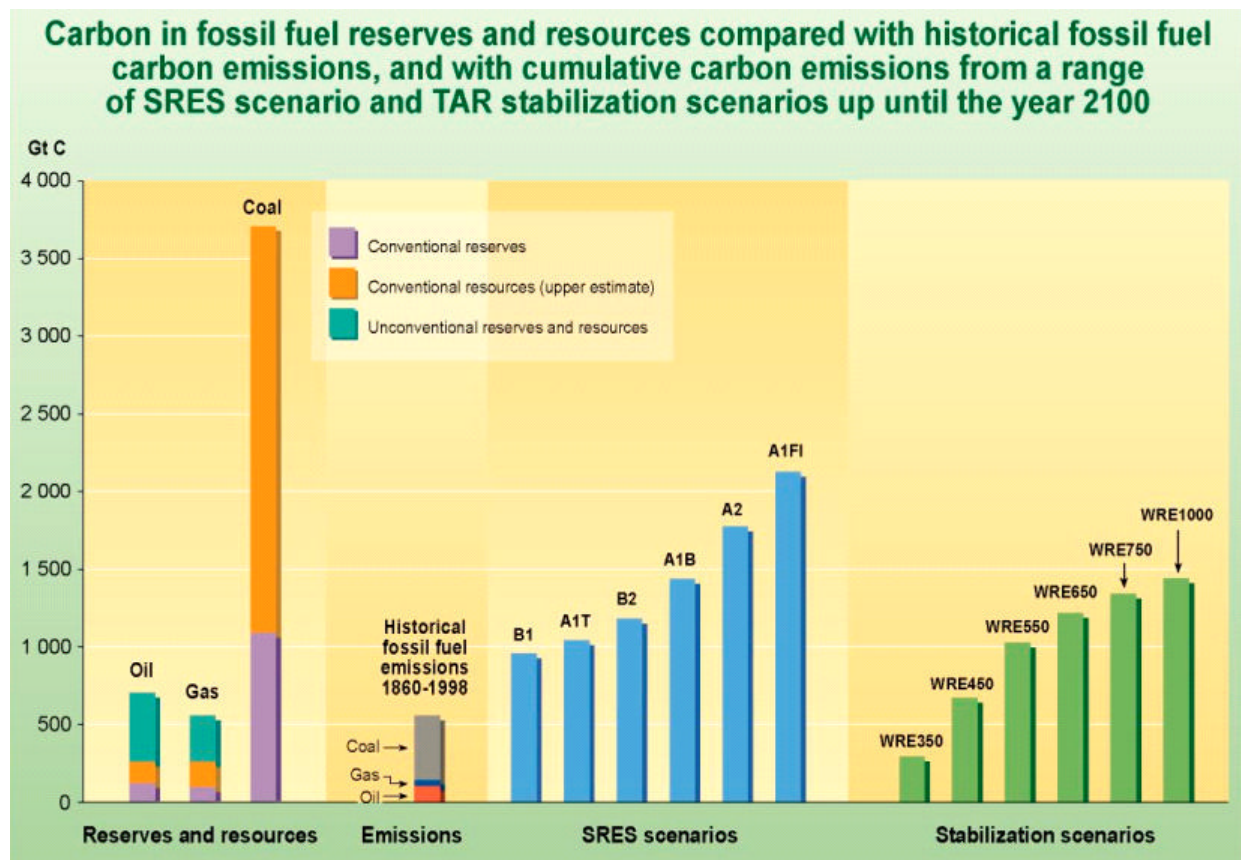


Evidence submitted to the Stern Review on the Economics of Climate Change by the UK Carbon Capture and Storage Consortium

1. The UK Carbon Capture and Storage Consortium is a multidisciplinary group of 12 universities and 2 NERC Research Institutes which has received £2M funding as part of the TSEC programme. The mission of the consortium is: "to promote an understanding of how options for decoupling fossil fuel use from carbon emissions through the use of carbon capture and storage could be used to assist the UK in achieving an energy system which is environmentally sustainable, socially acceptable and meets energy needs securely and affordably". The participants in the UKCCSC are not funded by industry interests on this project, although individual groups may have diverse income streams which include industrial sponsorship. The scope and structure of the UKCCSC is shown in Figure 1 overleaf. For further information on the Consortium and CCS see www.ukccsc.co.uk.

2. The potential role for Carbon Capture and Storage (CCS) in mitigation of climate change and ocean acidification is indicated in Figure 2 below, from the IPCC website. This shows the carbon contained in estimated fossil fuel reserves and resources, compared to the cumulative emissions corresponding to a range of stabilisation scenarios. It is clear that, unless potential users can be persuaded or forced to forego the use of accessible fossil fuel reserves, then capture and secure geological storage of the carbon dioxide from future fossil fuel use is the only option to avoid potentially-dangerous concentrations of atmospheric carbon dioxide and also excessive acidification of the surface layers of the oceans. It is also likely that reducing the rate at which fossil fuels were used, unless perhaps by an order of magnitude or more, would not, of itself, avoid adverse long term effects if the total amount consumed remained the same.



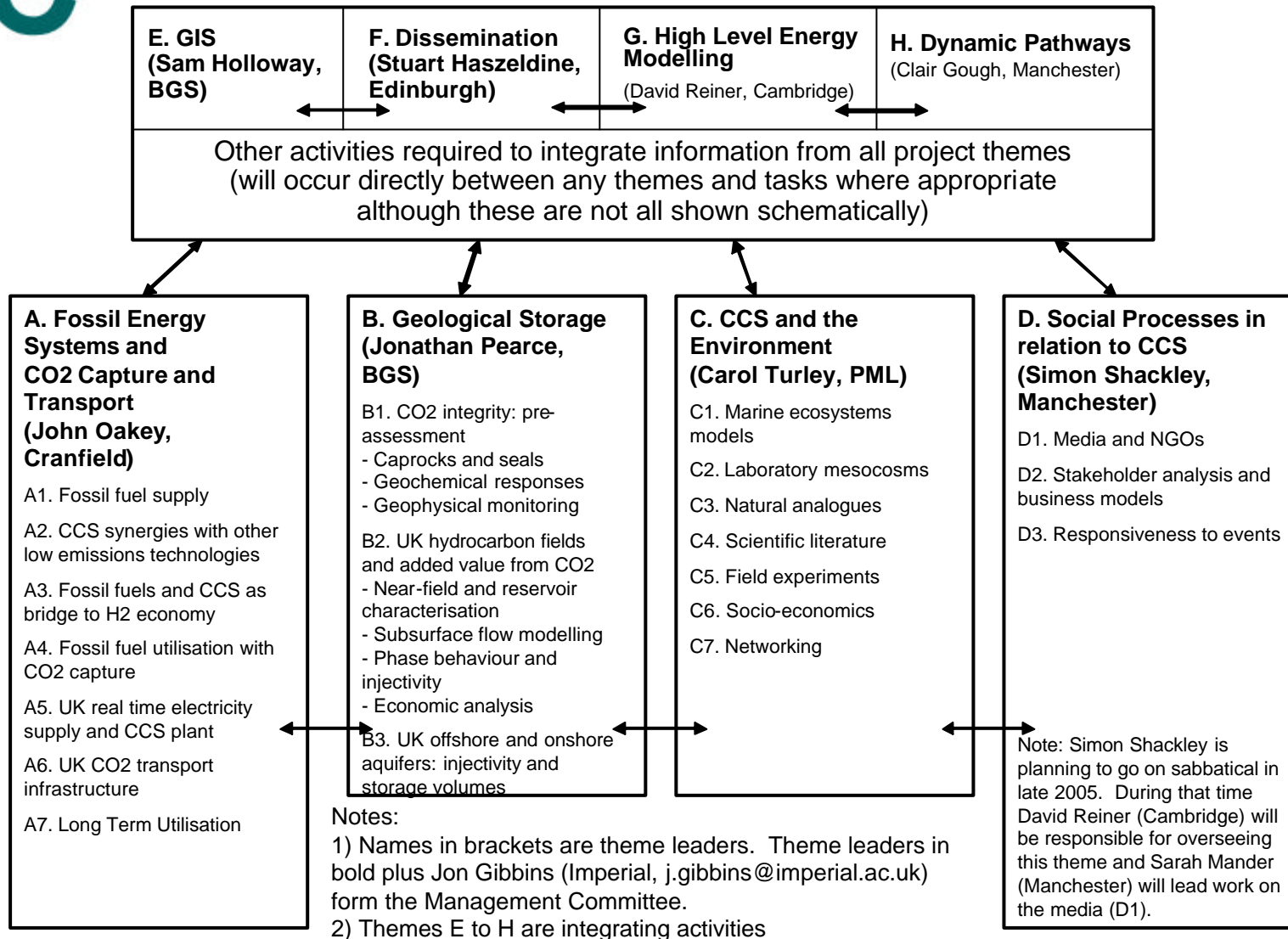
<http://www.ipcc.ch/present/graphics.htm>
<http://www.ipcc.ch/present/graphics/2001syrr/ppt/01.20.ppt>

Figure 2



Figure 1 UK CCS Consortium - Project structure

www.ukccsc.co.uk



3. Carbon capture and storage is likely to be widely deployed as part of a global strategy for mitigating the risk of dangerous climate change and the availability of proven and reasonably cheap CCS options could be a significant factor in facilitating global commitment to such a strategy. Developing economies, such as China where perhaps 30-50 GW/year of new coal power plants are likely to be built for at least the next decade, in particular are likely to find difficulty in reducing emissions without CCS. Currently CCS costs are above global carbon prices, but early research, development and demonstration activities for CCS in countries such as the UK could do much to reduce costs and increase confidence.

4. Getting Ready for Carbon Capture and Storage is a description for the current phase in the development of CCS technology options, prior to them becoming fully economically justified through the prevailing market value for carbon at a global level. A multi-track approach is necessary during this period (Wilson & Gibbins, 2005 - http://gcep.stanford.edu/pdfs/wR5MezrJ2SJ6NfFI5sb5Jg/12_china_gibbins.pdf):

- a) Making sure that new fossil fuel plants of all types are built so that, within the limits of the best current understanding, they can have capture retrofitted in the future with the minimum additional cost and performance penalty.
- b) Improving the technologies, through research, demonstration and deployment activities, that will be needed to convert these 'capture ready' plants (and other existing plants) to capture CO₂, and feeding experience from this back into capture ready plant design.
- c) Making sure that any additional technologies that may not be so competitive until CO₂ capture for fossil fuel conversion plants becomes the norm are also developed for rapid deployment then.
- d) Developing proven and socially acceptable CO₂ storage options.

5. Early CCS deployment in the UK electricity sector: it is highly probable that fossil fuel will be a large component of the UK energy mix until 2030 and beyond. Even if new nuclear build can be implemented rapidly enough to meet baseload electricity demand, new gas and possibly coal build will also be required. The relative costs of electricity generation from gas and coal with CCS depends strongly on gas price levels, but preliminary analyses by UKCCSC and others suggests that coal may well be cheaper under some circumstances. Coal has some advantages for energy security, as large stockpiles (months) can be simply held, in contrast to gas (days), and a range of secure supply options are available. The cost of nuclear electricity is difficult to evaluate on a comparable basis. Figures available suggest that simple generating costs may be less with nuclear, but these depend on the assumptions made for costs associated with commercial and environmental risks and waste management.

6. CCS combined with the use of existing UK North Sea infrastructure may offer an early route for CCS demonstration and deployment in the UK if additional economic benefits can be obtained through the use of CO₂ for enhanced oil recovery (EOR), or reduced storage costs apply through the use of existing natural gas pipelines and offshore facilities before they are decommissioned. These activities would have the advantage of prolonging indigenous energy supplies from the North Sea and also provide some continuity, possibly for many decades, for existing offshore industries. Government incentives may, however, be required to encourage the use of CO₂ EOR by the oil industry in order to achieve these indirect benefits for the UK.

7. CCS can advantageously be applied to biomass utilisation, particularly through co-processing with coal which allows for economies of scale and hence higher efficiencies and lower specific costs. This gives a route to remove CO₂ permanently from the atmosphere; the energy content of the biomass is also still largely available for electricity production

8. CCS can also be used to make hydrogen from fossil fuels with low CO₂ emissions. In this case much of the cost of CO₂ production and separation is covered by the hydrogen production process. Large scale hydrogen production from fossil fuels through gasification or reforming could be an

intermediate step in electricity production immediately or a means of 'kick starting' a future hydrogen economy.

9. Through the production of decarbonised energy vectors, electricity and hydrogen, CCS can potentially be applied to reduce emissions from the building and transport sectors as well as from the power sector. A transition to the effective and widespread use of decarbonised energy vectors by consumers would also facilitate a longer term transition to non-fossil, and hence generally non-carbon, energy sources.

10. A significant part of the economic benefit arising from mitigation actions by the UK prior to the existence of a general global commitment can be argued to arise from the extent to which these actions also increase the likelihood of such a commitment being arrived at and then leading to a successful outcome. This is because the direct effects of the any reductions in UK CO₂ emissions can, of themselves, have only a small effect, unless undertaken as part of a long-term and global campaign. In this respect, expenditure by the UK to develop and demonstrate CCS technologies is likely to achieve a significant added value over and above that attributed directly to the consequent reductions in CO₂ emissions because such technologies are both novel and, as discussed above, likely to be crucial for successful mitigation.

11. A more detailed discussion of the potential role of CCS in climate change mitigation is given in:

Gibbins, J., Haszeldine, S., Holloway, S., Pearce, J., Oakey, J., Shackley, S., and Turley, C.,

“Scope for Future CO₂ Emission Reductions from Electricity Generation through the Deployment of Carbon Capture and Storage Technologies”,

Ch. 40 in *Avoiding Dangerous Climate Change*, Schellnhuber, H J., Cramer, W., Nakicenovic, N., Wigley, T. and Yohe, G (Eds). Cambridge University Press, 2006.

(originally presented at the Defra Conference "Avoiding Dangerous Climate Change", Exeter, Feb 1-3, 2005. (http://www.stabilisation2005.com/61_Dr_Jon_Gibbins.pdf))

12. A more detailed discussion of the impact of high anthropogenic atmospheric CO₂ on the acidification of Earths oceans is given in:

Turley, C., Blackford, J., Widdicombe, S., Lowe, D., Rees, A. & Nightingale, P.

“Reviewing the impact of increased atmospheric CO₂ on oceanic pH and the marine ecosystem.”

In: *Avoiding Dangerous Climate Change*, Schellnhuber, H J., Cramer, W., Nakicenovic, N., Wigley, T. and Yohe, G (Eds). Cambridge University Press, 2006.

(originally presented at the Defra Conference "Avoiding Dangerous Climate Change", Exeter, Feb 1-3, 2005. (<http://www.stabilisation005.com/day1/Turley.pdf>))

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