

**Meeting UK energy and climate needs : the role of carbon capture and storage : Government response to the Committee's first report of Session 2005-06.**

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House of Commons  
Science and Technology  
Committee

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**Meeting UK Energy and  
Climate Needs: The Role  
of Carbon Capture and  
Storage: Government  
Response to the  
Committee's First Report  
of Session 2005–06**

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**Third Special Report of Session 2005–06**

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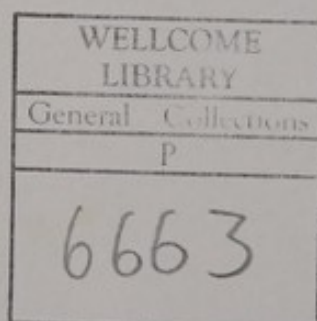
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# Third Special Report

On 9 February 2006 the Science and Technology Committee published its First Report of Session 2005–06, *Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage*, [HC 578–I]. On 20 April 2006 the Committee received a memorandum from the Government which contained a response to the Report. The memorandum is published without comment as an appendix to this Report.

## Government response

### Introduction

The Government welcomes the Committee's report on "*The role of Carbon Capture and Storage*" which is an important and timely contribution. We have considered the report carefully and the Government's response to the specific conclusions and recommendations of the Committee's report is set out below.

### Conclusion and recommendations

#### Background

##### *Climate change policy*

1. 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 CO<sub>2</sub> levels, eclipsing any reductions made by the UK and others. (Paragraph 18)

We share the Committee's concern that, on the basis of present policies, global consumption of fossil fuels and associated CO<sub>2</sub> emissions will increase over the next few decades. Inevitably a large proportion of this increase will be in developing countries as their economies expand and deliver the sort of energy services to their citizens that are taken for granted in countries like our own. The key challenge is to help these countries develop in such a way that they use energy with maximum efficiency and with minimum emissions of greenhouse gases. A portfolio of solutions have a role to play including best practice procedures and advanced technologies for efficient energy use in buildings, transport and industry, combined with the use of renewable energy resources and the deployment of other clean energy sources including near to zero emission fossil fuel plants.

To help engage developing countries, in 2005 the Government made climate change a priority of the UK presidency of G8 and included the heads of government of Brazil, China, India, Mexico and South Africa in discussions at the Gleneagles Summit. In addition to establishing an Action Plan to tackle climate change the summit also set up a Dialogue between developed and developing countries for on-going discussion of the links between climate change, energy and development goals. Subsequent to Gleneagles the UK, under its presidency of the EU, initiated agreements with China and India that included the advancement of clean energy technologies. The EU-China Partnership on Climate

Change includes a UK sponsored initiative on Near-Zero Emission Coal with Carbon Capture and Storage the overall aim of which is to bring forward the time when Chinese coal plant are built with CCS. Similarly as part of the EU-India initiative the UK and India have launched a joint study investigating potential methods for reinforcing collaboration on clean energy technologies between developed and developing countries.

## Technology

### *Capture Technologies*

2. Although it is clearly important that pre-combustion, post-combustion and oxyfuel capture technologies be developed, we believe that for new plant pre-combustion capture offers a significant advantage, in a carbon constrained world, as a potential source of hydrogen. As the technology develops, the Government should take into account the potential strategic importance of polygeneration systems based on pre-combustion capture technology and consider the case for putting in place incentives to promote the use of this technology in new build plant. (Paragraph 32)

We agree on the need to continue development of all three generic approaches for CO<sub>2</sub> capture on large combustion plants, but it does not follow that the UK should divide its effort evenly between the three. CO<sub>2</sub> capture plants are large, require high investment for development and demonstration and are the subject of innovation programmes in several countries. The Government's Carbon Abatement Technologies (CATs) Strategy published last May therefore emphasised the need for international collaboration. The DTI is now developing a Route Map for its CAT Strategy which will address how the UK should distribute its resources for CCS taking account of international market prospects and the capability and capacity of UK business.

The choice of pre-combustion capture for new plants may not be as clear cut as the Committee suggests. Pre-combustion involving gasification is indeed inherently cleaner for coal fired power generation, but with suitable additional facilities pulverised coal technologies can achieve similar environmental standards. Furthermore, almost all new coal fired power plants currently being ordered are based on pulverised coal combustion which requires either post-combustion or oxyfuel technology for CO<sub>2</sub> capture. These plants are likely to operate for the next 30–40 years.

We agree that pre-combustion offers the additional benefit of producing hydrogen that could be used, for example, to replace petroleum products in transport. However, most analyses suggest that hydrogen will be needed later than CCS applied to power generation in the transition to a low carbon energy system. Moreover, post-combustion offers the additional benefit of extending CCS to other large combustion plant such as iron and steel plant and cement factories.

3. In our view, no convincing case has yet been made for retrofitting of the UK's ageing fleet of coal-fired power stations with capture technology. Combining retrofitting with boiler and turbine replacement may provide a means of overcoming the loss in efficiency associated with current capture technology, but it remains to be seen whether this will prove economic for the majority of UK coal-fired plant. (Paragraph 35)

We agree that no convincing case has yet been made for retrofitting capture technology to the UK's existing fleet of coal-fired power stations. However, as the Committee indicates, it will ultimately be for the generation companies to decide on the most cost effective approach.

The MARKAL modelling analysis commissioned by DTI to advise the CAT Strategy indicated that the refurbishment of existing coal plant with advanced boilers and steam turbines, combined with the fitting of capture plant, might be a cost effective approach for CCS. However, we know that some generators question this finding because of the lost revenue associated with closing a plant for refurbishment, and the fact that some plant may not have sufficient space to accommodate CO<sub>2</sub> capture facilities. It will ultimately be a business decision whether to adopt this option or to invest in other low carbon options taking account of economic conditions including the policy environment.

**4. We recommend that Government makes capture readiness a requirement for statutory licensing of all new fossil fuel plant. This would compel the developer to demonstrate that consideration has been given in the planning and design of the plant to facilitating subsequent addition of suitable carbon dioxide capture technology, as and when it becomes available and economic. (Paragraph 38)**

This option was identified as meriting further examination in the DTI's CAT Strategy, which also made a first attempt to define what it might entail. The concept is currently being examined by the IEA as part of the G8 Action plan as a way of laying the groundwork for future CCS deployment in those developing countries that are currently investing heavily in fossil fuel power plant.

An issue needing clarification before capture readiness could be made a requirement is to have a generally agreed definition of what this involves.

One approach would be to limit requirements to essential factors such as providing enough land within the power plant boundaries to accommodate a capture facility and having enough space within the plant buildings to accommodate the additional pipe-work, valves, etc. needed to retrofit the capture plant.

There could also be more sophisticated requirements, for example to optimise the steam cycle of a pulverised coal plant so that capture can be integrated with the minimum energy penalty. However, it has been pointed out that capture technology is undergoing on-going development and what may be optimal for 2006 designs may not be so for capture plant retrofitted in 2015. This issue is being considered in the context of the Energy Review.

**5. Although in the near term CCS is most likely to be employed in the power sector, it has the potential to be applied to a range of industrial processes, as well as in the building and transport sectors. We recommend that the Government support for CCS research includes applications in these sectors. (Paragraph 39)**

The Government agrees on the need for research in these areas; indeed the DTI's CAT Strategy explicitly extended the reach of the programme to all fossil fuels and all forms of large combustion plant including iron and steel works, oil refineries and cement factories. The Committee will appreciate that CCS is a capital-intensive process and is not likely to be economic when applied to small to medium sized sources of CO<sub>2</sub>. However, CCS does

offer the opportunity to replace the use of fossil fuels with carbon free alternatives (e.g. electricity, hydrogen) in such small to medium sized applications.

### **Storage**

**6. The UK is fortunate in being very well endowed with potential CO<sub>2</sub> storage sites, many of which have been thoroughly characterised. This provides the UK with a competitive advantage in terms of access to potential CO<sub>2</sub> storage sites, both for its own use and to demonstrate UK geological skills to the rest of the world. (Paragraph 44).**

We agree that the UK is well endowed with potentially suitable storage sites for CO<sub>2</sub>. Many of these occur under the seabed. We are taking the lead through DEFRA in seeking to clarify or amend the Protocol to the London Convention and OSPAR Convention, which have been identified as the appropriate international treaties to permit the implementation of CCS in an environmentally responsible manner.

**7. Oil and gas fields have, in general, been better characterised than saline aquifers so may be more suitable for immediate development. Nevertheless, the best way of furthering understanding of storage of CO<sub>2</sub> in aquifers, which provide very substantial storage potential in the longer term, is through large scale demonstration projects. (Paragraph 45)**

Early deployment of CCS may well involve injection into oil or gas fields for Enhanced Oil Recovery (EOR) or Enhanced Gas Recovery (EGR). In part this is because these have been better characterised. It also reflects the potential to gain an economic return from the additional oil or gas produced. Another important consideration is that there is general agreement that EOR and EGR are clearly permitted under the London and OSPAR Conventions while there is more uncertainty over the position regarding storage in aquifers. However, the Committee is right to emphasise the importance of aquifer storage because aquifers account for a large part of the UK's potential storage capacity.

UK geologists are actively involved in the monitoring assessment of the Norwegian Sleipner Project, which has been injecting about 1 million tonnes of CO<sub>2</sub> into an offshore aquifer since 1996, thus contributing to the build up of UK expertise. Our comments on large-scale demonstrations are given in paragraph 11.

**8. 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. (Paragraph 46)**

We agree that the UK's capability in the geological sciences is world class, and that it is important to utilise this capability to establish the long term integrity of CO<sub>2</sub> storage. International collaboration to establish common standards for monitoring and verification will be an important aspect for CCS implementation, and the DTI's CAT Strategy includes an action for Government to help facilitate UK involvement and possible leadership in this work. We agree that the availability of these geological skills may well encourage international involvement in any UK based demonstration projects.

**9. On the basis of current information, coal seems unlikely to be a major storage option for the UK, at best being of small scale and local significance. (Paragraph 49)**

This is consistent with the conclusion of the DTT's CAT Strategy, which was advised that the majority of UK coal was too impermeable to be used for CO<sub>2</sub> storage.

**10. It is clear that storage in geological formations, providing that it can be done safely and securely, is the most desirable and competitive way of storing CO<sub>2</sub> of the currently available options. (Paragraph 50)**

This is consistent with the DTT's CAT Strategy, which is focused on geological storage as the option most relevant and appropriate for the UK.

## **RD&D and international competitiveness**

### ***Demonstration projects***

**11. 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). (Paragraph 54)**

We agree that CCS has advanced to the stage where it would benefit from a range of demonstration activities including full-scale demonstration of key elements and demonstration of the full chain of capture, transport and storage. DTT's CAT Strategy therefore included a provision of £25M (later increased to £35M) for capital grants to support demonstrations of capture ready plant and CO<sub>2</sub> storage. The CAT Strategy acknowledged that full-scale demonstration of the complete CCS chain would require a much larger financial support package.

**12. The BP-led DF1 project could be a crucial opportunity to test the viability of linked systems of onshore gas conversion, power generation and offshore CO<sub>2</sub> storage in the North Sea. (Paragraph 57)**

We welcome the initiative of BP and its partners in developing this project, and have an on-going dialogue with the DF1 project team as they progress their assessment of issues affecting the project.

**13. 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. (Paragraph 58)**

The Government welcomes the growing interest from industry in the deployment of CCS. We feel that the DTT's CAT Strategy published in June 2005 gave timely support to CCS and has played no small part in stimulating this growing interest. HM Treasury is currently undertaking a consultation on barriers to the commercial deployment of CCS and the potential role of incentives, which will feed into the Energy Review. We believe it is right to consider CCS along side other options for carbon abatement. Experience has also shown

that financial incentives are often not enough, and that other non-financial barriers also need to be addressed. In accordance with the CAT Strategy we are currently deploying considerable effort to examine legal and regulatory issues.

### ***Government RD&D funding***

**14. The additional £10 million provided for demonstration of carbon abatement technologies in the pre-budget report is welcome but the piecemeal allocation of funding suggests a worrying lack of strategic vision in Government decision making. (Paragraph 60)**

The DTI's CAT Strategy originally included a provision of £25M for capital grants to support demonstrations of capture ready plant and CO<sub>2</sub> storage. This was an important extension to our support for innovation in fossil fuel technologies, which previously had been limited to R&D, and was intended to encourage the growing momentum in the UK to development of CCS technologies. As discussed in Paragraph 11 above, the CAT strategy acknowledged that the full-scale deployment of the complete chain of CCS technologies involved substantial capital investment that might require a different form of incentive.

As studies under the Final Call of the DTI's Cleaner Fossil Fuel Programme have progressed it has become clear that there could be a wider need for demonstration projects covering key CCS technologies (eg. demonstration of oxy-fuel firing with hard coal). This has been confirmed by on-going discussions with industry that identified additional needs some of which related to large carbon sources outside of the electricity generation sector. The additional £10 million was provided to increase the range of demonstration projects that could be supported subject to EU State Aid approval.

**15. 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. (Paragraph 61)**

We agree that the Government may have a role to provide incentives for the initial deployment of CCS. But as the Committee notes, the scale of support that might be required from taxpayers and / or consumers is very large, and therefore the timing, size and form of any support needs careful consideration based on all the available evidence, on the international context within which progress is being made in bringing forward CCS, and in the context of the government's wider energy policy objectives. One important issue is deciding where the UK might lead and where we should follow the development of CCS technologies, and how we should coordinate our efforts with other national and international programmes, particularly in Europe. Clearly it is neither desirable nor realistic for the UK to support demonstrations of all the various options for CCS (particularly capture) that are currently being proposed. For this reason the DTI is taking a leading role in the European Commission's FENCO Project which is examining strategies to achieve greater collaboration for CCS development across Europe. DTI is also chairing the Mirror Group of the European Commission's Technology Platform initiative for the development of zero emission fossil fuel power plants. This is the forum in which Member State officials consider priorities for CCS within the European R&D Framework Programme in relation to their national strategies.

## **Skills**

**16. Once again, we find the Government erring on the side of complacency over the continued supply of skilled scientists and engineers. In view of the strategic significance of energy policy at this time, failure to take active steps to build and safeguard the UK skills base in this area will prove costly. (Paragraph 63)**

The Government recognises the need to build and safeguard the UK skills base to continue the supply of skilled scientists and engineers. For this reason, Budget 2005 announced a package of measures aimed at improving the science engineering, technology and mathematics skills in the UK to meet the goals of the ten-year Science and Innovation Investment Framework. Among the initiatives announced were a stepping up of recruitment, retraining and retention of physics, chemistry and mathematics specialist teachers; a package of measures to improve science teaching; simplification of radically institutional research funding; and an expansion of R&D support for midsized companies.

## **International co-operation**

### **Europe**

**17. The Government must do its utmost to work together with both the private sector and academia to give the UK the best chance of hosting any major EU-funded CCS demonstration project. (Paragraph 64)**

As described in Paragraph 15 above the Government is taking a leading role in the development of the EU's strategy for the development of CCS through its support for the FENCO project and in chairing the Mirror Group of the Technology Platform initiative. It is pleasing that UK industry and academia is well represented on the five working groups that are charged with developing the EU strategy. The Technology Platform will be producing two reports, namely a Strategic Research Agenda (SRA) and a Strategic Deployment Document (SDD), by the summer of 2006. We will study these reports carefully to inform how and where the UK should seek to take a leading role within EU initiatives.

### **Norway**

**18. The increasing co-operation between the UK and Norway on CCS is sensible, but the UK should also learn from the Norwegian Government's approach of backing its words with action and investment. (Paragraph 66)**

We believe the bilateral agreement with Norway to be an important step in the development of CCS for deployment by North Sea basin countries. This applies not only to technical development and innovation, but also to the establishment of authorisation and regulatory frameworks, where there are clear benefits for a common approach between countries, and both UK and Norway are engaged in relevant work conducted under the EU Climate Change Programme which will report later this year. The UK and Norwegian governments are also working, together with other countries, to find way of clarifying or amending the London and OSPAR Conventions to facilitate or regulate storage of CO<sub>2</sub> in geological formations below the seabed.

We do not accept the implication that the UK is not investing adequately in CCS. The DTI's CAT Strategy provides funding of £20 million over three years to 2007/08 for R&D together with the £35 million of capital grants for demonstration projects, which is comparable with Norwegian expenditure. Given the scale of support potentially required for demonstration of full-scale deployment of the complete CCS chain of technologies, any incentive for such demonstration necessarily requires careful consideration.

It is also noteworthy that Shell and Statoil have recently announced the first full-scale project involving the full chain of CCS technologies that could be deployed in Norway. This would take 2–2.5 MtCO<sub>2</sub>/yr from a gas fired power generation station and use the CO<sub>2</sub> for EOR. Like other projects, such as DF1 proposed for the UK, the companies have indicated that the project would “depend on substantial government funding”, although the exact scale of support is not yet known. The Norwegian government is currently considering this project. Further discussions will take place later this year to share information on the feasibility and costs of this technology.

### *China and India*

**19. The UK and EU bilateral agreements to co-operate in the development of CCS technology with China are to be welcomed. However, the timescales envisaged and sums allocated in no way reflect the urgency with which CCS technology needs to be demonstrated and deployed if it is to be able to play a significant role in mitigating climate change. Efforts to engage China and India in this area are to be encouraged, but we doubt whether Memoranda of Understanding in themselves represent an effective way of expediting the development of carbon abatement technologies, or of promoting their uptake by these countries. (Paragraph 68)**

The Government welcomes the encouragement of the Committee for the process of engagement with China and India. The Government regards the MoUs negotiated by the UK and the EU as very positive outcomes and believes that they represent the first step in engagement with these countries on CCS technologies. We agree with the Committee that successful outcomes based on these MoUs will need to lead to much more extensive engagement if they are to have a substantial effect on emissions reduction. This is likely to depend on access to carbon markets, via the CDM or another mechanism. We are working in the climate change negotiations to achieve this

**20. The DTI and DEFRA should ensure that there is strong co-ordination between their activities in promoting CCS RD&D in China and India and those undertaken by the FCO and DFID in these countries. (Paragraph 69)**

The Government agrees. There is excellent coordination between Government departments including DTI, Defra, FCO and DFID on promoting CCS activities in China and India.

**21. The major obstacle to the adoption of CCS technologies by countries such as India and China is still the lack of value attached to carbon internationally. (Paragraph 70)**

The Government agrees that CCS may not be widely adopted in China, India (or elsewhere for that matter) in the absence of economic incentives. Under some circumstances revenues from enhanced oil recovery or policies introduced at the national level may

provide these. However there is no doubt that access for CCS to an international carbon market would be a great incentive to increased uptake of these technologies. The UK is therefore working with the EC Climate Change Programme to establish the basis for monitoring and verification guidelines which will give CCS access to the EU Emissions Trading Scheme (which is already agreed in principle), and we are working to secure inclusion of CCS schemes in the Clean Development Mechanism which is linked to the EU-ETS via the Linking Directive. The UK is also doing all it can to secure a future carbon market that provides sufficient predictability to ensure investment in low carbon technologies of all types, including CCS.

## **A leadership role for the UK**

**22. The UK is well positioned to take an international leadership role in demonstrating the viability of CCS. British leadership in the use of CCS technology will both yield returns from domestic carbon reduction and provide a strong indication to other major polluters of the potential of CCS to reduce global emissions. (Paragraph 73)**

We agree that CCS has the potential to give major reductions in global CO<sub>2</sub> emissions, and acknowledged this in the Budget 2006 Report stating:

“It [CCS] is likely to be a critical technology in global carbon reduction strategies, particularly for countries with fast-growing economies and rapidly growing fossil fuel consumption”

As already indicated we accept that the UK is well placed to play a leading role in the development of CCS. Nevertheless, CCS is a large and capital intensive technology, with several major national and international programmes targeted at its development, and it is not economically feasible, and from a climate change perspective it would not be sensible, for the UK to “go it alone”. Decisions will also be informed by the EU’s Technology Platform initiative (paragraph 17 above) as well as activities in the Carbon Sequestration Leadership Forum (CSLF) and the IEA that have been initiated as part of the Plan of Action agreed at the G8 Gleneagles Summit (Paragraph 1).

Leadership is not only a matter of demonstrating the technology. The early engagement of countries with large and growing consumption of fossil fuels is vital to the longer term acceptance and deployment of CCS. This is why, under its presidency of the EU, the UK initiated agreements with China and India, that included the advancement of clean energy technologies, and why we are taking a leading role in developing the necessary authorisation and regulatory frameworks for CCS to be deployed internationally.

## **Export opportunities**

**23. Export opportunities for UK companies are likely to derive from intellectual property and licensing of CCS technology. (Paragraph 74)**

Intellectual property and licensing of CCS technology could provide important export opportunities for UK companies involved with CCS. There may also be opportunities for UK manufacturers and also in providing services to CCS projects in such areas as

monitoring and verification, safety and reliability audits, carbon accounting and trading, etc.

**24. If the UK is serious about making an impact on China and India, the most useful thing it could do would be to get full scale demonstrations of several different types of CCS technology up and running domestically as soon as possible. This would prove the viability of the technologies and give UK companies comparative advantage in terms of experience and know how. In the absence of such demonstrations, the idea of major export opportunities for UK companies is unrealistic. (Paragraph 77)**

We agree that it is important for developed countries like the UK to take a lead in the development of CCS. However, given the high costs of CCS demonstration projects and the international efforts that are underway to develop CCS technology, it is clear that funding several different CCS demonstration projects in the UK is not affordable nor would this be the optimal route to developing CCS technologies. The key challenge is for the Government and industry to learn from the experiences of other countries and work together to decide how to focus UK effort and resources. To help with this the DTI, in the context of the CAT Strategy, is developing a Route Map, which will address how the UK should distribute its resources for CCS taking account of international market prospects and the capability and capacity of UK business.

**25. A major refurbishment of a UK coal-fired power station combined with retrofitting of CCS technology could afford a very valuable opportunity to demonstrate the post-combustion capture technology required to retrofit Chinese coal-fired plant, as well as providing useful experience of combined retrofit and upgrade of a UK plant. (Paragraph 78)**

The refurbishment and retrofitting of CCS technology to existing coal-fired power stations was identified as one of the most cost effective options for implementing CCS by the MARKAL modelling analysis, which advised the DTI's CAT Strategy. Subsequently some generators have indicated that the cost balance between refurbishment and new build is closer than implied by the MARKAL analysis, which did not take account of lost revenue during the refurbishment shutdown and space limitations at some sites.

## **Risks and Regulation**

### ***Risks***

#### ***Leakage***

**26. Experience to date has demonstrated that, over the timescales studied, CO<sub>2</sub> can be safely stored in both depleted oil and gas fields and aquifers. Current and future large scale demonstration projects will play a key role in building the evidence base for, and public confidence in, geological storage of CO<sub>2</sub>. (Paragraph 79)**

We agree that current knowledge and experience indicates that CO<sub>2</sub> can be safely stored in geological formations. However, we also agree with the Committee that understandably this is a subject for concern to the general public, and that it is important to strengthen and present the evidence base in a clear and transparent manner. DTI is currently developing a CCS communications strategy, which, amongst other tasks, will consider how to present

the growing evidence base on CO<sub>2</sub> storage integrity to a broader audience. Furthermore, this is why the DTI included support for CO<sub>2</sub> storage demonstration in its CAT Strategy, and why BGS has been encouraged to take a leading role in a number of international projects studying the long term behaviour of CO<sub>2</sub> underground.

### *Boreholes*

27. The main source of leakage from CO<sub>2</sub> storage sites is likely to be via boreholes, although it is expected that any breach of the borehole seal could be remediated quickly. Further R&D to develop cements and sealants optimised for CO<sub>2</sub> storage would nevertheless be valuable. (Paragraph 85)

We are aware that boreholes have been identified as a potential leakage path for CO<sub>2</sub> stores, particularly for depleted oil and gas reservoirs that may have been penetrated by many boreholes during the extraction process. Ease of remediation in the unlikely event of leakage may depend on circumstances. The development of new cements and sealants was not raised as an important factor in the CAT Strategy consultation, but we will ask the CAT Strategies advisory committee (Advisory Committee on Carbon Abatement Technologies – ACCAT) if this should be included in the next call for R&D proposals.

### *Site characterisation*

28. We recommend that the Government works both with other interested parties within the UK and, over the longer term, internationally, in order to develop a standardised methodology for site characterisation. More generally, there is a need for codes of practice to be developed to ensure good design and management of CO<sub>2</sub> storage facilities. (paragraph 87)

We agree. DTI is in the process of establishing an inter-departmental task force that will examine the regulatory requirements for CCS, taking into account existing legislation and the new framework potentially provided by the Marine Bill, currently out for consultation. This will include the selection, operation and closure of storage sites. The Government is also closely engaged with work under EU Climate Change Programme which covers the possible legislative framework for CCS at the EU level, and the Task Force envisaged by DTI will take this into account, as well as other relevant activities including the North Sea Basin Task Force recently set up with Norway work by OSPAR on site characterisation and the development by IPCC of emission inventory guidelines relevant to CCS. The UK has had a major input into IPCC's work in this area.

### *Monitoring and modelling*

29. Further research is needed to improve the tools for site selection and subsequent monitoring and verification of CO<sub>2</sub> stored in geological formations. Although companies will be expected to take steps to improve monitoring and verification in the projects that they sponsor, the Government must take primary responsibility for commissioning research in this area in view of its significance for public safety and confidence in the technology. We recommend that the Government makes this an RD&D priority. (Paragraph 89)

We fully agree with the Committee and will seek to include the improvement of tools for site selection and monitoring in future competitions for funding under the DTI's CAT Strategy. Monitoring will need to be in the context of and internationally agreed methodologies and the UK has had a major input into IPCC's work to develop emissions inventory methodologies for use with CCS projects.

### *Transport*

**30. Providing that the pipelines are designed and routes are selected in such a way as to minimise risk, transportation of CO<sub>2</sub> by pipeline between capture and storage sites should not pose any greater threat to human health or the environment than natural gas transport and may indeed be lower. (Paragraph 91)**

**31. Overall, the evidence suggests that for well-chosen sites the risk of leakage of CO<sub>2</sub> from geological storage reservoirs or pipelines is low. The risks associated with storage of CO<sub>2</sub> would be further mitigated by thorough site characterisation and management, monitoring and verification of storage sites. (Paragraph 92)**

Responding to conclusions/recommendations 30 and 31, we agree that the evidence base indicates that the transport of CO<sub>2</sub> by pipeline both on land and over the seabed can be undertaken in compliance with established health and safety standards. This view has been supported by a study undertaken by Det Norske Veritas (DNV) which fed into DTI's CAT strategy. In addition, as part of the Energy Review consultation, we have requested the Health and Safety Executive (HSE) to report on some specific potential health and safety risks arising from recent and potential energy developments one of which is new demonstration projects for CCS.

**32. Clear and transparent information about CCS at an early stage will be crucial for securing public acceptance. The Government must therefore adopt a pro-active approach to communication. (Paragraph 95)**

**33. The Government has done little so far to engage the public in a dialogue about CCS technology. We accept that it is early days for the technology but previous experience has emphasised the value of early engagement. The evidence we have seen does not support the view that the Minister's confident and relaxed attitude towards the Government's performance on this issue is justified, and this is a source of concern. (Paragraph 97)**

Responding to conclusions/recommendations 32 and 33, we agree that public acceptance will be crucial to the success of CCS and that the first step towards this is to raise public awareness as the technology approaches deployment. In this respect it is encouraging that CCS is now, more often than not, reported as a major option for greenhouse gas abatement alongside energy efficiency, renewable energy and nuclear power. As reported to the Committee the DTI is developing a communication strategy, this is being undertaken in association with the BP led CO<sub>2</sub> Capture Project to benefit from industry experience gained from early demonstration projects. In the meantime the DTI is already taking action to raise awareness in the regions that are most likely to host CCS projects. Thus, in association with Scottish Enterprise, workshops on the prospects for CCS have been run in the last few months in Aberdeen, Glasgow, Norwich and York. In addition the Minister for

Energy has recently hosted a workshop on CCS in Middlesbrough as part of the Energy Review consultation.

**34. The first demonstration projects will need to give careful consideration to public engagement—early successes or failures are likely to have a disproportionate impact on subsequent public attitudes. (Paragraph 98)**

We agree with the Committee and would expect project champions to lead on this by taking a range of actions including discussions with the local councils to address all aspects of the plans for the project including the benefit to the local community. Exhibition, publications and DVD materials would also be useful increase awareness and understanding of what the project entails.

**35. Environmental NGOs can make a major contribution to ensuring that public debate about CCS is conducted in a responsible way. Their suggestion that they do not have influence over public opinion was perplexing and unconvincing. We call on the NGOs and the Government to work collaboratively to inform public perceptions of the risks and benefits associated with CCS. (Paragraph 99)**

We place great importance on keeping the environmental NGOs fully engaged with develops concerning CCS. When DTI launched its CAT Strategy in June 2005 NGOs were invited to the launch as well as to a more detailed briefing on the strategy later on the same day. It was pleasing that the NGO witnesses to the Committee acknowledged that the Government kept them informed of CCS activities.

## ***Regulatory Framework***

### ***International conventions***

**36. EOR can provide a useful stepping stone to CCS by enabling early proving of offshore CO<sub>2</sub> injection without contravening the multinational environmental agreements governing the disposal of waste in marine environments. (Paragraph 102)**

The Government agrees; since CO<sub>2</sub> is considered to be a working fluid rather than a waste when used for EOR activities, it is permissible to inject the CO<sub>2</sub> into sub-seabed geological formations without contravening the OSPAR and London Conventions. Furthermore, EOR will help offset the costs in developing CCS technologies due to revenues from the enhanced recovery of oil.

**37. It is commendable that the Government has taken a lead in international negotiations to amend the London Convention/Protocol to ensure that CCS projects are permissible. Whilst we appreciate that it may take time to secure international agreement, it is vital that the UK does its utmost to expedite this process: industry needs to have one hundred per cent confidence that multinational environmental agreements are not going to serve as barriers to future deployment of CCS technology. In addition, we urge the Government to take steps to clarify the legality of the various types of CCS project to ensure that uncertainty and ambiguity in this area does not hinder the progress of CCS demonstration projects in or around the UK unnecessarily. (Paragraph 105)**

The Government agrees on the need to remove barriers and is doing all it can to clarify the legal position under marine treaties. Specifically we have worked within the Jurists Linguists group under the OSPAR convention to clarify the circumstances under which projects can already be considered legal. The UK has assisted Norway in enabling OSPAR to review the risks, monitoring and surveillance required for CCS. The UK chaired the working group under the London Convention which made the recommendation to the 27<sup>th</sup> Consultative Meeting of the Contracting Parties, which recognised the role of CSS, and agreed to consider a clarification or amendment to facilitate and/or regulate CCS. The UK subsequently chaired an intersessional meeting on legal issues which took place in April 2006 and was informed by strong UK representation at a preceding meeting in London. . We expect the 28<sup>th</sup> Consultative meeting to make a decision on the way forward under the London Convention.

### *Liability for stored CO<sub>2</sub>*

38. The private sector should take responsibility for CO<sub>2</sub> during the injection phase of any CCS project but we believe that Government will have to take responsibility for the stored CO<sub>2</sub> thereafter. We are pleased that the Minister appeared to acknowledge this, but it is essential that the Government makes an explicit commitment to serve as the long term guarantor, and makes it very soon. Industry will not proceed with CCS projects in the absence of such a commitment. (Paragraph 107)

We agree that there may be a case for Government to take responsibility for stored CO<sub>2</sub> in the long term. However, issues such as the timing of such a transfer and the conditions under which it should take place require careful consideration, taking into consideration the fact that the private sector will have received a financial reward for the CO<sub>2</sub> abated. This, along with other regulatory issues affecting CCS, is currently under consideration.

### *Decommissioning of North Sea infrastructure*

39. The Government must take steps to enable and promote the reuse of existing North Sea infrastructure for the purposes of EOR and CCS. The window of opportunity for the pipelines and platforms is time-bound so rapid action is required. (Paragraph 110)

We recognised the potential economic and environmental benefits of reusing existing North Sea infrastructure. Following the initial report from the East of England Energy Group (EEEGR) that is referenced by the Committee, the DTI commissioned further work from the group to look in more detail at CCS. This second report from EEEGR has been delivered recently and is being carefully studied by DTI.

### *A Carbon Capture and Storage Authority*

40. At present, multiple Government Departments and agencies, including the DTI, DEFRA, Environment Agency and the Health and Safety Executive, have expertise and functions that would be required for the regulation and monitoring of CCS. In the absence of a Department of Energy, we propose the establishment of a CCS Authority to bring together all the relevant functions. We believe that a single body in this area could make regulation more transparent, thus building public confidence, as well as minimising bureaucracy for companies engaging in CCS projects. In order to ensure

that these objectives are met, it is essential that all the relevant onshore and offshore functions be subsumed into the CCS Authority, leaving no residual responsibilities in other Departments, and that the Authority has a clearly defined line of accountability to a single Secretary of State. (Paragraph 113)

41. In view of the wide range of tasks required to put in place the necessary regulatory frameworks for CCS, and the urgency with which they need to be undertaken, the Government should not delay in taking steps to establish the CCS Authority. Indeed, the Energy Review provides an ideal opportunity to set this process in motion. (Paragraph 114)

Responding to conclusions/recommendations 40 and 41, we believe it is too early to form a view on the merits of a CCS Authority. This is not the only activity relevant to a range of regulatory authorities and we are not aware of any problems at present where creation of a single Authority would be critical in finding a solution. As outlined in paragraph 28 of the Select Committee's report, DTI is in the process of establishing an inter-departmental task force to examine regulatory issues, and we will await the outcome of this before considering any further action.

## **Costs and Incentives**

### **Costs**

42. Overall, the data collected in this inquiry indicate that the cost of electricity generated using CCS is 1–2 p/kWh more than without. Taking into account the uncertainties associated with these calculations, the data suggest that there is no clear 'winner' between gas- or coal-fired plant fitted with CCS. It would also appear that an increased gas wholesale price has only a weak effect on cost data. (Paragraph 120)

The Committees findings are broadly in line with the costs presented in the DTI's CAT Strategy.

### **Infrastructure**

43. It seems unreasonable to expect industry to bear the full costs of the infrastructure required for CCS, particularly in the case of the first demonstration projects. The Government must make sure that this is not a deal breaker for the first demonstration projects. (Paragraph 124)

We expect the cost of the transportation infrastructure to be part of the overall CCS cost, and therefore would need to be covered by operators and by any incentive to deploy CCS.

### **Opportunities for cost reduction**

44. It seems reasonable to expect that new technological developments and benefits derived from increasing experience and economies of scale could collectively lead to significant reductions in the costs associated with CCS. (Paragraph 126)

The Committee's findings are noted and are broadly in line with our expectations.

### ***Market incentives***

**45. There are no fundamental barriers to the development and deployment of CCS in the UK, apart from the lack of a suitable long term policy framework to provide industry with the incentives and confidence it requires to make the substantial investments entailed in CCS projects. The Government must put this framework in place as quickly as possible—it is already at risk of holding back UK industry. (Paragraph 128)**

HMT has recently launched a consultation exercise to increase Government's understanding of CCS. This consultation particularly seeks to address the barriers to commercial deployment such as the uncertainties over the cost of CCS, the regulatory framework and long term liabilities of CO<sub>2</sub> storage; as well as the potential role of economic incentives in overcoming any barriers.

In addition, as outlined in PBR 2005, Government has developed a framework within which intervention on environmental issues is to be considered. This framework stipulates that:

- The decision to take action must be evidence-based;
- Any intervention to tackle environmental challenges must take place at the appropriate level;
- Action to protect the environment must take account of wider economic and social objectives;
- Action on the environment must be as part of a long-term strategy;
- The right instrument must be chosen to meet each particular objective;
- Where tax is used, it will aim to shift the burden of tax from 'goods' to 'bads'.

Any decision on longer term policy options for CCS will be made within the context of this framework and the Government's overall objectives for energy policy as set out in the 2003 Energy White Paper.

**46. In the longer term, the Government should seek to provide a level playing field for all carbon abatement technologies. A technology neutral incentive framework would better reflect the overall objective, which is to reduce CO<sub>2</sub> emissions. It would also be more efficient to let the market decide which technologies provide the best solutions to meet this challenge. (Paragraph 129)**

The Government agrees with the Committee that providing fair competition between carbon abatement technologies is appropriate, with the market playing an important role in the determination of which technologies are deployed.

**47. 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. (Paragraph 130)**

The Energy Review is currently examining all of the potential options for carbon abatement, and it would not be appropriate to pre-empt its conclusions.

### ***EU-ETS***

**48. The EU-ETS has the potential to provide the requisite incentive framework to stimulate investment in CCS and other carbon abatement technologies in the long term. At present, however, the scheme delivers neither the long term visibility nor a sufficiently high carbon price to fulfil this function. (Paragraph 136)**

The Government agrees that the EU-ETS has the potential to incentivise CCS and notes that present carbon prices are large enough to provide a significant incentive. For them to do so requires clarity on the provisions for monitoring and reporting, and sufficient confidence on future carbon prices. The UK is working with the European Climate Change Programme to help achieve the first of these conditions, and in the EU and international consultations and negotiations to achieve the second.

**49. Government should redouble its efforts to ensure that CCS is included in the next Phase of the EU-ETS and to get agreement for limits beyond 2012. Government should also make the case for a substantial tightening of the emissions cap in the next round in order to stimulate a higher carbon price. (Paragraph 137)**

CCS is already eligible for inclusion in the EU-ETS subject to agreement on monitoring and reporting guidelines with the European Commission, and the Government is doing all it can within the EU via the EU Climate Change Programme to achieve this. The Government believes that the need to take action to reduce emissions extends to all sectors of the economy and will seek to set an emissions cap in the next round that maximizes emissions reductions as a whole by achieving this.

### ***Other instruments***

**50. Competitive capital grants may be needed to encourage the first demonstration projects but they are not a substitute for developing a long term incentive framework. (Paragraph 140)**

The issue of possible incentives has already been discussed in Paragraph 45 above.

The Energy Review is looking comprehensively at future UK energy policy and assessing progress against the four goals set in the 2003 Energy White paper (climate change, security of energy supply, promoting competitive markets and tackling fuel poverty). As part of this process, it is considering all options including the role of current generating technologies (e.g. renewables, coal, gas and nuclear power) and new and emerging technologies (e.g. CCS).

**51. It is unacceptable that income from the Non-Fossil Fuel Obligation is not being used to support the renewable energy industry. We recommend that revenues generated through levies imposed in the name of 'green' energy be used in a manner consistent with that objective. (Paragraph 141)**

The Government does not accept that any income arising from the Non Fossil Fuel Obligation arrangements should be spent on renewable energy. The Government is providing substantial support to the renewables industry through the Renewables Obligation and has also committed around £500m of additional support for longer-term renewable and low carbon technologies.

52. There is now a pressing need for a policy that will provide the level of financing and long term framework necessary to persuade industry to start investing significantly in CCS. Since the Government is currently conducting extensive reviews of its climate change programme and energy policy, it is not feasible for us to determine which specific policy instrument would best meet these needs—the choice would depend on the approaches being taken to incentivise or support other technologies, such as renewables and nuclear energy. It is clear to us that urgent action is required. Doing nothing while waiting for the EU-ETS to come good, or postponing a decision on the policy beyond summer 2006 when the Energy Review reports, would have disastrous consequences for the UK's competitiveness in this area. (Paragraph 145)

We are pleased that the Committee recognise the need to develop a policy framework for CCS in conjunction with those for other technologies. The Energy Review currently underway is an opportunity to consider these complex and interrelated issues in the round.

53. In the longer term, as well as working towards an effective EU-ETS, the Government should continue to make the case for a global framework for trading carbon. (Paragraph 146)

The Government agrees and will work in the international negotiations to achieve the widest possible coverage of emissions trading and other flexible mechanisms for this in the international negotiations

54. In the meantime, the Government should also support efforts to enable CCS to qualify for the Joint Implementation and the Clean Development Mechanism, which were established by the Kyoto Protocol to allow investment in emissions reduction projects in developing countries and economies in transition. (Paragraph 146)

Accept. The UK continues to advocate within Europe inclusion of CCS projects in the CDM. The UK has also done extensive work on the development of emissions inventory guidelines, which will facilitate inclusion under both the CDM and the JI.

## **Role of CCS in the UK's Future Energy Portfolio**

### ***Energy review***

55. The Government's decision to launch another Energy Review less than three years after the publication of the last Energy White Paper in 2003 must be seen as a tacit acknowledgment that the previous White Paper did not foresee some of the key issues. (Paragraph 149)

The reasons for the 2006 Energy Review were fully explained in the consultation document published on 23<sup>rd</sup> January 2006.

**56. In view of the complexity of energy policy and the wide-ranging remit of the Energy Review, we were surprised at the short time—barely six months—allocated for consultation and analysis of the evidence. (Paragraph 150)**

The debate around the issues being considered in the Energy Review has been underway for some time. The Energy Review is building on the work and the analysis undertaken for the 2003 Energy White Paper and since then, and takes as given the 4 energy policy goals set out in the 2003 White Paper. Further, it is important that the Review is conducted in a timely fashion. Key investment decisions that will decide our energy mix for the long-term will be made by industry in the short-term.

**57. We are concerned that the review being undertaken by the Health and Safety Executive may be used by the Government as an excuse for delaying concrete decisions about commitments to CCS. This would be a major setback for the UK's progress in this area and must not be allowed to happen. (Paragraph 150)**

It is right and proper that the health and safety risks associated with new energy technologies are properly understood to inform the regulatory framework that should apply to these technologies. The HSE has been asked to provide an expert report on some of the health and safety risks associated with a number of recent and potential developments in the energy sector and their regulatory strategy to ensure that industry sensibly managed these risks.

### ***CCS and renewables***

**58. The availability of CCS should not become an excuse to deepen the world's dependence on fossil fuels as energy sources. Nevertheless, it is clear that neither the UK nor most other countries are yet willing or able to exclude fossil fuels from their energy mix and, this being the case, CCS can play a crucial damage limitation role during the transition to alternative energy sources such as renewables. (Paragraph 152)**

We fully endorse this conclusion, which is the central thrust of DTI's CAT strategy.

**59. The possibility of removing CO<sub>2</sub> from the atmosphere by fitting biomass-fired plant with CCS is highly appealing but further research is needed to ensure that this approach will deliver the expected environmental benefits. (Paragraph 153)**

It is likely that plant fuelled with 100% biomass will only be 50-100MW in capacity because of the logistics and energy use associated with collecting and transporting biomass over long distances. CCS on plant of this size is unlikely to be economic, except possibly if it is located close to other large fossil fuel sources, and hence can take advantage of any CCS infrastructure associated with such plant. An alternative approach to take advantage of biomass would be to use this for co-firing in new or refurbished fossil fuel plants that are also fitted with CCS. This would have the added advantage of using the biomass at the high conversion efficiencies attainable in advanced fossil plant. The DTI's CAT Strategy included biomass co-firing within its remit for precisely this reason.

**60. CCS has the potential to make a dramatic impact on carbon dioxide emissions in a short space of time and, given current performance, it will be hard for the UK to meet its 2050 target on emissions reductions without CCS. However, CCS must not be**

regarded as a substitute for developing renewable forms of electricity generation or implementing energy efficiency measures. (Paragraph 155)

The Government continues to place great importance on the development of renewable energy sources and implementing energy efficiency measures. This has been emphasised in the Energy Review Consultation and in the new Climate Change Programme. Nonetheless it is likely that a wider portfolio of measures will be needed to achieve our aims for CO<sub>2</sub> abatement. As discussed in the DTT's CAT Strategy CCS technologies should be regarded as bridging technologies giving short to medium term reductions in CO<sub>2</sub> emissions, and thus providing more time for the development of truly sustainable energy technologies.

### *CCS, nuclear energy and security of supply*

**61. CCS can contribute to security of supply by enabling the UK to utilise a range of fuels from diverse sources and suppliers, without impairing progress towards CO<sub>2</sub> emissions targets. (Paragraph 157)**

This is undoubtedly true for CCS applied to coal fired plant. It is noteworthy that all the main groups of energy technologies currently considered for CO<sub>2</sub> abatement, renewables, energy efficiency and nuclear power, would contribute security of supply.

### *Timescales*

**62. We are disappointed by the Government's repeated assertion that CCS technologies are at a very early stage and are concerned that this is being used as an excuse for inaction. If the Government were to demonstrate the ambition and determination that we believe is merited, the UK could significantly progress the status of CCS technology and perceptions of its viability. (Paragraph 161)**

The Government is far from inactive on CCS. The DTT's CAT Strategy, providing funding for R&D and demonstration projects shows significant commitment, the UK has been prominent in addressing the legal and regulatory issues affecting CCS deployment in the EU and under the marine treaties, and we have been instrumental in initiating work to prepare for CCS deployment in developing countries such as China and India.

The key issue is how to take the next steps in the development of CCS. As discussed in several previous responses above, this is not an easy question to answer. Full-scale demonstration projects, to use the Committee's own findings, are likely to be very expensive and of uncertain cost, and currently there are several options being proposed with equal enthusiasm by potential developers covering coal and gas, post and pre-combustion, storage and EOR. We need to consider what is most appropriate to the UK in terms of deployment, the capability of UK business, the suitability of the technology to other key markets, where our effort should fit into the broader international scene and the impact on consumers and taxpayers. In addition it is clear that other non-financial barriers, such as regulation, may affect the development of CCS. These questions are being considered in the HMT consultation, which will feed into the Energy Review.

**63. Regrettably, the Government's actions to date do not reflect the urgency of the situation. We trust that this will be rectified during the forthcoming Energy Review. (Paragraph 161)**

We do not accept that the Government is not making decisions concerning CCS in a timely manner. As explained above (Paragraph 62) the issues associated with the development of CCS are complex and need to be carefully considered in light of the Government's overall objectives for energy policy. The Energy Review is an opportunity to consider these issues in this broader context.

**64. One of the top priorities for the Government must be to develop the long term and coherent energy policy which has been sorely lacking to date. It is essential that, following the Climate Change Programme Review, Energy Review and Stern Review, the Government puts in place a stable incentive framework that will enable industry to find the most cost effective technological solutions to meet the UK's energy and climate change objectives. (Paragraph 162)**

The Government notes the Committee's comment.

## Reports from the Science and Technology Committee in the 2005 Parliament

### Session 2005–06

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| First Report          | Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage                                                  | HC 578 |
| First Special Report  | Forensic Science on Trial: Government Response to the Committee's Seventh Report of Session 2004–05                          | HC 427 |
| Second Special Report | Strategic Science Provision in English Universities: Government Response to the Committee's Eighth Report of Session 2004–05 | HC 428 |

