much more climate damaging fuel and although there are possible technologies to cope with this - like *carbon capture and storage* - they are unproven and 20-30 years from generalisation

Using more biomass puts pressure on land use which release soil carbon and speeds deforestation, again with negative climate effects

So...

there are two tasks for climate policy

(1) To stop putting CO₂ into the atmosphere

Requires effective and equitable mechanisms to deliver guaranteed emissions cuts – including for land based emissions

(2) To take CO₂ out of the atmosphere asap:

Task 1. Reducing emissions

There are currently 30 different policy instruments at national policy level in the UK alone

Fossil fuels are used, directly or indirectly, in almost every aspect of our lives and in a huge range of settings. One approach is therefore to devise a policy instrument for every setting and every kind of fuel use –

Thus - a cap and trade scheme for large emitters (the EU Emissions Trading Scheme); a trading scheme for smaller emitters (the forthcoming Carbon Reduction Commitment) and

then levies, obligations, funds, codes of good practice and raft of directives, regulation and standards for all other fuel uses.....

at European, national, regional and local level....

The end result:

A complicated policy mix – which is arguably not adequate for delivering on the forthcoming Climate Act and is resented by everyone.....

micromanagement, n. —

The control and direction of an enterprise, activity, etc., in every particular and to the smallest detail.

Making this worse many of these schemes do not “lock in” their CO2 reduction successes



Energy saving light bulbs are cheaper to run so they are left on longer; more fuel efficient engines save money which people spend on driving further or taking an extra holiday – taken by air. (Rebound or Jevons effects)]

The growth imperatives on companies and economies encourages these extra uses for carbon energy – to prevent this requires absolute economy wide-caps to “lock in” the gains.

“Lock in” requires an effective carbon cap – ideally for the whole economy - which is best enforced *upstream*

A reducing carbon cap to “lock in” carbon reductions is best imposed “upstream” on a small number of fossil fuel suppliers rather “downstream” on millions of energy users, usages and settings.

In the UK there are only 10 oil refineries, 4 natural gas terminals, 40 coal mines and 12 coal ports where fossil fuels are introduced into the economy – this is where carbon control is ideally imposed. At these places a “permit to sell” scheme could be introduced with permits reduced rapidly year by year.

Unfortunately current policy fashions are turning towards taxes



Carbon Taxes

– Pros

- Although unpopular they are well understood and tax enforcement arrangements are already in place so they can be introduced quickly
- Tax Revenue can be recycled to make impact more equitable and palatable

– Cons

- Opponents of a carbon tax are already organised – potential beneficiaries of recycled tax revenues are not
- Think of a tax which must be automatically increased every year for decades.
- Cannot deliver a definite result in terms of CO2 reductions and constant adjustments would be permanent political football

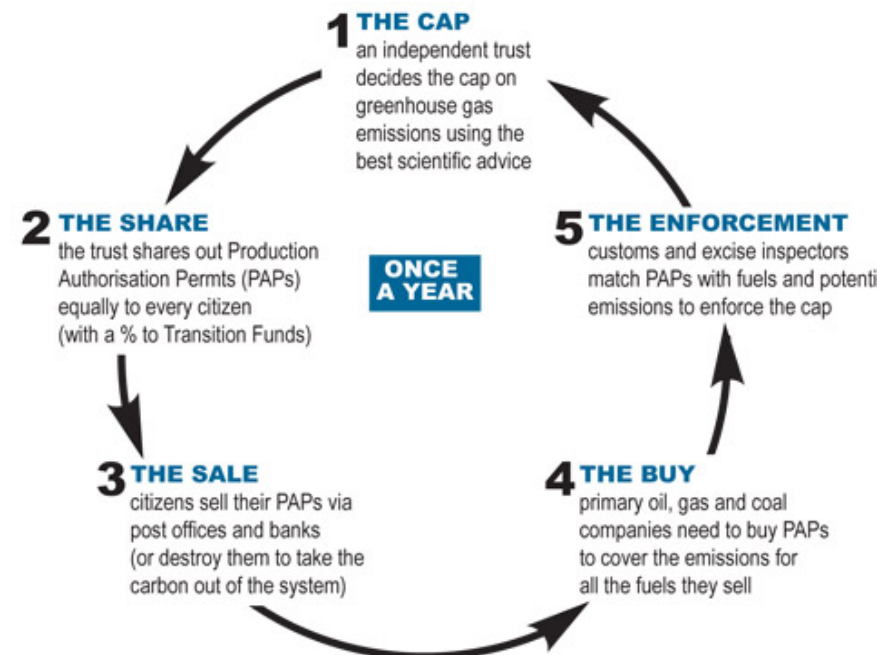
Simple and Effective: *Cap and Share*

Make **selling** fossil fuels from upstream suppliers illegal without a permit for the greenhouse gases of that fuel when burned e.g. at refineries and gas import terminals

The permits are denominated in the greenhouse gas content that the permitted fuels will give off when they are subsequently burned and the total number are reduced each year

Fossil fuel supplying companies are required to **buy** the permits

The money from the permit sales goes to everyone equally which partially protects poorer energy users



**Unfortunately for 'cap and share' proponents
the EU has already developed its own
Emissions Trading System (ETS)**



Cap imposed on the largest energy users (power stations, iron and steel blast furnaces etc) – about 900 in the UK (partially downstream)

Most permits to emit are distributed to the main emitters for free – so the companies capture the scarcity value of permits – a “pay the polluter” principle.

More auctioning of permits is envisaged in the future so the revenue from permit sales will be captured by governments.

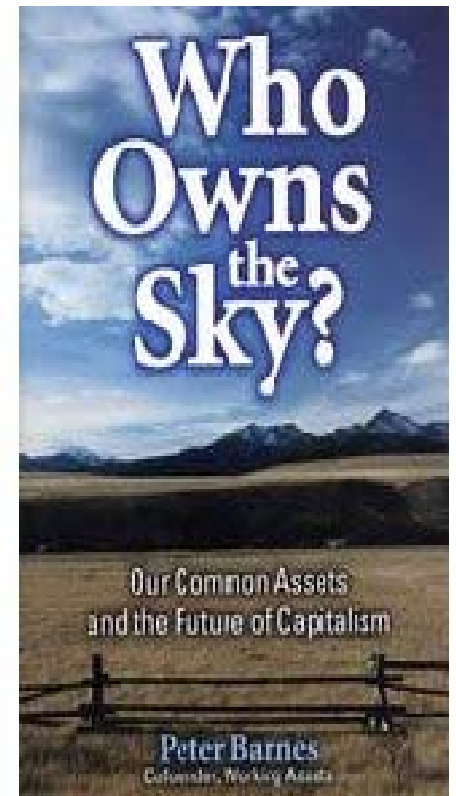
Note the implication - the right to use the earth's atmosphere is assumed to belong to polluters or governments

Emissions permits are rights to use the atmosphere – a resource which gets a scarcity value equal to the carbon price. Current schemes like the ETS assume the carbon scarcity rent should go to polluters or governments – but doesn't it belong to us all?

If governments get the carbon price it will be experienced like a carbon tax – with no guarantee of a rebate for the fuel poor or ring fenced for climate purposes

If corporations get the carbon price it creates windfall profits for the energy companies. If spent for climate purposes it is likely to be spent on mega projects like nuclear power or CCS

Without any rebate a heavier proportion of the costs of mitigation will be falling on those on low incomes.... exacerbating the fuel poverty problem.



The alternative: All adults get the carbon price because we all own the sky equally

*If **the public** get the scarcity rent on a per capita basis:*

Those on low incomes and in fuel poverty are (partially) protected by this rebate to offset the rising energy prices caused by the rising carbon price

The revenue from the carbon price goes to the base of the economy. Householders can be encouraged to invest what they get to make homes and lifestyles more energy efficient (e.g. On insulation)

People can actually make money if their lifestyle is less carbon intensive than the average.

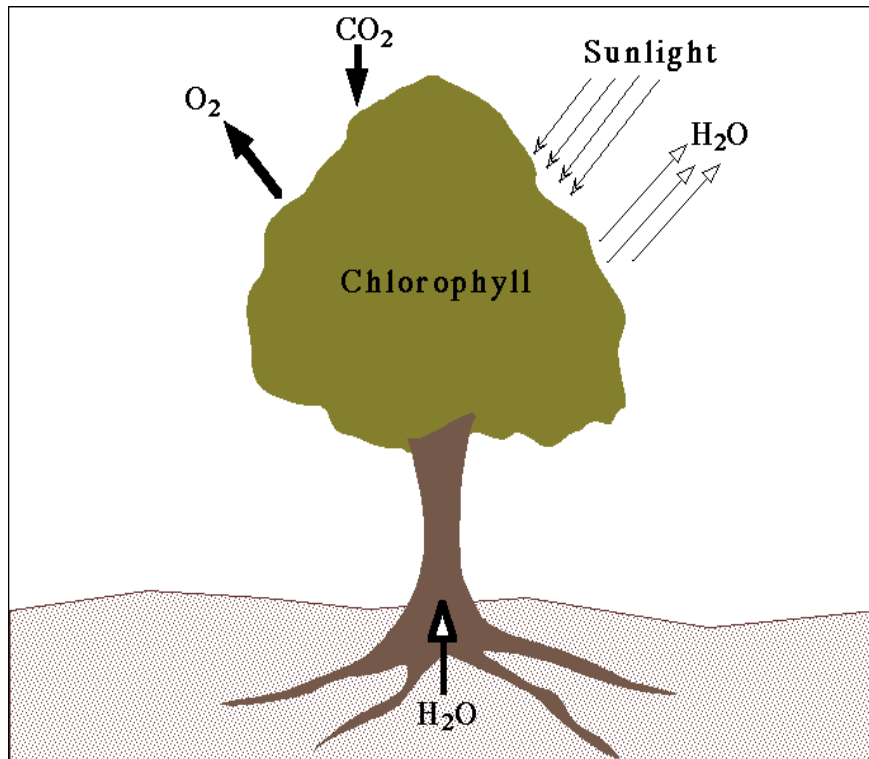
Hybrid Arrangements

Although the EU ETS is already in existence it can be combined with other policies like a Cap and Share system

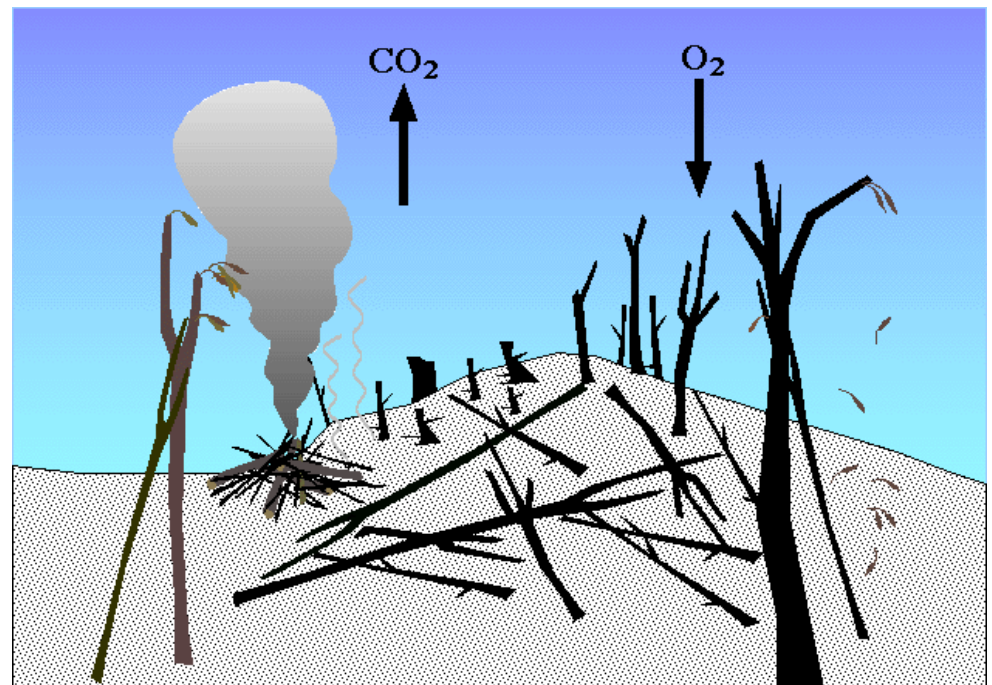
The EU ETS to cover large fossil fuel users
and
Cap and Share to cover other emissions

(The Irish Government are considering cap and share as a way of controlling transport and possibly household emissions)

In addition to progressively reducing emissions - we must also take CO₂ out of the atmosphere



Biomass is currently the only cost effective way of taking CO₂ out of the atmosphere on a massive scale...as long as it doesn't go back there



Are there ways in which biomass captured carbon can be sequestered long term?

(1) Burying wood anaerobically (so it doesn't turn back into CO₂)

(2) Pyrolysis - baking biomass (e.g. agri wastes or specially grown crops) without oxygen drives off energy gases as well as usable chemicals and leaves a char carbon residue.

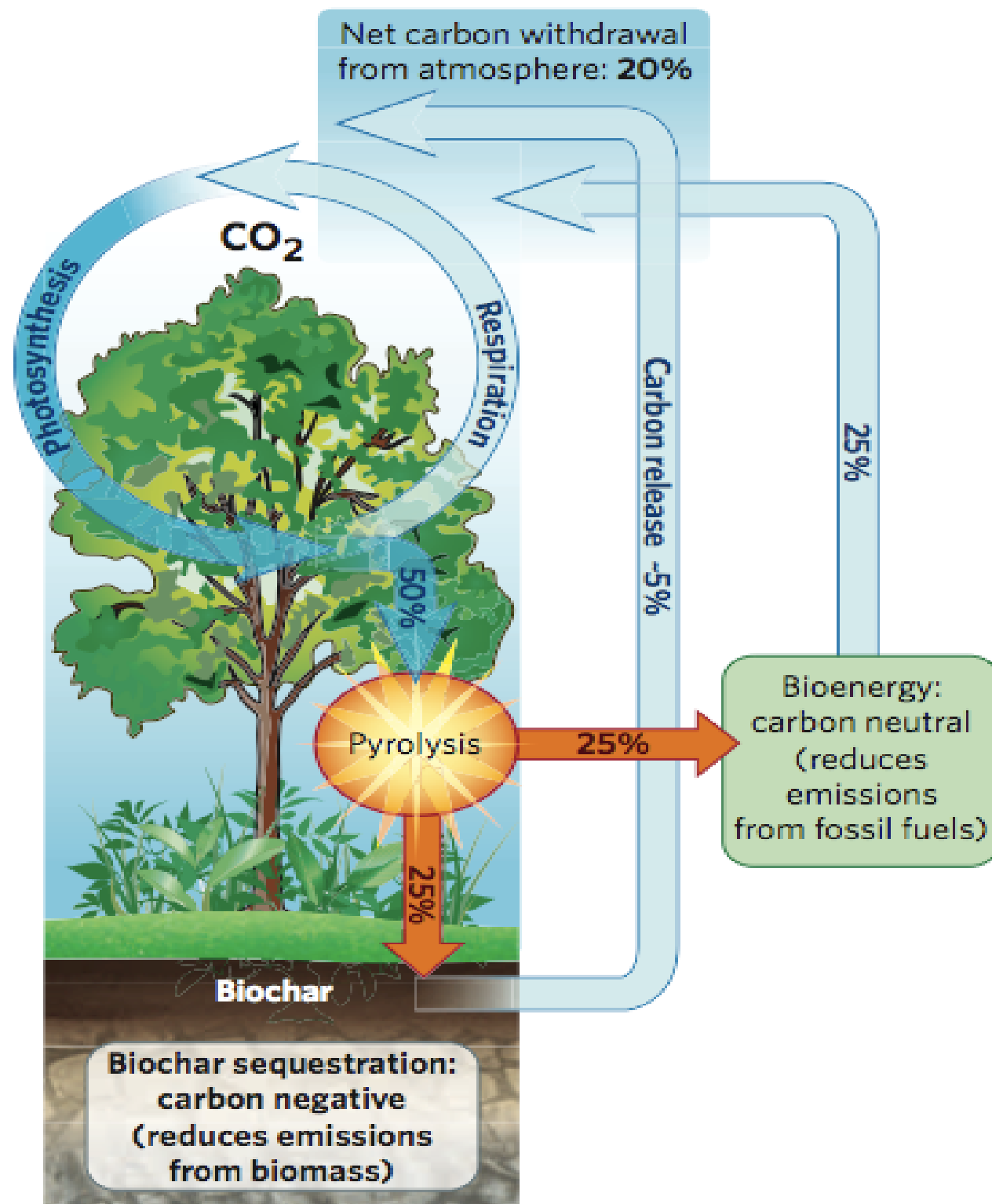
The char residue can then be put in soil and appears to be long term stable there. It is also a soil improver and increases fertility (which incentivises production and use).⁴

Scalable bio-char Technologies



Bio-Char
seems to be
preferable as
it appears to
have features
which
incentivises
its use

e.g. Waste Management
Source of energy
Soil Fertility
as well as
Carbon Sequestration



End

**(Further information and references
available on request)**

In memory of
Dr Will Howard (1951 - 2008)
Cap and Share Organiser



Supplementary Slides

Current Climate Science Thinking

“The possibility of a tipping point in the earth system as a whole which prevents the recovery of stable equilibrium and leads to a process of runaway climate change, is now the critical research agenda, requiring the concentration of global resources in a “Manhattan Project” style engagement. All other work on impact assessment, mitigation and adaptation depends on the outcome of this overarching issue.”

John Schellnhuber: Director, PIK Potsdam.

Quoted from EU Commission Report

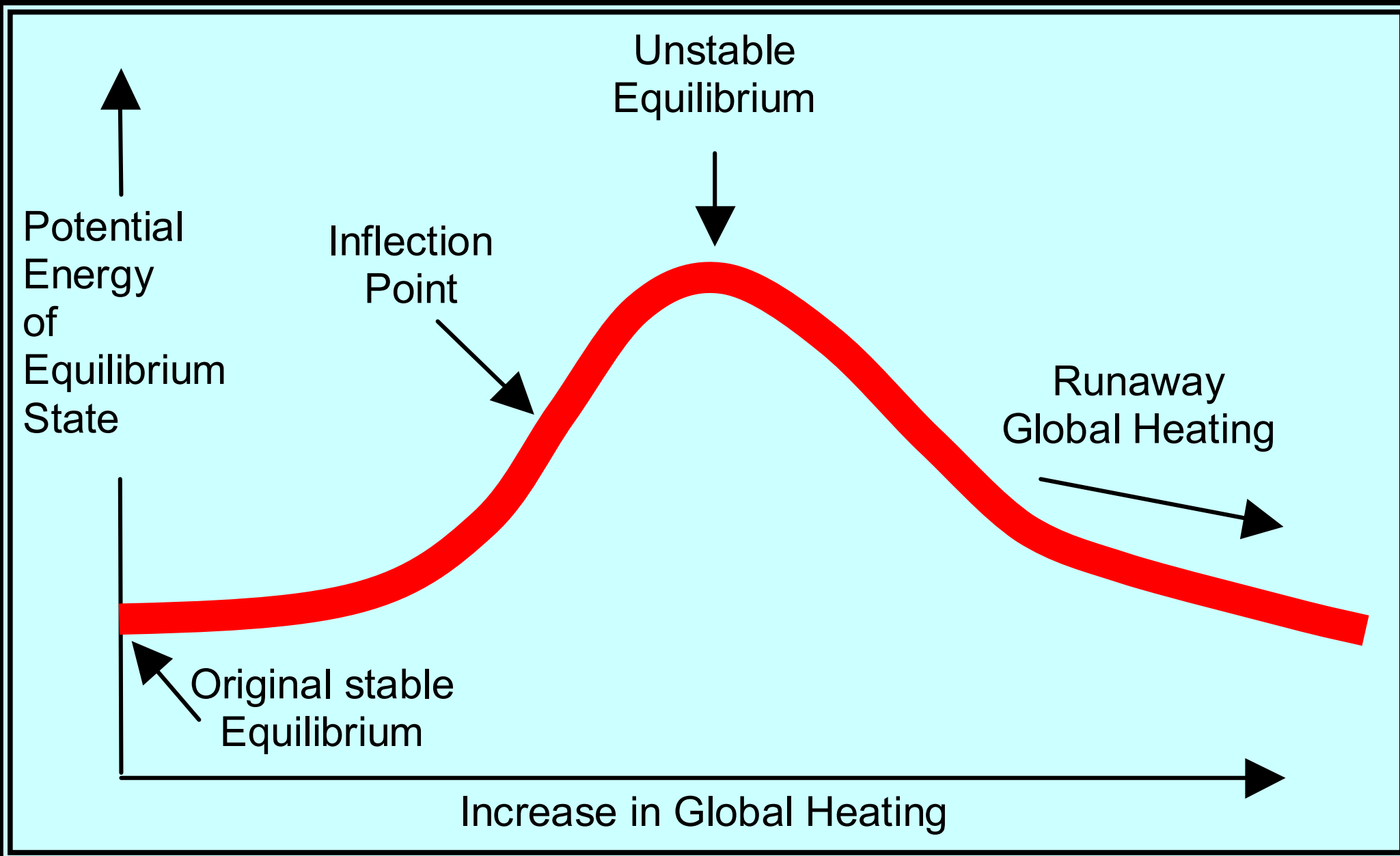
On Complexity Science Workshop. 15th June 2006

Climate report 'was watered down'

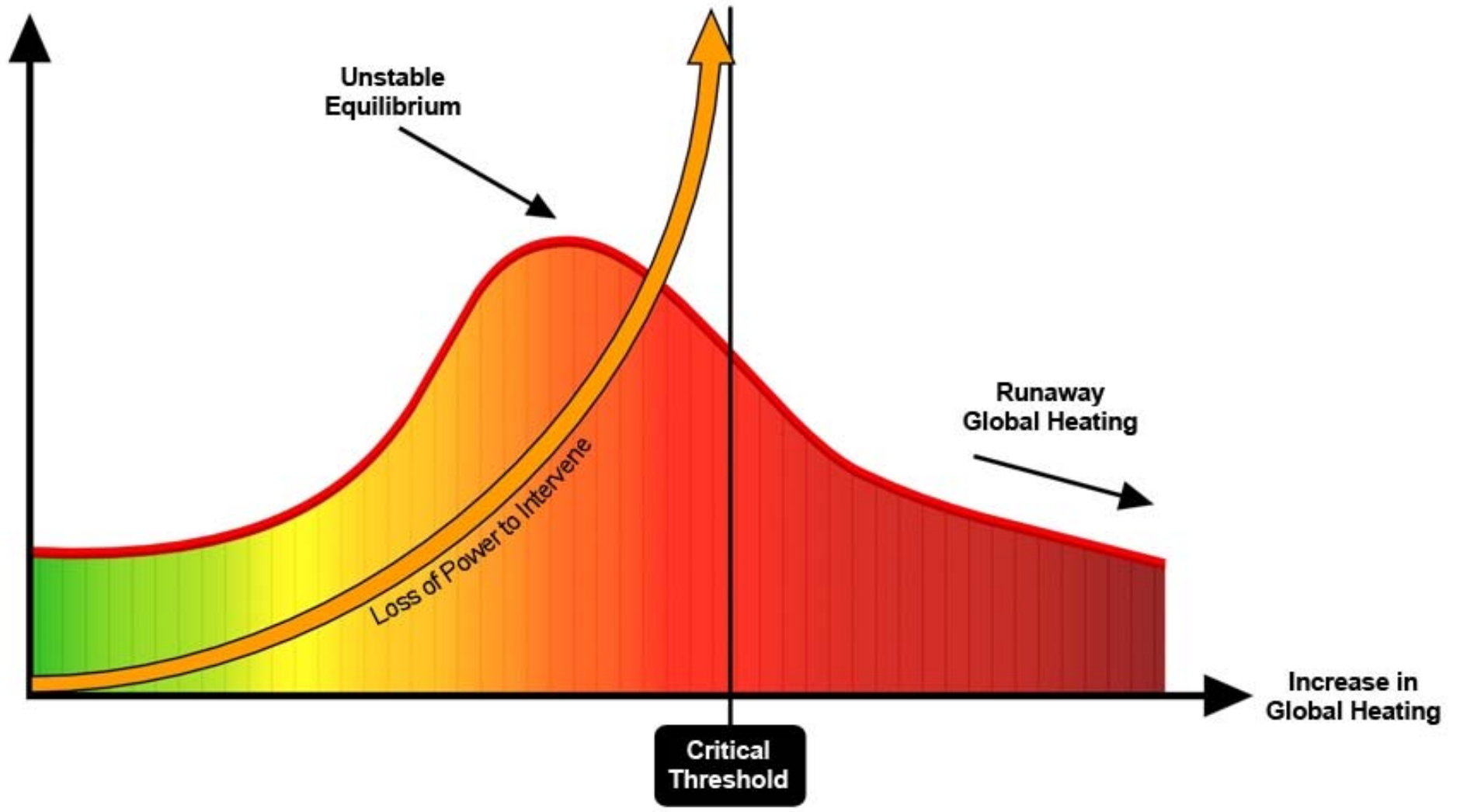
Fred Pearce *New Scientist* 08 March 2007

British researchers who have seen drafts of last month's report by the Intergovernmental Panel on Climate Change claim it was significantly watered down when governments became involved in writing it.

David Wasdell, an independent analyst of climate change who acted as an accredited reviewer of the report, says the preliminary version produced by scientists in April 2006 contained many references to the potential for climate to change faster than expected because of "positive feedbacks" in the climate system. Most of these references were absent from the final version.



Potential Energy of Equilibrium State

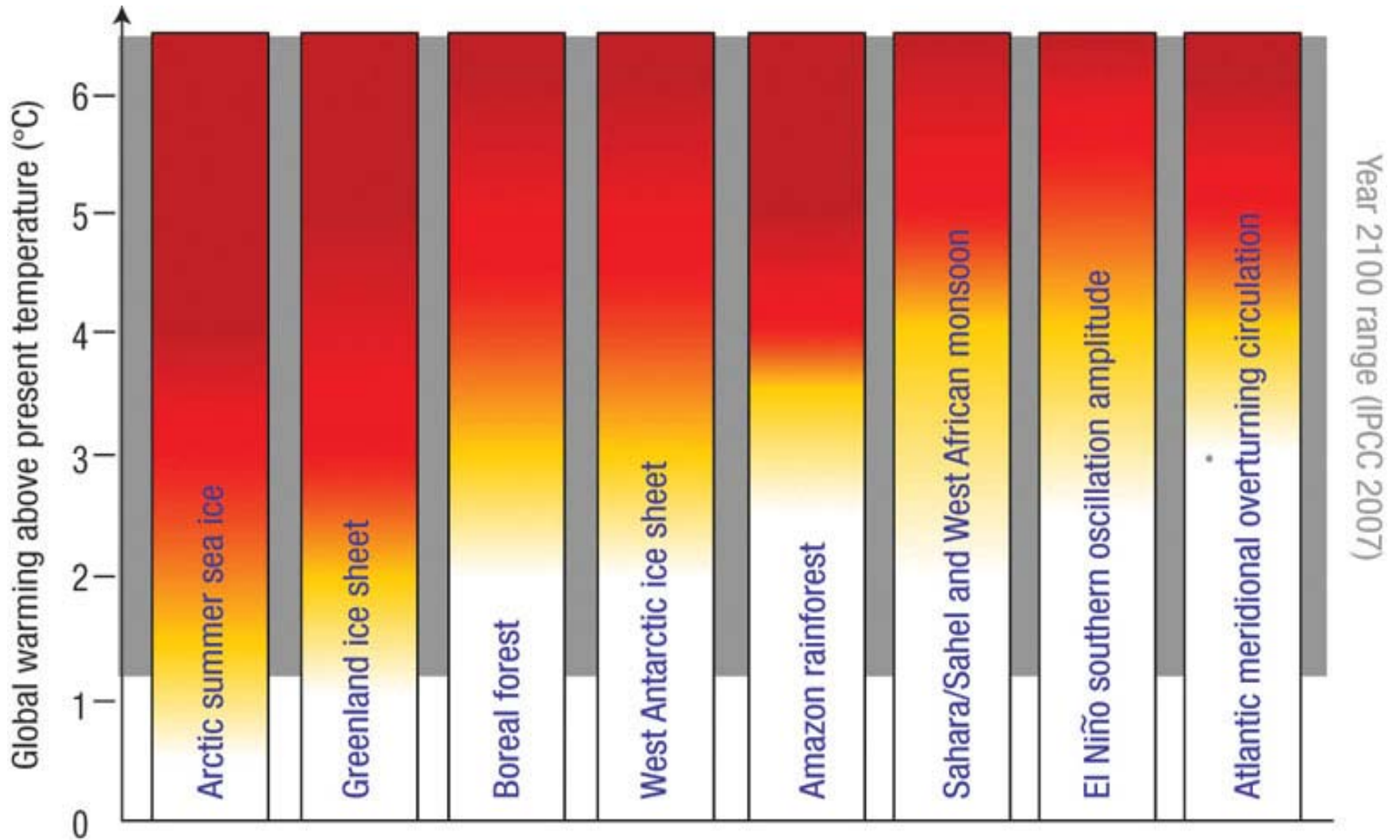


Tipping points

“Society may be lulled into a false sense of security by smooth projections of global change. Our synthesis of present knowledge suggests that a variety of tipping elements could reach their critical point within this century under anthropogenic climate change. The greatest threats are tipping the Arctic sea-ice and the Greenland ice sheet, and at least five other elements could surprise us by exhibiting a nearby tipping point.”

Tipping elements in the Earth’s climate system Timothy M. Lenton*†, Hermann Held‡, Elmar Kriegler‡§, Jim W. Hall¶, Wolfgang Lucht‡, Stefan Rahmstorf‡, and Hans Joachim Schellnhuber†‡ ***School of Environmental Sciences, University of East Anglia, and Tyndall Centre for Climate Change Research, Norwich NR4 7TJ, United Kingdom; ‡Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412 Potsdam, Germany; §Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA 15213-3890; ¶School of Civil Engineering and Geosciences, Newcastle University, and Tyndall Centre for Climate Change Research, Newcastle NE1 7RU, United Kingdom; and Environmental Change Institute, Oxford University, and Tyndall Centre for Climate Change Research, Oxford OX1 3QY, United Kingdom

From the following article **Tipping the scales** Timothy M. Lenton & Hans Joachim Schellnhuber Nature Reports Climate Change , (2007) Published online: 22 November 2007 doi:10.1038/climate.2007.65



Scientists identify 'tipping points' of climate change

By Steve Connor, Science Editor, Independent, Tuesday, 5 February 2008

Nine ways in which the Earth could be tipped into a potentially dangerous state that could last for many centuries have been identified by scientists investigating how quickly global warming could run out of control.

A major international investigation by dozens of leading climate scientists has found that the "tipping points" for all nine scenarios – such as the melting of the Arctic sea ice or the disappearance of the Amazon rainforest – could occur within the next 100 years.

Resource Allocation appropriate to an emergency

Military outlays as per cent of national income

UK

1939	15
1940	44
1941	53
1942	52
1943	55
1944	53

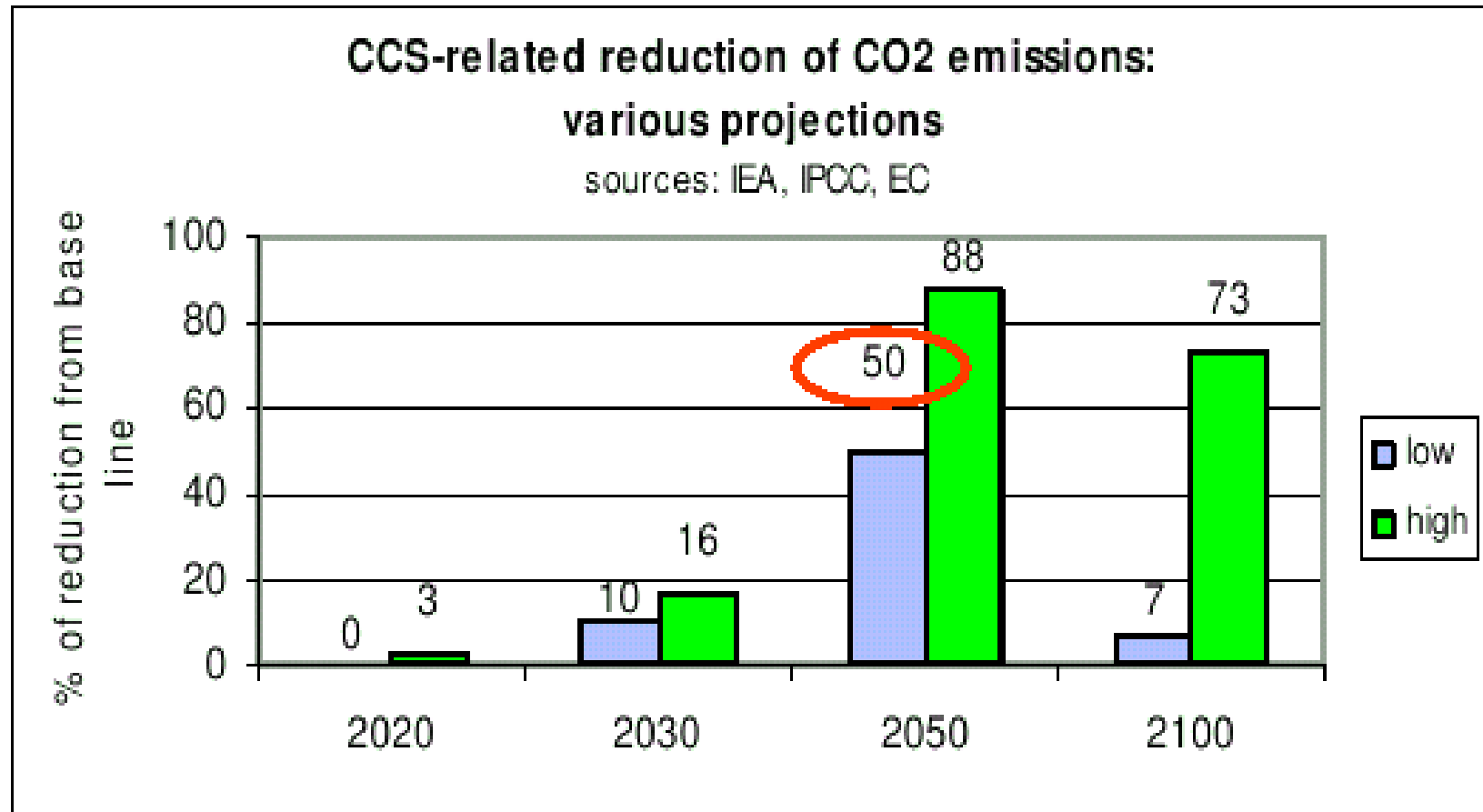
The Scale of the Intervention Required

An estimate is that there is an excess of about 475 Gt carbon dioxide in the atmosphere (since pre-industrial times).

There are about 5×10^9 ha agricultural land out there. Say that you sequester it evenly over the world's agricultural land, then you need to put down about 95 kg carbon per hectare to reduce the atmospheric content down to pre-industrial levels.

Time scales for CCS

- Potential:



Explanations and sources: 2020: OECD region, IPCC 2005, p. 358; 2030/2050 low: reduction of global energy-related emissions compared with a base line without CCS (IEA WEO 2006, p. 358; and IEA 2004, p. 101); high: reduction of emissions from EU coal power plants compared with 2005 (EC, p. 71); 2100: average 2000-2100 reduction of global energy-related emissions compared with a baseline without CCS (IPPC 2005, p. 350, 354)

“Optimism Bias” – Time Over runs are the Norm – Quotes from the UK Treasury Green Book

" There is a demonstrated, systematic, tendency for project appraisers to be overly optimistic. To redress this tendency appraisers should make explicit, empirically based adjustments to the estimates of a project's costs, benefits, and duration....."

"non standard civil engineering" project are typically between 3% to 25% optimistic as regards duration. Projects of an "equipment and development" character have typical duration overruns between 10 – 54%.

The Green Book – Used for Appraising Capital Projects

www.hm-treasury.gov.uk/media/D/B/GreenBook_optimism_bias.pdf

CCS – 67-78% CO2 only captured

A World Coal Institute claims that CCS will reduce emissions by 80-90%. However 5% of the CO2 emissions associated with a power station occur in the mining and transport leading up to the delivery of the fuel. Because CCS reduces the efficiency of the power station there will have to be a lot more mining and transport. Anything between 20-44% more energy input is needed. When one takes that into account the real reduction of CO2 may begin to look more like a 72 to 78% of the CO2 (starting from an assumption of 88% capture at the power station itself).

In addition extra methane is released during the additional mining of the coal so the greenhouse gas reduction, measured in CO2 equivalents, is more like 67-78%

