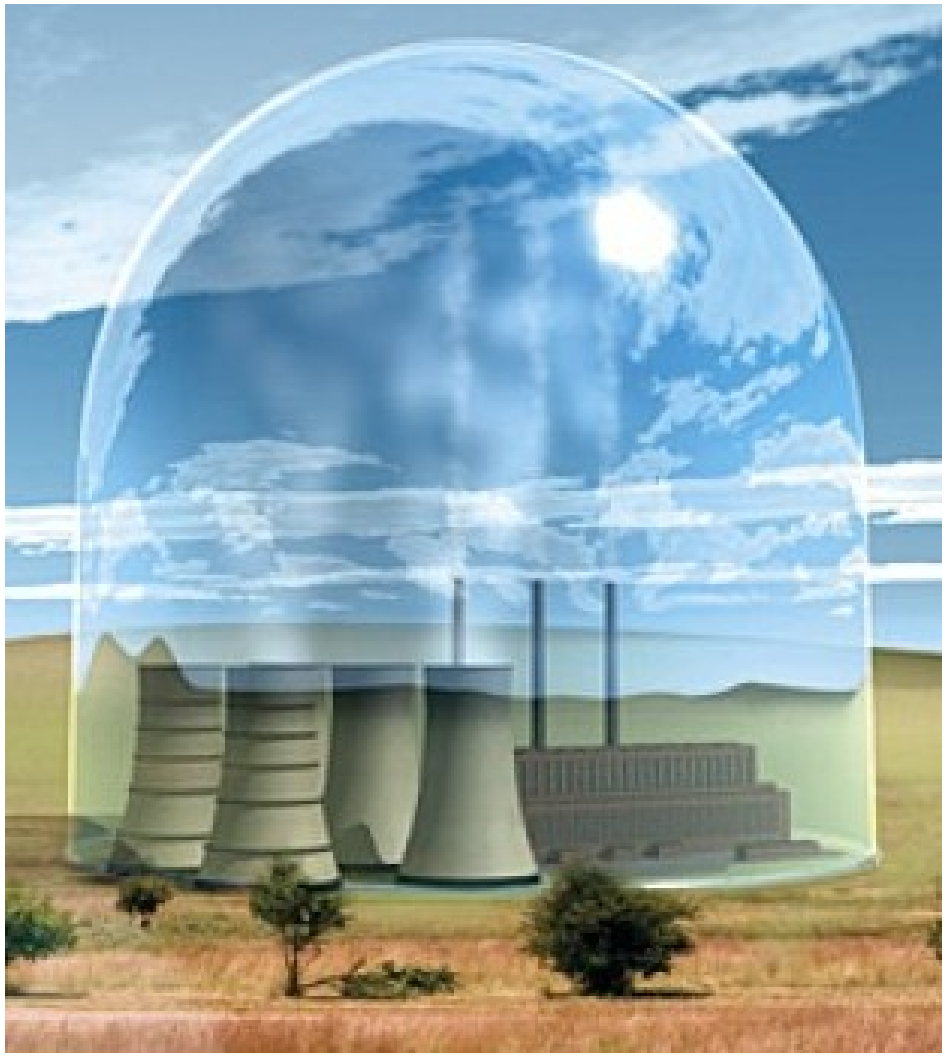
Carbon capture and storage (CCS): the solution to global warming?

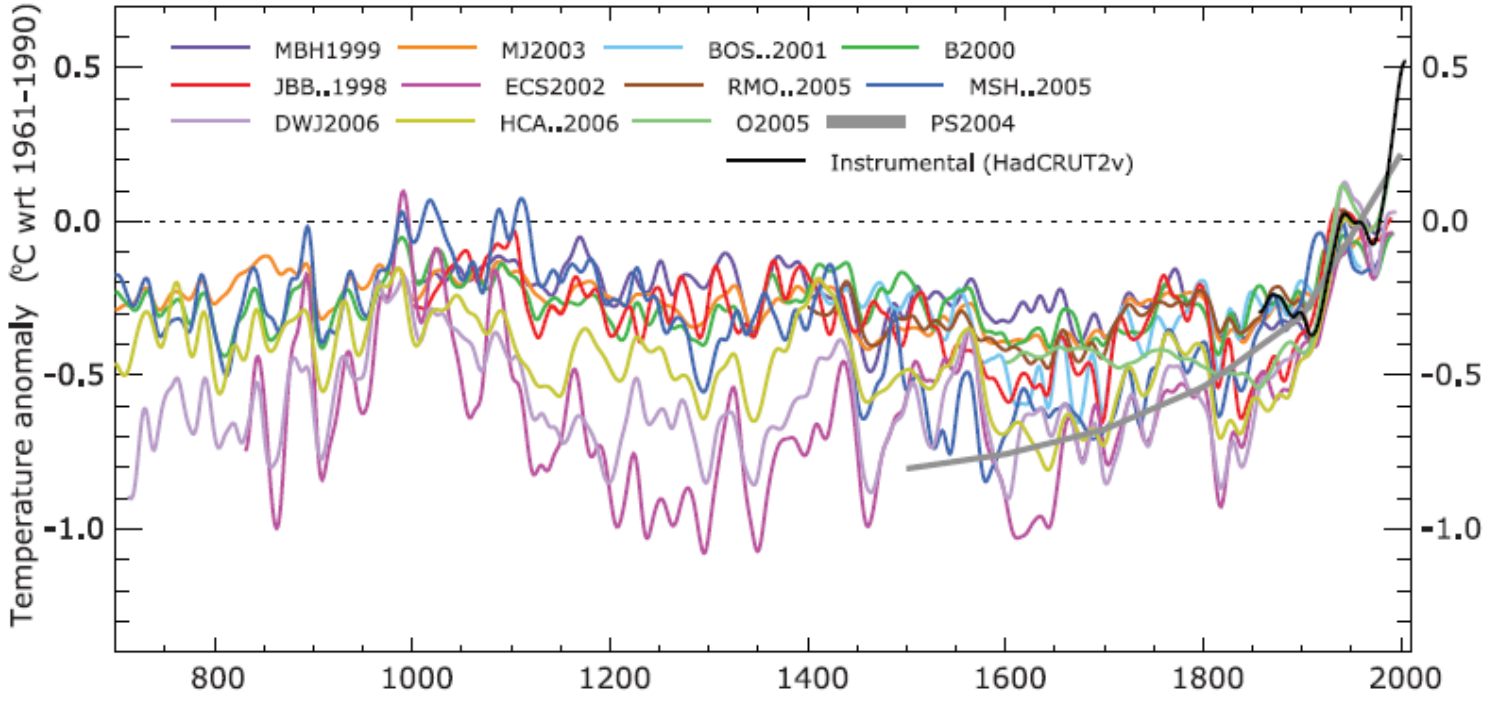


Emma Stone

Outline

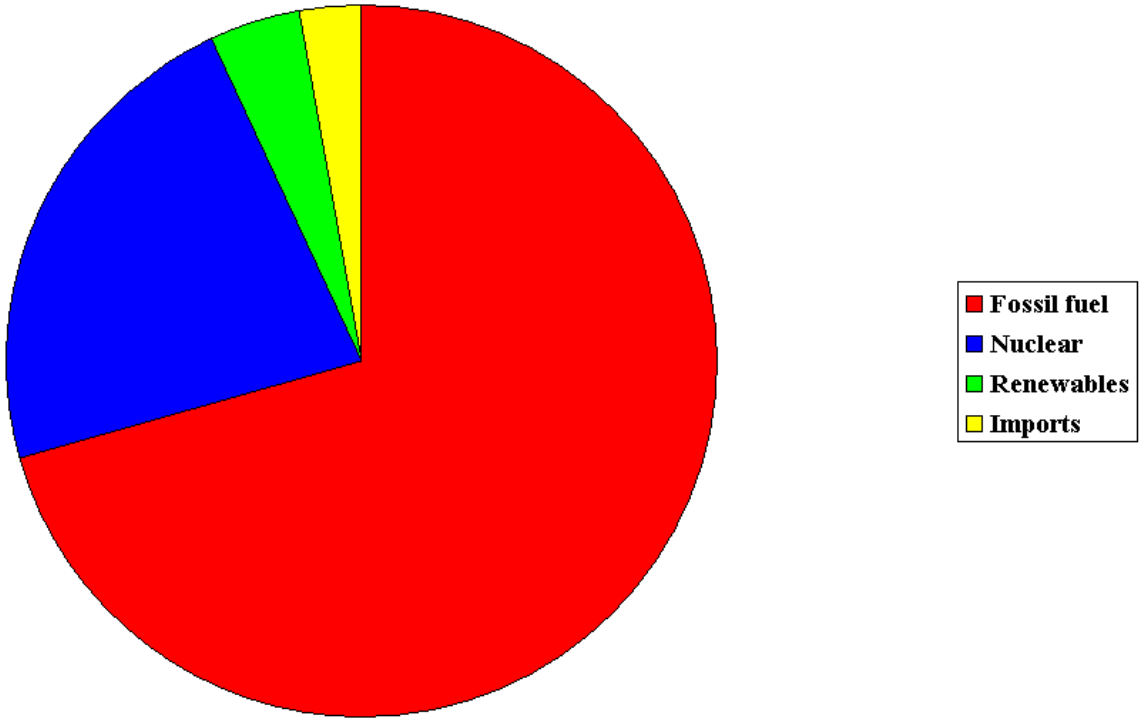
- State of the climate
- Coal as a source of energy
- What is CCS?
- Is CCS an exciting prospect for climate change mitigation?
- What are the issues with CCS?
- How do we model CCS?
- Results from my study & summary

Is the Earth warming up?



(**IPCC, 2007**)

Coal as source of energy



Would require ~45 new nuclear power stations (like Hinkley Point B) to replace all fossil fuel power production!

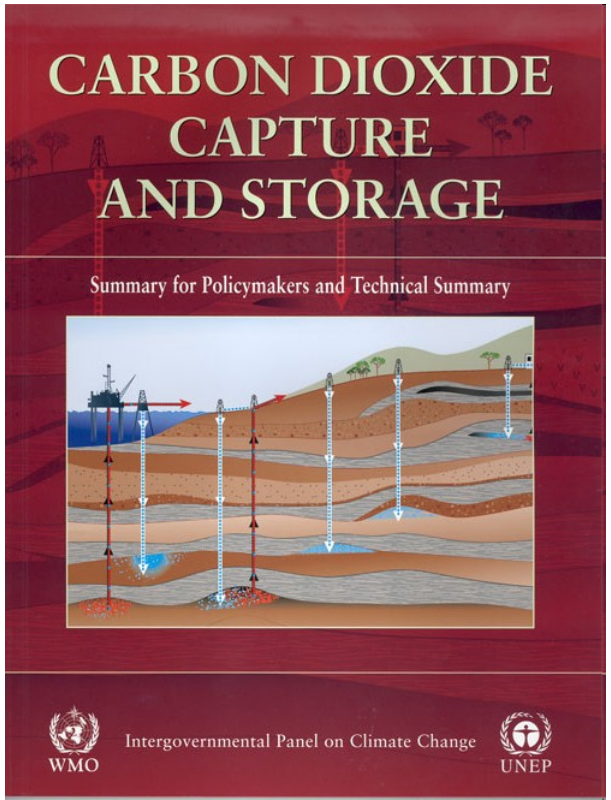
Coal as source of energy

- Despite the ongoing development of sustainable fuels we will carry on burning coal and gas to meet at least half of global energy demand until 2030 (optimistic view!).

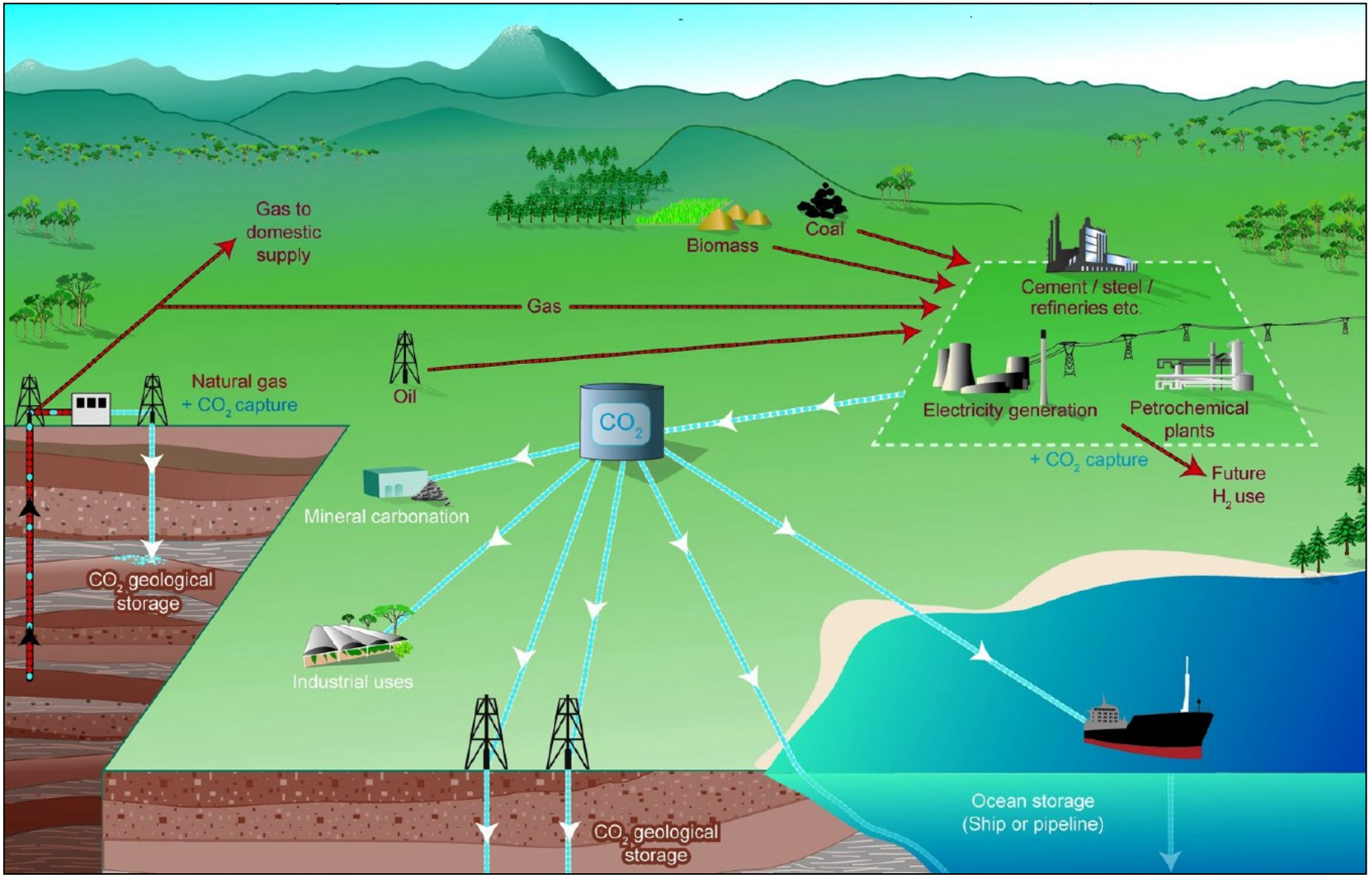
- So….can we have our cake and eat it?
  - burn coal but with little effect on the climate.

What is CCS?

‘ CCS is the process of separating CO2 from industrial and energy related point sources and transporting it to a site for long-term storage away from the atmosphere.’ (IPCC, 2005)

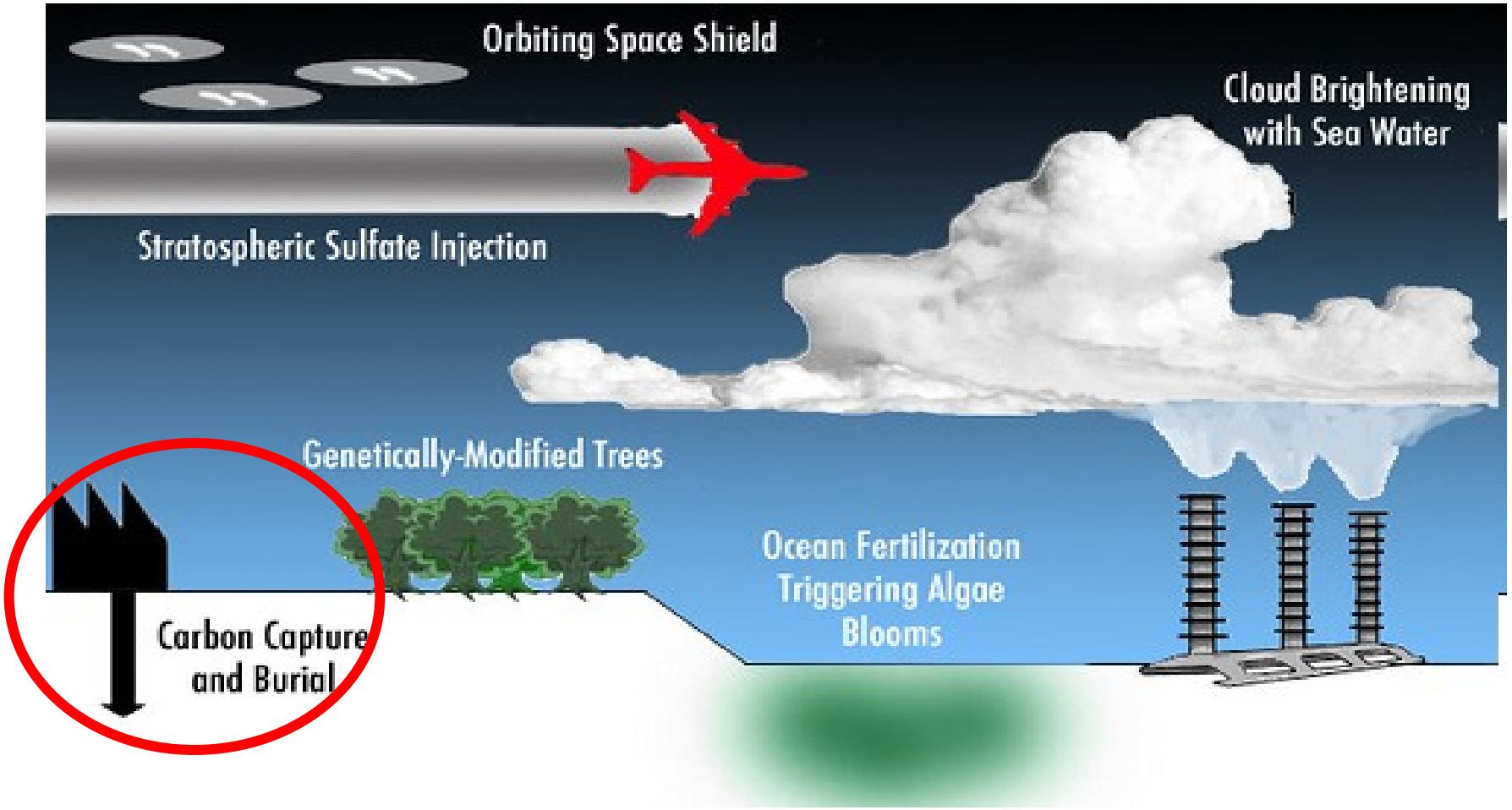


What is CCS?

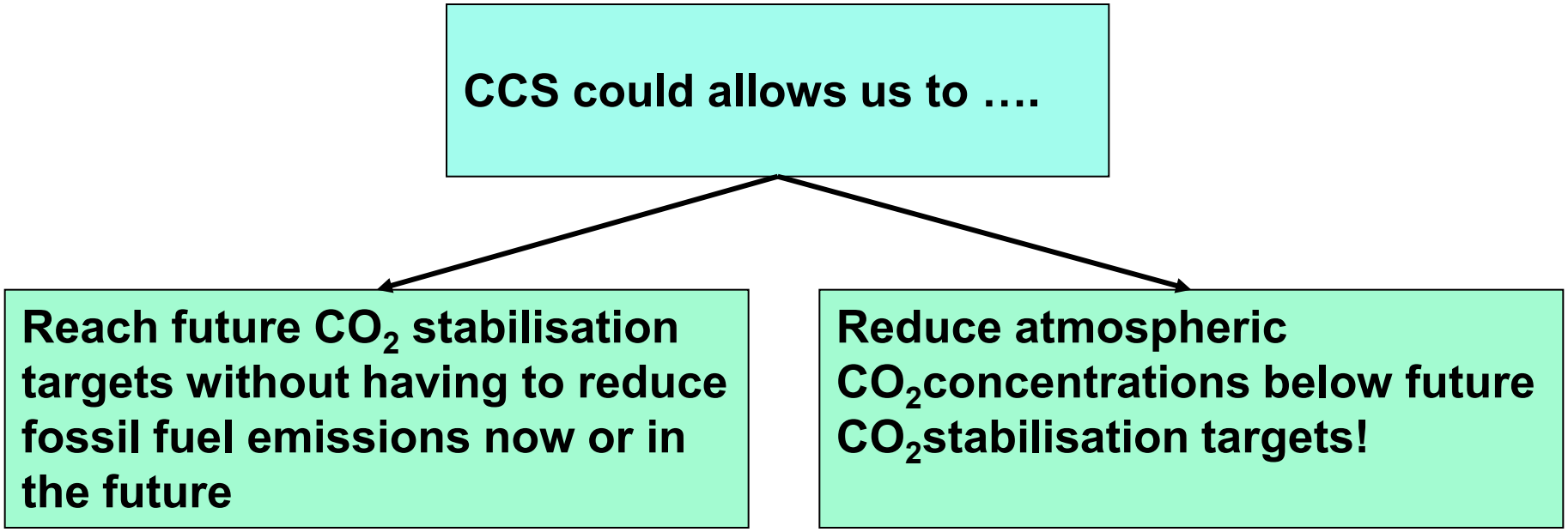


Schematic diagram of possible CCS systems (IPCC, 2005)

Is CCS an exciting prospect for climate mitigation?



Is CCS an exciting prospect for climate mitigation?



- **Some technology already exists!**
- **Could be an economically viable mitigation option for climate change.**

Is CCS an exciting prospect for climate mitigation?

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Carbon capture technology tested

The scheme will allow carbon to be captured so that it can be stored underground

New carbon capture technology is being tested for the first time in the UK on a working coal-fired power station.

A 30-tonne test unit will process 1,000 cubic metres of exhaust gas per hour from Longannet power station in Fife.

Carbon dioxide will be removed using chemicals and turned into a liquid, ready for storage underground.

Energy company ScottishPower wants to test technology which could lead to a full scale carbon capture plant becoming operational by 2014.

The UK government recently gave the go-ahead for a new generation of coal-fired power stations provided they were able to limit their CO2 emissions.

"The energy provided by coal, oil, and gas is so valuable that it is crazy to think that we will just leave it all in the ground in a carbon-constrained world"

(Ken Caldeira, Stanford University)

"…findings confirm that natural gas fields can be used to store CO_2 safely over millions of years…"

(Stuart Gilfillan, Edinburgh University)

CCS in the news

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Will carbon capture work?

By Roger Harrabin
Environment analyst, BBC News

Roger Harrabin reports on the principle, the practice, and the controversy of carbon capture

The UK government has given a massive boost to world ambitions to develop clean-coal technology. It announced a decision that will herald a new generation of coal-fired power stations in the UK - but all of them will have to have their CO2 emissions partially captured by cutting-edge technology.

guardian.co.uk

New era for fossil fuels as first carbon capturing power plant begins work
French power station leading the way in the world's sluggish move towards using environmentally vital CCS technology [8 April 2009]

Mail Online

Government U-turn means new coal-fired power stations will have to bury carbon emissions
[24 April 2009]

CCS in the news

"Up to four new projects are to be announced to demonstrate the capture and storage of carbon dioxide - rather than its release into the atmosphere - and to help drive this technology to commercial viability" (UK Government, April 2009)

What are the issues with CCS?

General

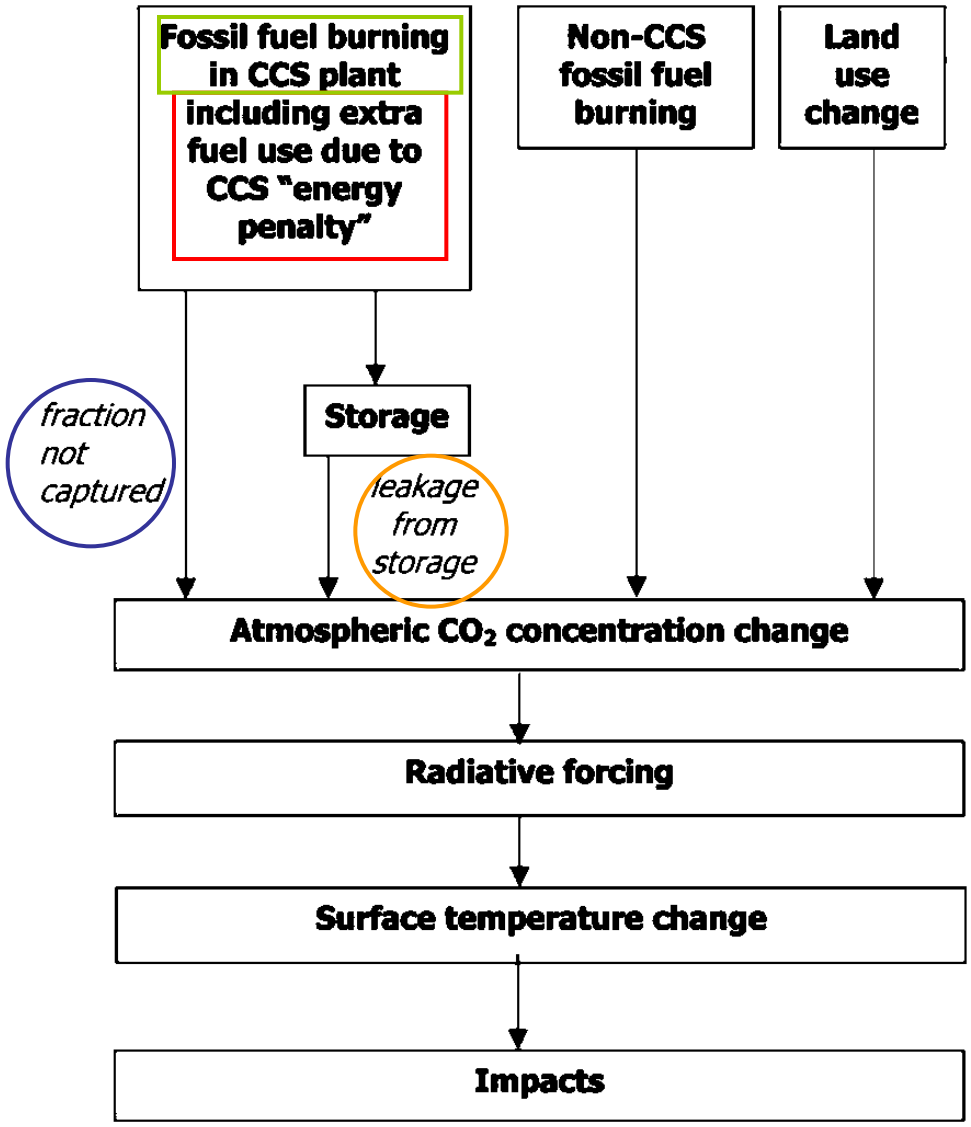
- Technological advancement
- Cost of implementation
- Storage capacity
- Is CCS sustainable by future generations?

What are the issues with CCS?

Is CCS feasible?

- The energy penalty
- Efficiency of CCS plant
- Fraction of power stations capable of CCS globally
- Environmental risk: leakage from reservoirs
  - Local scale
  - Global scale

How do we model CCS?

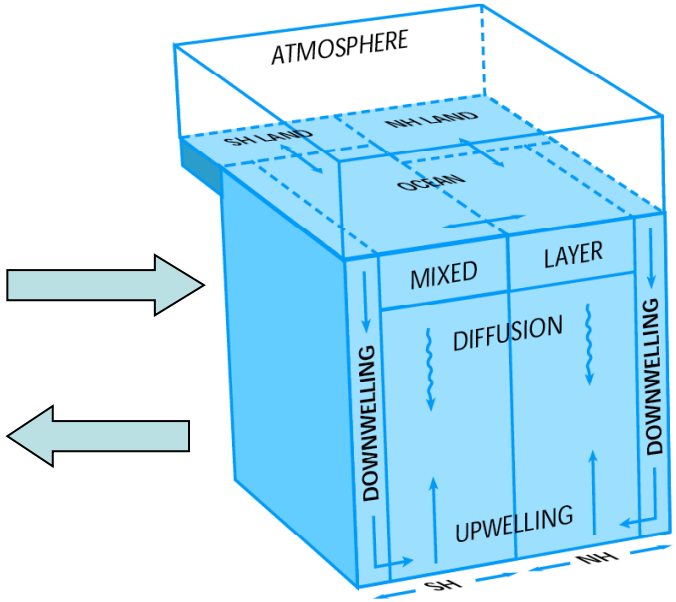


Energy penalty = **10-40%**

Retention time = **10-1000 yrs**

Fraction not captured by plant = **5-15%**

Fraction of CCS fossil fuel burning plants = **25-50%**



Schematic of the simple energy balance climate model

How do we model CCS?

SRES
(future storylines)

Global

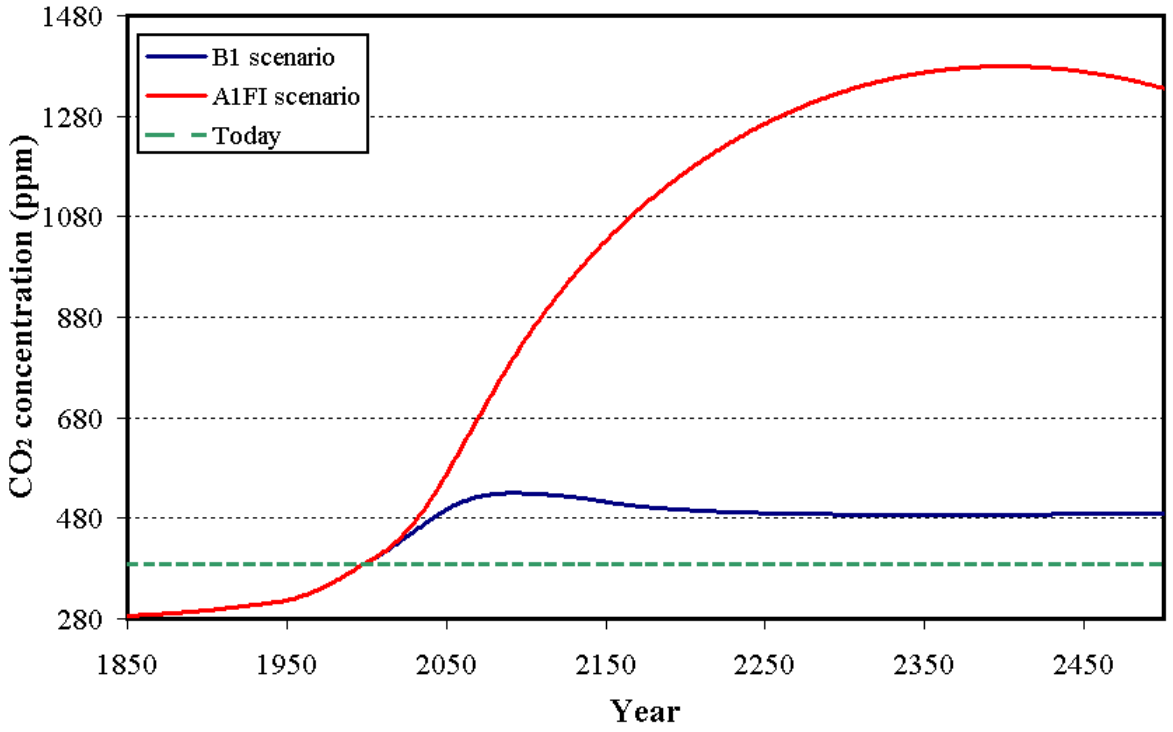
A1FI

Material/economic

Regional

B1

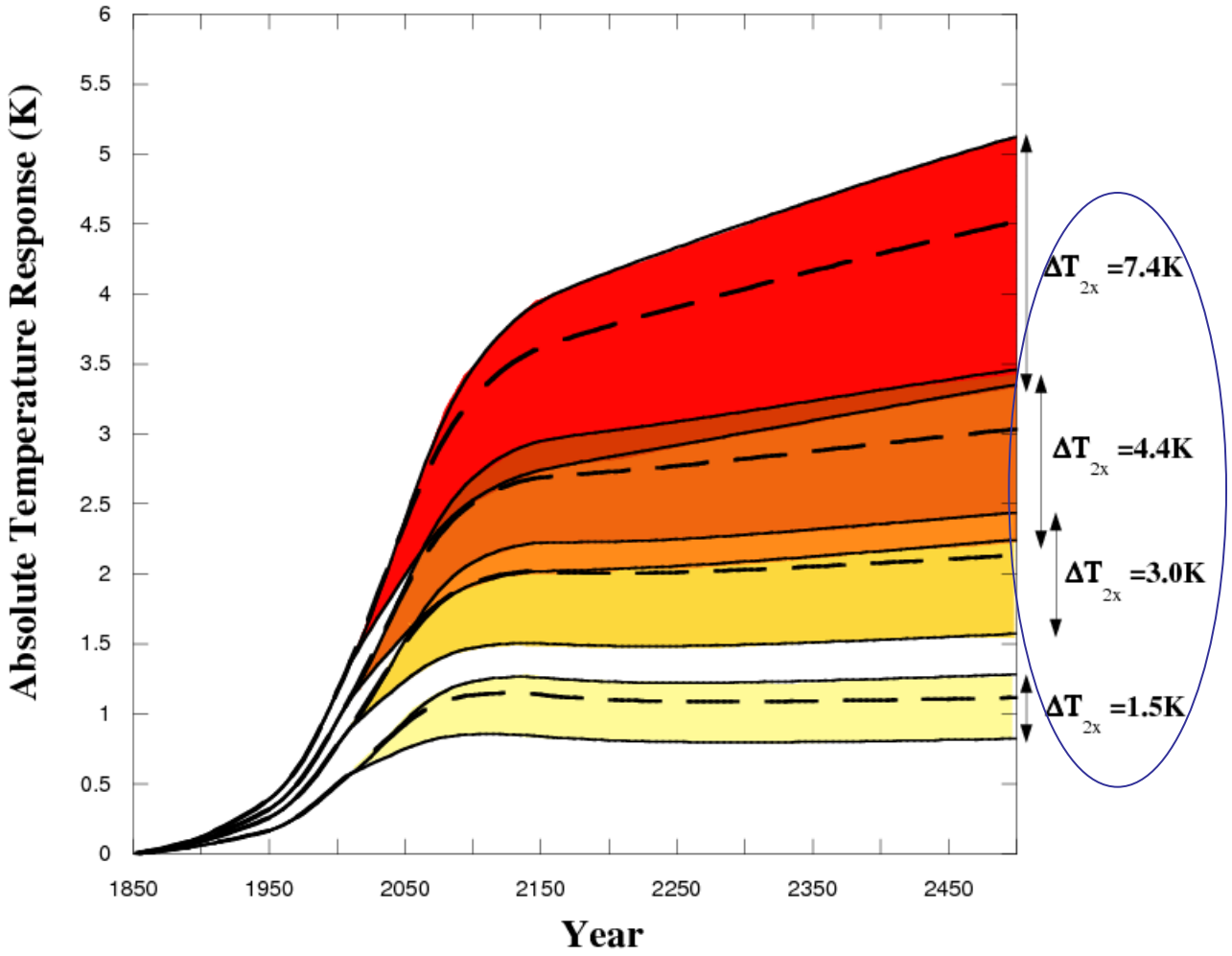
Social /Environmental



390ppm today!

Impact of CCS on climate

B1 storyline



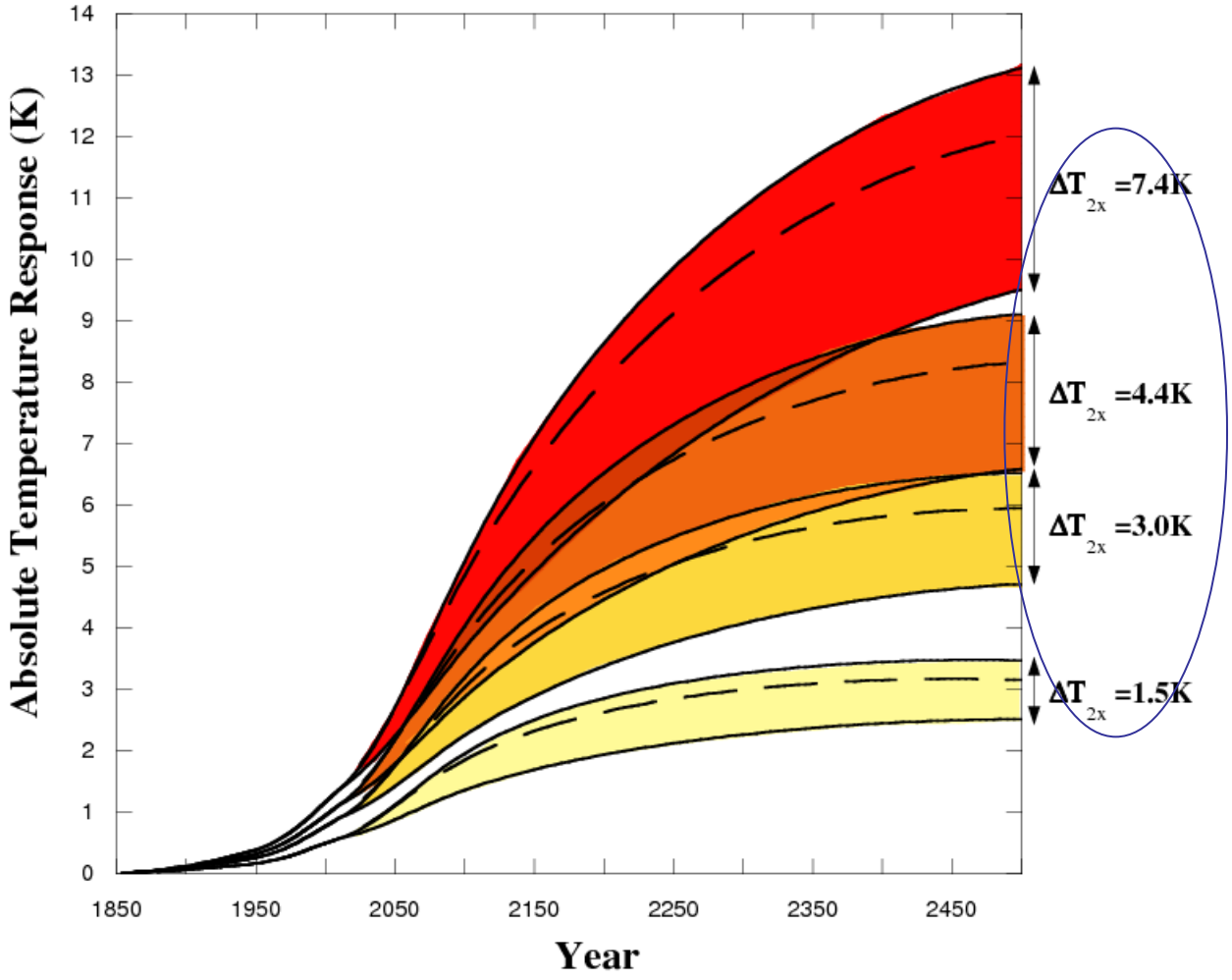
Range of parameter accounting for unknowns in models

Case where there is NO CCS

[Stone et al. 2009]

Impact of CCS on climate

A1FI storyline



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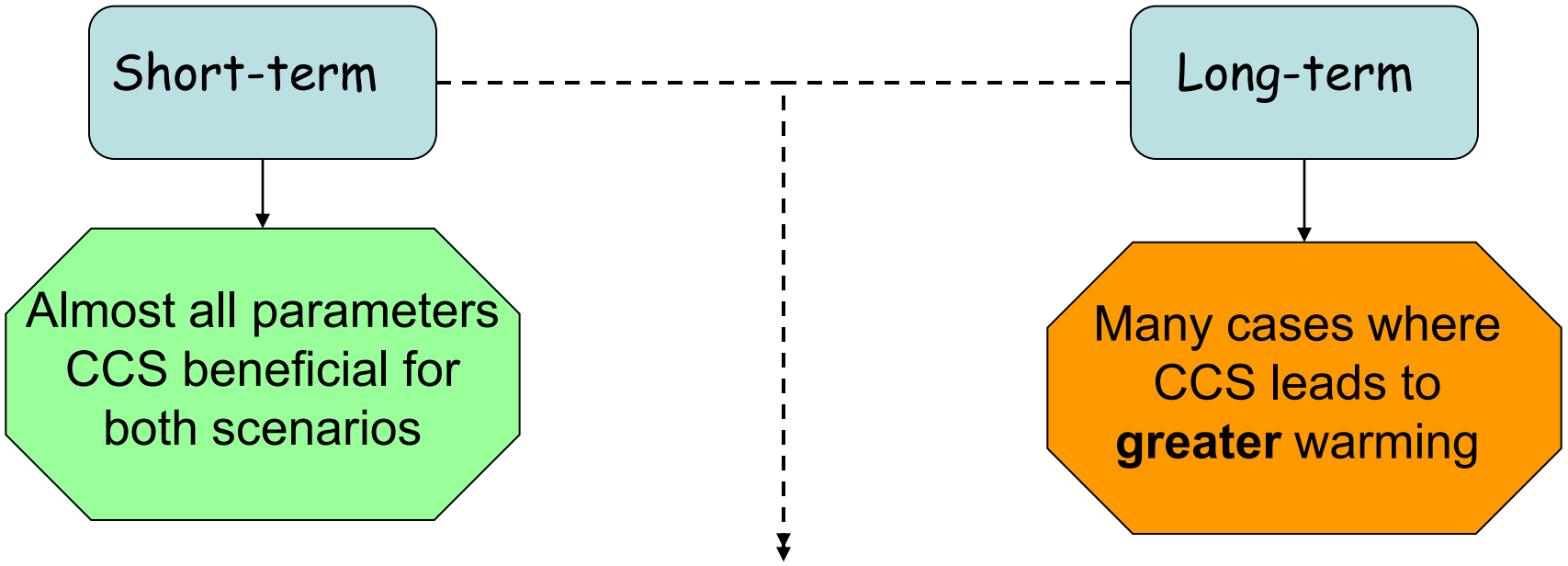
[Stone et al. 2009]

Impact of CCS on climate



Main controlling factor is retention time of stored carbon

Absolute benefits increase with an increase in the climate sensitivity

Absolute benefit greater for **higher** fossil fuel emissions

Summary

- Coal will continue to be an essential energy source for the future
- CCS could provide a solution to the impact of coal on the climate
- It is economically viable and technology exists and is being tested
- Health warning: we are uncertain how much benefit it may have on mitigating climate change

Thank you

“Politicians are pinning their hopes for delivery from global warming on a technology that is not quite airtight” *The Economist* (March 2009)