Prospects for Carbon Capture and Storage

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A Rorschach Test: What is CCS?

Geosequestration is one option for trapping CO2 emissions from gas or power plants. But not everyone agrees – *ABC (Australia)*

Recycled geological structures to reduce CO2 – *Independent (S. Africa)*

Carbon dioxide storage holds limited promise: Approach could halve industrial emissions by 2050 – *Nature*

No Potential for CCS?

Source: New Statesman, Energy Supplement, 2005, p. xiii

Potential for the future?

Wind Pros: windmills have been a feature of our landscape for centuries; they provide a clean and renewable source of power. Cons: wind farms can be expensive to commission and maintain; piping the electricity to the national grid poses technical problems.

Biomass Pros: produced from fermented and refined organic matter such as sugarcane and oilseed rape, which consume as much carbon dioxide during growth as they produce during combustion; uniquely offers a renewable alternative to liquid transport fuels, with which it can be blended. Cons: needs a lot of space.

Nuclear fusion Pros: has the potential of producing vast amounts of energy; perpetual, cheap and relatively hassle-free, with minimal waste. Cons: fusion technology has a long way to go and at the moment is prohibitively expensive.

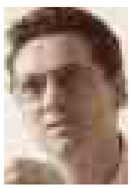
Geothermal Pros: in the right places, provides a clean, safe and stable source of power. Cons: effective use depends on the right geological conditions and there are few sites around the world capable of producing power at a competitive cost; it is not strictly renewable – over time, heat-producing sites will cool as more energy is extracted.

Combined heat and power Pros: reduces emissions, waste and cost by transferring the production of electricity to the point of use; well established among larger businesses and public-sector organisations. Cons: it still burns fossil fuel, giving it a limited appeal for the long term.

Hydrogen Pros: efficient, versatile and completely clean – the only emission being pure water; huge potential for transport. Cons: does not occur naturally in a usable form.

What Difference Does a Year Make?

The case for carbon capture




Whether we like it or not, the world is going to burn a lot of coal and gas. UK industry can lead the way in carbon capture and storage, but government must be prepared to act quickly, too.

SIMON SHACKLEY and **JON GIBBINS** report

<u>Source:</u> New Statesman, Energy Supplement, 2006, p. xiii

G8 Plan of Action

14. We will work to accelerate the development and commercialization of Carbon Capture and Storage technology by:

(a) endorsing the objectives and activities of the Carbon Sequestration Leadership Forum (CSLF), and encouraging the Forum to work with broader civil society and to address the barriers to the public acceptability of CCS technology;

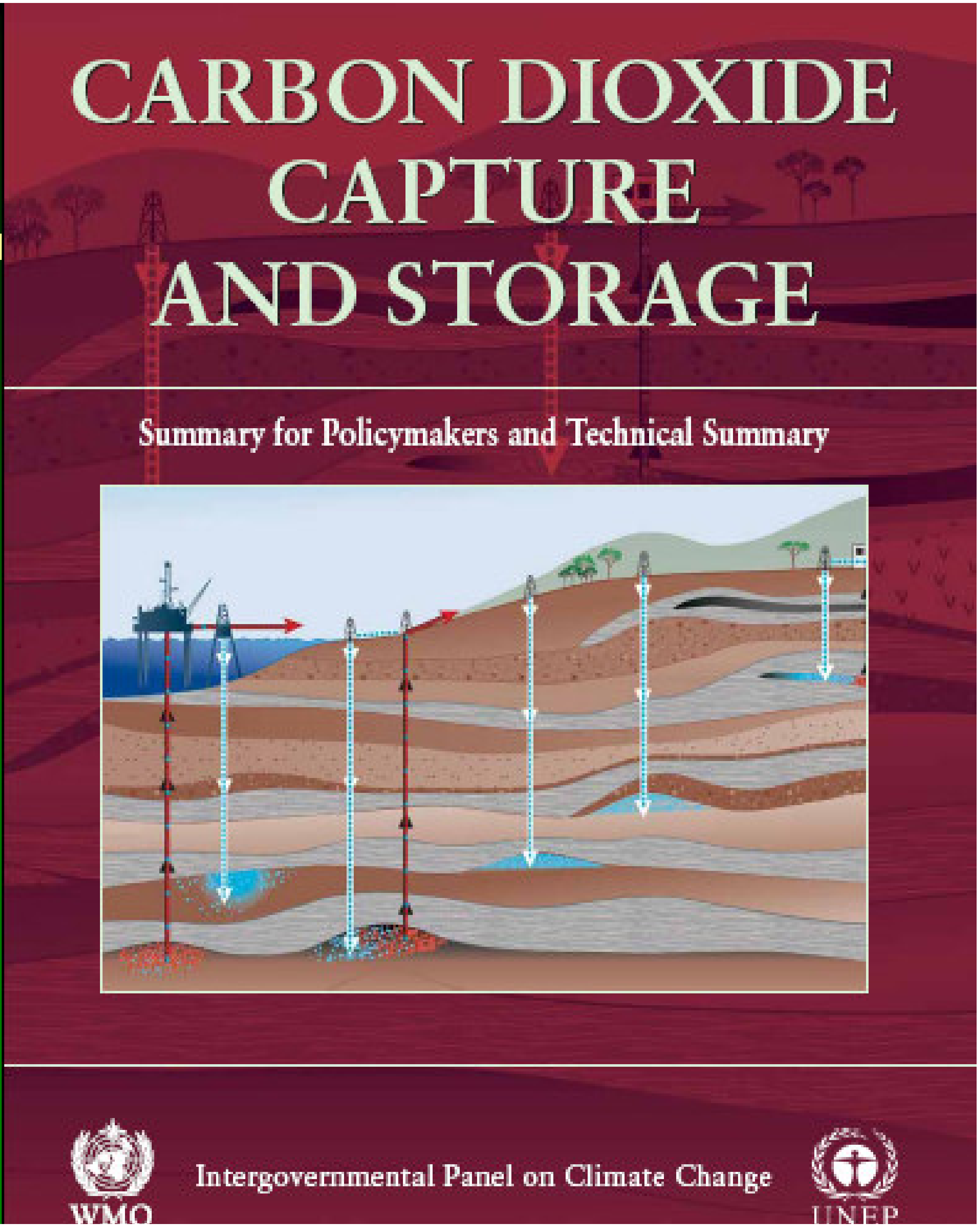
(b) inviting the IEA to work with the CSLF to hold a workshop on short-term opportunities for CCS in the fossil fuel sector, including from Enhanced Oil Recovery and CO2 removal from natural gas production;

(c) inviting the IEA to work with the CSLF to study definitions, costs, and scope for 'capture ready' plant and consider economic incentives;

(d) collaborating with key developing countries to research options for geological CO2 storage; and

(e) working with industry and with national and international research programmes and partnerships to explore the potential of CCS technologies, including with developing countries.

IPCC Special Report
- presented at COP/MOP1



Global profile of large point sources

Table S.1. Profile by process or industrial activity of worldwide large stationary CO_2 sources with emissions of more than 0.1 million tonnes of CO_2 ($MtCO_2$) per year.

Process	No. of sources	Emissions ($MtCO_2$/yr)
Fossil Fuels		
Power (coal, gas, oil and others)	4,942	10,539
Cement production	1,175	932
Refineries	638	798
Iron and steel industry	269	646
Petrochemical industry	470	379
Oil and gas processing	Not available	50
Other sources	90	33
Biomass		
Bioethanol and bioenergy	303	91
Total	**7,887**	**13,466**

Source: IPCC Special Report on Carbon Dioxide Capture and Storage (SRCCS): Summary for Policymakers (2005)

Distribution of sources

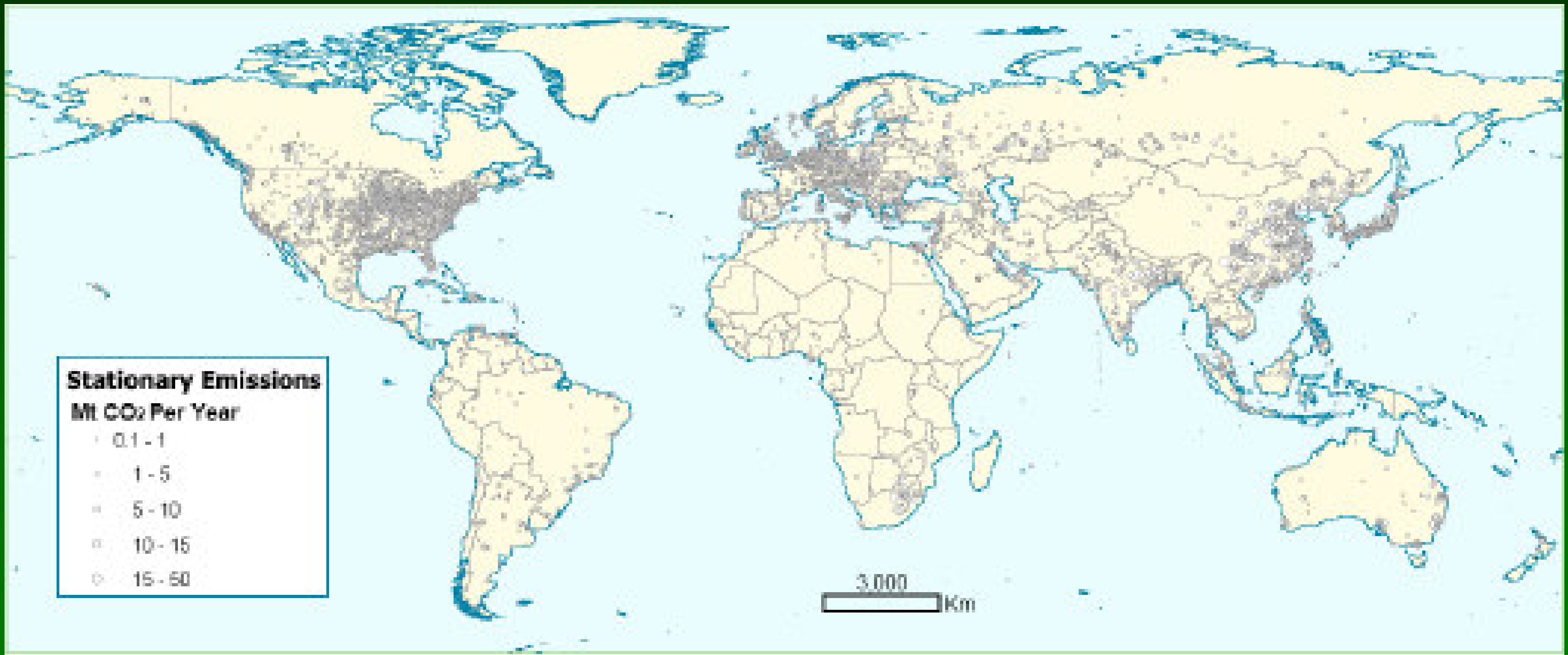


Figure S.6a. Global distribution of large stationary sources of CO_2 (Based on a compilation of publicly available information on global emission sources, IEA GHG 2002)

Mapping prospective storage sites

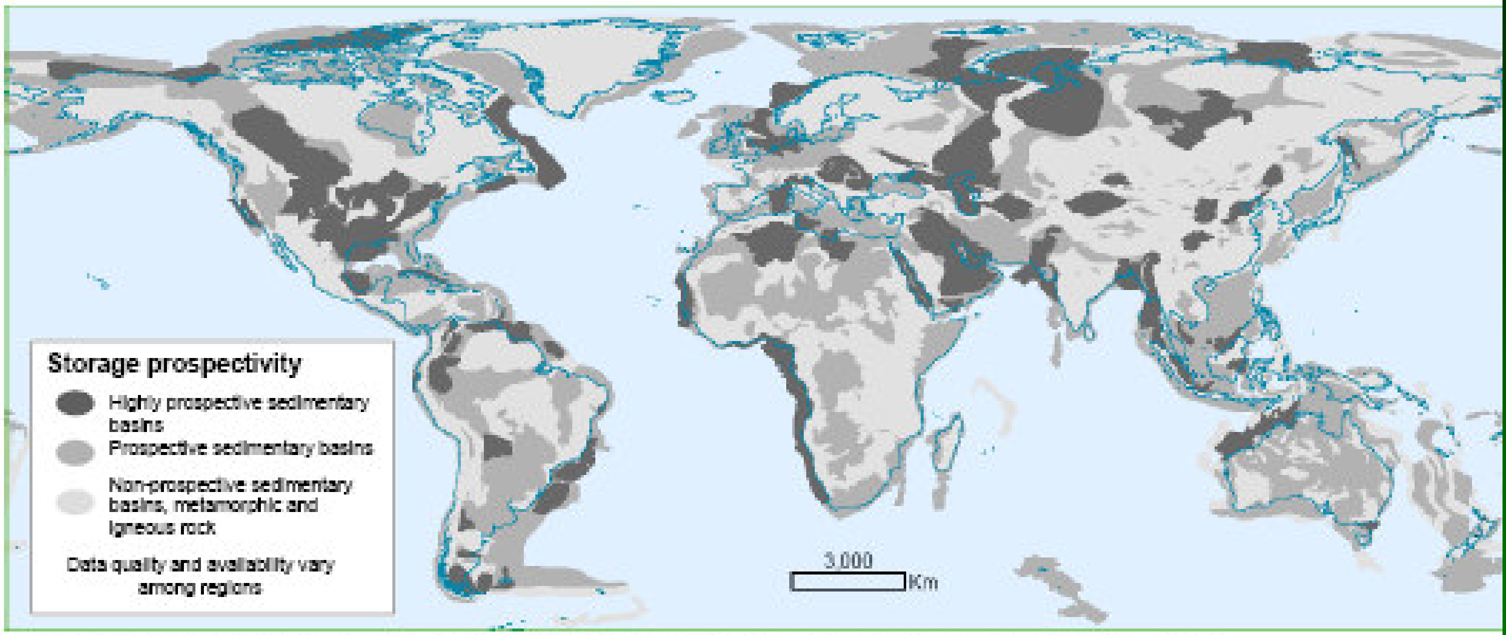
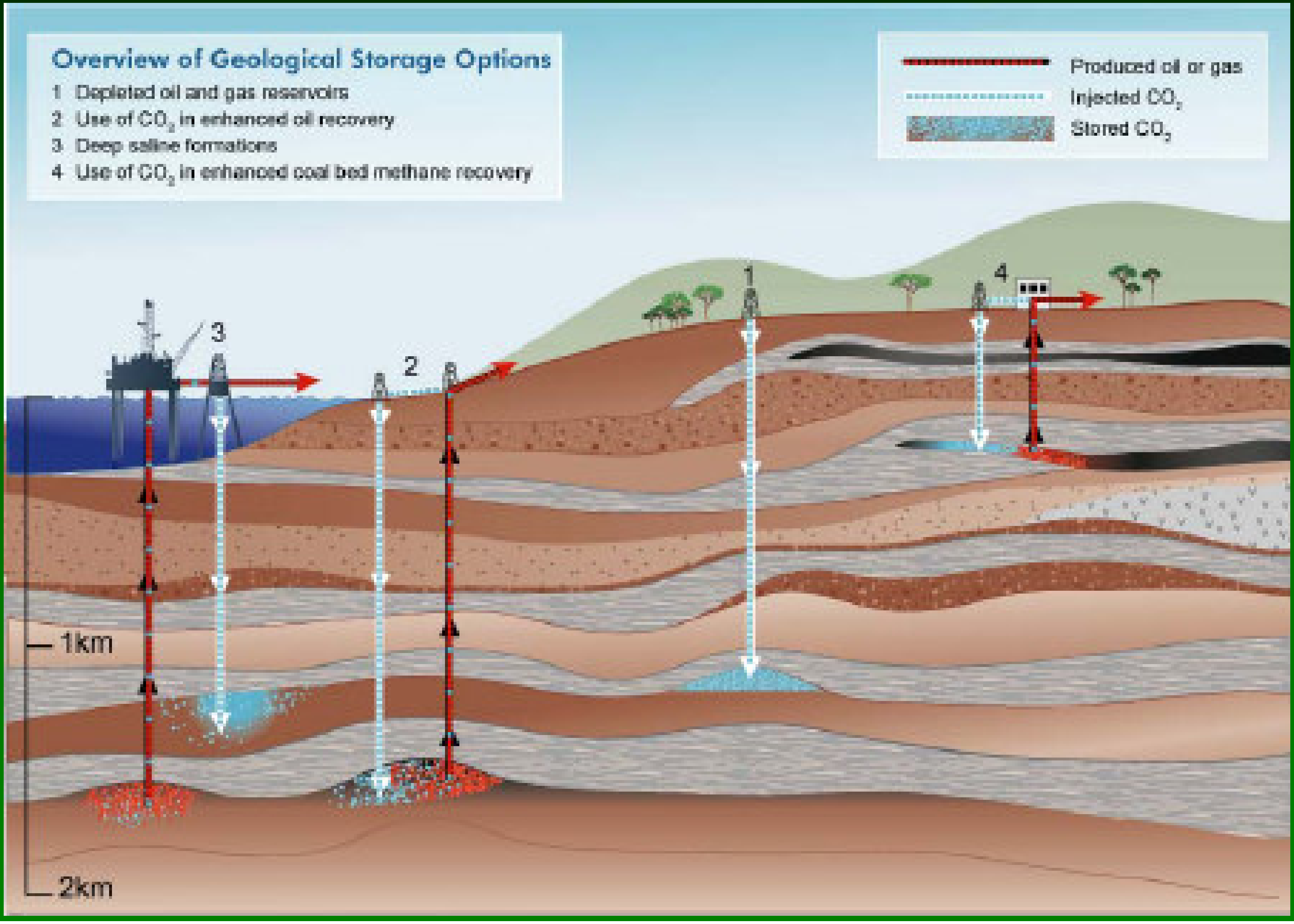


Figure S.6b. Prospective areas in sedimentary basins where suitable saline formations, oil or gas fields, or coal beds may be found. Locations for storage in coal beds are only partly included. Prospectivity is a qualitative assessment of the likelihood that a suitable storage location is present in a given area based on the available information. This figure should be taken as a guide only, because it is based on partial data, the quality of which may vary from region to region, and which may change over time and with new information (Figure 2.4) (Courtesy of Geoscience Australia).

Storage Options



Source: IPCC SRCCS, Figure S.4

Maturity of system components

CCS component	*CCS technology*	*Research phase* [13]	*Demonstration phase* [7]	*Economically feasible under specific conditions* [5]	*Mature market* [6]
Capture	Post combustion			X	
	Pre combustion			X	
	Oxyfuel combustion		X		
	Industrial separation (natural gas processing, ammonia production)				X
Transportation	Pipeline				X
	Shipping			X	
Geological storage	Enhanced Oil Recovery (EOR)				X[a]
	Gas or oil fields			X	
	Saline formations			X	
	Enhanced Coal Bed Methane recovery (ECBM)		X		
Ocean storage	Direct injection (dissolution type)	X			
	Direct injection (lake type)	X			
Mineral carbonation	Natural silicate minerals	X			
	Waste materials		X		
Industrial uses of CO_2					X

Economically feasible under specific conditions [5]
Mature market [6]

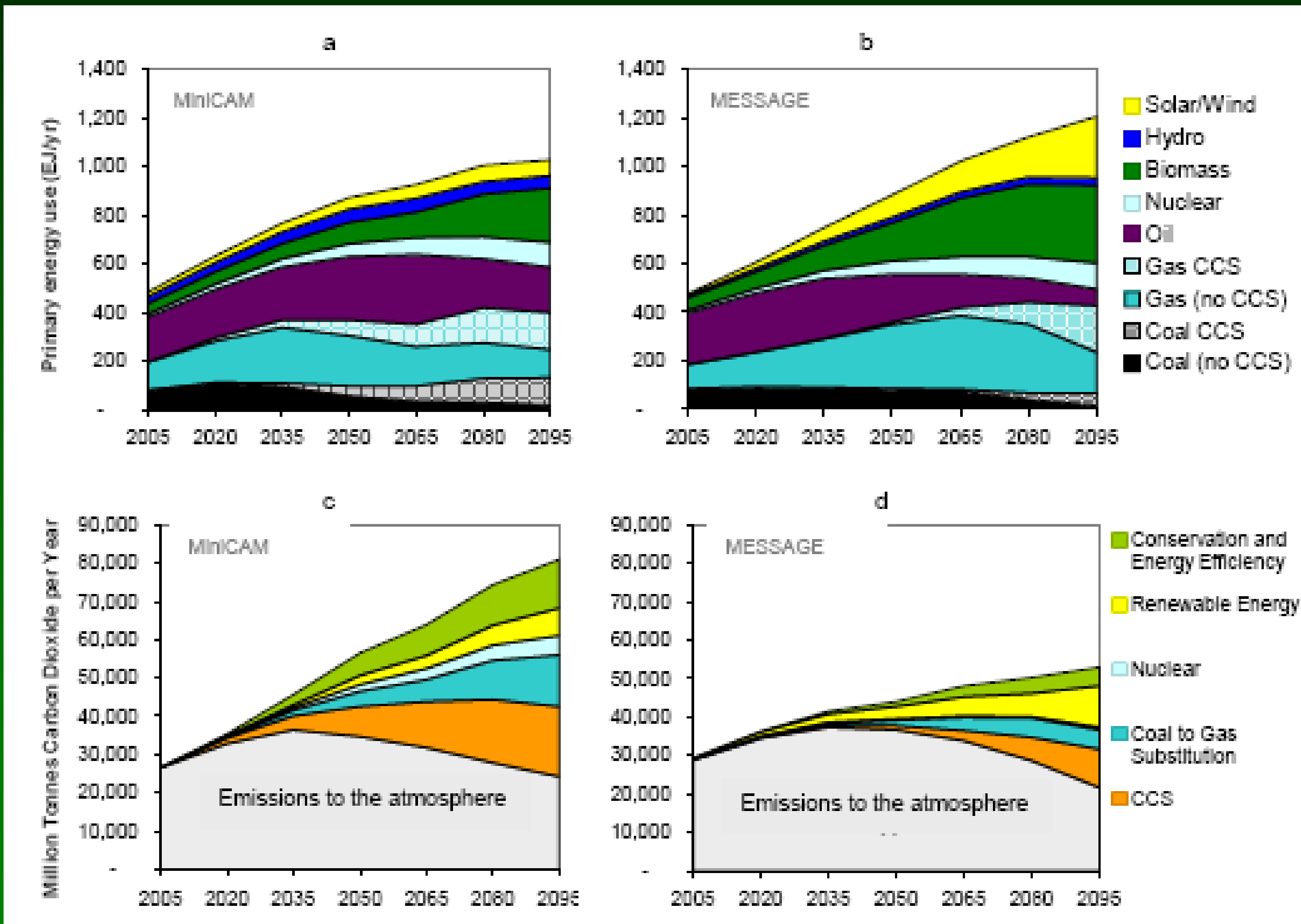
Source: IPCC SRCCS, Table S.2

Projected costs

Power plant system	Natural Gas Combined Cycle (US$/kWh)	Pulverized Coal (US$/kWh)	Integrated Gasification Combined Cycle (US$/kWh)
Without capture (reference plant)	0.03 - 0.05	0.04 - 0.05	0.04 - 0.06
With capture and geological storage	0.04 - 0.08	0.06 - 0.10	0.05 - 0.09
With capture and EOR[17]	0.04 - 0.07	0.05 - 0.08	0.04 - 0.07

Source: IPCC SRCCS, Table S.3

CCS as Part of Portfolios to Address Global Warming



Source:

IPCC SRCCS, Figure S.7

House of Commons

Science and Technology Committee

Meeting UK Energy and Climate Needs:

The Role of Carbon Capture and Storage

S&T Committee Conclusions

- It is indisputable that—in the absence of CCS—fossil fuel consumption in countries such as China and India will have a profound and potentially catastrophic impact on global atmospheric CO2 levels, eclipsing any reductions made by the UK and others.
- The UK's geological expertise through the hydrocarbon industry and British Geological Survey is recognised to be amongst the best in the world. This expertise should be leveraged to facilitate and promote UK demonstrations of CCS and, ultimately, uptake of CCS internationally.
- Most of the component technologies of CCS are not novel: the key outstanding requirement is to integrate them within full-scale demonstration projects involving different elements of the technology and operating under different conditions (including offshore)

S&T Committee Conclusions II

- We are encouraged by the number of companies considering investing in UK CCS demonstration projects. Industry evidently believes that CCS technology is sufficiently advanced to proceed with full scale demonstrations. What is needed now to complement this positive response from industry is a commensurate effort from the Government.
- Government can play an essential role in ‘pump priming’ the initial demonstration projects. In order to do this effectively, Government support in the order of hundreds of millions of pounds needs to be forthcoming over the next five years.
- We acknowledge the need for Government support during the early stages of technology development.. Ultimately, however, a market-based mechanism that puts a price on carbon is the best way to incentivise industry to invest in CCS and other carbon abatement technologies.

Source: Science and Technology Committee, Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage

HM TREASURY

Carbon capture and storage:

A consultation on barriers to commercial deployment

HM Treasury Consultation

- An important contribution to the Government’s energy policy objectives could be made by carbon abatement technologies (CATs) which enable fossil fuels to be used with substantially reduced CO_2 emissions. The most radical CAT option is carbon capture and storage (CCS) ….
- This consultation invites answers to questions that aim to establish the extent to which there are barriers to commercial deployment and whether and how these could be addressed. Specifically, the consultation aims to build understanding on: the current state and future development of CCS technologies and the likely costs attached to deploying them commercially; the potential carbon savings available from CCS; the barriers which currently exist to further development and commercial deployment; and whether there is a case for Government

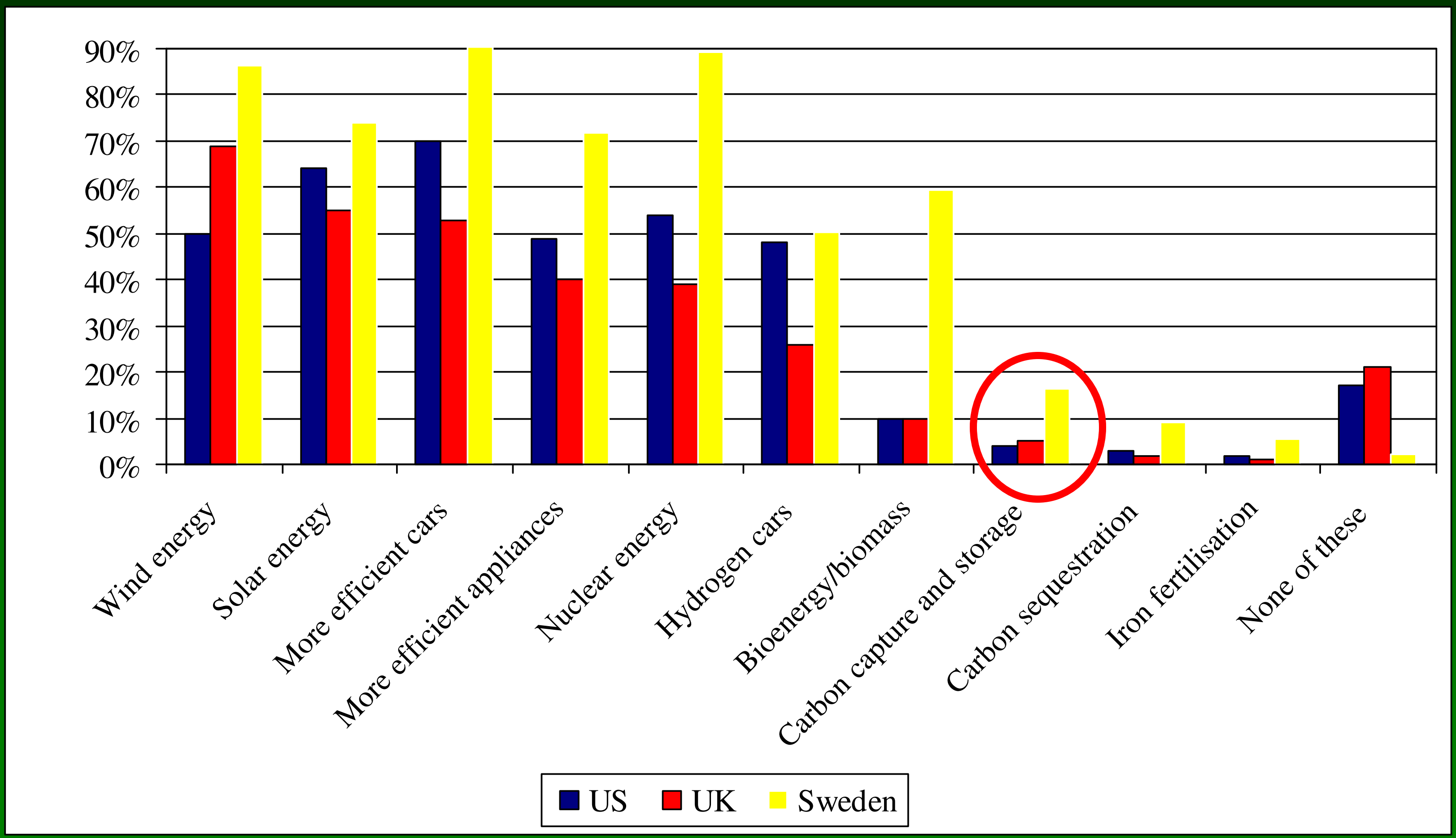
Announced Prospects (>300 MW)

Company/ Project Name	Fuel	Plant output/cost	Capture technology	Commissioning date*
BP DF1 Peterhead UK	Natural gas	350 MW	Autothermal reformer, Precomb'n	2010
BP DF2 Carson, Calif	Petcoke	500 MW ($1bn)	Gasifier+shift	2011
Statoil/Shell Draugen Norw	Natural gas	860 MW	Post-combustion Amine	2011
Hatfield UK	Bituminous coal	~500 MW (£800m)	IGCC + precombustion	2011
SaskPower Sask Canada	Lignite coal	300 MW	Post-combustion or oxyfuel (TBD Q3 06)	2012
E.ON Lincolnshire UK	Bituminous coal (+pet?)	450 MW	IGCC + precombustion?	2012
Stanwell Qld Australia	Bituminous coal	N/A	IGCC + precombustion (Shell gasifier)	2012
RWE Germany	Coal	450 MW (€1B)		2014
RWE Tilbury UK	Bituminous coal	~500 MW (£800m)	PC (supercritical retrofit) + post-combustion	2016 (w/), supercritical retrofit earlier?

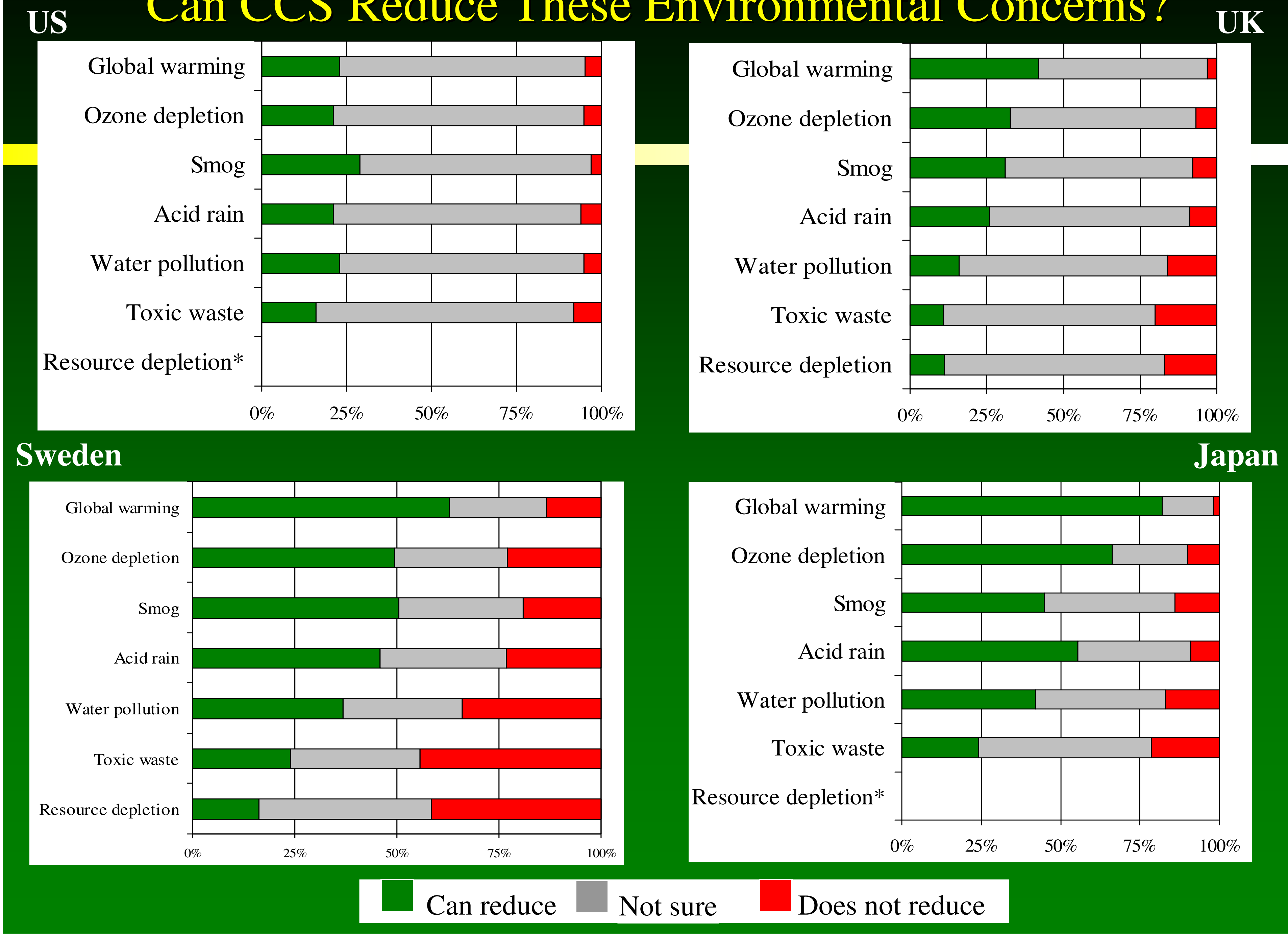
Projects on Social and Political Aspects of CCS

- AGS
- CCP/CCP2
- Manchester/Tyndall
- UKCCSC
- CATO
- CSIRO
- CMU/SFU/Calgary
- DOE Regional partnerships
- ACCSEPT
- C2S2RN

Respondents Who Have Heard or Read of Listed Technologies in Past Year



Can CCS Reduce These Environmental Concerns?



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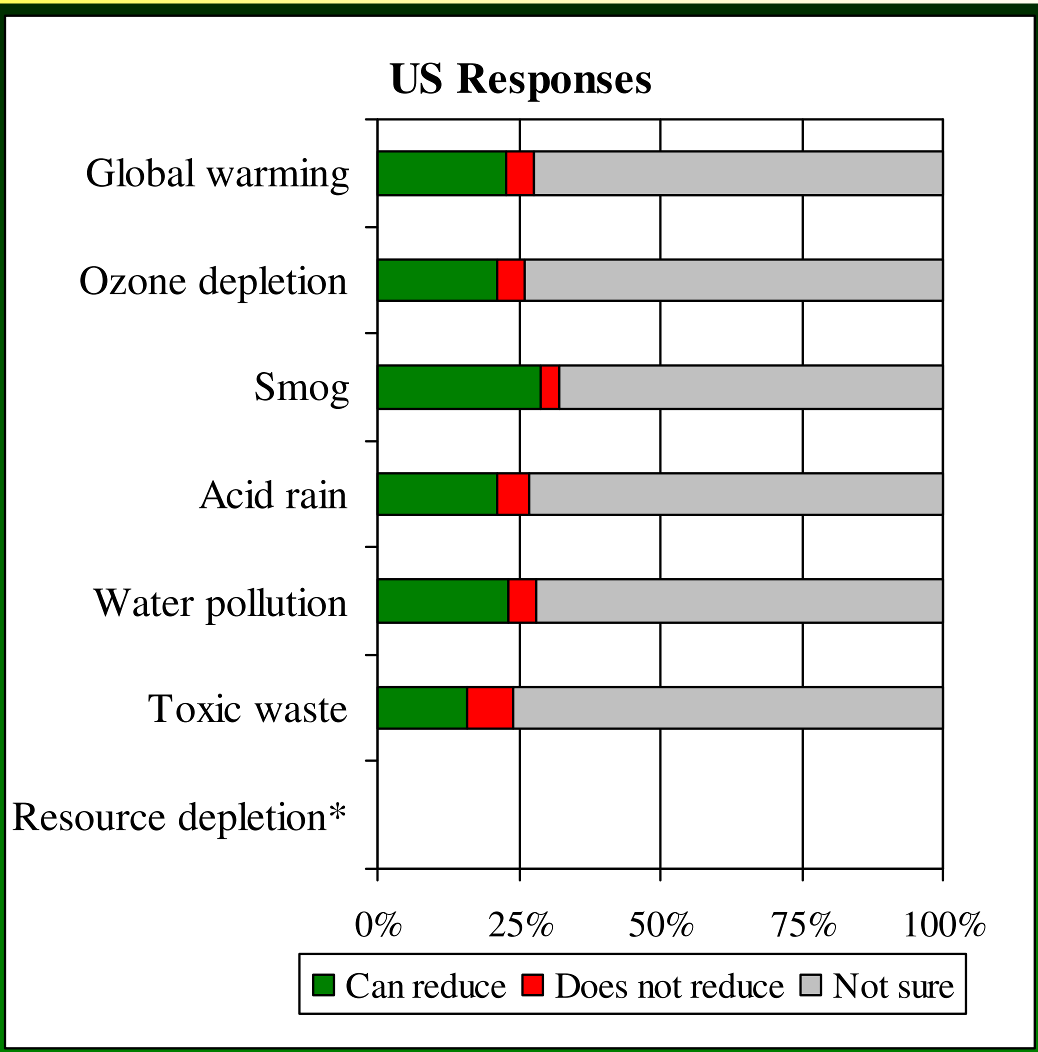
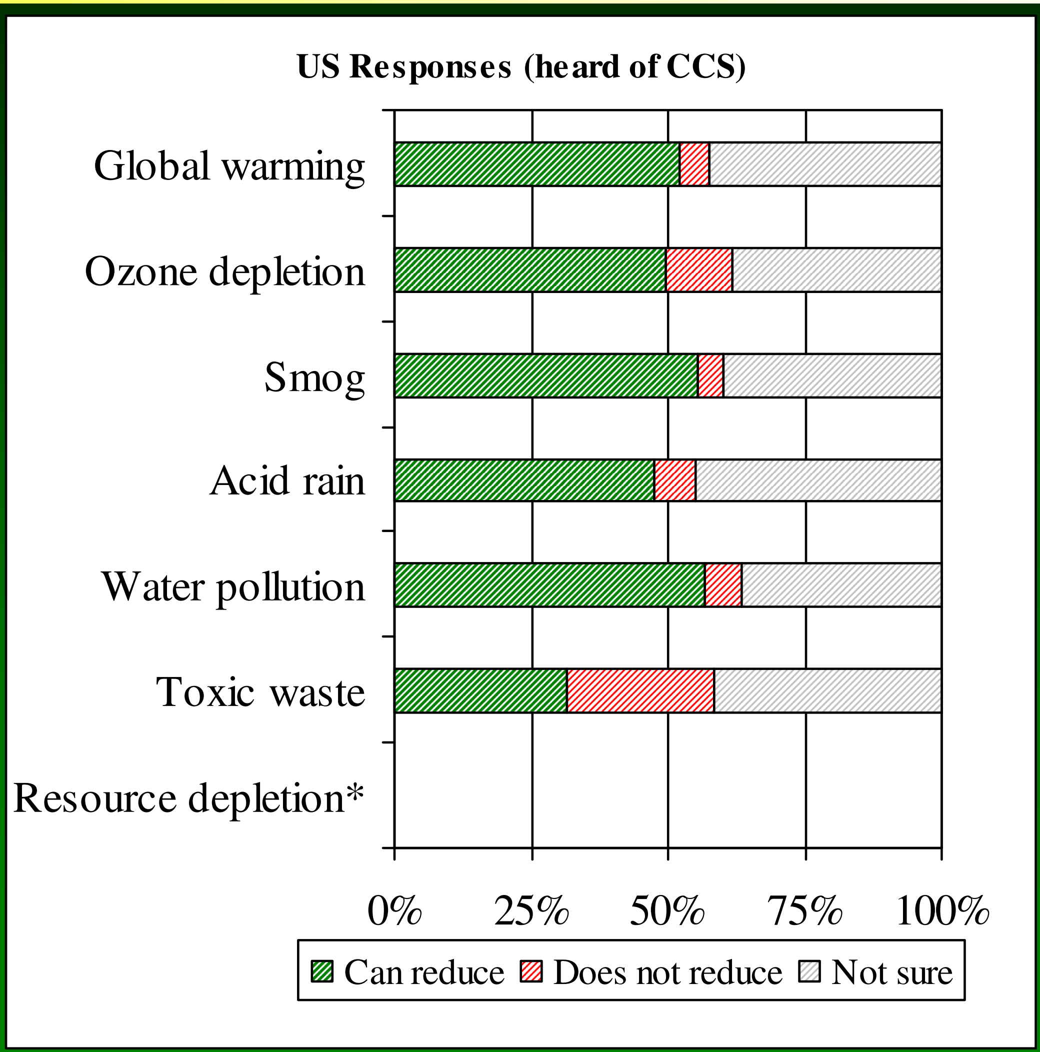


For respondents who have heard of CCS:

Can CCS Reduce These Environmental Concerns?



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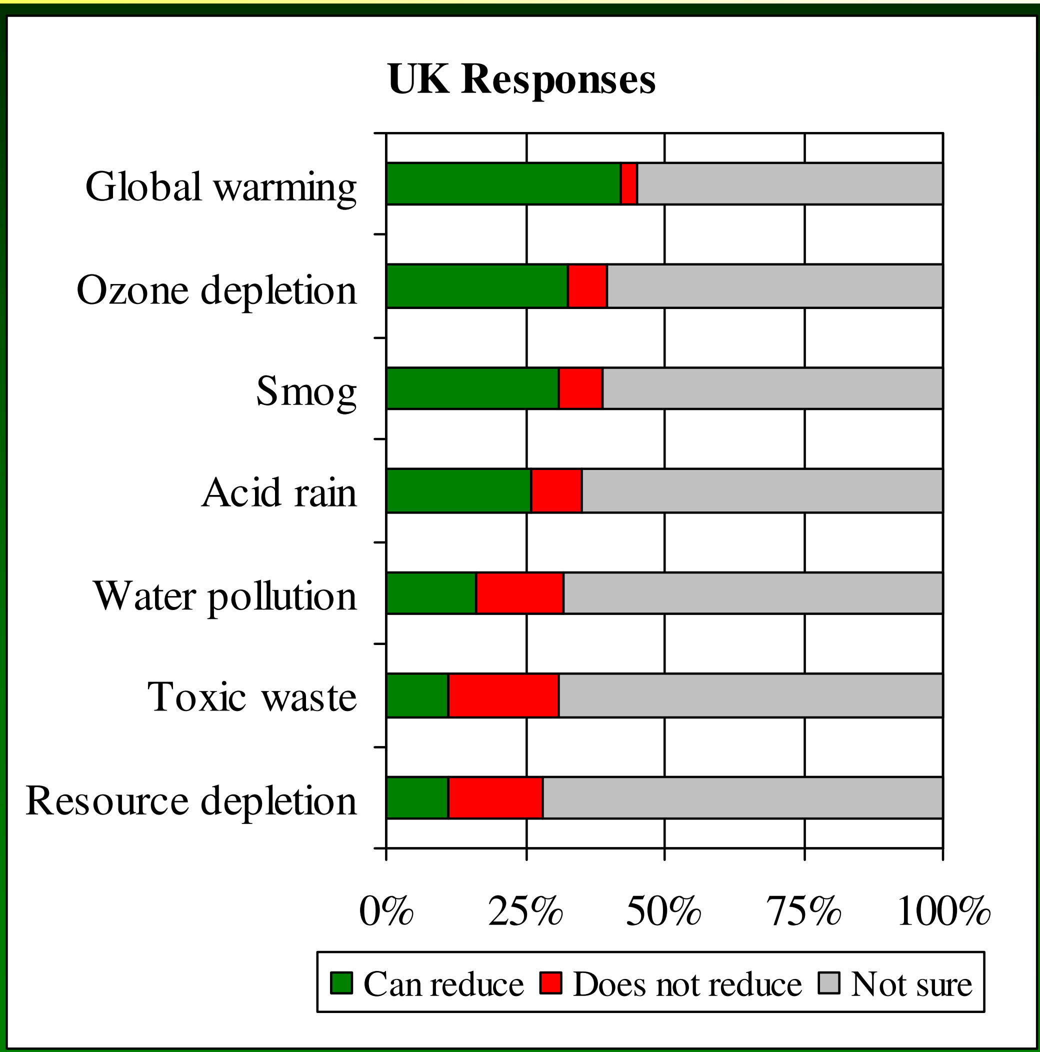

* Resource Depletion not included in the US Survey

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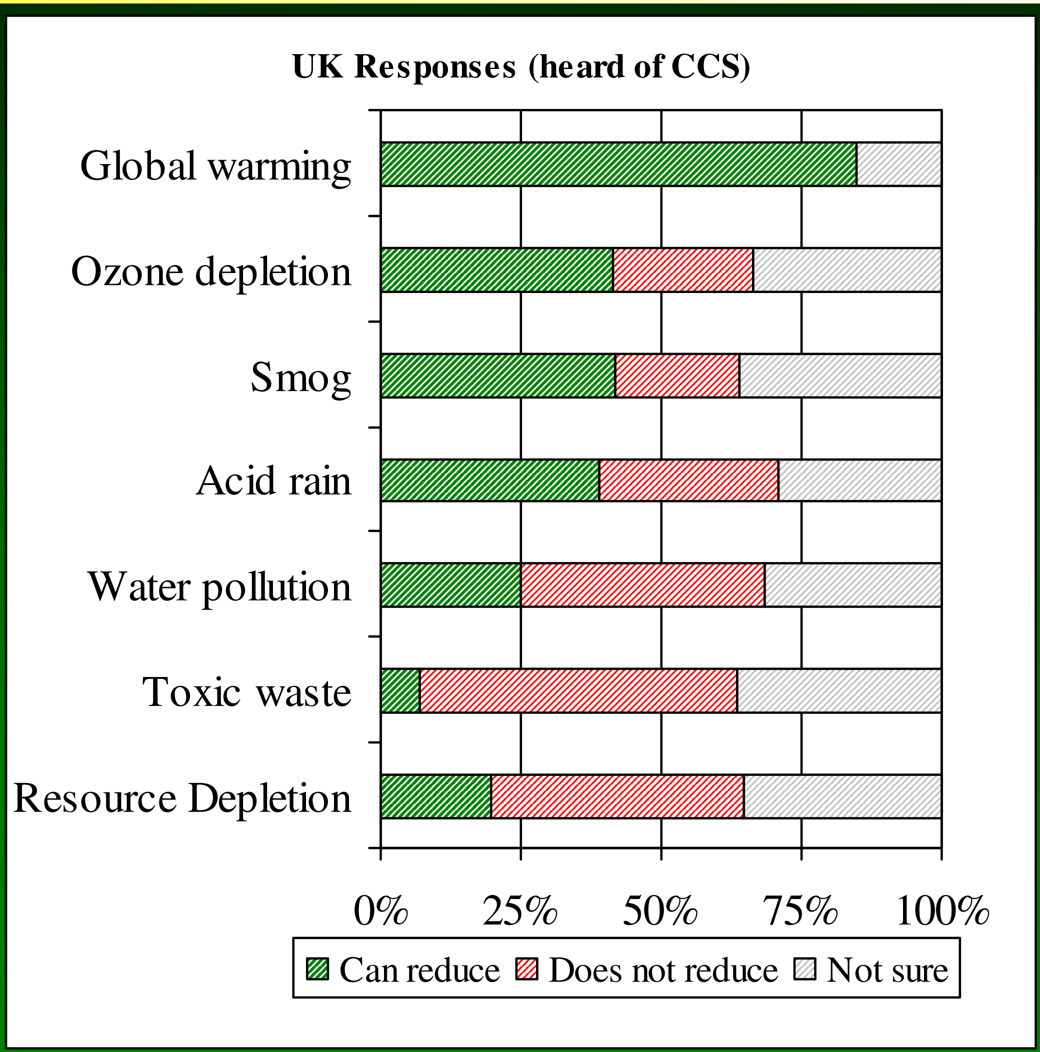
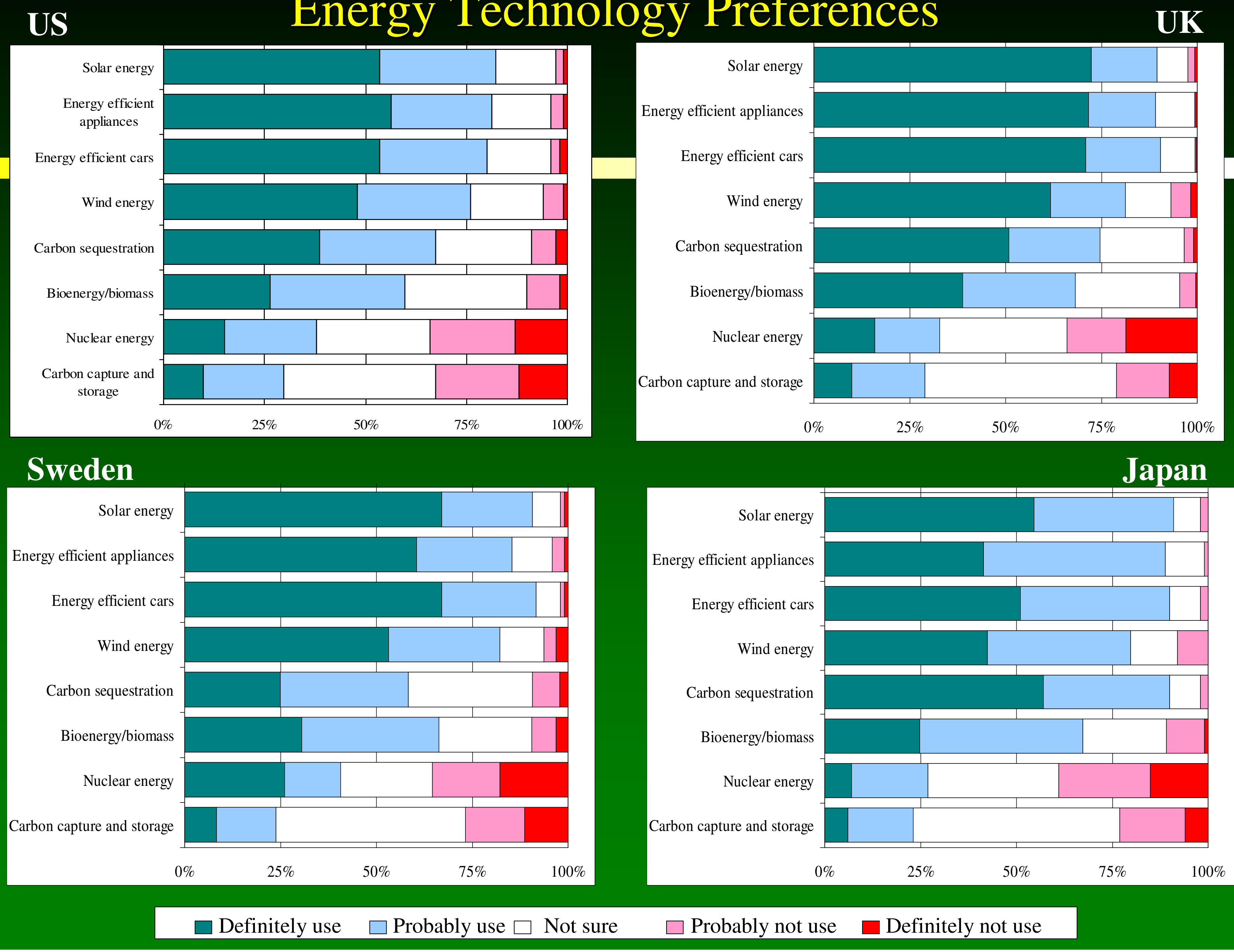


Energy Technology Preferences



Hopes and Fears?

- US Hopes to reverse oil decline by burying CO2 – *Reuters*, March 13, 2006 / US Says CO2 Injection could quadruple oil reserves, *Reuters*, March 4, 2006
- U.K. Favors `Clean' Fossil Fuel Over Nuclear Power, Morley Says – *Bloomberg*, Sept 26, 2005
  - » "Nuclear plants are expensive and if you're looking at the energy mix, then at the moment I think you'll probably get more value from investment in clean coal." – Elliot Morley, MP
- MP's clean coal energy solution: Unmined coal in Wales could be the answer to Britain's energy crisis – *BBC News*, Oct 12, 2005
  - » It seems like absolutely amazing science fiction... but it's already being done in Algeria and elsewhere, and highly productively - Huw Irranca-Davies, MP

Greenhouse Gas Grave

Despite the critics, massive geo-sequestration projects are already underway in Australia… Is burying hundreds of tonnes of carbon dioxide underground a novel way to reduce greenhouse gas emissions or a large-scale attempt at sweeping them under the rug?

Renewable energy would reduce our dependence on coal
Image: iStockPhoto

If you enjoyed this feature, you might like...

Pipe Dream (Geosequestration) (09/09/2004)

Geosequestration won't rock world (04/08/2004)

Workers at a power plant
Image: Reuters

Cautionary Tales

- Industry and CCS advocates explicitly trying to avoid fate of nuclear power by engaging stakeholders
- National energy context frames debate over CCS
- Lumpy nature of projects – Having DF1 equivalent to CO2 reductions from all UK wind is both good and bad
- Dependent on ETS price but likely insufficient in near-term
- Rationale for HMG support on grounds of energy security, climate leadership, and postponing decommissioning of North Sea infrastructure, BUT great reluctance to pick winners, be seen as subsidising energy industry and opening public purse to 'unproven' technology