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Carbon capture and storage

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The Environmental Audit Committee

The Environmental Audit Committee is appointed by the House of Commons to consider to what extent the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development; to audit their performance against such targets as may be set for them by Her Majesty's Ministers; and to report thereon to the House.

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1 Introduction

1. In March 2008, E.ON UK asked the Government to delay consideration of its planning application for a controversial new coal-fired power station at Kingsnorth, until the Government had undertaken a consultation into the meaning of the term 'carbon capture ready'. Shortly after, E.ON UK announced that they would be entering the Kingsnorth development into the Government's competition for a carbon capture and storage demonstration project.

2. This episode highlighted a number of our concerns about the Government's carbon capture and storage policy, namely:

- the possible resurgence of unabated coal as a power source;
- the lack of clarity over the definition of 'carbon capture ready', and any requirements arising from it; and
- the uncertainty over when, and how, carbon capture and storage would become either desirable in terms of cost, or required by regulation.

We took oral evidence from EON.UK and the Minister for Energy, Malcolm Wicks MP. A list of the written evidence we received is reproduced at the end of the Report. We are grateful to all those who submitted evidence, given the tight deadline we imposed on them.

2 Background

3. Carbon capture and storage (CCS) is the removal, capture and storage of carbon dioxide from fossil fuels either before they are burnt (pre-combustion CCS) or after (post-combustion CCS). Captured CO_2 must then be contained in some kind of long-term storage such as the features available in disused oil and gas fields. CCS has the potential to reduce emissions from fossil fuel burning power stations by 90%.[1] In addition to being included in new power stations, it is hoped that CCS could be retrofitted to existing plants. All of the different components of CCS technology have been demonstrated in isolation from each other. Now the challenge is to demonstrate the full chain of CCS technology working on a commercial scale.

4. In 2006 the House of Commons Science and Technology Committee published a detailed report on the merits of CCS.[2] In our 2006 report *Keeping the Lights On: Nuclear, Renewables and Climate Change* we agreed with their conclusion that CCS must play a decisive role in reducing emissions both domestically and internationally.[3] The International Energy Agency has suggested that CCS could reduce global CO_2 emissions

[1] Defra, Science Note 6, *Carbon Capture and Storage*, March 2008, p6

[2] Science and Technology Committee, First Report of Session 2005–06, *Meeting UK Climate and Energy Needs: the role of carbon capture and storage*, HC 578-I

[3] Environmental Audit Committee, Sixth Report of Session 2005–06, *Keeping the Lights On: Nuclear, Renewables and Climate Change*, HC581-I, para 54

significantly.[4] CCS is a particularly important way of reducing emissions given that up to 83% of the increase in world energy demand will be met by fossil fuels. Coal will play a prominent role because of its abundance and the fact that coal-fired generation can easily respond to fluctuations in energy demand.[5] China, India, and other large developing countries will be reliant on coal-powered generation for years to come. The Government argues that the ability of CCS to reduce emissions could help to meet the UK's growing energy needs and maintain the security of the UK's energy supply by making coal a viable option for reducing dependence on gas imports.

5. In certain areas the Government's record on CCS is good. Research and development funds, mainly to develop the individual components, have been provided through a variety of bodies.[6] There are good examples of bilateral work with other countries, most notably in China, where the UK Government has funded the Phase 1 assessment of the EU-China Near-Zero Emissions Coal agreement and demonstration project.

6. The cornerstone of the Government's policy in the UK is the competition for a demonstration plant. This competition will provide funding for a power station to demonstrate the CCS process chain at 50-100MW scale by 2014. The plant will then be expected to scale up the process and demonstrate the technology at 300-400MW 'as soon as possible' thereafter. The Government hopes that the competition will open the door to generating companies to develop further CCS projects, by reducing 'uncertainty on a range of technical, construction, operational and regulatory/planning factors that affect the costs of CCS'.[7]

7. There has, however, been criticism of the Government's decision to restrict the competition to a single project using post-combustion CCS from coal, notably because this decision excluded nearly half of the CCS projects under development in the UK at the time the competition was launched.[8] A report by Policy Exchange said:

> In early May 2007 there were nine commercial propositions for CCS in the UK. This was by far the greatest number, and greatest diversity, of commercially proposed CCS plant in the world. Were all of these to have been built, 20% of UK baseload electricity could have been decarbonised by 2015. However this number was reduced as BERR refined the specification for the procurement Competition. In March 2008, a different nine proposals have been submitted to BERR for the CCS Competition, of which just one may be developed on part of a power station, sometime after 2014.[9]

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[4] Ev 13

[5] Ev 12

[6] According to the Government, Ev 15, the Natural Environment Research Council and the Engineering and Physical Sciences Research Council are funding a £2.2m project consortium led by Imperial College to explore issues relating to CCS. The Technology Strategy Board has provided £11m to support 16 Carbon Abatement Technologies projects in industry-led applied research. In 2005 the Government established a fund of £25m (since increased to £35m) to encourage the industry-led demonstration of assemblies and elements that contribute to Carbon Abatement Technologies including CCS.

[7] Ev 16

[8] House of Commons Library Research Paper 08/05—*The Energy Bill*, January 2008, p17

[9] Policy Exchange, *Six Thousand Feet Under—Bury the Carbon Problem*, June 2008, p26

The Government argued that the restriction to post-combustion technology from coal was necessary in order to focus attention on the single form of technology that was most deserving of further development, and to avoid duplicating the work of demonstration projects in other countries.[10] They insisted that post-combustion CCS is easier to retrofit to existing power stations than pre-combustion technology, meaning that it could have a greater impact, sooner, on tackling 'locked-in' emissions.[11] It was also the technology with the greatest export potential, particularly in developing countries with growing emissions, such as China.

8. In our Report on the 2007 Pre-Budget Report we concluded that, if the Government is only going to fund a single CCS demonstration project, it was right to restrict the competition to post-combustion CCS from coal.[12] However, the decision to limit funding to a single project has led to the loss of a number of promising projects developing other forms of technology. **We welcome the competition on post-combustion CCS from coal and recognise that it will make an important contribution. However, we feel it would aid the development of CCS if the Government were to extend its support to a programme of demonstration projects, including pre-combustion technology. Furthermore, the Government must view its competition as only one part of a wider strategy; it must continue to support other CCS projects including the development and integration of the individual components and new CCS technologies. While undoubtedly valuable, the competition must not detract effort and resources from other work on CCS within the UK. The timely development of a range of CCS technologies would also give the UK a clear competitive advantage on the global stage.**

9. Progress on CCS in the UK has been very slow and a serious lack of both clarity and urgency has clouded the Government's strategy in this area. The 2003 Energy White Paper stated:

> We will […] set up an urgent detailed implementation plan with the developers, generators and the oil companies to establish what needs to be done to get a demonstration project off the ground. This study will reach conclusions within six months to enable firm decisions to be taken on applications for funding from international sources as soon as possible thereafter.[13]

Three years later, we concluded that Government activity in this area had largely been confined to issuing documents and reports:

> The plethora of reports creates an impression of activity whilst progress in 'learning by doing' appears minimal. It is scandalous that so little progress in developing clean coal and carbon capture and storage has been made.[14]

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[10] The Norwegian Government is supporting commercial-scale CCS projects on gas fired power stations; the USA has undertaken work on pre-combustion on coal.

[11] Ev 17

[12] Environmental Audit Committee, Third Report of Session 2007–08, *The 2007 Pre-Budget Report and Comprehensive Spending Review: An environmental analysis*, HC 149-I, para 22

[13] DTI, *Energy White Paper*, February 2003, paragraph 6.63

[14] Environmental Audit Committee, Sixth Report of Session 2005–06, *Keeping the Lights On: Nuclear, Renewables and Climate Change*, HC581-I, para 53

In our Report into the 2007 Pre-Budget Report, some five years on from the White Paper statement, we revisited this matter.

> It is now two years since our criticism was published, and there has still only been slow progress on the demonstration project and no substantial progress on setting out the financial framework.[15]

Once again, **we are extremely disappointed by the lack of progress on CCS.** The competition has emerged very late in the day. Malcolm Wicks MP admitted that 'the decision to support a demonstration project was not taken until May 2007. As I recall, we were busy on one or two other things'.[16] Even now, when the competition seems to herald a new commitment to action, critical issues such as the definition of CCS Ready remain at consultation stage, while the competition itself has extended the planning stage of projects that, with more direct assistance, could have been underway much sooner. E.ON UK cautiously expressed frustration with the inconsistencies in Government policy:

> For companies such as ours, stability in Government energy policy is vital. Constant changes in the rules of the game create risks for investors and make it far more difficult to justify investments commercially. The Government has only recently set out its overall approach to energy in its 2007 Energy White Paper 'Meeting the Energy Challenge'. Governments are of course entitled to make changes, and may wish to alter the balance in the priority they give to climate change, security of supply and affordability objectives. But the consequences need to be fully spelt out. They also need to allow time for investors to adjust taking account of the long lead times for capital investment in this sector.[17]
>
> […]
>
> From our perspective it would of course have been desirable if the Government had decided to support the demonstration of the technology earlier, and to have funded clean coal technology generally on a more consistent basis at higher levels of funding.[18]

10. The lack of a clearer signal from Government on this matter has slowed the development of CCS technology and reduced the chances of Britain gaining a technological lead in an important area. We acknowledge that there are barriers to the deployment of CCS that need to be overcome. We accept that the Government has taken some steps in this direction; its planned consultation into the European Commission's proposed EU Directive on the Geological Storage of Carbon Dioxide should resolve a number of critical issues, such as the regulatory regime for the storage of CO_2, and the policy on carbon capture readiness. However, **it is essential for the Government to give a far higher priority to the development of CCS. It must communicate and follow a clearer and more urgent strategy in order to speed this development and provide a**

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[15] Environmental Audit Committee, Third Report of Session 2007–08, *The 2007 Pre-Budget Report and Comprehensive Spending Review: An environmental analysis*, HC 149-I, para 29

[16] Q 64

[17] Ev 3-4

[18] Ev 4-5

stronger signal to industry. The indecision that has afflicted the development of CCS up to now must end; any further delay will be extremely damaging environmentally and will mean that the chance to gain a competitive advantage is being squandered.

3 Is coal the answer?

11. In general, the use of coal to generate electricity within the EU is declining. Air quality legislation, such as the Large Combustion Plants Directive, has required the closure by 2016 of up to 11GW of coal plant, with further challenges likely to be introduced by the draft Industrial Emissions Directive.[19] E.ON UK state that, even with the development of Kingsnorth, coal is likely to fall from 50 per cent of their portfolio to 20 or 30 per cent, as older coal-fired power stations reach the end of their lives. However, against a background of increasing concern about reliance on imported gas and a sharp rise in oil and gas prices, coal is currently enjoying something of a resurgence, with more effective coal-fired power stations hailed as the answer to concerns over energy security and the imminent 'energy gap'.

12. E.ON UK said 'we believe some new, more efficient, coal-fired capacity is justified to ensure the diversity of energy sources we need to provide secure and affordable energy supplies'.[20] The Government is equally enthusiastic about the need to retain and develop coal as a source of generation: 'coal is and will continue to be in our judgement a vital part of the UK's energy mix, essential for providing us with secure and reliable energy supplies'.[21] The retention of a significant level of fossil fuel generation may be needed as a back up to renewable energy—E.ON UK have claimed that generation from renewables would need to be 90 per cent supported by coal and gas in order to ensure supply during periods when intermittent renewable sources were not available.[22] E.ON UK is not the only generator seeking to construct a new coal-fired power station. The Government estimated that, in addition to Kingsnorth, three other applications for new coal-fired power stations in the UK were in the pipeline.[23] WWF have estimated that, in total, generating companies are considering 'as many as six or seven new coal-fired power stations in the UK by 2015'.[24]

13. CCS may itself have contributed to the resurgence of coal. Generators fall back onto the promise of CCS when challenged over the environmental impact of coal-fired plants: 'we recognise that new coal-fired power generation still gives rise to significant CO_2 emissions, and therefore carbon capture and storage will be required in the long term.'[25] But since it is not clear when CCS will be available, or whether it will ever be available at all, such arguments are deeply flawed. The Government admitted there was significant uncertainty around the costs, technical requirements and risks associated with CCS, and that it was

[19] Ev 65

[20] Ev 1

[21] Q 31

[22] The Guardian, "*E.ON warns over backup for renewables*", 4 June 2008

[23] Ev 17

[24] WWF, *Evading Capture—Is the UK Ready for Carbon Capture and Storage*, May 2008

[25] Ev 1

unlikely that CCS would be widely deployable before 2020.[26] Also, **unless the Government is able to show there is sufficient storage capacity there must be some question about the long-term viability of CCS.** The Royal Academy of Engineering noted:

> Even the most optimistic proponent of CCS would not envisage any demonstration plant to be operational much before 2015, which would put wide-scale deployment as far away as 2020 or later after lessons from the pilot have been learned and digested.[27]

14. This uncertainty is of vital importance when considering the likely environmental impact of coal-fired power stations. E.ON UK told us that they could not fully guarantee that Kingsnorth power station would be fitted with CCS, in spite of their clear intention to do so.[28] Until CCS is developed, all existing and new coal-fired power stations will be running unabated, with all the negative environmental impact this entails. We cannot emphasise strongly enough that **the possibility of CCS should not be used as a fig leaf to give unabated coal-fired power stations an appearance of environmental acceptability.**

15. This increasing acceptance of coal gives us cause for considerable concern. It is based on security and affordability rather than environmental concerns; emissions reductions through CCS are no more than a promise for the future, and a long way from being a certainty. We are concerned that coal is being embraced as the line of least resistance, regardless of the damaging environmental consequences. Although our support for the development of CCS necessarily implies an acceptance of the continuing role of coal, coal plant must be developed with extreme caution, and with due regard for its substantial environmental implications. We also note with concern the most recent comment of James Hansen, of the NASA Goddard Institute, that scientific evidence on CO_2 concentrations and tipping points demands no less an approach than a total moratorium on the development of unabated coal-fired power stations.[29] **The current momentum for new coal-fired plant is not taking adequate account of its environmental impact and the challenges of developing and deploying CCS technology.**

16. EON.UK and the Government have tried to account for the unabated running of new coal-fired power stations in two ways. Firstly, they have argued that the new, more efficient plants will 'make a contribution to lower emissions' because they emit around 20 per cent less CO_2 than the old coal-fired power stations they are replacing.[30] This argument is misleading, and a distraction. The Government admitted to us that even with this 20 per cent reduction in emissions, coal-fired electricity generation still emits more CO_2 than any other form of electricity generation available.[31] **Replacing old coal-fired power stations with new ones, rather than using alternative energy sources, locks Britain in to a high level of emissions for many years to come. The increased efficiency of new plants is**

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[26] Ev 13

[27] Ev 60

[28] Q25

[29] Dr James Hansen, Briefing to the US House of Representatives Select Committee on Energy Independence and Global Warming, June 23 2008.

[30] Ev 1, Q36

[31] QQ 36-38

nowhere near enough to make unabated coal an environmentally acceptable choice. Any alternative form of electricity generation would provide significantly more substantial emissions reductions.

17. Secondly, EON.UK and the Government argued that new, unabated coal-fired power stations will have no impact on overall emissions because the EU Emissions Trading Scheme (EU ETS) will account for any extra emissions produced. The Government said:

> Any new coal plant will have no impact on the overall emissions effort by the EU as it will need to operate within the EU ETS cap, so neither CCS nor carbon emissions would form part of our assessment of any application.[32]

It is true that, in theory, the EU ETS cap should keep emissions within a certain limit. However, the Government is wrong to rely on the EU ETS cap to excuse the increase in emissions that would derive from the new unabated coal-fired power stations. Emissions included in the EU ETS do not disappear—they must be accounted for somewhere. The EU ETS is a mechanism designed to reduce emissions; using it as a cover for choosing high emissions technology goes against the purpose of the scheme. Furthermore, it completely ignores the risks to Britain's economic position if the carbon price rises substantially in Phase Three of the EU ETS. The Government should prioritise emissions reductions within the UK as soon as possible.

18. We appreciate Mr Wicks' argument that "those who reject coal […] have to answer the question about from where we will get our energy supply." **The Government argues that coal has a role to play in meeting energy demand. If this is true then the Government must prioritise the development of commercial scale CCS. However, the argument that coal is essential to guarantee energy supply must not be abused. Unless there is a dramatic technological development, coal should be seen as the last resort, even with the promise of CCS. We are concerned that the Government is considering opening the door to a new era of coal-fired generation because it is the easy option, and one that generators will be only too willing to take. Such an approach is extremely dangerous both environmentally and economically when there is no certainty over when, or if, CCS will be commercially viable.**

19. The consequences of new unabated coal-fired power stations could be damaging, both for the prospects of meeting UK emissions targets, and for the UK's claim to an international leadership role on climate change. **The Government should make clear to industry that it will not permit the operation of unabated coal-fired power stations in the longer-term. The Government must take more urgent and ambitious steps to incentivise the development and retrofitting of CCS and, equally importantly, to prevent the prolonged operation of unabated coal-fired power stations.** In section 5 we make some recommendations on how this might be done.

[32] Ev 17

4 CCS Ready

20. A new build power station that is 'CCS Ready' will have fulfilled certain conditions that will enable it to retrofit CCS technology in the future, once the technology has been proved viable. The use of CCS readiness as a planning condition will be essential should the Government permit the construction of new fossil fuel-fired power stations before CCS technology has been demonstrated commercially. CCS readiness has already been included as a condition in the planning permission of a handful of gas-fired power stations, although the status of this requirement is far from clear.[33]

21. EU proposals for a Directive on the Geological Storage of Carbon Dioxide would require all new combustion plants of 300MW or above to be CCS ready. The Government has stated: 'our interim position is a positive one in regards to the intention of the carbon capture readiness proposal, but we are seeking more clarity about its scope and how the Commission intend it to be implemented'.[34] However, EON.UK said that, although there was no direct requirement for CCS readiness, it had become clear that planning applications for fossil fuel-fired power stations were unlikely to succeed unless they did make such provision.[35] This shows that the Government and planners are already sending a signal to operators that CCS readiness should be a consideration in their applications. However, in the absence of a large-scale demonstration project, the definitions of CCS readiness are necessarily vague. Some require little more than the provision of land alongside the power station, where a future CCS plant could be built.

22. CCS readiness is only half the battle. The term 'CCS ready' is too often conflated with an assumption that the power station *will* have CCS in the future. E.ON UK told us:

> The proposed new Kingsnorth power station will be built carbon capture ready and, once the technology has been demonstrated at a commercial scale, we will retrofit CCS to the new units as soon as regulatory and market conditions reward the investment.[36]

As we have already shown, even once CCS has been shown to be technologically viable, the challenge of making it commercially attractive will remain. **There is no guarantee that a plant approved on the basis that it would be CCS ready will actually be willing or able to retrofit CCS once the technology has been demonstrated on a commercial scale. We believe that planning permission granted on the condition of CCS readiness is meaningless unless the Government places a requirement on all power generators to retrofit CCS as soon as it is available and to shut down any power stations which are not then fitted with CCS. Such a requirement would need to be supported by continued investment in research and development and action to ensure that CCS becomes commercially viable.**

[33] QQ 96-97

[34] Ev 16

[35] Q5

[36] Ev 1

5 Making it happen

23. CCS is expensive and challenging. It is anticipated that the cost of building the first CCS plant could be anything up to £500m, on top of the £1bn cost of a new coal-fired power station.[37] Retrofitting CCS at a station like Kingsnorth is likely to cost more than £1.1bn.[38] CCS plants will incur extra build, operational and infrastructure costs over conventional power stations. There is significant uncertainty over the scale of these costs: 'the absence of experience with fully integrated commercial projects means that costs estimates for CCS differ considerably and have significant uncertainty attached to them'.[39]

24. It is also evident that the installation of CCS technology, whether as part of a new development, or retrofitted to an existing plant, will have a negative impact on the output and efficiency of the plant. Defra have estimated that fitting CCS could increase the fuel needs of a power station by between 10 and 40 per cent, depending upon the type of plant and the technology used.[40] Approval on the basis of being 'CCS ready' is no guarantee that a generator will choose to retrofit CCS technology once it becomes available. The high cost of installing and running CCS makes it even less likely this will happen. The full cost of retrofitting CCS will not be known until the technology has been demonstrated on a commercial scale.

25. The Government is relying on the carbon price to drive investment in CCS:

> As the EU ETS is strengthened and the cap tightened year on year, emissions allowances will become increasingly expensive. This will make the more expensive abatement options, such as CCS, cost-effective. At some point, the cost of emissions should reach a level where it should be cost-effective to retrofit CCS, as this will be cheaper than buying permits. When this point occurs depends on the carbon price and the costs of fitting and operating the CCS chain. It will not be cost effective to retrofit before the price is right.[41]

The Government is staking everything on the carbon price, yet the current price of carbon is entirely inadequate to deliver investment in the development and deployment of CCS. Even the Energy Minister noted 'prima facie, there is no profit at the moment in storing carbon dioxide'.[42] In our inquiry into the 2007 Pre-Budget Report, Centrica told us 'with the current Emissions Trading Scheme and the uncertainty around the future carbon price, no commercial entity would build a clean coal project today'.[43] This lack of bite from the carbon price in incentivising carbon abatement technologies is already partly evident from the generators' willingness to develop coal as a future power source in the first place.

[37] ENDS Report 396, January 2008, *King coal promises to clean up*

[38] WWF, *Evading Capture—Is the UK Ready for Carbon Capture and Storage*, May 2008

[39] Ev 34

[40] Defra Science Notes 6, March 2008, Carbon Capture and Storage.

[41] Ev 17

[42] Q 62

[43] Environmental Audit Committee, Third Report of Session 2007–08, *The 2007 Pre-Budget Report and Comprehensive Spending Review: An environmental analysis*, HC 149-I and HC 149-II, Q 86

Although E.ON UK state that the carbon price 'provides a natural incentive to think carefully before we build coal plant,'[44] it was clearly not enough of an incentive to dissuade them from seeking to build an unabated coal-fired power station at Kingsnorth.

26. Nor can we rely on the carbon price to incentivise investment in or retrofitting of CCS technology in the future. E.ON UK estimated a carbon price of €40 per tonne of CO_2 for retrofitting CCS to coal-fired plants to be commercially viable. This seems compatible with some predictions for the cost of carbon: the Government cites an EU estimate of a forward price of carbon of €39 for 2013 to 2020, while E.ON estimated that €40 to €50 per tonne 'is a credible, realistic target as we move towards the back end of the third phase'.[45] However, other estimates place the cost of retrofitting CCS significantly higher. Greenpeace cites a Climate Change Capital estimate of a carbon price of between €90-155 per tonne of CO_2 to make retrofitting of CCS cost effective.[46] The UK Energy Research Centre states that 'many estimates exist of the support needed to avoid losses on demonstration plant, typically stated to be a total of €70-100 per tonne of CO_2'.[47] It also set the predicted EU ETS Phase 3 price at €30. With this less optimistic assessment, the gap between the carbon price and the cost of CCS is enormous. Even with the Government's more positive figures, the Minister recognised the uncertainties regarding the future carbon price:

> I hope that the strengthening of carbon markets in Europe but maybe elsewhere—there are signs of that in North America—will bring forward a sufficiently good price for carbon that it will provide some of the financial incentive for CCS. Will it be enough? I do not know.[48]

With even the Energy Minister recognising that there is no guarantee the carbon price will reach a sufficient level to incentivise the deployment of CCS, it is evident that the Government will need to accompany its faith in the carbon market with measures to mandate the installation of CCS technologies.

27. As CCS is developed and made more widely available, the cost of implementation could fall as the carbon price is rising, leading to a smaller gap between the two figures from 2020 onwards.[49] ScottishPower noted that before this happens, 'some sort of bridging support is likely to be needed to ensure sufficient deployment to bring the costs down to an economic level'.[50] The primary difficulty, therefore, lies in getting CCS technology up and running, and widely deployed, in the next 15 years or so.

28. The Government describes its role as ensuring that 'there is a suitable range of generation technologies available for operators to choose from'.[51] But the Government

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[44] Q 9

[45] Q 22

[46] Ev 54

[47] Ev 37

[48] Q 50

[49] See, for example, Ev 39, and also *Carbon Capture and Sequestration—A report for the London Accord*, JP Morgan, p22.

[50] Ev 59

[51] Ev 13

must make clear to industry and investors that CCS is not only desirable, it is essential. The Carbon Capture and Storage Association set out the views of the industry on this matter:

> Most investors accept that CCS will become mandatory at some point in the lifetime of a new plant and believe CCS is an important part of the climate mitigation mix. They are therefore not uncomfortable about a statement that anticipates this. Their concerns relate to firstly, fixing a timescale [for the commercial introduction of CCS, and related measures aiming to encourage this] and secondly, facing an unstable long-term regulatory environment'.[52]

29. The Government must provide this statement, and give the necessary signals to industry. **We cannot rely solely on the carbon price, either now or in the future, to ensure the implementation of CCS technology. There is a real risk that the EU ETS will not deliver a carbon price that will make CCS cost effective.** The Government must investigate financial support needed above and beyond the price signal sent by the EU ETS, to encourage and facilitate the installation of CCS technology as soon as it has been proven technically viable. CCS will not be viable for commercial operation without an instrument that helps to account for commercial losses from capital and operational costs. The Government notes that:

> the successful deployment of CCS involves the formation of new business models to supply the equipment and services in a way that optimises plant and operating costs, electricity consumption, transport and storage facilities and that integrates these complex processes into a resilient chain.[53]

30. The Government also recognises that it has a role in helping the market to address these issues. **In our Report on the 2007 Pre-Budget Report we recommended that the Government 'introduce some form of financial mechanism for incentivising CCS power plants over conventional power stations', such as a feed-in tariff for CCS plants, or contracts which guarantee funding for the difference in costs between CCS and conventional plants.[54] The Government response to our Report failed to discuss the merits of such measures, instead reiterating the role of the carbon price. We fear that the carbon price will not deliver the level of incentive that is needed in the short- to medium-term. We urge the Government to develop and bring forward additional mechanisms that will provide an incentive for CCS.**

31. The Government must go beyond financial mechanisms and implement a regulatory requirement to prevent coal-fired power station from operating unabated beyond a certain date. There are two main options for implementing such a requirement. The Government could implement a proposal similar to that suggested by the Royal Society that planning permission is only granted to new coal-fired power stations on condition that operating permits would be withdrawn if the plant failed to capture 90% of its carbon emissions by 2020.[55] Alternatively, the Government could seek to impose an upper limit on permitted

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[52] Ev 45

[53] Ev 13

[54] Environmental Audit Committee, Third Report of Session 2007–08, *The 2007 Pre-Budget Report and Comprehensive Spending Review: An environmental analysis*, HC 149-I, para 28

[55] Letter from Lord Rees of Ludlow, President of the Royal Society, to Rt Hon John Hutton MP (Secretary of State for Business, Enterprise and Regulatory Reform), 1 April 2008

emissions from power stations, and set the limit so that unabated coal-fired power stations could no longer operate. This approach has been adopted in California, where an initial maximum of 500kg CO_2/MWh requires coal-fired plants either to fit CCS, or face eventual closure. An approach of this kind is supported by, among others, the Institution of Mechanical Engineers, and environmental groups such as Greenpeace, WWF, Friends of the Earth and RSPB. Greenpeace have proposed a UK standard of 350kg CO_2/MWh, 'a level which could be achieved by an efficient gas-fired power station which makes some use of waste heat'.[56] It is estimated that a newer, more efficient coal plant such as Kingsnorth would emit around 700kg CO_2/Mwh if built without CCS.[57]

32. **The Government cannot allow the prolonged operation of unabated coal stations; doing so will make it very unlikely the Government will meet its own carbon reduction targets. The Government should set a date by which all power stations will have to have emissions per unit of power generated below a certain limit (set in terms of kg CO_2/MWh) or face closure. This limit should be based on capturing at least 90% of carbon emissions. By setting such a deadline and making its intentions clear a strong signal will be sent to the power generation industry about the future of coal and the importance of CCS.** This approach is opposed by certain generating companies because it will mean that investors will need to put money into CCS before it is cost-effective.[58] We believe that a deadline remains necessary for this very reason—if we wait too long for CCS to become cost-effective, the environmental damage will be unacceptable. The environment cannot absorb the impact of coal-fired generation indefinitely, while waiting for the carbon price to provide the incentive.

33. Our proposal for a deadline to be set for power generators to achieve a certain emissions performance would need to be supported by the other measures we have called for in this Report: the ongoing research and development across the sector (paragraph 8); the full evaluation of financial mechanisms that could help CCS to become economically viable (paragraph 32); and an acceptance that the Government cannot rely solely on the EU ETS and carbon price to ensure the development and retrofitting of CCS (paragraph 17 and paragraph 31).

[56] Ev 54

[57] The Guardian, *CO_2 plan threatens new coal power plant*, 13/06/08

[58] See, for instance, Ev 59.

Conclusions and recommendations

1. We welcome the competition on post-combustion CCS from coal and recognise that it will make an important contribution. However, we feel it would aid the development of CCS if the Government were to extend its support to a programme of demonstration projects, including pre-combustion technology. Furthermore, the Government must view its competition as only one part of a wider strategy; it must continue to support other CCS projects including the development and integration of the individual components and new CCS technologies. While undoubtedly valuable, the competition must not detract effort and resources from other work on CCS within the UK. The timely development of a range of CCS technologies would also give the UK a clear competitive advantage on the global stage. (Paragraph 8)

2. We are extremely disappointed by the lack of progress on CCS. (Paragraph 9)

3. It is essential for the Government to give a far higher priority to the development of CCS. It must communicate and follow a clearer and more urgent strategy in order to speed this development and provide a stronger signal to industry. The indecision that has afflicted the development of CCS up to now must end; any further delay will be extremely damaging environmentally and will mean that the chance to gain a competitive advantage is being squandered. (Paragraph 10)

4. Unless the Government is able to show there is sufficient storage capacity there must be some question about the long-term viability of CCS. (Paragraph 13)

5. The possibility of CCS should not be used as a fig leaf to give unabated coal-fired power stations an appearance of environmental acceptability. (Paragraph 14)

6. The current momentum for new coal-fired plant is not taking adequate account of its environmental impact and the challenges of developing and deploying CCS technology. (Paragraph 15)

7. Replacing old coal-fired power stations with new ones, rather than using alternative energy sources, locks Britain in to a high level of emissions for many years to come. The increased efficiency of new plants is nowhere near enough to make unabated coal an environmentally acceptable choice. Any alternative form of electricity generation would provide significantly more substantial emissions reductions. (Paragraph 16)

8. It is true that, in theory, the EU ETS cap should keep emissions within a certain limit. However, the Government is wrong to rely on the EU ETS cap to excuse the increase in emissions that would derive from the new unabated coal-fired power stations. Emissions included in the EU ETS do not disappear—they must be accounted for somewhere. The EU ETS is a mechanism designed to reduce emissions; using it as a cover for choosing high emissions technology goes against the purpose of the scheme. Furthermore, it completely ignores the risks to Britain's economic position if the carbon price rises substantially in Phase Three of the EU ETS. The Government should prioritise emissions reductions within the UK as soon as possible. (Paragraph 17)

9. The Government argues that coal has a role to play in meeting energy demand. If this is true then the Government must prioritise the development of commercial scale CCS. However, the argument that coal is essential to guarantee energy supply must not be abused. Unless there is a dramatic technological development, coal should be seen as the last resort, even with the promise of CCS. We are concerned that the Government is considering opening the door to a new era of coal-fired generation because it is the easy option, and one that generators will be only too willing to take. Such an approach is extremely dangerous both environmentally and economically when there is no certainty over when, or if, CCS will be commercially viable. (Paragraph 18)

10. The Government should make clear to industry that it will not permit the operation of unabated coal-fired power stations in the longer-term. The Government must take more urgent and ambitious steps to incentivise the development and retrofitting of CCS and, equally importantly, to prevent the prolonged operation of unabated coal-fired power stations. (Paragraph 19)

11. There is no guarantee that a plant approved on the basis that it would be CCS ready will actually be willing or able to retrofit CCS once the technology has been demonstrated on a commercial scale. We believe that planning permission granted on the condition of CCS readiness is meaningless unless the Government places a requirement on all power generators to retrofit CCS as soon as it is available and to shut down any power stations which are not then fitted with CCS. Such a requirement would need to be supported by continued investment in research and development and action to ensure that CCS becomes commercially viable. (Paragraph 22)

12. With even the Energy Minister recognising that there is no guarantee the carbon price will reach a sufficient level to incentivise the deployment of CCS, it is evident that the Government will need to accompany its faith in the carbon market with measures to mandate the installation of CCS technologies. (Paragraph 26)

13. We cannot rely solely on the carbon price, either now or in the future, to ensure the implementation of CCS technology. There is a real risk that the EU ETS will not deliver a carbon price that will make CCS cost effective. (Paragraph 29)

14. In our Report on the 2007 Pre-Budget Report we recommended that the Government 'introduce some form of financial mechanism for incentivising CCS power plants over conventional power stations', such as a feed-in tariff for CCS plants, or contracts which guarantee funding for the difference in costs between CCS and conventional plants. The Government response to our Report failed to discuss the merits of such measures, instead reiterating the role of the carbon price. We fear that the carbon price will not deliver the level of incentive that is needed in the short- to medium-term. We urge the Government to develop and bring forward additional mechanisms that will provide an incentive for CCS. (Paragraph 30)

15. The Government cannot allow the prolonged operation of unabated coal stations; doing so will make it very unlikely the Government will meet its own carbon reduction targets. The Government should set a date by which all power stations will

have to have emissions per unit of power generated below a certain limit (set in terms of kg CO2/MWh) or face closure. This limit should be based on capturing at least 90% of carbon emissions. By setting such a deadline and making its intentions clear a strong signal will be sent to the power generation industry about the future of coal and the importance of CCS. (Paragraph 32)

Formal Minutes

Tuesday 15 July 2008

Members present:

Mr Tim Yeo, in the Chair

Mr Martin Caton	Mark Lazarowicz
Colin Challen	Mr Graham Stuart
Mr David Chaytor	Jo Swinson
Mr Ian Liddell-Grainger	Dr Desmond Turner
Martin Horwood	Joan Walley

Carbon Capture and Storage

The Committee considered this matter.

Draft Report (*Carbon Capture and Storage*), proposed by the Chairman, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 33 read and agreed to.

Resolved, That the Report be the Ninth Report of the Committee to the House.

Ordered, That the Chairman make the Report to the House.

Written evidence was ordered to be reported to the House for printing with the Report.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Wednesday 16 July 2008 at 2.20pm

Witnesses

Wednesday 4 June 2008

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Bob Taylor, Managing Director (Generation) and **Sara Vaughan**, Director of Regulation and Energy Policy, E.ON UK Ev 5

Malcolm Wicks MP, Minister for Energy, **Martin Deutz,** Head of Cleaner Fossil Fuels Unit, and **Bronwen Northmore**, Policy Director, Cleaner Fossil Fuels Unit, Department for Business, Enterprise and Regulatory Reform Ev 18

List of written evidence

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2	Client Earth	Ev 62
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5	Doosan Babcock Energy Ltd	Ev 52
6	E.ON UK	Ev 1:Ev 10
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8	Greenpeace UK	Ev 53
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17	The Royal Academy of Engineering	Ev 59
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List of Reports from the Committee during the current Parliament

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2007–08

First Report	Are biofuels sustainable?	HC 76-I & -II (HC 528)
Second Report	Reducing Carbon Emissions from UK Business: The Role of the Climate Change Levy and Agreements	HC 354 (HC 590)
Third Report	The 2007 Pre-Budget Report and Comprehensive Spending Review: An environmental analysis	HC 149-I & -II (HC 591)
Fourth Report	Are Biofuels Sustainable? The Government Response	HC 528 (HC 644)
Fifth Report	Personal Carbon Trading	HC 565
Sixth Report	Reaching an international agreement on climate change	HC 355
Seventh Report	Making Government operations more sustainable: A progress report	HC 529
Eighth Report	Climate change and local, regional and devolved government	HC 225
Ninth Report	Carbon capture and storage	HC 654

Session 2006–07

First Report	The UN Millennium Ecosystem Assessment	HC 77 (HC 848)
Second Report	The EU Emissions Trading Scheme: Lessons for the Future	HC 70 (HC 1072)
Third Report	Regulatory Impact Assessments and Policy Appraisal	HC 353 (HC 849)
Fourth Report	Pre-Budget 2006 and the Stern Review	HC 227 (HC 739)
Fifth Report	Trade, Development and Environment: The Role of FCO	HC 289 (HC 1046)
Sixth Report	Voluntary Carbon Offset Market	HC 331 (HC 418)
Seventh Report	Beyond Stern: From the Climate Change Programme Review to the Draft Climate Change Bill	HC 460 (HC 1110)
Eighth Report	Emissions Trading: Government Response to the Committee's Second Report of Session 2006–07 on the EU ETS	HC 1072
Ninth Report	The Structure of Government and the challenge of climate change	HC 740 (HC 276)

Session 2005–06

First Report	Greening Government: the 2004 Sustainable Development in Government Report	HC 698
Second Report	Sustainable Timber	HC 607 (HC 1078)
Third Report	Sustainable Procurement: the Way Forward	HC 740
Fourth Report	Pre-Budget 2005: Tax, economic analysis, and climate change	HC 882 (HC 195)
Fifth Report	Sustainable Housing: A follow-up report	HC 779
Sixth Report	Keeping the lights on: Nuclear, Renewables, and Climate Change	HC 584 (HC 196)
Seventh Report	Sustainable Development Reporting by Government Departments	HC 1322 (HC 1681)
Eighth Report	Proposals for a draft Marine Bill	HC 1323 (HC 1682)
Ninth Report	Reducing Carbon Emissions from Transport	HC 981
Tenth Report	Trade, Development and Environment: The Role of DFID	HC 1014 (HC 197)
Eleventh Report	Outflanked: The World Trade Organisation, International Trade and Sustainable Development	HC 1455 (HC 354)
Twelfth Report	Transport Emissions: Government Response to the Committee's Ninth Report of Session 2005–06 on Reducing Carbon Emissions from Transport	HC 1718

Oral evidence

Taken before the Environmental Audit Committee

on Wednesday 4 June 2008

Members present

Mr Tim Yeo, in the Chair

Colin Challen	Mark Lazarowicz
Mr David Chaytor	Jo Swinson
Martin Horwood	Dr Desmond Turner
Mr Nick Hurd	Joan Walley

Memorandum submitted by E.ON UK

Diversity in Fuel Supply and the Role of the Coal-fired Generation and Carbon Capture and Storage

Key Points

By 2020 we expect 25GW of new generating capacity to be needed to replace closing coal, oil and nuclear power stations and meet some demand growth. This is one third of total UK capacity.

The UK faces a massive challenge as we seek to achieve reductions in carbon dioxide emissions whilst making sure that electricity supplies remain secure and affordable for consumers.

Delivery of this investment should not be taken for granted and there is a risk that the UK will find itself with capacity shortages, with adverse consequences for the reliability and price of energy which policy makers need to take seriously.

Unless the goals of lower CO_2 emissions, secure and affordable energy are met in a balanced way, we believe the goal of reducing carbon emissions will be put at risk.

We believe that the UK needs a diverse range of energy sources for power generation to achieve these objectives.

More efficient use of energy is vital and renewable energy technologies can also meet some of this generation gap but they cannot bridge it on their own.

Continuing construction of gas-fired plants alone will leave the UK highly exposed to the price and availability of gas. This could lead to rises in the price of gas and power in the medium term with adverse consequences for consumers and the UK economy.

We believe some new, more efficient, coal-fired capacity is justified to ensure the diversity of energy sources we need to provide secure and affordable energy supplies.

We recognise that new coal-fired power generation still gives rise to significant CO_2 emissions, and therefore carbon capture and storage (CCS) will be required in the longer term. However, new coal plant will make a contribution to lower emissions as CO_2 emissions per unit of output will be of the order of 20% lower than the plants they are replacing.

The proposed new Kingsnorth power station will be built carbon capture ready and, once the technology has been demonstrated at a commercial scale, we will retrofit CCS to the new units as soon as regulatory and market conditions reward the investment.

We have entered Kingsnorth power station into the Government's CCS demonstration competition and see this as a tremendous opportunity to demonstrate CCS technology.

CCS is an essential technology if CO_2 emissions from fossil-fired plants in China, India and other countries reliant on coal are to be reduced and global emission reduction targets are to be met.

Without Kingsnorth or a similar supercritical plant, post-combustion CCS cannot be demonstrated at a commercial scale in the UK.

E.ON UK

1. E.ON UK is one of the largest retailers of electricity and gas in the UK and has over seven million customer accounts nationwide. We are the second largest generator in the UK, with over 10GW of existing capacity and produce electricity from gas, coal, and renewable energy sources. We distribute electricity to five million customers in the Midlands through Central Networks.

2. E.ON is one of the largest developers of renewable technologies in Europe. E.ON has 7,300MW of renewable energy in operation in Europe and North America and by 2010 intends to invest about €6 billion in this sector. We expect to double this capacity to 15,000MW by 2015 and triple this capacity by 2030. In the UK we have one of the UK's first offshore wind farms in operation at Scroby Sands and operate one of the UK's largest biomass generating plants at Steven's Croft. We are also building the Robin Rigg offshore wind farm in the Solway Firth. We have consent for the London Array Project in the Thames Estuary, which would be one of the largest offshore wind farms in Europe, and have applied for consent to build the 300MW Humber Gateway offshore wind project.

3. We are also developing a number of distributed technologies including microCHP and ground source heat pumps (in which we are the market leader), and biomass-based CHP and district heating schemes. We are very actively encouraging consumers to use less energy with new innovative products such as real time displays.

4. We have a substantial programme of investment in new plant to replace the coal and oil stations we are closing. We are building a gas-fired combined heat and power plant in Kent and have approval to build a gas-fired combined cycle gas turbine (CCGT) plant in the Midlands. We have also applied for consent to build a new coal-fired station at Kingsnorth, alongside the existing station which will close. Kingsnorth has been entered into the Government's competition to demonstrate CCS technology at a commercial scale. We explain the reasons for this in the rest of our evidence below. We wish to build at least two nuclear plants in the UK and have entered into an agreement with AREVA and Siemens to help deliver those plants.

The need for investment, diversity and the role of coal-fired generation

5. The scale of the investment challenge facing the UK power sector is daunting. 8.7GW of coal and 3.7GW of oil-fired capacity, which have been opted out of the Large Combustion Plants Directive, will close by 2015, and 7.4GW of nuclear plants will have closed by 2018 unless their operating lives are extended. Assuming growth in demand of 0.5% annually, the UK may need 25GW of new capacity by 2020. This is one third of present total UK generating capacity of 75GW. From our own perspective, we will have closed our coal-fired plants at Ironbridge and Kingsnorth (2.9GW) as well as our 1.3GW oil-fired plant at Grain—about two-fifths of our total generation—by 2015 and need to replace that generation. Delivery of all this investment should not be taken for granted and there is a risk that the UK will find itself with capacity shortages with adverse consequences for the reliability and price of energy which policy makers need to take seriously. We have stressed to Government the need to put in place a planning and regulatory framework which incentivises its delivery.

6. We also need to meet this generation gap while continuing to provide secure electricity supplies for our customers, reduce CO_2 emissions, and doing what we can to keep prices as affordable as possible. These potentially conflicting objectives need to be met in a balanced and sustainable way. If energy is not secure and affordable, public attention will shift to the priorities of keeping warm and paying their bills, and away from reducing CO_2 emissions, making the policy goal of reducing emissions much more difficult to achieve.

7. If these objectives are to be met in a balanced way, we believe we need to retain a diverse range of energy sources for power generation. In 2007 the UK generated 43% of its electricity from gas, 34% from coal, 15% from nuclear and 5% from renewable sources, with the remainder met by oil and net imports. This diversity provides important benefits and reduces our exposure to changes in the price and availability of any one fuel source, enhancing the security and affordability of the price of energy to the consumer. We need to retain this diversity in future while continuing to reduce CO_2 emissions.

8. More efficient use of energy is vital and renewable energy can also meet some of this generation gap. We expect to see a major increase in the volume of electricity from renewable energy sources, particularly in light of the proposed EU targets for renewable energy for 2020, and this will help deliver a large reduction in emissions from the UK power system. However, from a security of supply perspective, wind has some drawbacks. Wind farms will only generate about one third of their theoretical maximum throughout the year and less than 10% of UK wind capacity can be relied on to meet peak demand at any one time. This means that nearly all wind capacity has to be backed up with generating capacity from alternative sources to provide for those times when wind speeds are too low or too high. Renewable electricity can also be very expensive. For example, the current lifetime cost of generating electricity from offshore wind farms is around twice the current average annual cost of power on the UK wholesale market.

9. Distributed technologies also have a potentially significant role to play. However, some of these technologies such as micro-wind and photovoltaic cells are still very expensive and will not make a major contribution for some years. Even in Germany with very high levels of financial support, electricity production from solar energy is only around 0.3% of total electricity production. Some are reliant on gas

as a fuel source. Others such as biomass-based district heating schemes are logistically complex and raise local air quality issues. The availability of sufficient biomass which meets sustainability criteria is also an issue as is the potential effect on food supplies.

10. Some of this gap will be met by gas-fired plant and indeed a number of gas-fired CCGT plants are under construction, including our plant at Grain. It would be possible to build more. They have relatively low capital costs and can be built quickly. However gas prices have risen to very high levels and the outlook is uncertain. We are concerned that continuing construction of gas-fired plants alone will leave the UK highly exposed to the price and availability of gas, just as the UK's domestic gas supplies decline and as we become much more reliant on imported gas. We already expect to be 80% dependent on imported gas by 2020. This could have adverse effects on the price of gas and power with potentially severe consequences for consumers and the UK economy. If no new coal or nuclear plants are built, then the UK could be 70% reliant on gas for power generation by 2030.

11. New nuclear will also make a contribution. However, no more than one or two plants are likely to be in operation by 2020 and none by 2015.

12. We believe that some new, more efficient, coal-fired capacity is therefore needed to provide a secure and affordable transition to a low carbon energy system. This will be cleaner coal, with CO_2 emissions per unit of output being 20% lower than the plants they are replacing. In terms of CO_2 reduction this is preferable to keeping existing plants in operation but we recognise this can only be a transitional solution to the CO_2 impact. The longer-term potential for coal-fired generation within a low carbon world lies with the potential to fit CCS technology which can capture and permanently store 90% of the CO_2 emissions from the plant. Without CCS, we do not see a long-term role for coal fired generation. The proposed new Kingsnorth power station will be built carbon capture ready and, once the technology has been demonstrated at a commercial scale, we will retrofit CCS to the new units as soon as regulatory and market conditions reward the investment.

13. We have therefore applied for consent to build the new Kingsnorth power station to help bridge the generation gap in a way which will help the UK to meet all its energy goals. We also see it as a tremendous opportunity to demonstrate CCS technology and accelerate its roll-out. CCS is an essential technology if CO_2 emissions growth from fossil-fired power plants from China, India and other countries reliant on coal are to be reduced. It also means that the capability will exist to achieve radical reductions in CO_2 emissions from the new coal and gas plants we build in the UK. The Government's competition requires the submission of bids based on post-combustion capture of emissions. This effectively requires the construction of a supercritical plant as it is not economically feasible to retrofit it to existing coal plants on a commercial scale. Without Kingsnorth or a similar supercritical plant, post-combustion CCS cannot be demonstrated at a commercial scale in the UK, which would be an opportunity lost. We discuss CCS further below.

14. From an environmental perspective gas plants have lower emissions than coal but the economics of retrofitting CCS to gas plant is much less attractive, perhaps requiring a carbon price of €80/tonne to be commercially viable compared to around €40/tonne for coal. In time all fossil-fired plant is likely to need CCS if we are to meet our 2050 targets but gas plant would be fitted with CCS much later than coal plant assuming a continuing upward rise in carbon prices.

Kingsnorth and Government Policy

15. Government energy policy recognises the need for a diverse electricity generation mix to help deliver secure energy supplies and in particular that coal-fired generation can make an important contribution to the UK's energy security and the flexibility of the UK energy system. However, it also acknowledges that, in order to have a long term future, the environmental impact of coal must be managed effectively. We see our application for consent to build Kingsnorth together with our entry of Kingsnorth into the Government's CCS competition as very much supporting that approach.

16. The UK has a competitive energy market and this approach allows generators to make their own choices regarding investment within the framework of energy and environmental policy put in place by Government which is designed to ensure that the market works in a way which is consistent with achieving the Government objectives in a balanced way. In terms of climate change, the principal policy mechanism which applies to the generation of electricity is the EU Emissions Trading Scheme (EU ETS). This works by imposing a cap on total emissions from power generators and other large sources of CO_2 emissions. The European Commission has proposed that CO_2 emissions from the sectors covered by the EU ETS should by 2020 be 21% below 2005 levels and 30% below 2005 levels if there is a comprehensive international agreement. This approach allows generators to determine how best to provide secure and affordable supplies within this overall cap which ensures that total CO_2 emissions continue to decline.

17. This means that any new coal plant built will have to buy CO_2 emission allowances from the market, preventing any other power station from using them. Thus new coal plant will not in fact give rise to any increase in overall emissions—they will only generate if they can displace emissions from other units, most likely older and less efficient coal units elsewhere in Europe.

18. We expect the EU ETS to continue to drive CO_2 emissions downwards to a point where the power sector is largely or entirely carbon free by 2050. Carbon capture and storage technologies will make some contribution to the 2020 target and will have a major role to play in achieving the 2050 objective.

19. For companies such as ours, stability in Government energy policy is vital. Constant changes in the rules of the game create risks for investors and make it far more difficult to justify investments commercially. The Government has only recently set out its overall approach to energy in its 2007 Energy White Paper *Meeting the Energy Challenge*. Governments are of course entitled to make changes, and may wish to alter the balance in the priority they give to climate change, security of supply and affordability objectives. But the consequences need to be fully spelt out. They also need to allow time for investors to adjust taking account of the long lead times for capital investment in this sector.

Current state of play with Kingsnorth

20. E.ON submitted an application to the Government for consent to build the new Kingsnorth power station in December 2006, which will be built next to the existing station which will be closed when the new station is completed. The local planning authority, Medway District Council, raised no objections to the application and neither did the statutory consultees[1] although a number made other comments. The Secretary of State considers the application in light of the views of the planning authority and the statutory consultees and in the context of its overall approach to energy and environmental policy.

21. We have made clear that the new Kingsnorth station will be capture ready in that it is designed to facilitate the retrofitting of CCS once it is commercially demonstrated. This involves configuration of the plant to facilitate the capture of CO_2 emissions, the provision of sufficient space for installation of CCS equipment, and identification of a route for a pipeline connection to an appropriate sub-sea geological storage facility.

22. There is, however, ambiguity about the meaning of "capture ready". In the light of this, E.ON UK proposed in March 2008 that the Government should not decide on the project until after it had completed its consultation on what this means in the context of consent conditions. We hope the Government will publish its consultation as soon as possible. However, we do not now expect a decision on the project until later in the year. We have not withdrawn or deferred our application for consent and we expect discussion of other potential consent conditions to continue on a timetable which would not delay a decision further.

23. At the same time, E.ON UK announced its intention to enter Kingsnorth into the Government's CCS demonstration competition. We expect BERR to confirm whether the bid has been short-listed for further assessment in the next few weeks. A final decision is expected in 2009. There is a limit to what more we can say about the bid publicly as it is in competition with other projects.

24. Kingsnorth also has potential to supply heat to housing developments, public and commercial buildings. We have identified illustrative potential heat loads mainly to the west of the power station arising from existing and new developments proposed in the Medway, Gravesham and Dartford areas as part of the Thames Gateway development. This feasibility work will continue over the next few months.

Carbon Capture and Storage and Government Policy

25. We believe the development of CCS technology is essential if global CO_2 emissions from fossil-fired plants are to be reduced and global emission reduction targets are to be met. Many countries do not have access to large gas reserves and coal-fired generation is the only viable source for much of the power needed to support their populations. There are a number of technological options for capture but all involve transmission of CO_2 under pressure by pipeline to a geological storage facility.

26. For an independent view, the IPPC has published a special report on the technology. http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf. This states that 'CCS has the potential to reduce overall mitigation costs and increase flexibility in achieving greenhouse gas emissions as one of a number of mitigation technologies which also include nuclear power, renewable energy sources, enhancement of biological sinks, and reduction of non-CO_2 greenhouse gases'. While demonstration of post-combustion CCS technology at the scale of a large coal-fired plant is a significant engineering challenge, it is important to recognise that the technology is already available and in operation at smaller scales.[2] E.ON is well placed to develop this technology given its extensive engineering experience available at its Power Technology Centre in Nottingham and at its sister facilities in Germany.

[1] Statutory consultees include English Nature, Environment Agency, Medway Council, Kent Wildlife Trust, Kent County Council, Countryside Agency, English Heritage, RSPB, Medway Ports Authority and Hoo St Werburgh Parish Council.

[2] To quote the IPPC: "Post-combustion capture of CO_2 in power plants is economically feasible under specific conditions. It is used to capture CO_2 from part of the flue gases from a number of existing power plants. Separation of CO_2 in the natural gas processing industry, which uses similar technology, operates in a mature market. The technology required for pre-combustion capture is widely applied in fertilizer manufacturing and in hydrogen production. Although the initial fuel conversion steps of pre-combustion are more elaborate and costly, the higher concentrations of CO_2 in the gas stream and the higher pressure make the separation easier. Oxyfuel combustion is in the demonstration phase and uses high purity oxygen. This results in high CO_2 concentrations in the gas stream and, hence, in easier separation of CO_2 and in increased energy requirements in the separation of oxygen from air."

27. The Government has been criticised for developing CCS too slowly and for choosing post-combustion technology only for its demonstration competition. From our perspective it would of course have been desirable if the Government had decided to support the demonstration of the technology earlier, and to have funded clean coal technology generally on a more consistent basis at higher levels of funding. On the other hand the UK is the only country which has committed to fund a commercial demonstration project so far. The key issue now is to ensure that this commitment is carried forward. As far as the choice of technology is concerned we support the choice of post-combustion technology given that only one project will be supported and that a key objective is to demonstrate the technology so that it can be applied to the bulk of coal-fired plants which are or will be under construction in China and elsewhere.

28. We believe that further demonstrations of CCS technology at a commercial scale are very important, including pre-combustion technology with an integrated gasification combined cycle (IGCC) plant which has the potential to integrate CCS into power generation on a more economic basis in the longer term. It seems unlikely that the Government will be able to support further projects in the very short term given the other pressures on public expenditure. We should therefore look to funding from other European countries either for further projects in the UK or elsewhere in the EU. The US has its own FutureGen project which our sister company E.ON US is supporting. This project will need renewed focus after the Presidential elections later this year.

22 May 2008

Witnesses: **Mr Bob Taylor,** Managing Director (Generation), and **Ms Sara Vaughan,** Director of Regulation and Energy Policy, E.ON UK, gave evidence.

Q1 Chairman: Thank you very much for coming. You will know that there is a great deal of interest in this subject. We have arranged this brief inquiry at relatively short notice, so we appreciate your co-operation. We have tight time constraints this afternoon; we have until 2.45 but no later. By that time you may be perfectly happy to leave anyway. In the interests of getting on with the substance of the exchanges I will skip the formal introductions. Perhaps you would begin by telling us what role E.ON sees coal playing in its electricity generation portfolio in future?

Mr Taylor: Thank you very much. Coal certainly plays a very important role at the moment. We expect that it will play a smaller but nevertheless important one in the future. To us the next decade seems almost the most challenging that has faced energy in the UK since the middle of the previous century. If we look at the challenge ahead of us with the approaching energy gap as a result of older coal and nuclear plants closing, up to one third of the UK's capacity will need to be replaced. That combined with the move to approximately 80 per cent gas imports and the need radically to reduce carbon emissions probably sets the most challenging situation we have ever faced. When it comes to the Kingsnorth investment that goes very much to the heart of the diverse energy mix and the debate about the trade-offs with regard to coal. To put it in the context of E.ON, over the next five to seven years we shall be closing 40 per cent representing 4.2 gigawatts of our total UK capacity. To replace that is an incredible challenge in itself. In the context of energy policy we intend to address it by a major renewables programme that is under way. Members of the Committee are probably aware of the London array, Scrobie Sands and a number of major offshore schemes in addition to our existing portfolio. We are building two major gas-fired power stations, one in the Isle of Grain and one for which we have section 36 permission at Drakelow in the Midlands. We aspire to becoming involved in nuclear in the UK, but that will take some time and will not help to solve the 40 per cent capacity close out between now and 2015. Within that comes the role of coal. If we do not build Kingsnorth our portfolio will move to over 80 per cent gas. We do not believe that is wise for our customers and the business, hence our support for a diverse energy mix. As far as we are concerned the role of coal in the short to medium term is driven by security and affordability and naturally opens up the debate as part of the mix in terms of its carbon intensity.

Q2 Chairman: But if we are serious about cutting emissions—some of us believe that is at least as important, if not more important, a driver than price and security—how can any new coal-fired capacity be justified?

Mr Taylor: We intend to build Kingsnorth carbon capture-ready, but even in advance of carbon capture being able to abate any emissions from that plant it will be part of the emissions trading scheme. That scheme provides an overall cap for all of the fossil-fired generation in Europe. The impact of building or not building Kingsnorth will not change the overall cap. We shall have to buy emissions permits and the effect is that Kingsnorth, which will be more efficient than older coal-fired power stations which have the appropriate equipment—for example so-called UK opted-in plant which has the environmental equipment on it—will be displaced by a more efficient plant. The emissions trading scheme provides the overall driver to make sure there is not a dash for coal in a sense.

Ms Vaughan: The emissions trading scheme has a decreasing cap going towards 2020. The target agreed with the Commission is that the cap should decrease by 21 per cent from 2005 levels by 2020. That of itself will drive a reduction in carbon emissions.

Mr Taylor: These two points are critical when we think about the decision on Kingsnorth. It goes to the heart of the trade off which is implicit in an

energy policy, but when decisions come along they must be explicit and that is when it becomes more difficult. That plus a belief in the overall mechanism of the emissions trading scheme are two important factors in which people would have to believe in order to see the merit of Kingsnorth contributing to the mix at this point.

Q3 Chairman: Therefore, is it E.ON's strategy that it can justify choosing the most polluting method to generate electricity and salve its conscious by buying some credits abroad?
Mr Taylor: Our response is that we support a diverse energy mix.

Q4 Chairman: Including the most polluting ones?
Mr Taylor: Only if necessary to support a diverse portfolio and strike a balance between carbon emissions, security and affordability. After all, if one looks at the mix of our portfolio we are changing coal from 50 per cent potentially to 20 or 30 per cent over that period. Beyond that as we build nuclear and renewables, we hope we will be able to shift that mix even further.

Q5 Dr Turner: You have entered the government's CCS competition. Had you always envisaged Kingsnorth as a potential CCS project?
Mr Taylor: We have been developing Kingsnorth for about two and a half years and it has become increasingly clear that whether we are building a gas or coal project we do not expect to get consent for a new fossil-fired power station in the UK without it being carbon capture and district heating-ready. As to the consent for Drakelow which we obtained last year, that is a gas-fired power station and that consent is also based on it being carbon capture-ready.

Q6 Dr Turner: Is district heating envisaged for Kingsnorth?
Mr Taylor: We have made an initial feasibility study to look at potential heat loads around the Medway towns. We now intend to bring that forward and work collaboratively with local authorities in that area to investigate the potential for a heat load and the supply and use of waste heat from Kingsnorth as part of that activity. It is incredibly difficult to put in place those kinds of schemes. We have them elsewhere in our group, for example in Sweden and Germany where district heating forms a much more major part, but we shall certainly investigate that. Regardless of whether or not we have that scheme ready we shall ensure that the plant is capable of interfacing with that kind of scheme in future.

Q7 Dr Turner: What do you believe will be the impact of retrofitting CCS to stations in terms of CO_2 emissions? What reduction do you anticipate?
Mr Taylor: If, as we hope, we move towards full scale we expect CCS to remove as much as 90 to 95 per cent of CO_2.

Q8 Dr Turner: You say that you will fit CCS once the technology has been demonstrated on a commercial scale and, more importantly, as soon as regulatory and market conditions reward the investment. That could be a long time off and possibly could not happen at all. One wonders whether the competition entry and the promise of CCS readiness is something of a fig leaf to cover a standard coal-fired station. You have not quite justified why you are going for coal in particular when it could be taken as the line of least resistance and you could put your energies into another London Array, for instance, and achieve the same goal.
Mr Taylor: If one compares Kingsnorth with a London Array, one has different attributes from a wind farm, as I am sure you are aware. I described the balance of the portfolio a little earlier. That is extremely important. We have seen some of the impacts of that over recent years. We have seen gas and coal shift depending on their relative prices. When we think of our portfolio we look at potential fuel prices in future and test different scenarios against different mixes. If we moved to an extreme position of over-dependence on gas then under certain circumstances that would be very significant in terms of increased cost of wholesale prices.

Q9 Dr Turner: You have said that in the absence of CCS coal is very much a short-term fix, so why not wait until CCS is ready before building it? You are taking a bit of a risk with our atmosphere, are you not?
Mr Taylor: If we build Kingsnorth as we intend, we are taking a risk as to what happens to the carbon price. Whilst Kingsnorth is unabated those permits will become increasingly scarce and more expensive and so that is one element that we have to take into consideration. It provides a natural incentive to think carefully before we build coal plant. I come back to another two reasons for fossil plant in the short to medium term. One is the capacity gap and the balance. The other is the support of an increasingly large renewables portfolio. We have a portfolio that we intend to make even larger. The implications of having large volumes of wind in the system by 2020 mean that we need the ability to support that as well. I do not believe that coal will not have a long-term role if we do not solve the issue of carbon capture and storage. As a group we believe that if we do not solve CCS coal will not have a role beyond the next two decades, and in the decade after next it will have an increasingly smaller role. The challenge of developing carbon capture and storage is a realistic one. This is not new science or new technology. In our view to commercialise carbon capture and storage over the next decade is a realistic challenge.

Q10 Dr Turner: You are absolutely right that it does not involve a single piece of new technology. Each single part of the chain has already been demonstrated, so it is a question of assembling it as a package. Therefore, the technology risks are very

much minimised compared with a completely new technology. Given that, how quickly do you think you can get it up and running?
Mr Taylor: The rules of the government's competition are that we need to be able to demonstrate the process chain by 2014, to scale it up as soon as possible beyond that and have it fitted to a modern super-critical coal-fired plant of 300 megawatts net on a commercial scale by 2018. We are now getting into the competitive element of our bid. I am sure that one of the key criteria will be a judgment about the value of being able to put in place scale as soon as we can as well as the overall cost of the proposal that we would be making.

Q11 Dr Turner: Are you saying that you could shorten that timescale?
Mr Taylor: I think it really depends on the options we present in our bid. There are pros and cons in moving very fast with the technology at this stage. We have to establish the process chain and then gain value from it. Most of the research and development that will happen on post-combustion carbon and capture over the next decade will be about reducing the energy intensity of the technology. That is a very important factor. There could be value in working in phases so we do not waste public money, and we shall be coming forward with some options about risk and about phasing and create some choices around how we can bring forward that technology.

Q12 Dr Turner: But in the meantime if Kingsnorth is licensed it will operate unabated. Can you justify that? Further, if a licence was declined, what would happen? Would you be able to manage your energy portfolio?
Mr Taylor: If consent to build Kingsnorth was declined most probably we would have to revert to gas. Some people may feel very good about that. Earlier I talked a little about why we would believe that to be the wrong answer. We come back to the three issues: do we believe in a diverse energy policy or not? Do we believe in the effectiveness of the emissions trading scheme to cap the overall emissions from that unabated plant? Do we provide investors like ourselves with the choice but also the risk of building either coal or gas, albeit we have to take the consequences of that within the competitive market of emissions trading?

Q13 Dr Turner: What difference would it make to the prospects of retrofitting at Kingsnorth if you did not win the competition?
Mr Taylor: Competition or not, our intent is that that would be a modern super-critical plant carbon capture-ready. E.ON anyway, is involved in a whole host of other activity with carbon capture and storage. It is the commitment of the group to commercialise carbon capture and storage by 2020. Our CEO Wulf Bernotat has said that we do not expect to build another coal-fired power station anywhere in the group internationally beyond 2020 without carbon capture and storage. He has qualified it by saying it is subject to our achieving commercialisation and I believe that is realistic.

Q14 Mr Hurd: Can you give the Committee some sense of the different economics for E.ON in relation to the two scenarios of gas and coal at Kingsnorth?
Mr Taylor: We can talk about the basic generating costs and give you a flavour of them. Embedded within them are our views of the base case long run marginal cost of the various fuels. If I remember rightly, we envisage that it would be about £45 per megawatt hour for gas, up to £50 per megawatt hour for unabated coal and up to £55 per megawatt hour for coal with CCS. [1]That compares with onshore wind at about £70 per megawatt hour and offshore wind at about £100 per megawatt hour. Those assume various underlying fuel costs. As you test those according to different scenarios for fuels you might have a situation where the long run marginal cost of gas even for a period would shift and coal would be higher in the merit order during that period, hence the value of a diversified portfolio.[2]

Q15 Mr Hurd: What about the relative capital cost?
Mr Taylor: It is more expensive to build a coal-fired power station than a gas-fired power station. In a sense the first priority is to build gas which is what we have been doing. We have two gas-fired projects, and everybody else has been building gas. It is the only fossil plant that has been built since privatisation. All of the plants we are closing out are in some respects amongst the most inefficient in the world. If you look at China, which in 2006 built 90 gigawatts' worth of coal capacity, its plants are more efficient than a lot of the plants within our system in the UK. If we are serious about proving carbon capture and storage and demonstrating it on the back of a modern super-critical plant we have to build either Kingsnorth or an equivalent to provide us with the platform to do it.

Q16 Mr Hurd: To understand the decision better, given those economics your preference for coal may be a bit about diversity but it is a lot about your uncertainty and fear about the long term direction of travel in terms of the price of gas?
Mr Taylor: Yes. I referred earlier to the UK becoming 80 per cent dependent on gas by 2020. That is a major factor. If we sit here with a portfolio that is 80 per cent gas we feel very exposed.

Q17 Mark Lazarowicz: If my question is dealt with in the evidence you submitted[3] I apologise, but, to be clear, how many other coal-fired power stations do you envisage building in the UK in due course?

[1] *Note by Witness:* The cost is £40 to £45, per megawatt hour for unabated coal, not £50 and up to £70 per megawatt hour for coal with CCS, once commercially established, not £55. That compares with onshore wind at about £75 per megawatt hour, not £70 and offshore wind at over £100 per megawatt hour.
[2] See Ev 10
[3] See Ev 1

Mr Taylor: Are you talking about E.ON?

Q18 Mark Lazarowicz: Yes.
Mr Taylor: At the moment we have no active development beyond Kingsnorth. We hold various sites which are potential locations for future coal-fired as well as gas-fired power stations, but at the moment Kingsnorth is our active development.

Q19 Mark Lazarowicz: Presumably, if you see potential for CCS then you must see an opportunity for further coal-fired generation within the UK?
Mr Taylor: Yes. Perhaps I may explain the phasing of CCS. What we are really talking about during the next decade is the commercialisation and refinement of CCS to make it available for deployment. If we can do that we remove the trade off I talked a little about earlier which underlies a diverse mix and energy policy. Certainly, if we can make CCS work to remove that trade off then it unlocks the opportunity to use it across our portfolio. If we look at the long-term generation mix of E.ON and its broad view up to 2030 and beyond, we are really talking about 50 per cent of our generation portfolio coming from renewables and nuclear and the balance from gas and clean coal which we hope will incorporate carbon capture and storage. I paint a broad picture there.

Q20 Mark Lazarowicz: I understand that it is a broad picture and clearly at this stage you cannot be firm about some of the projections, but you must have some idea of what that means in terms of possible coal-fired power stations if the technology is right. What numbers are we talking about?
Mr Taylor: Across E.ON?

Q21 Mark Lazarowicz: In the UK.
Mr Taylor: At the moment we have only Kingsnorth under active development. It depends on the period at which we are looking. I really cannot see us bringing forward more than one more coal-fired power station before 2020 and I would even question that, but never say never. We are not under active development with another one at the moment, but for me that would be perceived as the maximum we would bring forward before 2020.

Q22 Mark Lazarowicz: Briefly, you understand our concerns. Is there any argument from the governmental or regulatory perspective about giving you some kind of incentive or imposing some kind of penalty if you do not deliver CCS by a certain date? Would that not be a good incentive on you to deliver the goods?
Mr Taylor: I shall sound a bit like a broken record about the ETS here as well. As we see scarcity across allowed emissions under the cap we expect also to see a significant movement in the carbon price. In the second phase it has reached about €25 per tonne; as we go into the third phase from 2012 with auctioning being part of the process we can easily see the carbon price starting to reach a level that incentivises and meets the long-term cost of operating commercialised carbon capture and storage. I believe that €40 to €50 per tonne is a credible, realistic target as we move towards the back end of the third phase, maybe even before then. Whilst we have to prove the technology—we are talking about very significant costs here—the competition that the government has proposed, which is the first one of its kind in terms of scale, could provide the kind of transitional support that is necessary to bring forward this technology and refine it over that period.

Q23 Martin Horwood: I want to question what you describe as the extreme alternative scenario of 100 per cent gas. Surely, that is not the alternative scenario; the alternative is accelerated development of carbon capture and storage with coal and a mix of sources including renewables. How can you be confident enough about carbon capture and storage to say it is 100 per cent certain this will be CCS-ready and yet not confident enough to invest in that accelerated development with CCS in place?
Mr Taylor: I just need to understand the question. Perhaps you would pose it again.

Q24 Martin Horwood: You said that the alternative scenario was an extreme one, that is, 100 per cent gas, but that is not the alternative. If you are forced to it by being refused permission for Kingsnorth the alternative is much faster investment in coal-fired stations with CCS in place. I am just trying to understand how you can be so confident in the technology that this will be CCS-ready but not sufficiently confident to have that alternative investment.
Mr Taylor: Is it worth my explaining what I mean by "CCS-ready"? I think that will be part of the consultation with which the government will come forward. What we mean by that is that engineering and assessment studies have been carried out to understand the full barriers to retrofitting CCS to a power station post-construction. That may mean that the configuration or design of the sub-systems, the layout and identification of a suitable storage site and a credible route to that site have all been assessed and can be presented to a competent authority which then assesses whether that site is a credible capture-ready power station. That is what we mean by being capture-ready.

Q25 Martin Horwood: In terms of credibility, are you 100 per cent confident that Kingsnorth if built will one day be fitted with carbon capture and storage?
Mr Taylor: One hundred per cent is a tough test.

Q26 Martin Horwood: What is your confidence level?
Mr Taylor: That is a really difficult question. This is not about basic science or technology; it is about engineering this chain and testing it at scale. In reality, until we understand the true economics of operating an integrated carbon capture and storage system at scale, I find it difficult to answer.

Q27 Martin Horwood: You must understand that your inability to answer that question raises real doubts about CCS-ready as a claim.
Mr Taylor: That takes us to an interpretation of what we mean by "CCS-ready". The other side of that equation is the ability to come forward later with commercialised carbon capture and storage, to go to a vendor, to be able to procure the capture plant and to have the confidence that you can operate that integrated system. I understand your point.

Q28 Joan Walley: To follow up what you mean by carbon capture-ready and what you would need to do to be in such a position in respect of this particular planning application, how does that square with your plans presumably to provide similar investment perhaps elsewhere or use that innovation in other countries?
Mr Taylor: We are preparing Kingsnorth as a carbon capture-ready plant and appropriate consideration is given in the design and so forth to allow it to be retrofitted along the lines of the definition I gave a second ago. A critical part of the competition will be the ability to exploit the technology wider than just within E.ON. We fully expect that in a sense this is a partnership where as part of our proposal we collaborate with experts and also government to seek to exploit the technology. You will know better than me what is happening in China and India. If we do not solve carbon capture and storage a lot of the other things become in some senses an intellectual irrelevance. We really must sort that out.

Q29 Joan Walley: How much is the planning application that we are now talking about a demonstration project for what is a much wider investment programme? Would you be looking to do this in respect of what you said about the energy mix and gas if competition and opportunities globally in terms of sharing technology and technology transfer did not exist?
Mr Taylor: If I understand your question, we are heavily involved in CCS anyway; we have a whole portfolio of much smaller pilot projects in both pre-combustion, as it is called, and post-combustion. We see CCS as a core element of our being able to have coal as part of our portfolio in the long term. As to Kingsnorth, we have been very clear certainly about the planning application and the consent. We expect Kingsnorth to be conditional on our making it carbon capture-ready, but in terms of demonstration and competition how we deal with that is part of the competition process. The arrangements and structure of the competition would need to be dealt with as part of that process. We would be in a very difficult situation if we had planning consent for Kingsnorth which was conditional upon winning the competition or not. There is no guarantee that we would win the competition. We have a need for coal as part of the plan to close our capacity gap and provide that portfolio anyway in the short to medium term. I am being quite honest and clear about differentiating these things: capture-ready consent and district heating consent for Kingsnorth; Kingsnorth being within the emissions trading scheme; in the mean time, the overall cap controlling anything that is abated from Kingsnorth in the event we did not win the competition; and then, as part of the competition if we were successful, how we could exploit it in terms of applying it to Kingsnorth.
Ms Vaughan: I believe I discerned from your question that we intended to build Kingsnorth before the competition was announced because our view about the UK's need and our need for Kingsnorth to fill our portfolio was all about the energy gap, our belief in diversity and our wish to avoid over-dependence on gas, so that was there first.

Q30 Colin Challen: I ask for clarification on two points. First, in this morning's press your chief executive Paul Golby said that meeting the 50 gigawatts required from renewables to achieve the EU 20 per cent target by 2020 would require 90 per cent of that amount to be backed up by coal and gas to ensure supply through intermittent periods. Perhaps we can have some written analysis that E.ON has done to back up that statement.[4] You do not need to respond now; I just ask for clarification. Second, to digress from Kingsnorth, in paragraph 11 of your memorandum[5] you say that new nuclear will also make a contribution and no more than one or two plants are likely to be in operation by 2020. Is that simply E.ON's own contribution to nuclear, or is it your anticipation of the UK-wide contribution to new nuclear?
Mr Taylor: It is our anticipation of UK-wide new nuclear build based on the current programme. We would not expect more than one or two plants and the soonest those plants would come on stream would be 2018 and 2019.
Chairman: Thank you very much for coming in; it is much appreciated.

[4] See Ev 10)
[5] See Ev 1)

Supplementary memorandum submitted by E.ON UK

Q14. The Individual Costs (£/MWh) for each Technology

	Total Cost no Carbon	*Carbon Price €20/te*	*Carbon Price €40/te*
CCGT	44.3	51.8	59.3
Coal	41.7	56.4	70.8
Coal + CCS[3, 4]	67.7	69.2	70.7
Nuclear	38.6		
Onshore Wind	75.0		
Offshore Wind	107.0		

1. This note responds to a request from the Committee to explain the basis for the statement that a high % of wind capacity needs to be "backed up" by thermal plant to meet winter peak demand.

Variability in Wind Generation

2. Wind generation and thus its contribution to meeting electricity demand varies with wind speed. A typical single 3MW wind turbine generates no electricity output when wind speed is less than about 3 metres per second (m/s), reaches its maximum output at about 15 m/s, and shuts down when wind speed reaches around 25 m/s to preserve its physical integrity.

3. A single wind farm with a number of turbines will smooth or average this effect as wind speed will vary somewhat across the area of the wind farm. For example at an average wind speed of about 3 m/s there will be some output because the wind will be above that speed at some locations and below it at others. On the same basis, it is less likely that the wind speed will be high enough across the entire area to deliver maximum output from all wind turbines. For a small part of the year (less than 1%) an individual wind farm is close to full output, but for much of the year it generates far less and for 15-20% of the year it generates no output.

4. The effect of operating a portfolio of wind farms is to smooth this effect further, with less variation in output across the year. The portfolio never reaches full output and peak output is around 80% of full capacity, but there is only a very small portion of the time when there is virtually no output.

Correlation between wind output, season and time of day, and with electricity demand

5. The extent to which wind speed, and thus output from wind generation, correlates with periods of high electricity demand is important in assessing the extent to which we can rely on wind generation to meet winter peak electricity demand. Winter is generally windier than the summer, with the median output for a winter day higher than in the summer. However, on the coldest days (with temperatures below zero), there tends to be little to no wind, corresponding to winter anti-cyclones. There is an increased risk of very low wind speeds, with wind generation output less than 10% of theoretical maximum, on high demand days.

6. It is also important to recognise that the output of windfarms are correlated with each other, so that if a particular windfarm is suffering a lack of wind it is very likely that those nearby are too, and even the most distant windfarms are less likely to be generating. This is a result of weather systems such as windless anticyclones being large enough to affect all of the UK.

7. The precise correlation between UK wind generation and wind speed is complex and needs further analysis but, overall, we conclude that the relationship between the level of UK wind power output and UK electricity demand is very weak and, at best, the availability of wind generation is no better during high demand periods than in periods of lower demand.

Assessment of the extent to which we can rely on wind to generate to meet winter peak demand

8. From the point of view of the system operator (National Grid) who must schedule sufficient capacity in order to meet winter peak demand with a very high degree of probability, an assessment must be made of how likely it is that the capacity available will in fact operate at the time required. For this purpose, planned outages and weekend maintenance can be ignored as they are highly predictable and scheduled for low demand periods.

9. Excluding these factors, the weekday availability (actual availability/maximum total availability) of thermal (ie burning coal, gas, oil or biomass) plant over the winter period is about 95% with breakdowns accounting for 5% of maximum total availability. Crucially, breakdowns are generally not correlated with each other. There are exceptions and these have to be taken into account (such as loss of gas supply at a number of stations, or type faults), but they are generally a small effect. So, if a unit at Station X is

[3] These costs are based on one view of future fuel prices and capital costs.
[4] These costs are based on one view of future fuel prices and capital costs.

unavailable, there is no reason to suppose that another unit at a different station is going to be unavailable. This means that conventional units are very effective at backing each other up, especially when the portfolio contains a mixture of plant types and fuels.

10. To assess the extent to which investment in wind capacity will be able to replace thermal plant on the system while ensuring that peak demand can be met at the same level of reliability, we need to assess how much wind capacity on the system can be relied on to meet peak demand at a dependability of 95%. Our assessment of winter wind generation data in 2007[5] indicates that the system operator could rely on 8% of total UK wind capacity to meet winter peak demand at the same level of dependability as thermal plant. On this basis, if the UK required, say, 40,000MW of wind capacity to meet its renewable target by 2020, only 8% of this renewable capacity (3,600MW) could be relied on to meet winter peak demand. This would avoid the need to build 3600MW of new thermal plant but the remaining 36400MW of renewable capacity would need to be "backed-up" by thermal plant to meet winter peak electricity demand in 2020. This effect could be to some extent mitigated by more extensive electricity interconnections with continental Europe (which would enable "back-up" power to be imported), the longer term development of new electricity storage technologies at a significant scale (which would be able to store power from the grid and produce it when required), or more demand side management capability which would enable demand to be varied in relation to the level of wind generation.

11. This assessment is consistent with other studies carried out in the UK and Germany,[6] where there is extensive experience of operating grids with large volumes of onshore wind. However, for the UK, the calculation should be refined in the light of a more detailed assessment of the actual wind portfolio likely in 2020, further analysis of the correlation between wind speed and demand and an analysis using data over a longer period, but we believe the broad implications for future generation requirements will remain valid. We recommend that the issue is explored in more detail as part of the Government's forthcoming consultation on delivery of the UK's share of its renewable targets.

June 2008

Memorandum submitted by BERR

Introduction

1. Atmospheric concentrations of carbon dioxide are at their highest levels for at least 650,000 years. If annual global emissions were to remain at today's levels, global carbon dioxide levels will reach double pre-industrial levels by 2050, with severe impacts on climate and the global economy. The Stern Review highlights the economic costs of failing to act to tackle climate change, estimating that the dangers of unabated climate change could be equivalent to at least 5% of GDP each year and could possibly rise to 20% of GDP or more if a wider range of risks and impacts are taken into account.

2. More than two thirds of the world's carbon dioxide emissions come from meeting energy demand. On the basis of present policies, the International Energy Agency (IEA) forecasts that global energy demand will be more than 50% higher in 2030 than today, with energy related greenhouse gases around 57% higher. Energy policy therefore needs to play a significant part in addressing the climate change challenge.

3. Our energy strategy, as set out in the 2007 Energy White Paper, aims both to provide the UK with secure energy supplies and contribute to the global climate change effort. Central to this strategy is a strengthening of the EU Emissions Trading Scheme which caps emissions from the power sector (and some other sectors), placing a market price on carbon, and drives a shift towards a low-carbon economy. Our strategy also includes support for new low carbon technologies and incentives for increased energy efficiency. It recognises that the UK is increasingly a net importer of fossil fuels and that our energy sector needs to undertake a programme of substantial investment in new infrastructure in the coming years.

4. Coal is, and will continue to be, a vital part of the UK's electricity generation mix, essential for providing us with secure, reliable electricity supplies. But with around a third of UK emissions resulting from electricity generation, we need to see a shift to lower carbon technologies if we are to continue to use coal-fired electricity and meet our 2050 climate change goals.

5. World-wide, fossil fuels are expected to remain the dominant source of energy world-wide, meeting 83% of the increase in energy demand. As the most abundant global fossil fuel and with characteristics that enable it to act as a flexible power source, responsive to needs, coal will continue to play a significant role in global electricity generation for the foreseeable future. The IEA estimates that, on present government policies, an increase in global coal demand of 73% by 2030, driven mostly by China and India.

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[5] Based on E.ON and E.ON contracted windfarms but assumed to be representative of all of UK.

[6] DENA Grid Study: *Planning of the Grid Integration of Wind Energy in Germany Onshore and Offshore up to the Year 2020* Cologne, February 2005.

6. The challenge in front of us is to reconcile the use of an abundant and flexible fuel to meet growing energy demands, with the urgency of the need to tackle global climate change. The ability to enable continued use of fossil fuels with greatly reduced emissions is what makes CCS such an important technology and it is why the UK Government is committed to taking steps that would enable global deployment of CCS.

7. It is in our vital interest that the technologies necessary to make coal low carbon are developed and deployed as rapidly as possible. The Government believes that the development and wide-scale deployment of CCS is therefore important for our climate change and security of supply objectives. In order for CCS to fulfil its potential, the technology must be demonstrated on a commercial-scale. This is why the UK Government is committed to supporting one of the world's first commercial-scale CCS demonstration projects, with a key objective of the project being the dissemination of knowledge and learning from the project in order to facilitate global deployment. Such a tangible demonstration of the Government's support for this technology will not only help to speed deployment of CCS but will also enhance our credibility when promoting CCS on the global stage.

8. This memorandum responds to the Committee's questions on coal, carbon capture readiness and carbon capture and storage. We cannot comment on live applications for new power plant.

What is the Government's assessment of the potential of CCS, in its various forms?

9. CCS technology has the potential to reduce emissions from fossil fuel power stations by up to 90% and is the only technology option currently available that has the potential to tackle emissions from large scale fossil fuel power plant. It also has the potential to be retrofitted to existing plant and can therefore tackle the carbon dioxide emissions "locked-in" by existing and planned fossil fuel power stations. The IEA suggests that CCS could contribute up to 28% of the global carbon dioxide mitigation by 2050, whilst the Stern Review estimates that to achieve stabilisation at 550ppm (or +2 degree C) without CCS will increase costs by more than 60%.

What role does the Government envisage CCS in playing in the UK energy mix, and towards meeting UK emissions reduction targets?

CCS and meeting UK emissions reduction targets

10. Given the clear need to tackle emissions from electricity generation as part of the climate change effort, we have put a long term strategy in place to deliver progressively lower emissions over time. At the heart of this strategy is the EU Emissions Trading Scheme (EU ETS), which was introduced in 2005 and has two fundamental components: a cap on emissions; and a system for trading the "right to emit".

11. The EU ETS cap sets a regulatory limit on the total emissions from the power sector and other large emitting industries across Europe. Some 11,000 installations, including the nineteen coal plants in the UK, are required to operate within this cap. The installations are required to obtain a permit for each tonne of CO_2 that they emit, and this requirement, together with an overall cap on emissions gives CO_2 a market value and creates a "carbon price". The trading part of the EU ETS sees permits allocated and/or auctioned to installations. Installations have to buy additional permits if they exceed the amount of emissions for which they have permits, and can sell permits they do not need. As the scheme is strengthened and the number of permits available is successively reduced, the incentives to abate emissions will increase.

12. What this means is that the total level of emissions for which the power sector is responsible is capped, at progressively lower levels. Plant operators need to either take abatement action on their plant to cut emissions or buy emissions permits, thus financing emissions reductions elsewhere. In this context, deployment of new technologies like CCS can affect the composition of the EU's emissions but not the level of emissions covered by the Scheme.

13. One significant benefit of this 'cap and trade' scheme is that it uses the power of the market to find the cheapest ways of reducing emissions, enabling us to tackle climate change at least cost and minimising the impacts on domestic and industrial fuel bills.

14. The Government believes that, once proven, CCS has the potential to be an important part of our emissions reduction effort, within the framework of EU ETS. However, if UK-based companies deployed CCS where not justified by the carbon price, this would have the effect of substituting CCS for more cost effective emissions reductions elsewhere. As a result there would be no net change in the overall level of EU carbon emissions.

15. Given the very real contribution CCS could potentially make to emissions reductions on a global scale, the UK government recognises the need to speed the widespread deployment of CCS. This is why we are supporting a commercial-scale demonstration project in the UK (further details below).

CCS as part of the energy mix

16. Our energy strategy is based on the principle that independently regulated, competitive energy markets, are the most cost-effective and efficient way of delivering our objectives. Within our regulatory framework, which includes the EU ETS cap, it is for the market to determine how to operate, including whether to invest in new fossil fuel power stations, with or without CCS. The carbon price is a key factor influencing their decision making.

17. Our role in assisting the market both to operate within the EU ETS cap and provide us with secure electricity supplies is to ensure that there is a suitable range of generation technologies available for operators to choose from. In the next 10 years or so, substantial electricity investment is needed—we expect there to be a need for new coal and gas plant, given the significant growth projected in renewable generation and the consequent need for flexible back-up, and the closure of older coal, oil and nuclear plant. By taking a leading role in developing and demonstrating CCS technologies, alongside measures to facilitate the deployment of nuclear and promoting the deployment of renewables, we are ensuring that there are a range of low carbon options available over the longer term.

18. Another key aspect of the regulatory framework for new and existing power stations is the Integrated Pollution Prevention and Control (IPPC) Directive, implemented through Regulations in the UK. Under these Regulations, the regulator sets pollutant emission limit values (ELVs) and other operating requirements set to provide a high level of protection for the environment for each power plant through its permit conditions. These permit conditions have to be based on the application of best available techniques (BAT) for pollution control. BAT are determined on the basis of technical and economic viability in the industry sector concerned. As BAT develop, regulators (the Environment Agency in England and Wales) are required to review permit conditions for new and existing plant and tighten them as appropriate. If CCS were successfully demonstrated, in technical and economic terms, the question would arise as to whether it could be determined as a BAT.

19. Given the significant uncertainty around the costs, technical requirements and risks associated with CCS, even moving as fast as we can it is unlikely that CCS will be widely deployable before 2020.

20. As CCS is not yet a proven technology, we are not in a position to require coal plants built in the UK today to be fitted with CCS. Were we to do so, the most likely result would be a voluntary moratorium on new coal build by the generating companies. This would make it harder to maintain security of supply.

When does the Government anticipate that CCS technology will be successfully demonstrated? When will CCS be ready for use on a significant commercial scale? Are we moving quickly enough?

21. The separate processes involved in CCS—capture, transport and storage—have been proven on an individual basis over many years. CO_2 capture has been part of refining and petrochemical process for decades, and CO_2 storage been demonstrated in a number of locations including the Sleipner field in the Norwegian North Sea and Weyburn in Canada. But the application of the full chain of CCS technology on a commercial-scale power station, which offers the greatest prize in terms of CO_2 reductions, has not yet been demonstrated. Commercial-scale demonstrations are required to help resolve the significant technical and cost challenges to be met and demonstrate the regulatory regime works. Assuming all of these hurdles are overcome, it is still unlikely that CCS will be widely deployed before 2020.

22. The rationale for pushing for demonstration projects to be operational by 2014 (the UK) or 2015 (the EU target) is so that a second tranche of projects can be constructed before we reach 2020, building on the experience of the first movers to help move CCS towards commercial viability by 2020.

23. In the UK we are moving as fast as possible on our demonstration project. It is critically important that our competition is transparent and robust. We are undertaking a unique procurement and must ensure that companies have sufficient time to fully understand the Government's requirements and undertake the design and engineering preparatory work required during the final stages of the competition. Alongside the competition we are also working on putting in place an appropriate regulatory framework to enable the permanent storage of carbon dioxide.

24. To move from one demonstration project to commercial deployment is not just a matter of proving technology. The successful deployment of CCS involves the formation of new business models to supply the equipment and services in a way that optimises plant and operating costs, electricity consumption, transport and storage facilities and that integrates these complex processes into a resilient chain. This new business of CCS then needs efficient finance, supported by effective supplier and operator warranties. These are all important factors in achieving the commercial viability required for deployment, but only the market can address them. The demonstration project catalyses action in resolving some of these issues and will help us to understand how the Government can help the market address the issues and what actions may hinder progress.

How is the consultation on CCS progressing?

25. The Government will be consulting shortly on various aspects of the European Commission's proposed EU Directive on the geological storage of carbon dioxide. This consultation will cover further detail on our proposed offshore regulatory regime for the storage of carbon dioxide, our proposed policy on carbon capture readiness, and our proposed approach to any other aspects of the Directive where our position is not already defined. We are planning for the normal 12 week consultation period and for decisions by Ministers on the responses to the consultations in time to inform the UK's negotiating position. We hope that the negotiations on this Directive will be concluded under the French Presidency in the latter half of this year.

What are the most crucial issues that the consultation seeks to address? Are there any issues that remain unresolved?

26. In general the Government supports much of the approach of the proposed Directive on geological storage and therefore the consultation focuses on areas where our policy is not yet defined: such as the conditions for transfer of the long term liabilities in relation to CO_2 storage sites to the State and the nature of the financial security that ought to be provided by storage operators. One of the potentially most significant proposals in the draft Directive is a requirement for Member States to take into account the carbon capture readiness of new combustion plant when deciding whether it can be built. This will be a key aspect of the consultation.

What is the Government's strategy for encouraging and supporting the development of CCS? What is the Government doing in addition to the CCS competition?

27. The UK champions CCS as part of its support for Carbon Abatement Technologies (CAT)—the menu of options available to reduce emissions from fossil fuels. From the G8 climate change discussions at Gleneagles in 2005, which raised the profile of emissions from fossil fuels significantly, and the publication of the DTI's Carbon Abatement Technologies Strategy in the same year the Government has recognised CCS as a critical building block in tackling global emissions. We have put in place a wide range of activities which, together, are making a significant global contribution to moving CCS forward. These include:

28. *Research and development*. At the level of basic research the Natural Environment Research Council and the Engineering and Physical Science Research Council are funding a £2.2m project consortium led by Imperial College to explore issues related to CCS. For industry-led applied research the Technology Strategy Board has provided £11m to support 16 CAT projects.

29. The newly formed Energy Technologies Institute—a 50:50 partnership between Government and industry, its current membership of BP, Caterpillar, EDF Energy, E.ON UK, Rolls-Royce and Shell aims to raise up to £1.1 billion over ten years for transformational research and development in low-carbon energy technologies—has identified CCS as a priority area for support.

30. We also manage small programmes of bilateral R&D relating to CATs with the USA and China.

31. *Demonstration*. Aside from sponsoring the UK demonstration project, in 2005 the Government established a fund of £25 million (since increased to £35 million) to encourage the industry-led demonstration of assemblies and elements that contribute to Carbon Abatement Technologies including CCS. So far one oxyfuel project has been supported and in Budget 2008 the Chancellor announced that a new call would be launched during this year. We are also working very closely with the Chinese Government to support an EU initiative for a Near Zero Emissions Coal project in China which will incorporate CCS.

32. *Regulation*. The Energy Bill includes enabling powers establishing the regulatory framework, and we will be launching a consultation shortly on the detail of how that should be implemented. Internationally the Government has been a key player in seeing through amendments to the London and OSPAR Conventions which regulate waste in the marine environment and which needed to be adjusted for the new possibility of sub-sea storage of CO_2. We are now working to encourage ratification of the OSPAR amendment. We are also working to ensure that CCS is appropriately reflected in the EU Emissions Trading Scheme going forward, and more widely that it is included in the Clean Development Mechanism—which is essential to encourage the deployment of CCS in emerging economies and developing countries.

33. *International*. The UK is an active member of multilateral organisations dedicated to making rapid progress towards deployment of CCS, including the International Energy Agency's Greenhouse Gas and Clean Coal programmes and the Carbon Sequestration Leadership Forum. We also collaborate on a bilateral basis with many countries. With Norway the shared resource of the North Sea has led to constructive cooperation under the North Sea Basin Task Force, the success of this Task Force is demonstrated by the fact that the Netherlands and Germany have since joined.

34. We are in the process of a significant lobbying exercise to push for ambitious wording in the G8 Energy Ministers statement that will commit the G8 nations to taking forward action on CCS. Within the EU we are working closely with the European Commission and other Member States to ensure the quick agreement of the draft Directive on the geological storage of CO_2, and we are also in discussions as to

whether there are further mechanisms that could be implemented at the EU level to incentivise CCS demonstration projects in order to meet the European Commission's ambition of up to 12 such projects operational by 2015.

35. The UK has funded the Phase 1 assessment of the wider EU-China Near-Zero Emissions Coal agreement signed in 2005, which has the objective of commercial demonstration of CCS for coal fired power generation in China by 2020. The UK also works bilaterally with several countries (including the US, Australia, France, India) to undertake various activities to promote the deployment of CCS.

36. *Post-demonstration*. The Government is also starting to consider the framework that will be required to deploy CCS widely, within the UK and globally, assuming the technology is successfully proven through demonstration. This includes issues such as effective sharing of information from a global network of demonstrations, including the UK demonstration project; how the supply chain for CCS might develop across the three elements, capture, transport; and the development of infrastructure, particularly pipeline networks. This work is in its very early conceptual phase and will be developed further over the coming months.

What does the Government hope to achieve through the CCS competition?

37. The benefit to industry of a commercial-scale demonstration of the full chain of CCS technologies would be the reduction of uncertainty on a range of technical, construction, operational and regulatory/planning factors that affect the costs of CCS. This benefit should be captured by power generators requiring a lower risk premium in the rate of return on the electricity produced from commercial CCS plant than they would if these plants had to be built and commissioned without the learning provided by a demonstration plant.

38. In addition to this generic benefit to the UK of the demonstration project, there are also the potential benefits to UK-based industry of the UK hosting one of the world's first commercial-scale CCS projects. Initial, and very rough, estimates suggest that in the period up to 2030 the UK's market share in the export market created by global deployment of CCS technology is estimated to amount to about £10 billion for equipment manufacture and £5bn for engineering consultancy and licensing of key technologies. Between 2030 and 2050 the UK may gain additional sales worth about £15 billion to equipment supplies and £7 billion for consulting engineering and licensing. In terms of job benefits this could equate to CCS sustaining around 20,000 to 25,000 jobs per year.

39. There are also substantial benefits to the UK in being one of the first to demonstrate the full chain of CCS technologies on a commercial-scale power station in terms of backing up our continued aim of leading the world in tackling global climate change. Taking concrete action to expedite the deployment of a technology that could be decisive in bringing emissions down to sustainable levels gives the UK credibility in international climate change negotiations.

40. But perhaps the most important benefit, and one that is really unquantifiable, is the influence that the UK demonstration project will have on bringing CCS towards the realms of commercial viability more quickly than would be the case without our demonstration project. Demonstrating the effectiveness of CCS on commercial-scale power plants is a pre-requisite to wider deployment. Industry will not take the risk of this demonstration on their own, so without firm government commitment it is possible that this technology may not reach commercial viability within the timescales required to bring carbon emissions down to sustainable levels. The actions taken by the UK Government to demonstrate CCS at a commercial-scale and to disseminate widely the knowledge and experience gained through this project in an effort to speed widespread deployment will have a significant positive benefit in bringing forward commercial viability and the subsequent widespread deployment.

Why is the Competition limited to coal and post-combustion capture?

Fuel type

41. CCS technologies are applicable to gas fired and coal fired power stations (as well as industrial point sources). But it is the application of CCS to coal-fired power stations that provides the largest benefits in terms of emissions reductions due to their higher specific carbon dioxide emissions per unit of electricity produced at around 750g/kWh compared to gas fired combined cycle plant (CCGT) at around 350g/kWh. A 90% capture capability on each would give 675g/kWh saving for coal plant or a 315g/kWh saving for gas CCGT.

42. On the basis of present policies, the IEA forecasts that that global energy demand will be more than 50% higher in 2030 than today, with an associated increase in coal demand of 73% by 2030. Between 2015–30 China is likely to see an increase in coal-fired generating capacity of 350GW and India an increase of 120GW over the same period. The UK is also likely to see more coal-fired power stations built in the coming years.

43. Furthermore, the two commercial-scale CCS projects being supported by the Norwegian government are both on gas fired power stations. The focus on coal-fired power stations for the UK project complements the Norwegian activity and ensures that the final project tackles the generating capacity that produces the greater level of harmful carbon dioxide emissions on a global scale.

CCS Technology

44. Initially we aimed to run a "technology neutral" competition to select the project to be supported. Pre-combustion and post-combustion capture are equally valid technologies. However, they each have different benefits and this makes it virtually impossible to design a competition that would allow the technologies to compete on a level playing field. Because each technology has different benefits, however carefully the evaluation criteria were designed, it is likely that there would be an inbuilt bias towards one or other. The only way to hold a fair and transparent competition was to focus on one capture technology.

45. Post combustion capture is a technology that can be retrofitted to tackle the carbon emissions being "locked-in" by existing power stations and those constructed before CCS becomes commercially viable and therefore an integral part of new power station construction. Pre-combustion capture is more integrated into the power station design than post-combustion capture, making it much more difficult for the capture elements to be retro-fitted.

46. Pre-combustion capture is used with Integrated Gasification Combined Cycle (IGCC) power stations—the IEA forecast that IGCC power stations will account for less than 20% of new build, the majority of which will be in the US. The technology being used for the coal fired power stations being built in the major emitting countries such as India and China, and also the new build power stations proposed in the UK, is pulverised fuel and therefore suitable for post-combustion capture. Post combustion capture is the capture technology most likely to have the biggest impact on global carbon dioxide emissions in the shorter term, and it is certainly critical in terms of tackling the emissions we are unavoidably committed to already. This is why it is the technology the Government has chosen to support for the purposes of the competition; although we consider that pre-combustion capture will still have an important role to play in tackling future emissions from power stations.

How does the Government define "CCS ready"? Will this definition be strengthened? Is the Government satisfied that it has provided enough clarity and guidance on this point?

47. As promised in the 2007 Energy White Paper, and in the light of the draft provisions on carbon capture readiness in the recent proposal for an EU Directive on the geological storage of CO_2, the government will be consulting shortly on carbon capture readiness.

48. The results of this part of the CCS consultation will feed into the UK's negotiating position on the Directive, part of the Climate Change package, which it is hoped might be concluded by agreement between the European Council and the European Parliament around the end of this year.

49. The draft Directive (Article 32) defines Carbon capture readiness in a combustion plant as ensuring "suitable space on the installation site for the equipment necessary to capture and compress CO_2 and that the availability of suitable storage sites, suitable transport facilities and the technical feasibility of retro fitting for CO_2 capture have been assessed."

50. This is the definition on which we will be consulting shortly to explore stakeholders' views in depth. We hope it will help ensure a clear and widely shared understanding of what carbon capture ready means at this stage of the development of the technology.

51. This definition is drawn from the IEA Greenhouse Gas's group 2007 study on capture readiness, a peer reviewed engineering study looking at capture and space (though not at transport and storage), whose five expert authors were drawn from Imperial College, London, EON(a power station operator) and Doosan Babcock (an power station equipment manufacturer). It is available at:

http://www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID = 1980

52. The Directive proposes that the requirement to be CCR should apply to all combustion plants of 300MW or more for which operating licences/consents are granted after the Directive had come into force. We understand from the Commission that this threshold is 300MW electrical, rather than thermal. It would at this level apply to all newly consented coal, gas, oil plants in the UK and also to the very largest standalone CHP plants.

53. The government's position on this proposal will remain reserved until Ministers' response to the consultation is agreed. Our interim position is a positive one in regards to the intention of the carbon capture readiness proposal, but we are seeking more clarity about its scope and how the Commission intends it to be implemented.

Will the Government grant planning consent for new coal-fired plant before CCS technology is ready to be fitted from the outset?

54. Given the amount of fossil fuel plant closing over the next few years as a result of stricter environmental legislation (notably the Large Combustion Plant Directive), and the need for fossil fuel plant to provide flexibility in the UK generation mix, we are likely to see consent applications for new fossil fuel plant before CCS is proven.

55. All generation proposals are rightly subject to rigorous scrutiny through a development control process. We do not comment on "live" applications. The Committee will be aware that some weeks ago E.ON asked for the s 36 decision taking process on their Kingsnorth application to be suspended until after the planned CCR (carbon capture ready) consultation has concluded. There are three other coal-fired applications in the pipeline (though not yet received) since scoping opinions have been sought for the mandatory environmental impact assessment that will accompany each application.

56. As explained in the previous section, any new coal plant will have no impact on the overall emissions reduction effort by the EU as it will need to operate within the EU ETS cap, so neither CCS nor carbon emissions would form part of our assessment of any application. We will be consulting on whether carbon capture readiness should be a requirement for new combustion plant shortly.

How confident is the Government that it will be possible for a station to retro-fit CCS technology and still remain cost-effective?

57. Until the technology has been demonstrated at commercial scale the full costs of retrofitting are not known. We have committed to demonstrate the full chain of CCS at commercial scale, to prove both the technical viability of commercial scale CCS and to better determine the cost. This is why we are keen to see more progress on the commitment by EU Member States to demonstrate a range of technologies across the EU—this is vital if we are to determine the viability and cost of retrofitting CCS for different types of plant.

58. As the EU ETS is strengthened and the cap tightened year on year, emissions allowances will become increasingly expensive. This will make the more expensive abatement options, such as CCS, cost-effective. At some point, the cost of emissions m reach a level where it should be cost effective to retrofit CCS, as this will be cheaper than buying permits. When this point occurs, depends on the carbon price and the costs of fitting and operating the CCS chain. It will not be cost effective to retrofit before the carbon price is right.

Will new coal-fired plants, even without CCS, be necessary in order to plug the energy gap?

59. Allowing energy companies to continue to have the option to invest in coal plant, as well as maintaining some old plant, is important for two core aspects of energy security:

(a) the need to meet consumer demand for electricity at all times, and hence for electricity supplies to be flexible, and

(b) the importance of diversity in our energy supplies.

60. Over the next decade or so a third of the UK's electricity generation capacity is set to close as coal and oil plant become subject to increasingly stringent environmental standards and nuclear stations reach the end of their licensed lifetimes. By 2015, six of our nineteen coal stations will have closed and the average age of the remaining coal plant will be 41 years.

61. Our electricity system needs to be able to meet the fluctuations in demand for electricity that we see over the year, within each day and hour by hour and it is power stations that run on fossil fuels that are able to provide this flexible responsiveness. Neither wind, as our primary source for renewable electricity, nor nuclear power can respond to these variations in demand: output from wind generation depends on the weather conditions and nuclear is suited to operating continuously and providing baseload generation.

62. Both coal and gas will be needed for reasons of diversity—avoiding dependence on a single supplier, country or technology—which is fundamental to managing the risks to the UK's security of supply. With gas and coal sourced from different parts of the world, and coal reserves available from a much wider range of countries than gas, one provides useful insurance against the other in case of supply problems. Further, we have the benefit of continued domestic coal production: about one third of the coal used in our coal fired plants is from UK mines.

63. We use gas not only for electricity generation but are also heavily dependent on gas for heating, whether for hot water, cooking or heating homes and workplaces. Without coal as an alternative for electricity generation, the UK would be more dependent on gas. In the winter of 2005–06, as a result of concerns about gas supplies, gas prices doubled compared to the previous year and were very unstable. This led to coal providing 42% of our electricity in the winter 2005–06, compared to 20% the previous year. As a result, the impact on electricity prices from the effects of the high and unstable gas prices was dampened, and supplies of gas were freed up to be used in other parts of the economy where fuel switching at short notice is not an option (eg to heat homes).

64. The winter of 2005–06 serves as a useful illustration of how the market reacts to cope with security of supply problems. Given the complex interplay of factors that determine the supply and demand of electricity, we believe that well-functioning markets are the best way to deliver security of energy supplies, and to determine the appropriate generation mix to minimise the risk of power cuts.

65. As acknowledged in an earlier section, the emissions from coal mean that for it to be part of a future low-carbon generation mix, actions have to be taken. The EWP set out a framework for action and we are making real progress.

(a) We are supporting the strengthening of the EU ETS with a steadily decreasing cap to ensure that we are able to meet our climate change goals.

(b) We are seeking to take a global lead on clean coal power generation by supporting one of the world's first commercial-scale carbon capture and storage plants on a coal-fired power station.

(c) We have also led the way in preparing for the future deployment of CCS with clauses in the Energy Bill on the regulatory framework for carbon dioxide storage. And we are working with other Member States to progress negotiations on the draft EU Directive on the geological storage of carbon dioxide.

(d) We will shortly be consulting on carbon capture readiness.

29 May 2008

Witnesses: **Mr Malcolm Wicks MP,** Minister for Energy, **Mr Martin Deutz,** Head of Cleaner Fossil Fuels Unit, and **Ms Bronwen Northmore,** Policy Director, Cleaner Fossil Fuels Unit, Department for Business, Enterprise and Regulatory Reform, gave evidence.

Q31 Chairman: As you know, we have organised this brief inquiry at relatively short notice because of the considerable interest and controversy surrounding Kingsnorth and the progress towards viable carbon capture and storage. We have squeezed it into our programme. Mr Wicks, I am very grateful to you and your officials for coming in. I understand that you want to make a brief opening statement.

Mr Wicks: First, thank you for enabling us to provide evidence today. This is an issue that is very dear to my heart and the government's priorities. I am accompanied by my colleagues Martin Deutz, head of the Cleaner Fossil Fuels Unit in the department, and Bronwen Northmore, policy director of that unit. The International Energy Agency predicts that global energy demand will be more than 50 per cent higher by 2030 with energy-related greenhouse gases around 57 per cent higher. The increased demand for energy will be met largely by fossil fuel power stations. In particular, demand for coal is predicted to rise by 73 per cent by 2030. It is not just in global terms that coal is an important fuel; coal is and will continue to be in our judgment a vital part of the UK's energy mix essential for providing us with secure and reliable energy supplies. Yet we recognise that lower carbon technologies are required if we wish to continue to use fossil fuels and meet our climate change objectives. The challenge, therefore, for the UK and the world is to reconcile increasing energy demand with the need for secure and diverse energy supplies while ensuring that we reduce our carbon dioxide emissions radically, which is where CCS could play a vital role. With the potential to reduce emissions from power stations by 90 per cent CCS can help us meet both our energy security and climate change objectives. However, the full chain of capture, transport and storage is yet to be demonstrated on a commercial scale power station. This is why the government is supporting one of the world's first projects to demonstrate post-combustion capture technology on a coal-fired power station with a generating capacity of at least 300 megawatts. We are also taking other actions to develop CCS technologies. We are supporting research and development through the research councils, the Technology Strategy Board and the new Energy Technologies Institute. We are providing capital grants for the development of components of the CCS chain through what we call the Environmental Transformation Fund and also developing and implementing one of the first comprehensive regulatory regimes for the storage of carbon dioxide. We are also working through multilateral organisations such as the International Energy Agency and the Carbon Sequestration Leadership Forum to promote CCS globally. Indeed, we are very active internationally. Finally, it is in our vital interest that CCS is developed and deployed as rapidly as possible both in the UK and globally. We are taking the steps required to achieve this with one or two other countries and leading the world by our actions.

Q32 Chairman: If the government is so keen on CCS and making such excellent progress towards it why on earth is it even contemplating authorising the construction of a coal-fired power station before we have the technology?

Mr Wicks: There are mechanisms in place. I am thinking of the European Union's emissions trading scheme of which we are fully a part. The objective of the ETS is to help us across Europe to hit the very demanding CO_2 reduction targets. The mechanism of the ETS is to bear down on carbon emissions over time. That means anyone contemplating a new fossil fuel power station will have to take that into account in terms of the economics and take steps to reduce carbon emissions. Alongside climate change, which I genuinely believe is the pre-eminent challenge for us and the planet this century, we must have regard to energy supply and security. If one looks ahead to

a future when much of our electricity comes from renewables—between 30 and 40 per cent of our electricity could come from renewables by 2020—after that time significant quantities of electricity will come from nuclear power stations. One needs fossil fuel power stations to provide flexibility and balance in the system.

Q33 Chairman: What you have said about the EU ETS and cap will confirm the very worst fears of critics of the system because you seem to be using it as justification for choosing the most polluting form of technology for the newest coal-fired power station in Britain.
Mr Wicks: I repeat that maybe together with Norway and the United States we are the leading nations in the world in CCS technology. We are developing very good capacity and we are working internationally. If we simply say there should be no more coal-fired power stations until the technology is fully proven, which sadly will be some years hence—

Q34 Chairman: When?
Mr Wicks: None of us can be absolutely certain because we need to demonstrate the technology. We hope that our demonstration project will be up and running in 2014.

Q35 Chairman: So, it may be another 20 years before it is economically viable?
Mr Wicks: It is very difficult to predict when this might become universalised in this country. I am not embarrassed to say we do not know because none of us knows the answer to that question. But those who reject coal—by the way, sometimes they are the same people who reject nuclear, but that is another issue—have to answer the question about from where will we get our energy supply? I think that given the geopolitics of energy insecurity in future diversity, in terms of energy resource is absolutely vital. If we did not have coal it would bring forward an extra dash for gas. We need to think of the national security implications of that.

Q36 Chairman: Even though you honestly admit, which I respect, that you have no idea when we may have economically viable carbon capture and storage technology you are quite happy to authorise the construction of new highly polluting coal-fired power stations in Britain?
Mr Wicks: You frame it in a certain way. When you say that I admit it, it is not a question of your dragging an admission out of me. I am proceeding on the basis of the science and technology and evidence base. I am pleased to do that before a Select Committee. Maybe I am a bit old-fashioned, but that is part of the thing you do before a Select Committee. That is what the knowledge base tells us. I just report that to you, Mr Yeo. What I am trying to say is that anyone who is serious in saying we should never have any coal until the technology is there must look at the implications for national security and some competence in terms of what it means for the diversity of resource for the national grid. There are a number of other serious issues. Perhaps my colleague Martin Deutz can add to the argument.
Mr Deutz: New super-critical coal-fired power stations emit about 20 per cent less for the same amount of generation. Although what you say would be correct if we built new unabated coal-fired power stations, the net effect in terms of emissions for the same level of generating output would be a considerable reduction.

Q37 Chairman: But even with a 20 per cent reduction in emissions from previous old-fashioned coal-fired plant it would be vastly more than if you adopted almost any other form of electricity generation?
Mr Deutz: It still emits more.

Q38 Chairman: You are still very seriously above any other alternative?
Mr Deutz: That is true.

Q39 Joan Walley: I want to return to the Chairman's question about allowing a planning application to go ahead without knowing exactly when the technology will be available. What is your response to the letter from the Royal Society to the Secretary of State that any planning permission should be conditional by a certain future date on the availability of abatement technology?
Mr Wicks: I hear the arguments. In a proper argument I would want to bring in the other matters that I raised today briefly about how to run a system without the flexibility that coal can provide. It is interesting that two winters ago when the price of gas was so high supply was maintained at a difficult time in large part because extra electricity from coal was brought on because of the flexibilities in the system. We are absolutely committed to developing clean coal technology and CCS as quickly as possible. One of the reasons we want a demonstration plant in the United Kingdom is not only for the benefit of this country in terms of our own carbon reduction targets but so we can help to develop a technology that has an application abroad. We are thinking particularly of China. I suppose that if we did not have coal-fired power stations we would be less able to demonstrate the technology which is the way to square the circle in future. As I said at the beginning when I quoted the IEA estimates, whatever people might wish in terms of renewables and energy efficiency the world will be burning huge amounts of fossil fuels. Eighty per cent of future demand will come from fossil fuels, a lot of it being coal in places like China. Our job with others is to make sure that technology can help us to tackle that problem.

Q40 Joan Walley: But the Royal Society's recommendation was that there should be a condition that would apply in future assuming the technology was available?
Mr Wicks: I am not sure that the emissions trading scheme is always fully understood, although I am sure this Committee understands it. After all, the emissions trading scheme which is worthy of study again, is about enabling us in Europe to hit our

carbon dioxide targets and year by year it bears down on carbon emissions and is a major incentive towards the development of these kinds of technologies.

Q41 Martin Horwood: The Secretary of State is on record as admiring the German Government's willingness to provide a certain environment for business in the medium term. Is this not a classic example of where talk about the need for flexibility and your rather hesitant language give the wrong signals to business? If you are to invest in this technology and you adopt the Royal Society's suggestion that if CCS is not in place by a definite point, 2020, a power station must close, is that not precisely the kind of environment to which business will respond and invest in, whereas the hesitant signals you give are precisely the wrong ones?
Mr Wicks: I was not trying to be hesitant but analytical and comprehensive, maybe unsuccessfully. If one is talking of business confidence, at the moment when the technology at a coal-fired power station has not been demonstrated—bits and pieces have been demonstrated round the world—we cannot fully appraise what the cost will be except we know that it is very substantial. The government will support a demonstration project to the tune of hundreds of millions of pounds. I do not give the precise figure. If we were to say to business that in a certain year it must provide this technology when it has not been proven and we cannot be sure of the cost that will simply lead to a new dash for gas. I do not think that is about business confidence; it certainly does not help us with diversity of supply.

Q42 Martin Horwood: In the end business needs a bit of carrot and stick. We have a measly carrot in place and I do not see the stick at all. Where is the risk in which you are asking them to invest?
Mr Wicks: It is not for me to ask you questions, but I think that a study of the emissions trading scheme is helpful here because, if you like, that is the stick. It is saying that unless companies reduce emissions they pay the cost by having to supply the certificate. I cannot stress enough that that is now a very significant driver in Europe.

Q43 Chairman: The problem about the emissions trading system in this context is that we all know that phase one was a failure; power stations made a huge financial gain from it and emissions were not reduced in Britain, the EU or anywhere else as a result. I acknowledge that phase two has a tighter and progressively reducing cap, so there is a limit, but if the existence of the EU ETS cap is to be used by industry or any government department as a justification for the choice of the most polluting technologies I think you are undermining the concept of emissions trading. You will say to people that if you have this system somehow it will allow them to salve their conscience and get away with polluting as much as they want because somewhere in the world someone will make a saving. I believe that is a very poor argument.
Mr Wicks: I hope that the Committee has not fully made up its mind at this stage. I am sure it will want to deliberate, looking round the room, in a very open-minded way upon the evidence that people will bring to bear on this issue.

Q44 Chairman: We have a record of producing very measured reports.
Mr Wicks: It is not for me to say how you should write your report, but it must include a significant chapter on ETS and it must recognise where we are moving to on phase three. Frankly, any serious contribution to this debate—I know that there will be a serious contribution by the Committee—must look at issues of diversity and from where supply in future will come. Some people do not like nuclear; maybe some people do not like coal, but the British people need fuel and serious people must address that question.
Chairman: They need low carbon fuel particularly.

Q45 Mr Hurd: The Committee has looked at the emissions trading scheme in great depth. I do not think there is a committee that has written more reports on the subject. The conclusion is quite clear: it has been a failure up to now in terms of reducing carbon emissions and it has signally failed to deliver a carbon price that will drive the private sector to accelerate the development, let alone the deployment—one must distinguish between the two—of this absolutely critical technology. The message is that this is the time when we need some ambition in the public sector and your government is not demonstrating it.
Mr Wicks: We can all play the game.

Q46 Mr Hurd: It is not a game.
Mr Wicks: There is one serious game. I am proud of the fact that the UK Government is doing this. We are not alone because the Norwegians are moving ahead very well and the Americans have set aside money. I cannot think of anyone else in Europe who is doing it. The European Commission would want 12 demonstration projects. I worry where the rest are coming from. One could say that there is a lack of ambition with only one and then one could have a bidding war. Should it be two or three? We would need to make judgments about where we cut other public taxes or expenditure to pay for that. I put it to you that with our demonstration project, other financial support for the R&D, a lot of science behind it and the international efforts we are making, we are not doing too badly as a country on this one.

Q47 Dr Turner: How will the government meet its emission reduction targets if coal-fired power stations like Kingsnorth and any others in the pipeline get the go ahead? Are not coal-fired power stations entirely contradictory to our need to reduce CO_2 emissions to meet our targets?
Mr Wicks: We are trying to balance a number of things here. I am as taken by the science as this Committee. This is the pre-eminent challenge for us. We can meet it rather easily if we close down all

power stations but the British public and industry want power, so serious people have to address the question of where that power comes from in future. I stress—because it is an issue that worries me—the national security implications of energy supply. The answer to the question is that we will bear down on carbon emissions by a major programme of energy efficiency measures, zero carbon housing by 2016, more efforts to improve the energy efficiency of our dwellings and a number of other schemes to encourage businesses to reduce energy. Part of the answer, as Dr Turner knows, is the development of renewables. We have made the commitment that 15 per cent of all energy should come from renewables by 2020 or thereabouts. That is the target set by the European Union. That means that perhaps 30 or 40 per cent of all our electricity comes from renewables by 2020. There is a raft of other measures including, though not fully demonstrated by 2020, carbon capture and storage.

Q48 Dr Turner: It does not really answer the question about the incompatibility of unabated coal-fired power stations and our emission targets.
Mr Wicks: But I thought the question was how we would tackle carbon emissions. I outlined very broadly our approach.

Q49 Dr Turner: But we make it that much more difficult by opening new unabated coal-fired power stations. Do you accept that failing to ensure the abatement, or at least making retrofitting absolutely conditional, weakens our position in climate change negotiations because it does not look as if we are serious?
Mr Wicks: I do not accept that. Most recently at the International Energy Forum when we organised with our Norwegian colleagues an informal meeting of ministers from a number of key countries on CCS we found that people respected our position on coal and CCS. I am sorry to return to it, Chairman. This is not a debate. I have been on the other side of the room, and I know which is the easier side. I look forward to returning one day to the more comfortable zone. It is not for me to ask the Committee questions, but in terms of our energy strategy one must put serious questions. If some Members of the Committee, maybe the majority, say no to coal in future, at least half say no to nuclear and probably the Committee does not like the idea of a dash for gas, it is beholden on you to tell the British public how to keep the lights on in future.
Chairman: A couple of years ago we wrote a report in which we left the door open for nuclear, which was a very controversial issue, so I do not think you can characterise this Committee as being wholly against it. But our concern about coal relates to the fact that alternatives are available and we are rushing into this before we even know when a viable carbon capture and storage system will be available. That seems to us to be extremely dangerous and underlies the concerns of this Committee which we know also exist outside it.

Q50 Mark Lazarowicz: Should not at least planning conditions be applied from the start to require CCS to be in place by a certain point and if it is not in place at that point the operating licence is withdrawn? Is it not sensible to have that kind of control? If you cannot do it by a certain date you cannot continue to operate it. That provides a potential guarantee that things will not get out of control.
Mr Wicks: I think much depends on the carbon price. If you look at it chronologically—none of us can be certain of it—let us assume that the demonstration project is up and running by 2014 and other projects by the Norwegians, Americans and we hope others—I do not want us to be the world leader on this; I would like there to be 20 world leaders—also demonstrate the technology. I suppose one would then assume that in the decade from 2020 onwards one would start to see the development of many such projects. The serious question is how those projects are funded. I do not have all the answers to that. I hope that the strengthening of carbon markets in Europe but maybe elsewhere—there are signs of that in North America—will bring forward a sufficiently good price for carbon that it will provide some of the financial incentive for CCS. Will it be enough? I do not know. There are some encouraging signs for enhanced oil recovery. After all, we need to store the CO_2 somewhere. In many places it will be in depleted oil and gas reservoirs. Enhanced oil recovery may help, but how this is funded in future is a very serious question. I guess that one way or another the price will be passed on to the citizen, either the taxpayer or, more likely, the consumer.

Q51 Mark Lazarowicz: But you are putting it all on the ETS forcing up the carbon price?
Mr Wicks: I cannot remember the forward projection for carbon, but in phase three it starts to look a lot healthier in terms of the forward price. That is all we can say in terms of phase three.

Q52 Martin Horwood: As Mr Hurd has already pointed out, the price of carbon is not yet sufficiently robust to disincentivise or change the investment patterns on issues like this. One of the factors in the Heathrow decision is the shadow price of carbon that your department supplied to the consultation. Is that same shadow price to be factored into this decision, or does the criticism you have received over Heathrow and the fact it was set so much lower than the Stern report's suggested shadow price for carbon enable you to look at that again?
Mr Wicks: I am trying to think how it affects what you call "this decision".

Q53 Martin Horwood: I am referring to whether or not to give the go ahead to Kingsnorth and whether it poses such an economic risk in terms of its threat to the environment which is the whole Stern scenario.
Mr Wicks: You will understand that we are not talking about any one power station application.

Q54 Martin Horwood: I was asking about the shadow price of carbon that Defra comes up with and supplies to other departments. Presumably, it will be used here.
Mr Wicks: I think that with ETS we need to look forward. I now have a figure in front of me magically which says that the European Union predicts that for phase three, 2013 to 2020, the forward price will be €39. Phase one was a disappointment. Going forward, one starts to see a reasonably robust price for carbon.

Q55 Martin Horwood: But will you use the Defra shadow number used on the Heathrow consultation which was much lower than that recommended in the Stern report?
Mr Wicks: I need to take advice and write to the Committee later.[7] I am not sure what relevance the shadow price has to this matter.

Q56 Martin Horwood: It enables you to calculate the economic risk of the threat to the environment. The whole basis of Stern's scenario is that you have to factor in the economic threat.
Mr Wicks: Let me write to the Committee to give precise information on it.[8]

Q57 Mr Hurd: You cited the 2013 to 2020 price of carbon as being about €39. Who knows? The point I am trying to make is that the chief executive of BP tells me that at the moment the cost to them is about €100. There is an enormous gap even on your rosy projections. The private sector has no economic incentive to accelerate this technology; it must be done by the public sector that drives the technological development phase. Reliance on the carbon price is extremely worrying. The gap is enormous.
Mr Wicks: Of course it is. I also share this frustration. I wish that the technology had been demonstrated 10 years ago.

Q58 Mr Hurd: So, why did we not proceed with Peterhead?
Mr Wicks: I will come to that. I wish the technology was out there and we could now see it being used for any fossil fuel power stations going forward, but that is not where we are. Coal is the biggest polluter, but why not go further and say there should be no more gas power stations? I am afraid that that is where a bit of political reality needs to come in terms of the need for diversity of fuel supplies in future. As to Peterhead, I do not believe it would have been sensible or proper governance, if we were to have a demonstration project that cost the British taxpayer literally hundreds of millions of pounds, to give it to the first one that came forward, namely the BP Miller Field Peterhead project. That is hardly sensible. Perfectly properly, we decided to have a competition and then made the decision—it was controversial but I believe it was the right one—that instead of pre-combustion it should be post-combustion. One can argue about that. We decided on post-combustion because of the advice that that technology could be of most relevance to China and could be retrofitted there. I think it is good governance to have a competition and let a number of companies and consortia come forward.

Q59 Dr Turner: You have told us why you restricted the competition to post-combustion, but what do you plan to do to facilitate the development of pre-combustion as well, because the rest of the CCS technologies should be allowed to develop and can make a contribution to coal as well as gas? What measures does the government have in mind to facilitate them?
Mr Wicks: Perhaps I may ask my colleague Bronwen Northmore to outline the other work we have been doing.
Ms Northmore: The decision was taken against the global background of demonstrations that were taking place elsewhere. These are very expensive and it is not really realistic for one country to be expected to demonstrate all the technology combinations. Therefore, we looked at what Norway was doing; it was concerned with post-combustion on gas. We looked at what the US was doing at the time which was pre-combustion on coal. It was carrying out an IGCC project. Therefore, the gap in demonstration was post-combustion on coal, and that also happened to be relevant to our new proposed coal generation in the UK and is the technology of choice for generators the world over. Post-combustion capture is by far the most relevant to the new coal projects being constructed in China and India. That was the thinking behind it. We are very keen to see a global network of demonstrations where information is shared as widely as possible among those projects in order to facilitate the fastest possible roll out of CCS across the world. Therefore, it is a global picture.

Q60 Dr Turner: I was told a year ago by the CCS Association that there were at least 10 projects ready to go but were being held in abeyance because the market incentives and regulatory framework were not in place. What you have not told me in your answer is what you are putting in place so that these 10 projects, which include various forms of pre-combustion and so on, can go ahead. They are ready as of now.
Ms Northmore: We have done a lot of work on the regulatory framework. There is an EU directive on carbon capture and storage, including carbon capture readiness, which is relevant to Mr Lazarowicz's question about where we go in terms of mandating. That regulatory framework is being applied in the UK through the Energy Bill and the EU directive, so I honestly believe that the UK is extremely well placed in terms of the regulatory framework and is leading the world on it. We are better placed to be able to store carbon dioxide.
Mr Wicks: A good chunk of the Energy Bill currently before Parliament puts in place a regulatory framework for the safe storage of carbon dioxide.

[7] See Ev 27
[8] See Ev 27

Q61 Dr Turner: But it contains no measures to give market incentivisation towards its use.
Mr Wicks: That Bill does not. I repeat the mantra about the ETS. That is one that does provide incentives going forward. If there are 10 projects or so that you argue the taxpayer should support—-

Q62 Dr Turner: I am not arguing that. My argument is that if you have the right conditions in place then, to quote a frequent government mantra, the market will provide.
Mr Wicks: This is where we are all struggling at the moment. Prime facie, there is no profit at the moment in storing carbon dioxide. Therefore, we have been discussing how to incentivise it. I do not think I would use the words "market failure"; it is not one of my favourite terms, but there is no profit in stripping out CO_2 very expensively, transporting it through pipelines and storing it under the North Sea, for example. Therefore, all of us are thinking through how to incentivise it. I have stressed the carbon market, but meanwhile we are spending a great deal of the taxpayer's money on this one demonstration project.

Q63 Dr Turner: As we have already discussed, so far the ETS has not delivered and will not deliver the kind of market signals of the strength and reliability that will be needed to incentivise this for a considerable time in future. Has the government had any other thoughts? You have had time to think about it.
Mr Wicks: We have had time to think about it. I am rather conscious of how we now often express frustrations over things that some of us at least had not heard of four years ago. Of course we are all very wise about these things after the event. I am not complacent, but I think we are doing pretty well as a country. I am not convinced that even if we found the money we could support 10 projects because we have not demonstrated one yet. We have to learn how to walk before we can run. If you are asking me, Dr Turner—you are not—why the taxpayer does not support 10 projects, that is a bid of, say, at least £5 billion.
Dr Turner: I was not saying that.

Q64 Mr Chaytor: What are the specific reasons for the time it has taken to come to the view that competition is the right way forward to bring CCS to reality, because the technology in its separate components has been in existence for a number of years? The 2003 White Paper contained considerable discussion about the potential for CCS, but it was five years before the competition was launched.
Mr Wicks: The decision to support a demonstration project was not taken until May 2007. As I recall, we were busy on one or two other things. The competition to select a project was launched on schedule in November 2007. I think we are sticking to quite a tight timetable.

Q65 Mr Chaytor: To explain, given that the Intergovernmental Panel on Climate Change has been in existence for the best part of 15 years, that the Kyoto protocol was signed in 1997, that we have known about the increasing consumption of coal in China and India for a number of years because of their rates of economic growth and about the crisis in our own coal industry, I just wonder why this was not on the government's agenda sooner after 1997 than it turned out to be. I am just asking whether there was a specific reason for the time taken by the relevant departments.
Mr Wicks: To be honest, I think it is because of the infancy of the science, technology and engineering. I am as much aware as you are of the Sleipner project in the Norwegian Sea which has successfully demonstrated that one can store CO_2 in a depleted gas reservoir. That has been going on for 10 or 11 years and geologists are still studying it. Geologically, the CO_2 is behaving as one would expect, which in plain English means it is still down there. Use has been made of CO_2 for enhanced oil recovery in different parts of the United States. I saw an interesting demonstration of that recently when I had the good fortune to visit Mississippi. There are a number of examples around the world, but no one has yet done it on a fossil fuel power station.

Q66 Mr Chaytor: I understand that, but why was not the decision to have a competition to decide if somebody could do it taken earlier?
Mr Wicks: I suppose I would be embarrassed now if you could tell me 12 countries that were ahead of us, but I do not think you can. I wish the National Health Service had been created in 1924. I am frustrated that things take so long.

Q67 Mr Chaytor: Is there a relationship between the likely timescale of CCS implementation and the closing down of oil fields in the North Sea because clearly the enhanced oil recovery is part of the economic equation to make CCS viable? Given we do not have certainty about whether CCS can come on stream by 2020 presumably at that stage some of the oil fields will start to close down. What is the relationship between those two timescales?
Mr Wicks: I do not mean to be in any way patronising but that is a very important question. Just as we are beginning to look forward and have interesting discussions about how to fund all of this stuff in future, another more technical discussion is about what kind of grid infrastructure we need. If we are right—we have to be right—that the obvious place is the North Sea then, given there is a grid infrastructure out there, we need to think through, as we are beginning to, the implications of the closure of certain oil rigs and the infrastructure out there. To some extent we are beginning to run before we can walk, but my guess is that for the next 40 or so years there will be a good deal of oil and gas extraction from the North Sea. There is a lot of life in the old dog yet in our own back yard, but we can well see the beginning of new industries and business around what we are discussing today, namely CCS.

Q68 Mr Chaytor: Does the department have a set of forward projections in terms of the timescales for closure of the different oil fields within the North Sea? Is the geology that certain?
Mr Wicks: Obviously, we keep very closely in touch with the North Sea; we have a good Pilot partnership with the industry. This is a matter that we are thinking through.

Q69 Mr Chaytor: But is there a risk that the time taken to bring CCS to fruition will go beyond the time at which a large number of oil fields will already have closed and, therefore, the enhanced oil recovery part of the equation will not be an option?
Mr Wicks: It is a risk that we have to avoid. It is not as if the North Sea will close down within the next 10 years; it will not.

Q70 Mr Chaytor: It will be in the next 20 years?
Mr Wicks: There will be a lot of activity over there for the next 30 or 40 years, but when it comes to specific oil rigs that is an important question to which we are paying attention.

Q71 Martin Horwood: You say that the North Sea is not closing down now, but as I understand it that is precisely the situation. At Peterhead and elsewhere the combination of market forces, your competition and the fact that ETS do not provide sufficient incentive to keep these geological storage facilities accessible means that they are now being closed and capped. Are you aware how many of these facilities will be lost?
Mr Wicks: Some will be, yes.

Q72 Martin Horwood: Do you know how many?
Mr Wicks: Two things are true of the North Sea when it comes to oil and gas. One is that it is passed its peak; it is in decline, but our estimate is that 25 billion barrels of oil equivalent are left in the North Sea. Someone today said it was 30 billion. No one can be certain. New fields are being opened up. We are doing a lot of work west of Shetland with four major companies and if it works, as we think it will, it will be a whole new oil and gas field. It is a very dynamic process. Some close down and some open up.

Q73 Martin Horwood: But the geological storage facility for carbon in future is being lost now.
Mr Deutz: It is not lost simply because it ceases to be a viable gas or oil reservoir; it can be reopened.

Q74 Martin Horwood: My understanding from BP is that it is much less economic once it has been capped.
Mr Deutz: It would not then be used for EOR, so to that extent it would be less economic, but it would not be lost to storage which was your question.

Q75 Martin Horwood: It would be much more expensive to exploit, would it not?
Mr Wicks: I acknowledge that these are very serious issues which confront the department and the industry. I cannot be precise. I am not sure it would be sensible for me to say that every oil and gas field will be maintained open for ever with all the costs involved in that. These are critical issues. But the North Sea is a dynamic place and oil and gas are found on a regular basis.

Q76 Mr Chaytor: It would help our Committee's report if the department could produce a note setting out what is already known about the closure dates of oil wells in the North Sea, because their capacity for EOR seems to me to be absolutely crucial to the economics of CCS.[9] If we have some information about whether the cost of reopening an oil well in order to pump the gas in is far greater than using an existing oil well where perhaps 10 per cent of its reserves is still waiting to be pumped up and the gas will make it possible to recover that additional oil it may be helpful to us in writing our report.
Mr Wicks: We will do our best to give you that information.

Q77 Colin Challen: As an addendum perhaps we can have an analysis from the department about what might happen with another Grangemouth-style situation[10] where it seems that we have so few access routes to the North Sea currently with the inward flow of oil, but if we are to use the same pipes for the outward flow of carbon—I do not know whether we are—the capacity needs to be looked at. I should like to ask one or two questions about the bigger picture. Listening to this afternoon's occasional debate I am just wondering how seriously BERR takes the issue of climate change and whether it would perhaps use the word "crisis" to characterise it. The IPCC said that globally we have to peak and commence to reduce emissions by 2015. Nick Stern says that we cannot rely on the market to set a price for carbon. Every time anybody asks a question about the future mix of fuel and generation the government says it is not up to the government; it is the market that must decide what the mix is and that will depend on price and other things. It seems to me that that kind of approach completely sidesteps the question of climate change. We do not know what number of new coal-fired power plants we will have. If they achieve 90 per cent carbon capture and storage their efficiency drops to 50 per cent. Does that mean we have twice as many coal-fired power plants? We heard today that E.ON does not believe there will be more than one new nuclear power plant built before 2020 and yet those Members of the Committee who were written to by EDF early this year were told there would be four by 2017. Why does the government not become a bit more interventionist, demonstrate that it believes some kind of crisis is taking place with climate change and start to tell people what to do, or is there some example from history, perhaps the Battle of Britain, where market forces have won the day for our side? It has never happened; we have to intervene—please! Is that a possibility?

[9] See Ev 27
[10] See Ev 27

Mr Wicks: Perhaps I may say as politely as I can that I do not think it helps by trying to say, "I am greener than you", which is the sort of debate going on now. You are accusing my department of not taking climate change seriously.

Q78 Colin Challen: Yes, I am.
Mr Wicks: As we say on these occasions, with respect that is total balderdash. We take it extremely seriously. The government works together on this. The Climate Change Bill is before Parliament. We have said we will reduce carbon emissions by 60 per cent by 2050; and it could go up to 80 per cent. We have made the difficult decision, which I know you do not agree with, Mr Challen—we think it is sensible for climate change—that in future there should be new nuclear power stations which provide a clean and a green source of energy. I know that some put their hatred of nuclear above their hatred of global warming, but that is not our position. We have said that 15 per cent of all energy should come from renewables by 2020. We have also said that we will look at the Severn barrage and the environmental assessment to see if that major project should be supported. We will put a considerable amount of resources into carbon capture and storage. It seems to me that that shows the government that is pretty interventionist in the market.

Q79 Colin Challen: I mentioned to your predecessor in your seat this afternoon that the chief executive of E.ON had said this morning in the press that if we are to meet the EU targets on renewables there was a need for 50 gigawatts of renewable electricity generation and that would require 90 per cent back up from coal and gas to ensure supply during intermittency. I have asked them to provide us with their analysis because I think that overstates what is required, but if all of these variables are left to the market in my view they will not add up to a solution. When we are promised new nuclear, we find that two of the major potential providers, E.ON and EDF, are at odds with each as to what it will contribute and the government says it is not its business. That is the government's response to my Parliamentary Questions. That is not the basis of a sound policy.
Mr Wicks: As to nuclear, we have been criticised for a number of things by anti-nuclear interests but not because government has said it is none of its business. We have been criticised because government has said that nuclear is its business which is why we are authorising it in future.

Q80 Colin Challen: But we have no idea at what level it will produce. I am trying to be open-minded here. If you are saying it is part of the solution as a critic I would like to know how big a part of the solution it is, when it will come on stream and what it does about climate change, which is not very much.
Mr Wicks: We know what it does about climate change.

Colin Challen: It might do something by the time we have used up the remainder of our allowance for the concentration of greenhouse gases in the atmosphere.

Q81 Chairman: I know that you are pressed for time. We want to return to the specific issues relating to Kingsnorth.
Mr Wicks: I cannot talk about Kingsnorth.

Q82 Chairman: I am talking about the issues relating to Kingsnorth. A number of planning applications have been approved for gas-fired plants on the basis that they are CCS-ready. However, you have announced that you are now consulting on the definition of CCS-ready. How can you reconcile those positions?
Mr Wicks: I do not understand the first part of the question about consent to gas-fired CCS-ready plants. We are about to consult on the concept of power stations being carbon capture-ready; in other words, the technology is not yet proven. We do not feel it is sensible to say that you must have it, but what would carbon capture-readiness look like? We are about to consult quite soon on that. It is a more complex question than it sounds. What do we mean by carbon capture-ready? There will be public consultation on that.

Q83 Chairman: So, when the government approved the building of three gas-fired power plants on the condition that they were built as CCS-ready, it did not know what it was talking about?
Mr Wicks: That was a voluntary agreement.
Ms Northmore: The companies concerned said voluntarily that they would be prepared to make their plants carbon capture-ready.

Q84 Chairman: You have just said that the government does not know what that means.
Ms Northmore: There is an EU directive on carbon capture and storage which has within it a draft provision that defines what carbon capture-readiness is.

Q85 Chairman: Why are you then consulting if you already have a definition?
Ms Northmore: We are consulting on whether or not we agree with the definition so we can go back on the directive.

Q86 Chairman: In other words, approving an application to build a gas-fired power plant on the basis that the company making the application says that it will be CCS-ready is a complete nonsense because you do not know what it means; you have just told us that. When do you think you will know what CCS-ready means?
Mr Wicks: That is just rhetoric, Chairman.

Q87 Chairman: It is not just rhetoric.
Mr Wicks: It is a very serious issue to discuss.

Q88 Chairman: It is a very serious issue, and I am sorry to make a debating point out of it. The fact is that you are saying you now need to define what CCS-ready means.
Mr Wicks: Yes.

Q89 Chairman: But you have already approved the construction of gas-fired power plants on the basis of a commitment by the companies that they will be CCS-ready. That is by any standards a complete nonsense.
Mr Wicks: I do not think it is a nonsense.

Q90 Chairman: When do you think you will know what CCS-ready means?
Mr Wicks: With respect, you are trying to make simple something that is rather complex.

Q91 Chairman: I am asking a straightforward question.
Mr Wicks: What is your question?

Q92 Chairman: When do you think you will know what CCS-ready means—next year, 2010, 2011?
Mr Wicks: In the autumn after the consultation. We have to look very carefully at this. It means more than having just a great space next to a power station. It is quite a sophisticated question and we want to get the best advice on it.

Q93 Chairman: Precisely what are the factors that you will be taking into account?
Mr Wicks: My colleague may be able to help me with this. We will send you the consultation document when it is ready.[11]

Q94 Chairman: When is that likely to be?
Mr Deutz: There are four elements to carbon capture-readiness in the consultation. The first is a feasibility study to establish whether the configuration and space on the site are adequate for carbon capture to be fitted to the power station. There are then three elements relating to assessment of the route from the capture site to the storage site and assessment of the viability in principle of accessing a storage site that is suitable. In relation to the complexity of developing and defining what carbon capture-readiness actually means we are doing it in a sense in advance of the CCS technology having been demonstrated. Therefore, we have to derive a set of broad principles and we believe that the application of them will become clearer as the demonstration project commences and we have more data on which to firm up what CCR means.

Q95 Mr Chaytor: That was going to be my question. Surely, it is absolutely impossible to define exactly what carbon capture-ready means until the technology is up and running.
Mr Wicks: There are some features that we know will have to be in place. For example, the site has to be configured so that the capture plant can be fitted next to the power station and the thing is the right way round. Another element is the transportation route with enough space either side of it to satisfy likely safety concerns, and the final element is the storage. Those things are understood in principle and they are the basic building blocks.

Q96 Mr Chaytor: For clarification, in terms of the commitment in relation to the existing gas-fired power stations Ms Northmore said that it was a voluntary agreement; that is to say, it is not a condition of the planning permission and so it has no statutory basis at all.
Ms Northmore: It is a condition but they volunteered to have that condition.
Mr Wicks: I am not sure it was much more than just making sure that space was available to retrofit. If it is more than that I shall write to the Committee and correct the record.[11]

Q97 Mr Chaytor: But there is no guarantee that that planning condition will be implemented.
Mr Wicks: It was not a planning condition according to my understanding. We shall write to the Committee to get the details absolutely right.[12]

Q98 Mr Hurd: If we do achieve a meaningful definition of CCS-ready is there not a risk that it will just be a fig leaf to wrap round big decisions like Kingsnorth now, because the reality is that unless the economics of carbon capture and storage change quite dramatically companies have no economic incentive to retrofit, so they are CCS-ready for what? Is there not a risk that this is just tokenism and a fig leaf to dress up these decisions?
Mr Wicks: It is certainly not a fig leaf. I am not commenting on the planning application, but we were developing our thinking on CCS before that particular application was made to us. I keep mentioning China which is rather important. I know that some people here, not all, might wish that more windmills and energy efficiency could do it without the need for fossil fuels or nuclear at all, but that is not the real world. In the real world 80 per cent of our energy going forward will come from fossil fuels. The only way to square the circle with the environmental agenda is through the development of these kinds of technologies.

Q99 Mr Hurd: I agree with you completely, but my concern is that this will continue to drift if we kid ourselves that giving planning permission on the basis of plants being CCS-ready means anything.
Mr Deutz: I think it is meaningful. Given the very significant area of space relative to the size of a conventional power station which is expected to be taken up by the carbon capture technology and the

[11] See Ev 27

importance of being able to connect that to a storage site, to make sure that something is carbon capture-ready, and therefore capable of collecting the gas when it becomes a viable technology, is an important step in ensuring that CCS can be fitted as and when it becomes economic. Without that power stations could be built without any certainty that even if CCS worked they would be able to adopt it.

Mr Wicks: Chairman, I feel slightly embarrassed. A large group of MPs wants to talk about coal health compensation. I am wondering whom I should embarrass the most.

Chairman: I appreciate that. You have given us the time that you said you would. If you have another commitment we quite understand. Thank you very much for coming. This has been a helpful session.

Supplementary memorandum submitted by BERR

Is a shadow carbon price used to take decisions in relation to consents for new build power stations?

Economic and commercial considerations are matter for the developer. Thus a shadow carbon price is not a factor in determining a section 36 decision. Similarly, the fact that a renewables project may benefit from the Renewables Obligation is not a factor taken into account in determining such projects.

Why is the shadow price of carbon used by the Government so much lower than that recommended in the Stern report?

The Shadow Price of Carbon (SPC) used by the Government is consistent with the Stern report analysis. The SPC the UK Government has adopted (£25/ tonne of CO_2) is based on the social cost of carbon associated with a 550ppm CO_2 stabilisation scenario, as estimated in the Stern Review. As such it makes assumptions about future atmospheric concentrations. The main arguments that have lead the UK to adopt this SPC, based on the Stern Review calculations, are:

- it is sensible to assume the world will take substantial action towards an upper stabilisation goal limit of 550 ppm CO_2;
- using an SPC consistent with the atmospheric concentrations above 550ppm CO_2 would lead the UK, or any individual country, to do "too much" relative to other countries and to the goal, would not reflect progress made from business-as-usual, and would ignore the evidence that the optimum range is 450–550 ppm; and
- adopting an SPC consistent with concentrations below 550 ppm might lead us to do too little, given current uncertainties.

Information on closure dates of oil wells in the North Sea; the costs of re-opening an oil-well compared to using EOR on an existing oil well

During the session on 4 June, the Committee invited the Energy Minister to provide further information on what is known about the closure dates of oil wells in the North Sea and the relationship with the timescale for the development of CCS; whether there is information on the cost of reopening an oil well as against using an existing well; and whether the access routes for taking CO_2 offshore are constrained by the inward flows of oil and gas.

The Department gathers annual projections from oil and gas operators on future production levels and the likely dates for closure of every field. The individual projections are supplied on a confidential basis and the information is used to inform the Department's understanding of the timescale for activities on the UK Continental Shelf. The projections must be treated with caution because of uncertainty in the underlying geology and performance of the reservoirs and the timing of field closures is heavily dependent on the oil price. The Department also encourages the extension of the life of oil and gas fields through a number of initiatives and a joint forum with the industry known as PILOT and expects to approve many new field developments over the next decades.

The closure of an oil or gas field is subject to an approval process and the department must be convinced that the field is no longer economic. The decommissioning of the facilities and wells on the field is then subject to a further approval process where the abandonment programme is examined and companies are required to consider possibilities for re-use ahead of recycling or disposal. The Department has had discussions with several companies which are developing concepts for CCS, are identifying possible oil or gas reservoirs and are discussing them with the current owners. The regulatory procedures are being amended to facilitate such a change of use which could involve Enhanced Oil Recovery in the first phase, under a Petroleum Licence, followed by a pure CCS phase under a CCS licence when the hydrocarbons are depleted.

The economic viability of re-using facilities and wells for CO_2 storage will depend on a number of factors including their location, suitability and the costs of refurbishing or upgrading. Reusing existing oil facilities for EOR and CCS would also require the installation of new equipment to deal with gases from the produced oil for re-injection back into the reservoir; otherwise the injected CO_2 will escape from the reservoir when oil is being produced. The costs of drilling a new well will vary dependent on several factors but could be as much as £25 million. Re-using an existing well may be much less costly although the existing well materials may need to be enhanced to provide long term storage integrity. It is unlikely to be cost effective or practicable to re-open a well which has been fully decommissioned and sealed. CCS is unlikely to need facilities on a platform as complex as those required for oil and gas and it may be more cost effective to close down an existing production platform and replace it with a simpler seabed facility purely for injection.

Although the number of pipelines from the oil and gas fields to onshore terminals is limited there are no proposals to decommission any of these lines and it is apparent that the owners are aware that these trunk lines have potential for re-use on projects including import of gas from outside the UK and storage of hydrocarbon gas to match seasonal demand as well as for disposal of CO_2.

Information regarding the capture ready conditions built into the consents given for the gas fired power stations last year

Section 36 of the Electricity Act 1989 requires any organisation wishing to construct, extend or operate a generating station with a capacity of more than 50MW to gain the consent of the Secretary of State—known as a "section 36 consent". Section 36 consents can impose conditions on the development. If the developer does not comply with any condition of a section 36 consent, the developer is liable to prosecution.

In the Energy White Paper last Spring, Ministers committed to consult, by the end of 2007, on the principle of, and what was meant by, "carbon capture ready". We delayed publication of this consultation to enable us to ensure that the proposals we were expecting from a planned EU Directive on the storage of carbon dioxide could be taken in to account.

Drawing on recent International Energy Agency and Intergovernmental Panel of Climate Change studies, we thought it likely that the most significant minimum requirement would be for a power station developer to show that they had enough land at the proposed power station on which to site a carbon capture plant. Discussions with the developers indicated that they too were anticipating this.

Using past experience of handling provisions for the retrofitting of flue gas desulphurisation plant at power stations, the Department drafted the following condition:

> "The layout of the Development shall be such as to permit the installation of such plant as may reasonably be required to achieve the prevention of the discharge of carbon and its compounds into the atmosphere."

This condition was voluntarily accepted by the developers of 3 gas-fired power station consented last year.

The draft EU Directive on the storage of carbon dioxide, published in late January, includes an Article (32) on carbon capture readiness which defines it by four factors. The government is consulting shortly on the principle of CCR, the meaning of the Commission's four proposed factors (space, technical feasibility study of retro-fitting, transport and storage assessments), the combustion stations to which they might apply, and how it might be implemented in England and Wales.

We would expect that, when a developer wishes to install the carbon capture plant at a later date, as with extensions to power stations now, a further section 36 consent (or in time the appropriate replacement legislation under the Planning Bill before the House this session) would be required.

28 June 2008

Written evidence

Memorandum submitted by Scottish Government

SUMMARY

The Scottish Government is committed to pursuing carbon capture and storage as a technology that has significant potential to reduce CO_2 emissions within Scotland, toward our target of an 80% reduction by 2050. We believe that Scotland is well-placed to play a leading role in the development of CCS, given our research expertise, the commitment of Scottish industry, and our significant storage potential in the North Sea. We are working with the UK Government to ensure an appropriate licensing framework for carbon storage as part of the Energy Bill, and are supporting the UK in its negotiations on the EU draft CCS directive. We recognise that time is of the essence in quickly bringing CCS to commercial viability, and will do everything we can as a Government to ensure that Scotland plays its part in meeting this challenge.

Leadership for CCS in Scotland—The Scottish Government Position

1. The Scottish Government supports CCS as a critical new technology that would assist Scotland, and especially growing economies such as China and India, to help meet significant carbon emission reductions. The Scottish Government has already published our ambitious proposals to reduce CO_2 emissions by 80% by 2050 as a statutory duty on the Scottish Ministers as part of our forthcoming Climate Change Bill on which we are currently consulting. At present, research indicates that CCS has the potential to reduce CO_2 emissions by up to 90% from conventional fossil fuel power station. This is of the scale of reduction that is likely to be necessary to meet the Climate Change Bill's statutory target, and is in line with the agreed advice of the Intergovernmental Panel on Climate Change (IPCC) on CCS.[1]

2. Scotland has vast potential for the geological storage of carbon, both onshore and under the North Sea. The size of the potential storage opportunities in the North Sea could also be of importance to the whole EU as a future carbon store.

3. As the technology is in its infancy, Scotland is well-placed to take a lead in its development and commercialisation. We have the knowledge and expertise in our universities and industry, the infrastructure in the North Sea, and the strong leadership in Government necessary to make this happen and achieve our ambition of a low carbon energy economy.

Regulating CCS in Scotland—The EU Draft Directive on the Geological Storage of CO_2

4. In its recent proposals on Energy and Climate Change, announced in January 2008, the European Commission stated that it expects CCS to be commercially feasible in almost 10–15 years and able to stand on its own within a European Emissions Trading Scheme (ETS)-driven system by 2020. The Commission has issued a draft Directive on the Geological Storage of Carbon Dioxide, which it expects the European Council and European Parliament to agree to by the end of 2008, with it coming into force in 2009.

5. The Scottish Government welcomes the Commission's CCS proposals and is supporting the UK Government in its negotiations in the Council. The North Sea is a vast potential store for CO_2, and the Scottish Government is fully-committed to working with the UK and the energy industry to ensure that it is exploited to the benefit of the whole EU.

Regulating CCS in Scotland—The UK Energy Bill

6. The UK Energy Bill was introduced on 10 January 2008. The Scottish Government has reached an agreement with the Secretary of State for Business, Enterprise & Regulatory reform which will allow the UK Parliament to legislate on Scotland's behalf to give Scottish Ministers powers to regulate the storage of carbon dioxide in Scottish territorial waters (0–12 nautical miles) where they have legislative competence. The Secretary of State will regulate storage in waters from 12–200 miles, and both administrations will agree a Memorandum of Understanding which will see the creation of a single licensing framework for carbon storage in the offshore area.

7. In return, Scottish Ministers have laid a Legislative Consent Motion (LCM) before the Scottish Parliament to allow the UK Parliament to legislate on carbon storage for Scotland. The LCM has been supported by the Economy, Energy & Tourism Committee, and a parliamentary vote will take place during June. This will ensure consistent regulations for carbon storage across the UK and will also implement the EU draft Directive on Carbon Storage. The Scottish Government believes that this simplified approach to regulation is in the best interests of industry to enable rapid development of this critical technology, and will consult jointly with the UK Government on the carbon storage licensing framework during summer 2008.

[1] http://www.ipcc.ch/ipccreports/srccs.htm

8. Regulation of Carbon capture and transportation in Scotland and the UK will be achieved by amendments to existing secondary legislation once the EU has finalised its amendments to the existing IPPC and EIA Directives. A key aspect of the EU directive on geological storage is that new power stations constructed will have to be "carbon capture ready", so that they can be retrofitted with CCS technology. This not only includes being able to demonstrate that the carbon can be captured, but also that it can be feasibly transported and stored in an identified site. This will be an important test to ensure that CCS can be deployed quickly once it has been demonstrated as commercially viable. Powers to consent new thermal generation are executively devolved to Scottish Ministers under s 36 of the Electricity Act 1989, and the Scottish Government will consult during 2008 on new guidance for thermal generation applications, including the carbon capture readiness requirement.

Feasibility oF CCS in Scotland

9. The Scottish Government is committed to assessing the feasibility for storage of carbon dioxide within Scotland and its adjacent waters. We are currently participating in a joint feasibility study on CCS with a range of partners including Scottish Power and Scottish & Southern Energy. This study is identifying potential CO_2 storage sites around Scotland. It is academically-led by the University of Edinburgh and Heriot Watt University through the partnership, *The Scottish Centre for Carbon Storage.* Industrial partners have also been invited to join. Work on the study began at the end of March with a completion date planned for end of 2008/early 2009.

10. Beyond this study, Scottish Power announced its plans at the end of 2007 to undertake a £2.5 million project with the University of Edinburgh to investigate storing carbon dioxide underground. This research-based project aims to evaluate near-shore/onshore sinks that are close to power stations and potentially suitable for CO_2 storage. The project funding is made up from £1.66 million from BERR and the Technology Strategy Board with the remainder from industrial partners. Whilst the Scottish Government is not participating directly in this study, we welcome the contribution that it will make in enhancing our understanding of CCS opportunities in Scotland.

Demonstrating CCS in Scotland—The UK Government CCS Competition

11. In the 2007 Budget, the then Chancellor announced a competition to develop a CCS demonstration project in the UK, with the government prepared to fund up to 100% of the cost of the CCS technology (although excluding the general capital cost of building any new power plant) subject to state aid clearance. BERR has specified that it will only support a post combustion coal fired project. BERR stated that it chose post-combustion coal-based CCS technology as it has the most global relevance, and could be retrofitted to existing coal-fired power stations—thus opening up the possibility for exporting the technology to countries such as China and India to assist in tackling climate change.

12. We understand that the shortlist of successful applicants will be made available in June 2008 with the final announcement on the successful project announced in May/June 2009. The Scottish Government is hopeful that a Scottish-based project will be a serious contender for this competition.

June 2008

Memorandum submitted by Plymouth Marine Laboratory

It is PML's view that:

— CCS is one of the key options for mitigation of climate change and ocean acidification, both caused by the build up of CO_2 in the atmosphere due to fossil fuel burning over the last 200 yrs. IPCC (2007) warns of substantial impact on Earth's terrestrial and marine ecosystems should emissions continue unabated.

Specific comments are as follows:

1. The best reservoirs for UK CCS are the geological strata below the North Sea.

2. Carbon dioxide in seawater is highly reactive and increases the acidity of seawater (reduces the pH). Large volumes of additional carbon dioxide in the marine environment, either through uptake of atmospheric CO_2 or through leakage from CCS reservoirs it is likely to have an impact (Royal Society, 2005, Widdicombe and Spicer, in press,). The impact from atmospheric uptake of CO_2 will be felt in our global oceans (Caldeira and Wickett 2003; Sabine *et al* 2004; Orr *et al* 2005; Turley *et al* 2006 and 2007; Kleypas *et al* 2006) as well as our shelf seas (Blackford and Gilbert: 2007; Feely *et al* 2004 and 2008). Whereas, the extent of the impact from CCS should it leak CO_2 into the marine environment will be more local and depend on the volume of CO_2, the location, hydrography and organisms present (Blackford *et al*, in press).

3. Ocean acidification is happening now and will continue to happen as we add more CO_2 to the atmosphere through continued burning fossil fuels. The risk of more localised acidification of marine waters from CCS leakage is considered to be low.

4. PML advises that The Committee recommend an investment into long term monitoring of the site. "Monitoring" should include that of the geological strata and the marine environment (sediment and seawater), and a baseline study should be conducted prior to storage.

5. It is PML's view that the first CCS demonstrator such as Kingsnorth must be very well monitored for leakage. Saying "it won't leak" (because of the choice of the geological reservoir for storage) and not monitoring for leakage will not be good enough as it opens the door for criticism by the media and NGOs such as Greenpeace and adverse public opinion. We need to demonstrate that no leakage occurs and no subsequent environmental impact occurs.

6. Research is required to a) assess the sensitivity of organisms to CO_2/reduced pH, b) test the applicability of current biological pollution assays for use with CO_2 contamination, c) model the potential dispersion of the CO_2 and its impact, d) assess the recovery of organisms, e) develop and test monitoring techniques for leakage f) assess risk to key marine species and ecosystems in potential leakage area. This knowledge will be vital to ensure appropriate risk assessment for CCS sites can be carried out.

7. In addition we submit three recent papers, one on the acidification of the North Sea through uptake of atmospheric CO_2 (Blackford and Jones, 2006), one on the more localised acidification from a catastrophic CO_2 leak from CCS (Blackford *et al* in press) and one on the impact of large volumes of additional carbon dioxide in the marine environment (Royal Society, 2005, Widdicombe and Spicer, in press.)[2]

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30 May 2008

Memorandum submitted by Progressive Energy Ltd

SUMMARY

— The UK requires ~15GW of new generating capacity by 2015.

— It is highly desirable to include coal generation in the mix to avoid overdependence on imported gas.

— Minimum environmental impact for any new coal plant is essential.

[2] Not printed.

— 800MWe coal power stations based on Integrated Gasification Combined Cycle incorporating CCS from the outset have been under development in the UK and their deployment awaits Government action to put suitable launch aid in place.

— The launch aid required is substantially less than that required for renewable generation and such plant therefore provides a cost effective means to ensure that UK carbon reduction targets are met whilst providing diversity in the energy mix.

1. Progressive Energy is a UK clean energy project development company. Progressive has been involved in CCS for a decade. Progressive's current projects cover both post combustion capture and pre-combustion capture, new station build station and retrofit of existing stations. Progressive is involved along the full chain including capture to storage.

2. The rationale for CCS is informed by studies from IPPC, Stern and others. These make clear that there is an essential requirement to reduce CO_2 emissions as soon as possible to avoid dangerous, possibly runaway, adverse changes to the climate and recommend that CCS is adopted. In Europe, in particular, there is a focus on achieving reductions in the electricity supply sector. The demand for energy is high in the UK, in Europe and across the world. Ageing power stations must be replaced and new environmentally acceptable plant built to meet increasing demand, and in parallel means must be developed to reduce the greenhouse gas emissions from existing fossil power stations, particularly carbon intensive coal stations.

3. The UK requires 15–20GW of new generating plant over the next 10 years with a particular requirement for plant to be operating before 2015 by which date ~9GWe of existing coal plant must close. It is highly desirable that coal generation remains as part of the generation mix to avoid over dependence on imported gas. The lead time for coal power stations is considerable with the development, order and construction process taking typically 5–6 years. Investor companies are developing possible stations now and firm investment decisions will be needed in the next two years for plant to meet this generation need. UK Government energy policy must recognise the near term requirement for new power stations so that investors can be clear whether coal generation should be considered.

4. The UK is one of a limited number of countries having substantial indigenous coal resources. In an energy hungry world this UK asset should be exploited to the full to minimise competing for sources overseas. However coal power stations are carbon intensive and any new plant must achieve environmental performance that is consistent with minimising CO_2 emissions.

5. The goal must be to introduce coal power stations with CCS as soon as possible. There are a number of approaches to capturing CO_2 from coal power stations and the technologies involved are at different stages of development and deployment readiness and an understanding of this is critical to the development of policy for coal generation in the UK over the next decade.

6. Commercial scale coal power stations, based on Integrated Gasification Combined Cycle (IGCC) technology, incorporating CCS from the outset can be built now. It is telling that prior to the announcement of the BERR CCS Competition all the large scale CCS under active development in the UK were based on IGCC with pre-combustion capture. All the IGCC developments were at a scale greater than the 300MWe target for post combustion capture demonstration in the BERR Competition, with three of these projects (Powerfuel, Conoco Phillips and the Centrica/Progressive's project) being developed at 800MWe. Investors, and technology suppliers are clear that such plants with CCS from the outset can be built now.

7. In contrast post combustion capture of CO_2 from coal power stations is much less developed with scale up and efficiency loss challenges yet to be resolved and demonstrated. The BERR CCS Competition recognises the challenge involved by limiting the demonstration to 300MWe and explicitly allowing this to be achieved in a staged approach with a first phase of possibly 100MWe.

8. The difference in development status and the inherent difference in the efficiency penalty involved (pre-combustion capture has about half the efficiency penalty associated with post combustion capture) suggests that in the near term the two technologies are suited to different applications:

(a) BAT (Best Available Technology) for new coal plant is IGCC with CCS incorporated from the outset.

(b) Post combustion capture is well suited to retrofitting to existing power stations.

9. The deployment of coal with CCS now is within the Government's gift. Without Government intervention no large scale commercial coal CCS will be built in the UK in the next decade to contribute to the new plant requirement. Eventually, the EU Emissions Trading Scheme is expected to sustain a price that would justify investment in CCS, but given the lead time for projects, the first of a kind risks involved and the need for investors to become confident in the ETS price, it is very likely that the such coal CCS plant will not be deployed and operating until 2020–25.

10. There are real First of a Kind risks involved and as for other low carbon technologies the cost of electricity is more expensive than that from an unabated coal plant (as efficiency is reduced and additional capital is need for the CCS plant, both capture and storage). All other low carbon technologies receive, or have received introduction aid and most receive on going support during operation. CCS is a cost effective means for creating low carbon electricity (and also decarbonised hydrogen for use in fuel cells for CHP,

transport and industrial applications). The "launch aid" required is modest compared to the support given to renewable generation through the Renewable Obligation, making CCS a cost effective means for the UK to meet its carbon reduction targets.

May 2008

Memorandum submitted by the Environment Agency

SUMMARY

Carbon Capture and Storage (CCS) has the potential to play a key part in the global battle against climate change. The Environment Agency believes that significant work is still necessary to prove CCS and the government should hedge against any risk that a failure to deploy CCS prevents us meeting our climate change targets.

Specifically our submission highlights:

- CCS is the only option that, at present, may bridge the gap between projections of global fossil fuel burning and the need to reduce global emissions.
- CCS is not the solution to climate change. CCS can only be used at large point sources and, even here, the greatest and most cost effective mitigation option remains cutting energy demand.
- CCS is not yet technically proven at a commercial scale. The new Kingsnorth power station would not be built if CCS was made a requirement.
- Kingsnorth and any other new fossil fuel power stations should be built carbon capture and storage ready and this should be required under Section 36 of the Electricity Act 1989.
- The Government's proposed CCS demonstration is an important contribution to deploying CCS. The Kingsnorth project, if approved, seems to offer the earliest opportunity to proceed with the demonstration.
- There remain a series of barriers to deploying CCS where more action should be taken and encouraged by government. In particular around:
  - developing a framework for funding and building CO_2 pipeline networks;
  - further work to map and prove the suitability of prospective storage locations;
  - work to understand the health and safety risks associated with CCS; and
  - work to gain public confidence in CCS.

1. Introduction

We have a range of statutory responsibilities for protecting resources and limiting and adapting to climate change in England and Wales.

We are responsible for the regulation of the major CO_2 point sources in England and Wales under the Environmental Permitting Regulations[3] and the EU Emissions Trading Scheme. These would apply to the proposed new coal fired power station at Kingsnorth.

2. Carbon Capture and Storage

2.1 *Background*

CCS is a potential mitigation option to achieve the greenhouse gas stabilization pathways that would prevent the most catastrophic impacts of climate change.

Coal fired power stations are the largest CO_2 point sources combining long operating life (30–50 years) and the highest relative CO_2 emissions per unit of electricity generated. In the UK, CCS is intrinsically linked to new coal build with E.ON's proposals at Kingsnorth the forerunner.

We believe that whilst the decision on regulating CCS at Kingsnorth is important, it needs to be considered in the larger national and international context of climate change mitigation.

2.2 *The potential benefits and limitations of CCS*

CCS has the potential to reduce CO_2 emissions from coal plants by up to 90% although it does increase the fuel needs of the plant by between 10–40%.[4]

Coal will probably continue to meet a significant and growing proportion of global energy demand until at least 2050. The International Energy Agency (IEA) suggests that coal demand could as much as double

[3] Formerly the Pollution Prevention and Control Regulations 2000 which implement the EC Integrated Pollution Prevention and Control Directive 96/61/EC and the Large Combustion Plant Directive 2001/80/EC.

[4] Carbon Capture and Storage, Defra Science Notes 6, March 2008.

in the 50 years from 2000 to 2050 exceeding 7,000 million tonnes of coal equivalent. In particular, rapidly developing countries such as India and China are exploiting abundant coal reserves. In 2006 alone, 89% of 102 gigawatts of new electricity generation capacity in China came from coal fired plants.[5]

CCS is the only technology that can bridge these demand projections with the general scientific consensus that we need to reduce global emissions by 50% from the 1990 level by mid-century in order to avoid dangerous climate change.

However, CCS can only be used at large point sources which are today responsible for 20–40% of global emissions and roughly 35% of UK emissions and where there are suitable storage sites. It can only ever be one option in a portfolio of ways to reduce emissions.

The debate on CCS cannot be allowed to divert attention from efforts to improve our energy efficiency and develop renewable energy supplies.

2.3 *The technological maturity of CCS*

CCS consists of three distinct components: carbon dioxide (CO_2) capture where fossil fuels are burnt, transporting CO_2 most likely by pipelines, and safe, permanent CO_2 storage in geological formations.

CCS is not technically proven at a commercial scale. Each of the elements has been shown to work, however the full chain is not yet proven. The Table below is a summary of the deployment of each stage in the CCS chain for coal fired power stations.

Stage	*State of Development*
Capture	A number of small scale (few Megawatts) post combustion pulverised fuel trial plants have been established. No large scale capture plant exists worldwide. The components for an IGCC[6] capture plant have been proven in applications in the chemical and refinery industries. No IGCC power station fitted with CCS has been constructed worldwide.
Transport	Transport can be via pipeline or ship. Both technologies are relatively mature. Several thousands kilometres of pressurised CO_2 pipelines exist in USA and Canada. Ship transport would be similar to liquefied natural gas.
Storage	Storage in oil and gas fields is understood fairly well as it has been going on for 30 years to increase the oil yield by Enhanced Oil Recovery (EOR). Other storage including saline aquifers which are common offshore from the UK are much less well understood. Large scale projects using the Sleipner aquifer in the North Sea have shown that it is possible to store CO_2 safely and monitor its movement reliably. Extensive monitoring over a longer period will be necessary to demonstrate its long term success.

The absence of experience with fully integrated commercial projects means that cost estimates for CCS differ considerably and have significant uncertainty attached to them (see figure 1).

In addition to this and despite the European Commission's recent proposal for a Directive on geological storage of CO_2[7] (the draft CCS Directive) the future regulatory framework remains uncertain.

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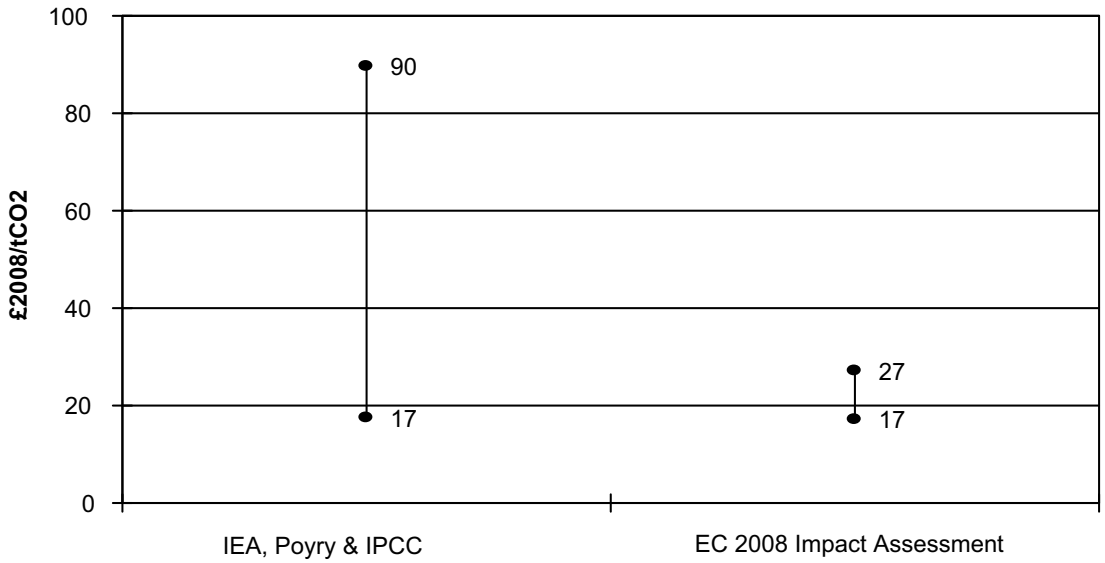
[5] IEA and CIAB, Clean coal technologies, http://www.iea.org/textbase/papers/2008/Clean_Coal_CIAB_2008.pdf

[6] IGCC—Integrated Gasification Combined Cycle.

[7] Proposal for a Directive of the European Parliament and of the Council on the Geological Storage of Carbon Dioxide 2008/0015 (COD). http://ec.europa.eu/environment/climate/ccs/pdf com 2008 18.pdf

Figure 1

COST RANGES PER TONNE OF CO_2 ABATED AT £2008 PRICES.



Source: Environment Agency using IEA,[8] Poyry,[9] IPCC[10] and EC[11].

For all these reasons we believe that no developer would currently risk building a new coal power plant that deployed CCS in the UK.

For the same reasons the government must ensure that new fossil fuel plants do not prevent us achieving the UK's medium and long term targets to cut greenhouse gas emissions. There are a number of ways the government can hedge against this risk. We believe the principle ways are:

- Ensuring that any new fossil fuel plant is built so that CCS can be retrofitted in the future ie it is carbon capture and storage ready (CCR).
- Taking steps that move CCS forward so that it can be deployed at the earliest opportunity. This includes, but is not limited, to the UK's announced CCS demonstration project.
- Providing the long term certainty that the UK will not accept carbon "lock in" should CCS prove to be either technically or economically unattractive. CCS will either need to be deployed or new fossil fuel stations will face the need to buy potentially expensive emission permits, or face domestic regulation forcing restrictive operation or premature closure if the EU ETS does not provide sufficient price signals.

The consideration of CCS on new natural gas plants is less mature than for coal. It is expected that CCS can also be applied to such plants in the future.

2.4 *Carbon Capture and Storage Readiness (CCR)*

We believe that CCR is an essential requirement for any new coal fired power station. We support the recommendations of the IEA study on CCR[12] which has also been adopted by the draft CCS Directive.

This sets out four factors to define CCR for coal as:

- sufficient space and access requirements on the original plant to allow capture related equipment to be retrofitted;
- feasibility assessments of the retrofitting of capture equipment;
- feasibility assessments of suitable storage locations; and
- feasibility assessments of suitable transport routes to storage.

The "state of the art" for these factors will develop rapidly in the next few years. It is important that potential developments are subject to detailed verification to ensure they have gone as far as is reasonable.

We estimate that the cost of making a plant CCR based upon the above definition is modest and certainly less than 0.5% of the overall capital costs.[13]

[8] IEA (2006) CO_2 Capture as a Factor in Power station Investment Decisions, *IEA GHG Report No. 2006/8.*
[9] Poyry, (2007) Analysis of Carbon Capture and storage cost supply curves for the UK, Report for DBERR.
[10] IPCC (2005) IPCC Special Report: Carbon dioxide capture and storage.
[11] Regulatory Impact Assessment presented with reference 5 above.
[12] IEA GHG (2007) CO_2 capture ready plant, *IEA GHG Report No 2007/4, May 2007.*
[13] Draft Environment Agency Science Report on Carbon Capture and Storage Readiness.

The draft CCS Directive proposes mandatory CCR for plants above 300 megawatts electrical (MWe). This will not be enacted until at least 2012 and will be too late to apply to the significant new capacity that may receive planning consent in the UK within the next few years.

In light of this, we believe that CCR must be made a requirement for new fossil fuel plants in the UK by an amendment to Section 36 of the Electricity Act 1989.[14]

Section 36 consents have already been used to require CCR conditions on new gas fired power stations.[15]

2.5 *The UK CCS Demonstration Project*

It is unlikely that CCS will be deployed before commercial and technical viability has been proven through a number of demonstration projects. The European Commission has called for twelve demonstration projects to be built by 2015 but so far only three countries in the world, including the UK, have committed to funding such projects.

Therefore, the UK demonstration project is an essential step on the path to proving and deploying CCS globally. We believe there is an urgent need to accelerate this deployment. Wide-scale CCS deployment by 2030 is likely to be too late. We must act to bring CCS deployment forward to 2020 at the latest. This would create an argument for the UK demonstration project to be sited at Kingsnorth, as it appears this is the most advanced proposal.

There remains a need for the European Commission to determine a funding mechanism for additional CCS demonstration projects. They could for instance be funded through the proceeds of EU Emissions Trading Scheme (ETS) permit auction or from the EU budget. The UK has approximately ten gigawatts electrical of new coal proposals which have been developed to replace the nuclear and coal generating capacity that will close between now and 2015. With the right funding mechanism this could be a significant opportunity for the UK to play a major leadership role in climate change.

2.6 *Support for deployment of CCS*

There remains a series of difficulties to the deployment of CCS that go beyond the CCS demonstration project where the Government can either take or encourage action.

These include:

- promoting a stronger carbon market that will incentive CCS through the EU ETS price mechanism;
- developing a framework for funding and building CO_2 pipeline networks;
- further work to map and prove the suitability of prospective storage locations;
- work to understand the health and safety risks associated with CCS; and
- work to gain public confidence in CCS.

3. Recommendations

CCS has the potential to be a key component in the global battle against climate change. However it remains technically unproven and has significant economic and regulatory uncertainty.

Our key policy recommendations are:

- The UK's CCS demonstration project is a critical global step. There is an argument to proceed with whichever proposal can be developed most quickly. This seems to be the Kingsnorth project.
- The CCS demonstration project should be part of a bigger strategy to support CCS deployment. More work is needed from government and others in a range of areas in particular around pipelines and storage locaions.
- The government must ensure that any new fossil fuel power station is built carbon capture and storage ready under Section 36 of the Electriticy Act 1989.
- The government must protect the achievement of our domestic greenhouse gas targets by hedging against the failure of CCS to be commercially deployed within an acceptable timescale.

June 2008

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[14] The Consenting Process for Onshore Generating stations above 50MW in England and Wales. Consents are issued by DBERR.

[15] Sections 36 consents issued for Combined Cycle Gas Turbines at Drakelow, Barking, Newport and West Burton all contain CCR conditions. The extent of these CCR conditions is not made clear.

Memorandum submitted by UK Energy Research Centre

SUMMARY OF POINTS

- Carbon capture and storage (CCS) can be a critical CO_2 reduction technology for the UK. CCS is now commencing the early pre-commercial demonstration stages worldwide, with the objective of widespread commercial deployment by 2020–25.
- Capture ready design is a very important set of practical actions during the design and building of new power plant, which can be utilised at a later date, to enable the avoidance of "locked-in" high carbon emissions in future.
- BERR has already given Section 36 planning consent to Natural Gas Combined Cycle (NGCC) power plants including a condition that they are capture ready, but without a clear definition of this condition.
- The Kingsnorth plant is currently awaiting a decision on capture ready requirements for coal-fired power plants in the UK. This has become a focus for objectors.
- A wide and encompassing specification of capture ready is needed, to ensure feasible conversion to CCS, when it is required by regulation and/or economically justified.
- It is very unlikely that a CCS plant will operate in the UK until additional costs are covered by appropriate financial support.
- Many estimates exist of the support needed to avoid losses on demonstration plant, typically stated to be a total of €70–100 per ton CO_2. Several approaches are suggested here to regulate or incentivise CCS.

1. The UK Energy Research Centre (UKERC) was established in 2004. Its mission is to be the UK's pre-eminent centre of research, and source of authoritative information and leadership, on sustainable energy systems.

2. Carbon Capture and Storage can become one of the UK's options for sustainable generation of low carbon electricity in the near to mid-future. Government estimates of cost show that retrofit CCS is expected to be cheaper than many other options (*Energy White Paper 2007*i fig 10.2). CCS components, and small-scale whole systems, are now at different stages of demonstration in countries worldwide, but no full-size power plant has yet been fitted with CCS. Several variants of CCS can be envisaged in the UK, using gas, coal, or petroleum coke as fuel. A unique attribute of CCS is its capability to directly reduce CO_2 emissions from very large centralised power plants. It is generally expected that 85–95% of CO_2 produced at a power plant fitted with CCS could be captured and stored.[ii] This capture percentage depends on the detail of technology chosen and how the capture plant is operated. Pre-combustion variants of CCS are capable of using coal or gas to produce hydrogen, or liquid hydrocarbon fuel for transport, as well as electricity, but with hydrocarbon fuels additional CO_2 will enter the atmosphere.

Aspirational benefits of CCS for the UK are:

(i) The ability to continue burning coal or gas with minimal CO_2 emissions, as a transitional technology whilst other low carbon technologies such as renewables are perfected to be deployed at large scale.

(ii) The possibility to deploy CCS with significant impact in the UK before 2020.

(iii) The potential to commence transfer of CCS expertise to developing economies before 2015, within a series of demonstrations in the EU and worldwide.

(iv) Continued improvement in power plant CCS components, even whilst the first commercially deployed CCS plant are operating—similar to the way conventional coal Pulverised Fuel plant has continued to increase in efficiency from 1945 to 2008.

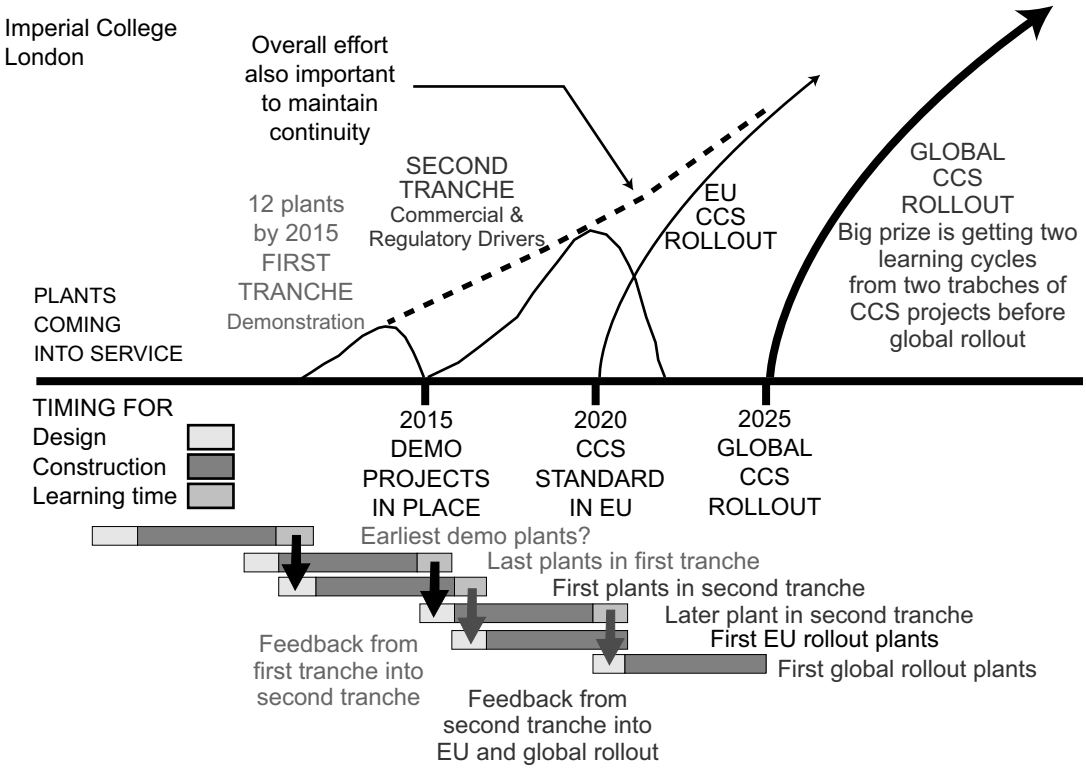
(v) Mitigation of world CO_2 emissions from 2015, significant from 2020. Developed countries will implement CCS first. If CDM routes are created, then CCS projects can quickly occur in developing economies, which can help to offset UK emissions and create opportunities to make profits for UK project management, manufacture, and trading.

Major effort is required to make these benefits a reality on the timescales suggested. But if the necessary financial and policy support is forthcoming, then it is quite possible that this challenging programme could be successfully implemented from a technical perspective. This implies that initial demonstration projects to become operational by 2015, overlapping with a successor second tranche of plants from (say) 2015 to 2022 to implement learn-by-doing, overlapping with full commercial rollout commencing in 2020. For example, the impact assessment of the European Commission draft directive on geological storage of CCS[iii] stated that:

> *"Assessments have been made that if widespread global deployment of CCS is required from a particular date (say 2025 onwards), two generations of learning are required prior to that in order to progress along the initially steep learning curve and reduce the costs of the global rollout.* [Gibbins

and Chalmers, 2008] *This is shown in schematic terms in* [Figure 1] *below, which also shows the timeline for development of the projects and the timing of learning feedback from one tranche to the next."*

Figure 1



3. Capture Ready (CR) is a term describing deliberate design of a fossil-fuel-fired plant to ensure that it can operate with CCS at a future date, if it is not built with CCS initially. Although the concept has been discussed for several years, there is no agreed definition within the UK, Europe or globally.

Recent analysis of the CR concept commissioned by WWF[iv] recommends a wide definition of CR which considers how to make the whole system CCS-ready. This approach stresses the importance of ensuring that transport and storage for CO_2 is possible, in addition to being able to fit capture equipment at the power plant. In this approach, crucial endeavours to enable assurance that CR can be converted to CCS, are:

- Design to fit capture equipment at the power plant (see below).
- Plan a detailed route to storage, either by pipe or boat.
- Outline assessment of storage volume, security, and availability.
- Creation of business links along the CCS value chain.
- Development of design, engineering and operation skills within the power company.
- Stated criteria for the date of transfer to CCS operation, and penalties for failure.

A detailed, peer-reviewed study on how power plants should be designed to ensure that capture equipment can be retrofitted was undertaken in 2007 commissioned by the IEA Greenhouse Gas R&D Programme as part of the G8 Gleneagles plan of action.[v] This work details requirements for plant design for pulverised coal-fired power plants, Integrated Gasification Combined Cycle (IGCC) and NGCC and concludes that a number of low-cost or no-cost alterations are essential requirements for capture readiness. Further non-essential pre-investments can also be considered. The authors suggested that CR status should be linked to a process where "competent authorities [are] provided with sufficient information to be able to judge whether the developer has met [CR] criteria" which might include "identification of reasonable route(s) to storage of CO_2" as well as power plant design considerations.

It should be noted that designing a plant to be CR does not necessarily guarantee that CCS will be fitted. For CR to be converted to CCS operation, it is also necessary that Government provides the legal framework both onshore and offshore. Sufficient financial incentives or regulatory requirements for CCS deployment are also required. These are needed so that investors are able to recover the increased capital and operational costs of generating decarbonised electricity, compared to fossil-fired plants without CCS. One method to achieve this could mean the implementation of current EU proposals to recycle revenue gained from auctioning of EU-Allowances for emissions (see section 4 below).

Operation of CCS plants, and hence the finances required, will also be influenced by other developments in the electricity system. For example, one scenario can be argued that a CCS plant will be run continually as a baseload supply of electricity. By contrast, if high penetration of nuclear and renewables occurs, it is possible that the main role for fossil-fired plants would be as back-up to ensure security and quality of supply. CCS would then be used to ensure that these support services are provided by low carbon sources.

At the nascent stage of a new large-scale technology, there can be a role for Government to provide public education, not least to enable informed decisions to be made by citizens directly affected by any development. BERR intends to undertake a Consultation during 2008 on the role of CR in the UK. It is likely that this will be important in both informing public on CR issues and ensuring that the public are able to express their views as part of the development of the regulatory regime for CCS in the UK.

Although DTI/BERR have already licensed four gas plants as CR, there is some uncertainty over how CR requirements will develop for coal-fired power plants in the UK. In particular, E.ON have applied to build a replacement supercritical steam coal plant at Kingsnorth which is also described as capture ready. Several environmental NGO's have used this as a focus to query the reality of the CR concept, and have pointed out that building new coal plants has the potential to increase UK emissions of CO_2 if not regulated properly. Since Government had not developed policy on CR before the Kingsnorth planning application process began, this has created an opportunity for vocal and organised single-issue groups to create a campaign around Kingsnorth. Such a campaign has the potential to shape public perception on issues such as "new coal", "clean coal", "greenhouse gas", "capture ready", and "carbon storage". Consequently, the BERR consultation process could come into conflict with continued campaigning activity around Kingsnorth, and could significantly shape national perception of CR and CCS. Ultimately, the outcomes of these activities are likely to determine whether CCS is seen as an acceptable technology for Government to include within the suite of options it uses to control CO_2 emissions in the UK.

4. Incentives for CCS deployment, including EU actions, are important in shaping the future of CCS. The European Commission has proposed aligning energy strategy with climate strategy.[vi] A proposed Directive on CCS[vii] outlines a common methodology across the EU for conditions relating to permitting, operation, monitoring, and eventual transfer of ownership to the state. The Communication[viii] on Demonstration plants recognises the large finance involved, includes CCS in the EU-ETS and supports a coordinated programme that seeks to share lessons learned from up to 12 flagship demonstration projects.

Funding the capital and operating costs of CCS demonstrations is a large item with an uncertain cost in the UK and elsewhere, deterring investment. Companies could be assisted with capital costs by a variety of Government mechanisms, ranging from tax credits, to direct support. The EU communication on CCS Demonstration[viii] specifically includes CCS research facilities as eligible for State Aid.

Additional measures are required to fund the operational cost of CCS demonstrations. These are important since CR plant consented, or proposed, in the UK will not have CCS technology fitted and operated unless investors can expect to receive a reasonable return on their investment. A number of different approaches can be considered (below).

It is often argued that a CO_2 price (tax/penalty or emissions trading certificate price) which is long term and high enough should be sufficient to ensure that CCS is fitted and operated. This additional price has been analysed many times, and is typically stated to be a total of €70–100 per ton CO_2 for the initial projects. However this is significantly more than the current EU-ETS price of €25, or the predicted EU-ETS phase 3 price of €30 per ton CO_2.

A large price gap needs to be overcome initially, but it is generally accepted that this is for a few projects for a time period of 10–15 years on those projects. By making best use of shared learning from the proposed European flagship demonstration programme[vi] it is expected that the costs will be significantly reduced for later plants. For example, the European Commission has a stated aim of reducing CCS costs to EU-ETS levels of €30 per ton CO_2 from 2020.

Deployment of CCS after 2020 is not planned to require special funding, since it is anticipated that CCS will compete successfully with other low carbon technologies in the context of an EU and/or global agreement to significantly reduce CO_2 emissions. The UK appears to expect this to be as part of a market-based system that identifies the lowest-cost opportunities for mitigation (and penalises CO_2 emitters). In such an EU, or world market, routine CCS would not need any special incentives unless other technologies received incentives which distort the market.

The UK has not yet provided any general funding for CCS demonstration or deployment, but has instead focused on a Competition to demonstrate a restricted amount (300–400MW) of post-combustion (or oxyfuel) capture at commercial scale at part of one coal-fired power plant (which could be generating 800MW or more in total).

In addition to this Competition, there are still several opportunities to fund transitional CCS arrangements, by methods which can be "blind" to the choice of CCS technology, or can support particular strategic developments. Funding to support such projects can be available from EU arrangements. From 2013 the EU-ETS phase 3 is proposed to auction all CO_2 emissions allowances for power plants.[vi] It is expected that this will provide the UK Government with about €4,800 Million per year of new income. A number of methods could be used to fund CCS demonstrations in the UK, including:

— EU-ETS income could be used by the UK to provide funding to power companies as infill for the gap between the variable EU-ETS price and a fixed base price for CO_2 sufficient to avoid financial losses in operating CCS plant. No additional costs would pass to consumers, but the Treasury has to pay.

— Free EU allowances could be given by the UK or EU to reward CO_2 actually stored from CCS demonstration plant. More than one allowance will be needed, to enable companies to derive sufficient income from their sale. No additional costs pass to consumers, as EU allowances are already priced into UK electricity.[ix]

— The UK could create a Decarbonised ROC, parallel to, but separate from, the ROCs for renewable technologies already in place. The extra DROC cost is spread amongst all electricity supplied to consumers.

Emissions standards could also form an important element of CCS/CR legislation and incentivisation. If this approach is adopted then Government would focus on determining acceptable emissions from power generation, but leave technology choice to electricity suppliers. This type of approach is similar in principle to car emissions standards, and has been adopted by legislators in California. Here a maximum of 500 kg CO_2/MWh is being applied initially; this enables NGCC plants to continue operation without emission reduction technology, however, coal-fired plants, because of higher CO_2 emissions, are required to fit CCS or, eventually, to close. Environmental NGO's and others in the UK have suggested tougher standards for the UK, although it is not clear when it would be feasible to introduce these.

It seems likely that careful choice of incentives and/or regulation (using one or more of the methods identified here or other approaches), combined with commitment to the long-term value of CCS, can create an environment in the UK that would foster several successful commercial-scale demonstrations and deployment of CCS. Many of the companies involved in developing CCS projects are international. Such companies may choose to develop CCS technologies (and invest in power generation plant) elsewhere if sufficient incentives are not available in the UK. For example, a BP-SSE project proposed at Peterhead (near Aberdeen) has now been transferred to Abu Dhabi. Most (probably all) of the nine or more demonstration projects currently proposed for the UK would require some form of Government intervention for profitable operation. CCS projects that are additional to the current BERR-run competition can provide advantage to the UK by:

(a) demonstrating world leadership in projects as well as legislation;

(b) creating skills and learning in UK companies and workforce which confer a competitive advantage on UK business; and

(c) directly reducing UK CO_2 emissions.

5. In summary, to create an option to use CCS as a fossil fuel CO_2 mitigation measure, it is necessary to act now. Rules to enable gas and coal power plants to be built "capture ready" are important to maintain electricity supply and commercial interest in UK CCS leadership. Capture ready can be achieved either by detailed specification of the preparations made for deploying the CCS chain for the plant, or (assuming a rational response from project developers) by stipulating the emissions standard(s) that the plant will have to meet. To enable actual operation of CCS, a financial mechanism to avoid commercial losses in capital and operation costs is essential.

References

i DTI Energy White Paper 2007 CM7124 Fig 10.2 cost curves including retrofit CCS.

ii Intergovernment Panel on Climate Change 2005 Special report on CCS www.ipcc.ch

iii European Commission 2008 Impact assessment Draft Directive on Geological Storage; Paragraph 43 http://ec.europa.eu/environment/climat/ccs/pdf/ccs_ia_jan2008.pdf

iv University of Edinburgh (2008) How ready is "capture ready"?—Preparing the UK power sector for carbon capture and storage www.geos.ed.ac.uk/sccs/

v IEA GHG (2007) CO_2 capture ready plants, 2007/4 www.ieagreen.org.uk/2007.html

vi EU Com (2008) 30 20 20 by 2020 Europe's climate change opportunity. http://ec.europa.eu/commission_barroso/president/pdf/COM2008_030_en.pdf

vii EU COM(2008) 18 Directive on the geological storage of carbon dioxide. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008PC0018:EN:NOT

viii EU COM:2008:0013 Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0013:FIN:EN:PDF

ix Ofgem January 2007 Response to Consultation on Renewables Obligation http://www.ofgem.gov.uk/Sustainability/Environmnt/Policy/Documents1/16669-ROrespJan.pdf

2 June 2008

Memorandum from the Institution of Mechanical Engineers

The Institution of Mechanical Engineers (IMechE) is a professional body of over 78,000 professional engineers in the UK and overseas. The Institution's membership is involved in all aspects of energy exploration, conversion, supply, use and recovery. As a Learned Society, IMechE's role is to be a source of considered, balanced, impartial information and advice.

IMechE welcomes the Environmental Audit Committee's inquiry into Carbon Capture & Storage (CCS). CCS has the potential to reduce the impact of energy generation. Given the very short timescale, the Institution's response will focus attention on general issues affecting new and existing coal plants in the UK (including Kingsnorth) and particularly the need for market, certainty regarding the implementation of CCS.

The Institution believes that:

1. For a variety of reasons, including diversity, security of supply and grid balancing, coal-fired power generation should be allowed to continue to meet the UK's energy demand, at least in the short and medium terms. There is, therefore, a strong case to allow new coal-fired plants to be built.

2. Coal's high carbon content dictates that new and existing plants should only be allowed to continue to operate if their carbon emissions can be substantially reduced by roughly 85–90%. To achieve this, CCS and biomass co-firing are the two most viable options.

3. The Government needs to provide a strong incentive for coal plant operators to reduce their emissions, over and above the uncertainties of the EU ETS. We believe this is best provided by setting a date, after which all coal-fired plants would only be allowed to operate if the amount of CO_2 emitted per MWh used (heat and/or electricity) are below a specific level.

4. Although the full CCS technology chain has not yet been demonstrated at commercial scale, all the individual elements of that chain have been realised; there is every reason to be optimistic that full-scale CCS is a practical prospect.

5. CCS is applicable to natural gas-fired generation as well as coal. A similar emissions limit and cut-off date should apply to gas to ensure a fair and level playing field for both energy sources.

6. Our preliminary assessment is that a suitable cut-off date would probably be 1 June 2018.

7. Efficient modern coal-fired plants, operating in power-supply mode only and without CCS, have emissions factors of about 700gCO_2/MWh. Our preliminary assessment, therefore, of a suitable post-2018 emissions factor for coal would be 100kgCO_2/MWh.

8. Making use of a significant proportion of the heat currently wasted, by operating in Combined Heat and Power (CHP) mode, through links to suitable domestic, commercial and/or industrial heat users, would also greatly reduce the plant's emissions per unit of energy delivered. Alongside CCS and biomass co-firing, such schemes should be strongly encouraged and incentivised.

9. Such a technology blind approach gives operators freedom to find the most cost effective ways to meet this requirement, be it by pre or post-combustion CCS, CHP, biomass co-firing or any combination of these measures; and

10. The Government must recognise and support the tremendous potential for UK engineering, applied via CCS and other projects, to set a world lead in this vital emerging technology area, and the consequent job creation, export earnings and global emissions reduction opportunities.

2 June 2008

Memorandum submitted by the National Oceanography Centre

SUMMARY

I. Observations of the marine environment confirm that efforts should be in place to reduce anthropogenic greenhouse gas emissions as quickly as possible.

II. Ocean acidification poses as great, if not greater risk to natural ecosystems as changing temperatures and sea level rise.

III. Technology exists to remove carbon dioxide from the exhaust flow of hydrocarbon-fuelled power stations.

IV. Hydrocarbon-fuelled power stations are very large emitters of carbon dioxide.

V. If the UK wants to make significant cuts to CO2 output quickly, carbon capture and storage presents an engineering solution able to quickly deliver reductions.

VI. New-build hydrocarbon, particularly coal,—fuelled power stations should include CCS from day one as an integral part of the design. Older stations could have the technology retrofitted.

VII. The technology is not especially risky and industry already has experience of how to do this.

VIII. Suitable geological formations exist within UK territory for long term carbon storage.

1.0 The National Oceanography Centre, Southampton, welcomes the opportunity to respond to this enquiry. Jointly owned by the Natural Environment Research Council and the University of Southampton, we are the UK's leading centre for observations of the deep ocean environment, see www.noc.soton.ac.uk

2.0 Our oceanographic research and observations lead our scientists to endorse the view that anthropogenic carbon emissions pose a potent threat to the stability of our climate and to the biochemical balance of the oceans.

2.1 There are real risks of the existence of climate "tipping points", beyond which effects could be rapid and irreversible in the short to medium term.

2.2 The relatively recent discovery that ocean pH is being affected by anthropogenic carbon has shown that even if CO2 had no climate impact, it is still necessary to lower our emissions if we are to avoid causing damage to the ocean ecosystem, in particular to coral reefs and to organisms that have shells made of calcium carbonate.

2.3 We accept that there are varying estimates of what the "safe" level of atmospheric CO_2 equivalent are. In view of these uncertainties, and the very great impacts posed by rapid climate change in particular, it is prudent to instigate carbon capture and storage techniques to help remove carbon dioxide from the atmosphere.

3.0 It is difficult to engineer carbon capture systems for small, mobile systems such as aircraft and road vehicles but much easier for fixed land structures that burn hydrocarbons such as power stations, and to other large emitters of CO_2 such as cement production plants.

3.1 The Norwegian pilot CO_2 injection scheme at the Sleipner platform in the North Sea points the way ahead to long term carbon capture and storage (CCS) in a stable geological structure.

4.0 If the UK, as a nation, intends applying measures to reduce CO_2 emissions, coal fuelled electricity generation should only be permitted if carbon capture and storage techniques are applied.

4.1 It is reasonable to say that CCS could be retrofitted to older installations, and new stations should not be built without it.

4.2 The risks to the environment of failing to reduce CO_2 output are potentially so serious that to commission new coal-powered plant without CCS could be seen as negligent, and could give the impression to the world that the UK is not treating climate change seriously.

5.0 The UK has geological formations that have retained vast quantities of oil and natural gas for millions of years.

5.1 These formations are now depleted, and it is reasonable to hold that these same formations can absorb similar volumes of carbon dioxide and retain the substance for a long enough period that even with leakage, the rate at which the carbon re-enters the atmosphere is vastly less than the rate at which it is currently being generated.

2 June 2008

Memorandum submitted by Co2 Deepstore

This submission is the views of CO2DeepStore Limited on the subject of carbon capture and storage, with a particular emphasis on developments surrounding the Kingsnorth power station.

Our 6 page submission is made under the following headings:

* An introduction to CO2DeepStore Limited.
* Observations on the requirement for new power stations.
* Comments on the urgent need for carbon capture and storage (CCS).
* Observations on the steps required to implement CCS.
* Recommendations on steps required to implement CCS.

1. *Introduction to CO2DeepStore Limited*

1.1 CO2DeepStore Limited is a UK based company specifically focussed on the commercialisation of geological storage of CO_2 deep within the earth. The need for this is based on the growing global imperative for immediate and sustained reduction of CO_2 emissions to mitigate climate change. The company was founded in 2007 by four former oil industry executives. More information is available at www.CO2DeepStore.com.

2. *Observations on the requirement for new power stations*

Drawing on extensive discussions with a number of power generation companies, we are of the view that:

2.1 There is a growing need to build new electricity generation capacity in the UK as a significant number of existing coal-fired power stations will be decommissioned from 2015 onwards under the Large Combustion Plant Directive (2001/80/EC).

2.2 Power stations represent a substantial long term investment. Power stations such as Kingsnorth will contribute to both meeting the demand for electricity in the UK, and to the UK's long term carbon emissions, for 30–40 years.

2.3 A range of technologies exist which provide the opportunity to capture CO2 at power stations. These include pre-combustion capture and oxy-fuel technologies which require the construction of completely new power stations, and post-combustion capture technologies suitable for retro-fitting to existing power stations.

All of these technologies are at the early stages of development. Some are still under development in the laboratory where concepts are being proved, the most advanced are at the stage of early small-scale pilot plant.

None of these approaches is presently at the stage where power station operators could deploy the technology with confidence.

2.4 There is confusion over the definition and implications of being "capture ready". This uncertainty is hindering the development of new power stations.

3. *Comments on the urgent need for carbon capture and storage (CCS)*

3.1 We are of the view that the case for action on climate change has been powerfully made by others.

Independent studies, notably the Stern Review Report on the Economics of Climate Change, unambiguously accept the evidence that the emissions of carbon dioxide by the human race are driving the rises in global temperature, and spell out the serious consequences of failure to act.

More recent updates from the United Nations Intergovernmental Panel on Climate Change provide evidence that the pace of change in the climate appears to be accelerating.

3.2 We are of the view that mankind urgently needs to take a wide range of measures to address this issue.

Reducing energy consumption through passive measures such as better building insulation and low-energy lighting, substantial increases in the use of renewable energy, and fiscal measures to discourage CO_2 emission all have their place.

Ultimately we will have to generate all our energy in a carbon-free manner.

However, over the next 20–30 years the only credible sources of energy in sufficient quantities to meet our requirements are nuclear and hydrocarbons (coal, oil and gas).

As a result we are of the view that carbon capture and storage is essential to enable us to enjoy the benefits of hydrocarbon sourced energy whilst avoiding the worst consequences of climate change.

3.3 We are also of the view that the implementation of CCS is an urgent requirement—substantial volumes of CO_2 should be captured and stored within 5 years, not 10–15 years as suggested by others.

We regard the UK government competition to partially fund CCS on an existing coal-fired power station as encouraging. However, we are concerned that it sets expectations for action at scale over a timeframe of 10–15 years. In particular, it is described as a "demonstration scheme", with CO_2 being stored by 2015. The implication is that large scale CCS activity will follow some years afterwards.

3.4 We are of the view that the case for CCS has not yet been made to the public and that urgent action is required to effectively communicate the risks and benefits of this activity. There is a danger that without timely explanations the public argument for CCS will be lost in a manner similar to the launch of the nuclear industry in the 1960s.

4. *Observations on the steps required to implement CCS*

The technology to implement CCS exists, but some components have not been proven at the scale associated with power stations:

4.1 Amine extraction technology is routinely used to extract CO_2 from natural gas at a scale of millions of tonnes per annum. However, in the context of post-combustion capture, it is known that coal-fired power station exhaust gases contain contaminants that are detrimental to the amine process. No plant is currently capturing CO_2 from power station exhaust gases at a scale of millions of tonnes per annum. As an amine plant costs £100–£200 million, there is reluctance amongst power generators to commit to the technology scale-up risk associated with amine extraction.

4.2 Other post-combustion capture technologies exist, but are all significantly less mature than amine extraction—generally at the stage of University laboratory "proof of concept" experiments. They are however very attractive as they offer the prospect reduced capital and/or reduced operating costs relative to amine capture. Funding should be increased to accelerate the development of such capture technologies in the UK.

4.3 Pre-combustion and oxy-fuel technologies also exist, with various technologies at different stages of commercialisation. We believe it is important for the UK to implement an IGCC plant, with CO_2 capture, urgently in order to balance the post-combustion emphasis provided by the government competition and ensure the UK can be a world leader in CCS and climate change mitigation.

4.4 Pipeline transportation of CO_2 is well established. There are some hazards associated with transporting CO_2 but such hazards are less onerous that those associated with the natural gas pipeline network and should not present problems if managed appropriately.

4.5 Many reservoirs have been identified as suitable for long term reliable storage of CO_2. We particularly favour the use of depleted gas reservoirs as their long term ability to contain gas has been demonstrated over the millions of years that hydrocarbon gas was trapped. Likely leak paths such as well bores are known and can be readily monitored.

The financial and regulatory uncertainty relating to CCS is a significant impediment to implementation :-

4.6 CCS adds significantly to the operating costs of a power station due to increased capital costs and energy consumption associated with CCS.

As a result we are of the view that in the absence of financial support no electricity generator would take on the cost penalty associated with CCS in the near term, as this will render their electricity price uncompetitive.

4.7 As there is significant potential for new technology to reduce the capital and operating costs of CO_2 capture, electricity generators might reasonably take a "wait and see" approach.

4.8 The future cost of carbon emissions to atmosphere is highly uncertain. The EU Emissions Trading Scheme (EU ETS) is designed to attribute a cost to CO_2 emission through a "cap and trade" system. The EU has announced measures to require power generators to bid for EU ETS emissions allowances from 2013, and to restrict supply of allowances.

Whilst we welcome this measure, and believe it will attribute an increasing cost to carbon emissions, it is inadequate for commercial organisations such as our own to secure project finance for CCS projects. Whilst recognising that future carbon price will be "higher" than today, banks cannot see the future revenue stream that will repay their loans with sufficient certainty.

4.9 Proper measurement, monitoring and verification of CO_2 volumes sequestered are essential for operational and commercial reasons. However some of the proposed guidelines seem to require a level of accuracy and precision not yet possible when working with the natural environment.

Gaining public acceptance of the need for CCS

4.10 We believe that there is a significant risk of political backlash if the general public are not better informed of the impact of climate change. It is our view that the general public currently have little awareness of the linkage between their day-to-day behaviour, their personal energy consumption decisions, and climate change.

4.11 It is essential to establish a clear and strong link between the convenience associated with the generation and consumption of 350,000 GWh of electricity annually, and the associated impact on the environment.

4.12 We therefore believe that it is appropriate to convey the urgent need to implement CCS as a means of mitigating the worst effects of climate change. Part of this process will involve communicating the cost of CCS, and the inevitable impact on energy prices.

5. *Recommendations on steps required to implement CCS*

We wish to suggest the following steps to accelerate the process of adoption of CCS:

5.1 The power generation and industrial markets need certainty over the future cost of emitting CO_2 to atmosphere, so that they regard CCS as a lower-cost option to be implemented as soon as practical. This certainty is currently not present. We suggest that the UK government and the EU send stronger and clearer signals of their intent to actively manage the EU ETS to ensure that CO_2 emissions to atmosphere are financially less attractive than CO_2 avoidance or CCS.

5.2 Ideally, this clarity would take the form of clear EU ETS price objectives such that markets will see that future CO_2 prices will be high enough and stable enough to justify investment in CCS.

5.3 We suggest that, with immediate effect, the UK government require all new power stations (including Kingsnorth) to install carbon capture and storage technology as a condition of their consent to build.

5.4 We suggest that existing major CO_2 emitters are actively encouraged to retrofit CCS technology, and that financial support as outlined below is offered to finance this initiative.

To eliminate the competitive disadvantage that the early power plants with CCS will experience, we propose that the government contract to pay to the power generators the difference between the actual EU ETS carbon price and the carbon price required to deliver an agreed economic return on the CCS investment (a so called "contract for difference"). Implementation of such an approach could involve offering a certain guaranteed carbon price and inviting project proposals.

We believe that such a mechanism would enable CCS projects to proceed immediately with no loss of competitive position in the electricity market.

It would also address the challenge of reluctance to invest in one technology for fear of a lower cost technology being proven later.

5.5 We are of the view that this mechanism should be funded through government receipts from the EU ETS (estimated to be £2–4 billion per annum) until CCS is well established. We are of the view that this "variable state aid" will gradually fall away as the EU ETS price of carbon rises.

5.6 The UK Government should begin to make the case for CCS more forcibly with the objective of winning the public acceptance of this technology.

We look forward to seeing these ideas reflected in the deliberations of the Committee.

2 June 2008

Memorandum submitted by the Carbon Capture and Storage Association

INTRODUCTION

The Carbon Capture and Storage Association welcomes the opportunity to respond to the Environmental Audit Committee's Inquiry into Carbon Capture and Storage and would like to submit the following evidence.

1. All of the evidence that the Association submitted, both written and oral to the EAC inquiry, The 2007 Pre-Budget Report and Comprehensive Spending Review remains valid in this context. A copy of this submission is appended.[16]

2. We are currently awaiting the Government Consultation on "Capture Readiness" we have not formulated a formal position on the subject but we would like to make the following observations:

3. The CCSA is positively in favour of measures that stimulate the commercial introduction of CCS and prefers incentives as a means to do so but in the absence of sufficient financial inducement will be happy to consider all other options.

4. Our philosophy is that mandating the concept of 'Capture Ready' is largely unnecessary however, if it is necessary to introduce it as a political expedient, it should be minimally prescriptive as the extent of readiness will be a commercial decision set against the risk of excessive cost in a future regulatory regime.

5. We consider that it is not yet appropriate to mandate CCS on new plant because it is insufficiently proven to give certainty about cost and performance. This is exactly why demonstrations are needed to encourage "learning by doing" and to bring forward cost reductions and performance improvements.

6. There are severe dangers of unintended consequences resulting from mandating CCS on new coal plant, such as sweating existing dirty assets or driving towards over-dependence on gas.

7. At present, there is a discussion taking place on mandatory CCS for new plant in relation to the European Directive on CCS. Whilst uniformity across Europe should be an aim, it should be remembered that it may be more difficult or expensive to mandate CCS at any level in some Member States than in others.

8. Most investors accept that CCS will become mandatory at some point in the lifetime of a new plant and believe CCS is an important part of the climate mitigation mix. They are therefore not uncomfortable about a statement that anticipates this. Their concerns relate firstly to fixing a timescale given the reservations expressed in 3 above and secondly, facing an unstable long term regulatory environment.

[16] Third Report from the Environmental Audit Committee: The 2007 Pre-Budget Report and Comprehensive Spending Review: An environmental analysis, HC 149

9. To stimulate investment in new power plant we would like to see the uncertainties surrounding regulation resolved as quickly as possible. In the UK this means bringing forward the CCS consultations on Regulation and Capture Readiness without any further delay.

The view expressed in this paper cannot be taken to represent the views of all members of the CCSA. However, they do reflect a general consensus within the Association.

2 June 2008

Memorandum submitted by World Development Movement

1. Introduction

1. The World Development Movement (WDM) campaigns to tackle the root causes of poverty. With our partners around the world, we win positive change for the world's poorest people. We believe that charity is not enough. We lobby governments and companies to change policies that keep people poor. WDM is a democratic membership organisation of 15,000 individuals and 70 local groups.

2. We welcome the Environmental Audit Committee's decision to hold an evidence session into carbon capture and storage with particular focus on developments surrounding the proposed new Kingsnorth power station.

3. There are three issues which should be addressed separately: the UK government's competition for a 300–400MW demonstration carbon capture and storage power station; E.ON's application for a new 1600MW unabated coal power station at Kingsnorth in Kent; and E.ON's entering of Kingsnorth into the carbon capture and storage (CCS) competition. Whilst these issues are separate, unfortunately they are often conflated as being the same issue.

4. This submission makes the following three points:

The CCS demonstration project

5. The UK government's subsidy for a CCS demonstration project to research the effectiveness and cost of post-combustion CCS technology should be supported.

E.ON's application for a 1600MW unabated coal power station

6. The UK government should refuse to consent E.ON's application for a 1600MW unabated coal-fired power station at Kingsnorth. Any new unabated coal power stations in the UK would make it extremely difficult for the UK to meet targets for reducing emissions by 2020. Furthermore, there is and can be no guarantee that CCS technology would be added to Kingsnorth in the 2020s, and so any decision to consent Kingsnorth risks locking the UK into high-carbon infrastructure for decades to come. Instead, the UK government should set a greenhouse gas standard which any new power stations built in the UK have to meet.

Kingsnorth and the CCS demonstration project

7. If Kingsnorth wins the 300MW CCS demonstration project competition, the 300MW CCS plant should not be used to justify the 1300MW of unabated coal which would still exist if the government consents E.ON's application for a 1600MW power station. Around 80% of Kinsgnorth would be unabated coal and emit CO_2 at the rate of a supercritical coal power plant; around 0.9 tonnes of CO_2 for every MWh of electricity produced. The remaining 20% would be CCS and emit at a rate of 0.16 tonnes of CO_2 for every MWh of electricity.

8. Overall, a Kingsnorth with 300MW of CCS and 1300MW of unabated coal would emit at a rate of 0.75 tonnes of CO_2 for every MWh. This is still almost double the emissions of a modern gas power plant. If the UK government regards E.ON's CCS application as the best entrant into the CCS demonstration project competition, it should consent the 300MW CCS plant and only the 300MW plant.

2. The CCS Demonstration Project

9. Technology for CCS exists in separate plants around the world but there are no full-scale power plants currently operating capturing, transporting and storing CO_2.[1] Therefore, CCS is not yet deployable at scale. It is therefore not yet known whether the technology can be made to work and how expensive it will be.

10. The UK government has launched a competition to subsidise one CCS project with 50–100 MW of capacity by 2014, rising to 300–400MW "as soon as possible thereafter".[2] By 2014, the project will have to demonstrate the full cycle of capturing, transporting and storing the CO_2.

11. The IPCC says that current technology captures 85–95% of the CO_2 generated.[3] The UK government has said the demonstration plant should be able to capture and store "up to 90%" of the CO_2 emissions.[4] Given that this is an aspiration for 90%, rather than a clear commitment, we will assume for the purposes of this submission that the CCS demonstration plant will capture 85% of the CO_2 emitted. Coal CCS should therefore emit less CO_2 per MW hour directly from the power plant than modern gas power plants (see Table 1 below).[17] However, coal CCS still emits some CO_2 directly from the power plant, unlike renewable technologies such as wind.

Table 1

CO_2 EMISSIONS DIRECT FROM POWER PLANTS

Type of power plant	*CO_2 per MW hour*
Subcritical coal	1.20
Supercritical coal	0.9
Gas (CCGT)	0.4
Subcritical coal with CCS[18]	0.23
Supercritical coal with CCS[19]	0.16
Wind	0

12. On current policies, if the government's targets are met, a 50 MW rising to 300 MW demonstration power plant will start operating from 2014–16. Following the results of this trial, information might be available around 2018 to inform future CCS development in the UK. This means CCS might be deployable in other power plants from the early 2020s. Therefore, CCS cannot realistically play a part in meeting the UK's targets for reducing emissions by 2020.

13. The EU energy package has effectively set the UK a target to generate 40% of electricity from renewable sources by 2020. After 2020, the generating capacity of renewables will hopefully continue to increase. But, unfortunately it is likely that from 2020–40, fossil fuels will need to remain some part of electricity generation in the UK. Coal (and gas) with CCS may potentially have lower emissions than gas without CCS, so could be part of this mix, whilst helping to reduce emissions.

14. CCS could potentially be part of reducing emissions in the UK, and elsewhere in the world, from 2020 to 2040. WDM therefore supports the 300MW CCS demonstration project in the UK as part of a research programme into CCS.

3. E.ON's Application for a 1600MW Unabated Coal Power Station at Kingsnorth

3.1 *Emissions from Kingsnorth*

15. E.ON has applied to build a new 1600MW unabated coal power station at Kingsnorth in Kent. E.ON are aiming for the plant to be generating electricity before 2015. By 2015 the current Kingsnorth plant will have to close having opted out of the EU Large Combustion Plant Directive.

16. Kingsnorth would be a supercritical coal power station. It is therefore likely to emit around 0.9 tonnes of CO_2 for every MWhour of electricity generated. This is in comparison with 1.2 tonnes per MWh for subcritical coal power plants, 0.4 tonnes per MWh for combined cycle gas turbine power plants and 0 tonnes per MWh for wind. If the new Kingsnorth plant operated for 60% of the time, it would emit 7.6 million tonnes of CO_2 a year;[20] more than the total emissions of Ghana.[5]

17. The fourth assessment report of the IPCC released in 2007 suggests that to keep the increase in global temperatures to between 2°C and 2.4°C requires global emissions to peak between now and 2015, at the latest, and then fall by between 50 and 85%, on 2000 levels, by 2050.[6] For the UK to play its part in reducing global emissions by 50–85% by 2050, UK emissions must fall by 80–95% by 2050.[7] For global emissions to start falling from 2015, and for the UK to be on track for reducing by more than 80% by 2050, the UK needs to reduce emissions by 40% on 1990 levels by 2020.

[17] The indirect emissions from CCS coal and other technologies also need to be identified. Power stations cause indirect emissions from their construction, mining of fuel, transportation of fuel and (for CCS) transporting and storing the CO_2. Part of the CCS demonstration project should be to produce figures for the indirect emissions of the CCS coal power stations to be compared with the indirect emissions of other energy options such as gas and forms of renewable energy.

[18] Subcritical with CCS: Efficiency reduced from 34–25%. This is an increase in coal used of 26%. 15% of coal used still results in CO_2 emissions into the atmosphere. The relative emissions are 12.6 tonnes of CO_2 for every 100 tonnes of CO_2 emitted by a comparison subcritical coal power plant.

[19] Supercritical with CCS: Efficiency reduced from 43%–34%. This is an increase in coal used of 16%. 15% of this coal used still results in CO_2 emissions into the atmosphere. The relative emissions are 17.4 tonnes of CO_2 for every 100 tonnes of CO_2 emitted by a comparison supercritical coal power plant.

[20] Every hour it is operating Kingsnorth would emit 1,440 tonnes of CO_2 (0.9*1600). 60% of the year is 5256 hours. 5256*1440 = 7,568,640

18. The UK government's current targets are to reduce CO_2 emissions by 26% by 2020 and 60% by 2050 compared to 1990 levels. However, in a speech hosted by WWF on 19 November 2007, the Prime Minister said: "The evidence now suggests that, as part of an international agreement, developed countries may have to reduce their emissions by up to 80% [by 2050]. So we will put this evidence to the committee on climate change and ask it to advise us, as it begins to consider the first three five-year budgets, on whether our own domestic target should be tightened up to 80%".[8]

19. In UK government models of how to reduce emissions by 2020, the electricity generating sector has to reduce the most. For instance, in the 2007 Energy White Paper emissions pathways are set for five sectors in the UK economy to meet the 60% by 2050 reduction target.[9] These show possible contributions towards CO_2 reductions on 2000 levels for the energy, industry, residential, services and transport sectors.

20. Of these, the White Paper suggests the energy sector should make the largest emission reductions; 15% cuts on 2000 levels by 2020. For electricity this means reducing emissions from 158.3 million tonnes of CO_2 in 2000[10] to 135 million tonnes in 2020. Unfortunately, these emission reduction pathways only cut the UK's overall CO_2 emissions by 14.5% on 1990 levels by 2020, rather than the 26% targeted in the climate change bill. Based on the emissions pathway in the Energy White Paper, we estimate that:

- For the UK as a whole to meet the 2020 target set in the current climate change bill—26% over 1990 levels—emissions from electricity generation need to be 26% below 2000 levels by 2020: 117 million tonnes of CO_2.[11]
- For the UK to meet possible future emission reduction targets—those which are in line with the science of preventing dangerous climate change for the world's poor—total emissions from electricity generation need to be 40% below 2000 levels by 2020—95 million tonnes of CO_2.[12]

21. With coal power stations that will still be operating in 2020, and current levels of emissions from gas power stations, we estimate that total UK CO_2 emissions from electricity generation in 2020 will be at least 120 million tonnes of CO_2 (see Appendix).[13] [14] This is:

- Higher than the level of emissions from electricity generation by 2020 required to meet the current UK government carbon reduction targets (117 million tonnes)
- Significantly more than the level of emissions from electricity generation by 2020 for the UK to play its part in preventing dangerous climate change (95 million tonnes).

22. Given the scale of the challenge the UK faces in reducing emissions from electricity generation, it appears that any single, new, unabated coal fired power station, such as Kingsnorth, will significantly reduce the likelihood of hitting the government's current, inadequate 2020 target and put beyond reach any globally adequate target.

23. Furthermore, the energy industry is currently considering a further six unabated coal fired power stations at Tilbury (Essex), Blyth (Northumberland), Longannet (Fife), Cockenzie (East Lothian), Ferrybridge (West Yorkshire) and High Marnham (Nottinghamshire). Consenting Kingsnorth would likely prejudice decisions in favour of these new coal power plants as well, destroying any ability of the UK to meet its 2020 reduction targets.

3.2 *Kingsnorth and the EU Emissions Trading Scheme*

24. The reason the UK government thinks building new unabated coal power stations may be consistent with its emission reduction targets is because the electricity sector is covered by the EU Emissions Trading Scheme (ETS). This means that whilst emissions from electricity generation in the UK will not be reduced by enough by 2020 to meet the UK government's target, emissions may be "offset" through buying carbon credits through the Clean Development Mechanism (CDM) and Joint Implementation (JI), or from elsewhere in the EU.

25. The way in which phase three of the EU ETS will operate is not yet decided. However, the European Commission has proposed that permits will be allocated centrally by the EU. The number of permits available from within Europe will fall by around 2% per year from 2012–20.

26. Buying ETS permits to emit will not be the only way for electricity generators to acquire permits. If no global agreement on tackling climate change post-2012 is reached, then one-third of required emissions reductions from 2013–20 can be met through purchasing JI and CDM credits from overseas. If a global agreement is reached, then half of the additional emissions reductions required under the ETS can be bought from outside Europe.[15]

27. Climate change cannot be tackled through accounting tricks. Rich countries, with 18% of the world's population, account for 54% of CO_2 emissions. Developing countries, with 82% of the world's population, account for 46% of emissions. It is a simple fact that to tackle climate change:

- Rich countries like the UK have to reduce their own emissions;
- And rich countries like the UK need to help some developing countries, such as China, to curb the growth in, and ultimately reduce, emissions
- And rich countries like the UK need to help some other developing countries to avoid large increases in emissions.

28. This additional financing and technology transfer requirement is already established in international law under Article 4.7 of the UNFCCC. This requires that emissions reductions in developing countries take place in as much as they are financed by industrialised countries, leaving developing nations to focus on poverty reduction and development priorities.

29. Phase three of the EU ETS will not reduce UK and EU emissions from electricity generation by enough to prevent global temperature increases of 2°C or more. By itself, the EU ETS will not lead the UK and EU to becoming low carbon economies, and the UK and EU will not develop the ideas and technology which can be transferred to other parts of the world to help mitigate climate change.

30. Furthermore, as the Environmental Audit Committee are aware, there are serious problems with the CDM. There is not space to revisit these problems here. The EAC has previously said: "there is plenty of evidence that much CDM investment is currently going into projects of dubious merit, concentrating on the abatement of exotic gases; not only will such investment do nothing to forestall the growth of carbon-intensive infrastructure in developing prosperity, but it will do little to improve their people's prosperity and quality of life".[16]

31. Additional measures beyond the ETS are needed to cut electricity sector emissions as needed to prevent disastrous climate change of 2°C or more. In some areas the UK government recognises the need for additional measures, such as energy efficiency and the development of renewable energy. The UK government therefore also needs to recognise that additional measures are needed in terms of consenting new power stations. One option, as adopted by the US state of California, would be a greenhouse gas emissions standard where a new power plant could only be built if it emits less than a certain amount of CO_2 for every unit of electricity generated. For instance, a standard of 0.35 tonnes of CO_2 for every MWh of electricity produced would allow CCS coal and gas to be built and non-CCS gas which made some use of the "waste" heat.

3.3 *Kingsnorth and "carbon capture ready"*

32. E.ON claims that the new unabated coal power station at Kingsnorth would be "carbon capture ready". The UK government claims that it is supporting post-combustion CCS technology in the demonstration project it is subsidising because such technology can be added to pre-existing coal fired power stations; in countries such as India and China as well as the UK. Therefore, the logic of post-combustion CCS technology is that any coal power plant is "carbon capture ready".

33. "Carbon capture ready" is a marketing ploy, not a robust concept. Because CCS has not yet been properly demonstrated, there can be no guarantee that CCS will one day be added to any power station. Furthermore, the costs of CCS are not yet known. The cost of CCS may be so exorbitant that there is no prospect CCS will be added to coal power stations in the future. It may be that various forms of renewable energy technology will be cheaper and more effective at reducing emissions, and so from 2020 government subsidies would be better spent on various renewable technologies than CCS coal.

34. The earliest CCS technology could be added to Kingsnorth would be the 2020s. As has already been highlighted, Kingsnorth's operations before 2020 would make it extremely difficult for the UK to meet emission reduction targets by 2020. If Kingsnorth began operating in 2013, by the start of 2020 it would have emitted 53 million tonnes of CO_2.[21]

3.4 *Kingsnorth and international negotiations*

35. The Bali decision on international climate change negotiations charts a twin track towards a more ambitious climate change agreement. On the one hand, talks will take place under the UN's Framework Convention on Climate Change (UNFCCC) aimed at securing actions to limit and reduce emissions in countries that currently have no legally-binding targets. On the other, industrialised countries covered by the Kyoto Protocol will discuss how to deepen and speed up reductions of their own and help finance the transfer to and use of clean technologies in poorer nations.

36. In the context of these negotiations, which are due to be completed in late 2009, rich, industrialised countries will have two responsibilities. The first will be to commit themselves to deeper cuts in a second commitment period of the Kyoto Protocol, post 2012. The second will be providing finance and technology to facilitate poorer countries' emission limitation and reduction activities. Both the financing and the corresponding activities must be done in a way that is measurable, reportable and verifiable.

37. Countries with high historical emissions and surplus wealth with which to rise to the challenge of financing clean development and transferring new technology are obliged, under Article 4.7 of the UNFCCC, to do so. Under the current negotiations, this is already a critical issue and, if rich nations meet their obligations, could unlock significant action in developing countries. However, countries that are less responsible for climate change and less able to afford its solutions will need convincing that richer nations are cutting domestic emissions and willing to make the necessary financial and technological transfers.

[21] 7.6 million tonnes a year*7 years = 53.2 million tonnes of CO_2.

38. Approving new, unabated coal fired power plants would undermine the UK's credibility as it would make meeting the targets we set ourselves in the climate change bill significantly more difficult, implying that poorer and less wealthy nations would have to shoulder additional burden. New coal would also take the UK further away from being able to fulfil its responsibilities as a rich country under the Bali negotiations as it would absorb finance in a carbon intensive activity and yield no new technology to transfer.

4. Kingsnorth and the CCS Demonstration Project

39. E.ON has now entered Kingsnorth for the CCS demonstration project competition. It is assumed that if Kingsnorth won the competition, and E.ON's plans for Kingsnorth are consented, 300MW of a new coal power plant would be CCS, with the remaining 1300MW an unabated supercritical coal power station.

40. This means that if the government consents to Kingsnorth, 80% of it will emit CO_2 at a rate of 0.9 tonnes of CO_2 for every MWh of electricity produced. The remaining 20% will emit at a rate of 0.16 tonnes of CO_2 for every MWh of electricity. This means overall, a Kingsnorth with 300MW of CCS will emit at a rate of 0.75 tonnes of CO_2 for every MWh. This is still almost double the emissions of a modern gas power plant.

41. In emissions terms, this means Kingsnorth would be likely to emit 6.3 million tonnes of CO_2 a year rather than 7.6 million as just a supercritical power plant. All the reasons given in section 3 above would still apply to why a Kingsnorth plant with 300MW of CCS and 1300MW of unabated coal should not be consented by the UK government.

42. If Kingsnorth wins the CCS demonstration project competition, the CCS plant cannot be used to justify the 1300MW of unabated coal. The UK government should refuse consent to the application for the 1600MW power plant at Kingsnorth. If the UK government regards E.ON's CCS application as the best, it should consent a 300MW plant and only a 300MW plant. If the 300MW plant requires the rest of the new plant to be built, the UK government should disqualify Kingsnorth from the CCS competition.

Appendix

43. We do not know of any comprehensive government estimate or analysis of how the addition of new coal power will affect the UK's electricity generation mix in 2020. We have tried to estimate CO_2 emissions from electricity generation in 2020 based on known changes in capacity of coal power stations by 2020, but these estimates do not include new coal power stations.

44. Six coal power stations are due to close in the UK between now and 2015. In addition, a further eight will only be able to operate for a maximum of 27.5% of the time.[17] Given this, we can estimate that the current capacity from coal and gas power stations which will be operating in 2020 will be emitting 120 million tonnes of CO_2. Any additional coal-fired power stations will push CO_2 emissions above this level.

45. The average annual emissions for 2005 and 2006 of the three coal power plants which will still be operational in 2020 were 38.5 Mt of CO_2. The average annual emissions for 2005 and 2006 of those coal power plants which will operate at a maximum capacity of 27.5% in 2020 were 51.6 Mt of CO_2. Average capacity used for UK coal-fired power stations is 64%.[18] We can therefore estimate that emissions from these coal power plants will be 22.2 million tonnes of CO_2 in 2020 (27.5/64 = 0.43. 0.43*51.6 = 22.2 Mt of CO_2). CO_2 emissions from electricity generation, minus coal, were 60.9 million tonnes in 2005 and 57.8 million tonnes in 2006. 38.5 + 22.2 + 59.3 = 120 Mt of CO_2.

Table 2

UK COAL POWER STATIONS

Power station	*GW*	*Status by 2016*[19]	*Current emissions (2005 + 2006)*[20]
Aberthaw	1.5	Limited use[21]	12.6
Cockenzie	1.2	Closing	7.6
Cottam	1	Limited use	18.1
Didcot A	2	Closing	13.5
Drax	4	Operational	43.5
Eggborough	1	Operational	14.9
Ferrybridge	2	Half closing, half limited use	17.3
Fiddler's Ferry	2	Limited use	16.9
Ironbridge	1	Closing	6.4
Kilroot	1	Limited use	4.9
Kingsnorth	2	Closing	16.7
Longannet	2.3	Operational	18.5

Power station	*GW*	*Status by 2016*[19]	*Current emissions (2005 + 2006)*[20]
Ratcliffe	2	Limited use	16.5
Rugeley	1	Limited use	8.3
Tilbury	1.2	Closing	10.1
West Burton	2	Limited use	17.3

Table 2. UK coal-fired power stations operating in 2006 (various sources).

June 2008

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9. DTI. (2007). Meeting the energy challenge: Energy white paper. DTI. London. May 2007.

10. Defra. (2008). http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gatb05.xls

11. The 2007 energy white paper has emissions reduction pathways by sector. Energy has a pathway to reduce CO_2 emissions by 15% by 2020 on 2000 levels. This is the most of any sector. When all sectors are calculated, total UK CO_2 emissions are only reduced by 14.5% on 1990 levels (8% on 2000 levels). Extrapolating from this, for the UK to actually meet its 26% reduction target by 2020, based on the relative contributions of sectors in the energy white paper, the energy sector has to reduce emissions by 43% on 1990 levels (26% on 2000 levels).

12. The assumptions for this are the same as above. For the UK to reduce emissions by 40% on 1990 levels by 2020 would require a 53% cut in CO_2 emissions from electricity by 2020 on 1990 levels (40% on 2000 levels). None of these figures take into account the extra reductions which will be required of UK electricity generation to cancel out the planned increase in emissions from UK aviation. The Secretary of State for Transport, Ruth Kelly, has said: "any future growth in emissions from international air journeys would be balanced by compensating reductions elsewhere".

13. The calculations for this estimate are in the Appendix. It assumes that: three coal power stations which can keep operating until 2020 continue to emit at their current rate of 38.5 million tonnes of CO_2. A further eight coal power stations can operate at a maximum of 27.5% of the time, which will together be emitting 22.2 million tonnes of CO_2. We have assumed gas power stations continue to emit at the current rate of 59.3 million tonnes of CO_2. This is a total of 120 million tonnes of CO_2. It is of course only an estimate, but highlights the contradiction between targets for reducing emissions and building new coal power stations.

14. Although this does not account for any increase in use of gas to compensate for the reduced use of coal power stations.

15. EC. (2008). Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System. Memo 08/35. Brussels. 23/01/08.

16. EAC. (2007). The EU Emissions Trading Scheme: Lessons for the future. Environmental Audit Committee Second Report of Session 2006–07. 20/05/07. http://www.publications.parliament.uk/pa/cm200607/cmselect/cmenvaud/70/70.pdf

17. BWEA. (2008). Renewable energy body calls for mixed energy economy in response to Government's nuclear energy announcement. BWEA News Release. 10/01/08.

18. The average capacity used for UK coal-fired power stations was 63% in 2005 and 66% in 2006 http://stats.berr.gov.uk/energystats/dukes5_10.xls

19. Based on Defra. (2007). UK National Emissions Reduction Plan for the implementation of revised Large Combustion Plant Directive (2001/80/EC)—February 2006. Update No. 1 December 2007. Tables A3, A5 and A6.

20. EU ETS verified site emissions 2005–06 http://ec.europa.eu/environment/climat/emission/pdf/internetgb2006.xls

21. Limited capacity is 27.5%

Memorandum submitted by Doosan Babcock Energy Limited

1. Doosan Babcock is a UK-based supplier and developer of advanced supercritical pulverised coal power plants and CO_2 capture systems. We welcome this inquiry by the EAC because we are concerned that the government is not moving fast enough to deliver its own objectives on global CO_2 reduction from fossil fuels or security of electricity supplies in the UK. More urgency is vital.

We have more than 116 years experience of supplying boilers for coal-fired power plant, including half of the UK fleet and over 42 GW in China. Our advanced supercritical boiler technology is world-class. The company has invested heavily in innovation and offers best-in-class boiler technology (capture ready) and CO_2 capture systems. Doosan Babcock has been nominated the centre-of-excellence for boilers and CO_2 capture in the global Doosan Group.

2. The company recognises that early introduction of Carbon Capture & Storage (CCS) is a vital step towards achieving global CO_2 reductions from use of fossil-fuels.

We believe that rapid building of coal-fired power plants is essential to meet the "generation gap" in the UK, ahead of the date when new nuclear plants will be commissioned, if a balanced generation portfolio is to be retained.

To this end, we advocate two parallel actions in the UK:

(i) Early implementation of several CCS demonstration projects for CO_2 capture and storage, such projects are needed in the UK to cover the range of capture technologies and storage sites. These are needed to determine the best technologies and to initiate the build-up of industry capacity, with a view to full commercialisation and rapid and widespread deployment of CCS globally from 2020. Funding support incentives for such projects should come from the new revenues which will arise from the auctioning of CO_2 allowances for power plants (7% in Phase 2 of the ETS, 100% in Phase 3 from 2013). This is proposed by the EU Commission in the draft EU Directive on revision of the Emissions Trading System.

(ii) Early build of best available technology, capture-ready advanced supercritical pulverised coal power plants, such as that planned for Kingsnorth and those being considered for Tilbury and Longannet.

We believe these actions—in parallel—set the best global example with respect to CO_2 reduction and security-of-supplies.

3. Our experience is that many new power plants overseas are being designed without regard for subsequent CCS and thereby potentially will lock-in carbon emissions. We need to be able to point to examples of capture-ready plants in our home territory. References of best-available technology are essential for our export business.

4. The concept of capture-ready has been studied by the IEA Greenhouse Gas Programme in response to a request at the July 2005 G8 summit. The IEA report (IEA GHG 2007/4 "CO_2 Capture Ready Power Plants") concludes the main considerations for Capture Ready are:

* Carry out a study of capture retrofit options.
* Leave space and access for capture plant.
* Identify reasonable route(s) to storage of CO_2.

We understand that the Kingsnorth project (2 x 800 MW) meets all three criteria.

5. In the capture-ready mode, the proposed Kingsnorth power plant would reduce CO_2 emissions by about 20% compared to the old coal-fired power plants it would displace and once CCS is fitted the reduction would be about 90%. The CO_2 capture technology envisaged for Kingsnorth would be suitable for retrofit to capture-ready supercritical coal-fired power in China, India, etc.

6. In 2004, we were predicting that 22 GW of new plant would be needed by 2016. There is now clear evidence that the capacity of the power industry (globally) will be insufficient to meet the needs for new power plants unless the contracts are reasonably phased, and this will require capture-ready coal and capture-ready gas projects to be built as soon as possible—in parallel with an early CCS demonstration.

A programme of three or four coal-fired power plants in parallel with the currently planned gas-fired power stations would create 8-10,000 Engineering and Construction jobs in the UK—in skill sets that will also be needed for construction of nuclear and renewables power plants.

2 June 2008

Memorandum submitted by Greenpeace UK

1. * Greenpeace believes that the single greatest threat to the climate comes from burning coal. Coal-fired power generation is historically responsible for most of the fossil-fuel CO_2 in the air today—about half of all fossil-fuel carbon dioxide emissions globally.

(*Dr. James E. Hansen, open letter to Gordon Brown, December 2007. http://www.greenpeace.org.uk/blog/climate/letter-to-the-prime-minister-20071219*)

2. * The carbon intensity of coal explains why coal-fired power generation is the most environmentally damaging means of generating electricity. Burning coal is more damaging in climate terms than using oil or gas. Supercritical coal plants emit 710gCO_2/Kwh compared to 404gCO_2/Kwh for CCGT, for example. (*IPCC Working Group III Fourth Assessment Report chapter 4 table 4.9*)

3. * As the eminent climate scientist Dr. James E. Hansen, director of the NASA Goddard Institute for Space Studies, stated: "*The only practical way to prevent CO_2 levels from going far into the dangerous range, with disastrous effects for humanity and other inhabitants of the planet, is to phase out use of coal except at power plants where the CO_2 is captured and sequestered." (Hansen, Testimony to the State of Iowa, 2007 http://www.columbia.edu/~jeh1/IowaCoal_071105.pdf*)

4. * The Business Secretary, John Hutton, is currently considering whether or not to approve plans for an entirely unabated 1.6GW supercritical coal-fired power station at Kingsnorth in Kent that will emit around 9 million tonnes of CO_2 per year[22]. E.ON's proposal for Kingsnorth is the first proposed coal plant in the UK for three decades. However, similar proposals for unabated supercritical coal plants are now being considered by a number of other utilities for at least another six sites: Tilbury, Blythe, Ferrybridge, Longannet, Cockenzie and High Marnham.

5. * Greenpeace is concerned that approval of the fleet of proposed new unabated coal stations—totaling 10.6 GW of additional capacity—will severely undermine the UK's efforts to meet existing carbon reduction targets in response to climate change. Further, if—as seems likely—the UK targets are revised in the light of the most recent climate science, from 60% overall reductions by 2050 to 80% by 2050, then Greenpeace estimates that the presence of this many unabated new coal fired power stations will account for half of the UK's entire annual carbon budget[23], putting considerable pressure on all other sectors of the economy to compensate for the emissions resulting from coal generation.

6. * The review into the economics of climate change conducted by Professor Nicholas Stern said:

> "It is critical that governments consider how to avoid the risks of locking into a high-carbon infrastructure, including considering whether any additional measures may be justified to reduce the risks"[24]

7. The high emissions from any new coal plants would gravely undermine progress towards emission targets under the Climate Change Bill, and lock the UK into a high-carbon pathway for many decades.

8. * As CCS is not yet commercially proven, Greenpeace is concerned that the new coal-fired plant at Kingsnorth is being sold by BERR and E.ON as "capture ready".[25] In private, the company is more sceptical. In an email E.ON sent to officials at the Department of Business on 16 January 2008, they said that CCS technology at Kingsnorth "*obviously . . . has no current reference for viability at any scale.*"[26]

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[22] 1.6GW x 7884 hours = 12.6 TWH/y. 0.710 kg x 12.6 = 8.95 mt/CO2/yr

[23] In December 2007, Gordon Brown said he aspired to an 80% cut in emissions by 2050. That would give us a carbon budget of 117.8mt/CO_2/per year. The new coal plants currently proposed—10.6 GW of capacity—would emit more than 54 million tonnes of carbon dioxide which represents almost half of that quota. (10.6 GW x 7884 hours of generation per year, assuming 90% operational = 83.57 TWH/y. 83.57 TWH/y x 0.65 = 54 mt/CO2/y)

[24] Stern Review on the Economics of Climate Change—Professor Jonathan Stern, October 2006

[25] "capture ready" essentially means a plant that is able to incorporate CCS should the technology ever become safe and commercially viable in the future

[26] Emails obtained by Greenpeace under the Freedom of Information Act—available to view at www.greenpeace.org.uk/coalsecrets

9. EON's competitor RWE has also sought to cast doubt on the immediate viability of the technology. In response to local opposition to its plans to apply for a new supercritical coal plant at its site in Blythe, Northumberland, RWE is quoted by the local media conceding that "proving this technology is a long way off"[27].

10. Even if the technology is technologically proven, question marks over its commercial viability will remain. Fully functional CCS retrofit will reduce the efficiency of the plant, which in turn will increase the cost per kilowatt hour of generation. Compounding this, investors will likely demand a large premium to compensate for the high risk and uncertainty of the long term performance of a new, still relatively unproven technology. The necessary price under the ETS to deliver this sort of risky investment therefore is extremely high. Investment bank Climate Change Capital has estimated that the range of carbon prices necessary within the ETS to ensure the cost effective retrofit of CCS range from 90–155 Euros/Tonne CO_2[28]. To put this in to context, the most recent forecasts from Deutsche Bank now estimate a 2020 carbon price of 67 euros per tonne[29].

11. * Greenpeace believes proposals to approve new coal stations that are "capture ready" are a dangerous distraction from the significant risk they pose to the climate and the taxpayer. CCS technology has not yet been proven at scale on an integrated power plant and CCS may well prove not to be technically or economically feasible. Building "capture ready" stations now would therefore impose unacceptable risks both to the climate and to the taxpayer, who may well be trapped into footing the bill for any future CCS retrofit.

12. * The Government's apparent attempts to conflate the approval of new coal plants with the competition to fund a carbon capture and storage demonstration are a cause for concern. If E.ON wins the competition with a view to demonstrating the technology at Kingsnorth, the 300MW capacity envisaged by the competition will represent little more than one sixth of the overall capacity of the plant. Any demonstration plant that is established should not be used as an excuse to build plants that operate mainly as unabated coal plants, and should therefore focus solely on exploring technical feasibility and full price discovery at an appropriate scale, and should be fully equipped with CCS abatement. Safe, responsible storage of captured carbon dioxide emissions would also be essential components, ensuring that the lifetime oversight of waste CO_2 is guaranteed.

13. * Whilst it is clear that CCS is years away from viability on any significant scale, renewable energy and energy efficiency can close the so-called "energy gap" right now, thereby improving the UK's energy security and slashing our climate change emissions. Greenpeace is united with WWF, FoE and the RSPB in the view that the absolute priority for UK energy policy should be the sustainable delivery of the EU target for renewable energy in 2020 and the aggressive promotion of energy efficiency measures.

14. * With regards to securing our energy future, research commissioned by Greenpeace and conducted by energy consultancy Poyry has identified a potential for 16GW of currently untapped electricity generation potential at sites of industrial heat demand around the UK. In terms of securing the UK's future energy supplies, exploiting opportunities to meet demand for heat and electricity in the most efficient way possible should be prioritized. High carbon, inefficient plants should be ruled out.

15. * Greenpeace is also united with WWF, FoE and the RSPB in support for new legal standards that set a limit for greenhouse emissions per kilowatt hour produced for all new generating plant which has yet to secure planning consent. A similar policy is already successfully in force in the State of California. A UK standard should be set at 350g/kWh, a level which could be achieved by an efficient gas-fired power station which makes some use of waste heat. The standard should be tightened significantly if CCS technology is proven to be technically and economically viable. Equally, given the urgency of the climate change challenge, it will be important to apply an emission limit to existing stations from 2020, or earlier if plant undergoes significant upgrade.

2 June 2008

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[27] "*Another question mark on carbon*"—The New Castle Journal, 23 May 2008

[28] Research conducted by Climate Change as part of the Zero Emissions Platform project sponsored by the European Commission. See:
http://ccs-association.com/docs/2008/23%20April%202008/2%20Tony%20White%20-%20Climate%20Change%20Capital%20%20%2023%20April%202008.ppt

[29] "*Deutsche ups EU carbon price to 40 Euros*"—Reuters News Agency quoting Mark Lewis, Deutsche Bank Carbon Analyst, 30 May 2008. See:
http://uk.reuters.com/article/environmentNews/idUKL3049225320080530

Memorandum submitted by RWE npower

Key Messages

- Secure and affordable energy supplies need diverse energy sources and coal will continue to be a major global fuel source for the foreseeable future.
- To meet its climate and energy policy goals, the UK electricity sector faces a massive new plant build challenge and developing new coal power plants would provide fuel diversity, while at the same time providing the potential to accelerate CCS development and deployment.
- The cost of delivering climate change targets will be minimised if market mechanisms such as the EU ETS send clear long term signals and provide a stable policy framework to underpin investment.
- Mandating CCS to fixed timescales ahead of commercial scale demonstration will deter and delay CCS development.
- EUETS is the mechanism best suited to supporting CCS over the longer term. The immediate priority has to be to ensure the availability of sufficient funds at UK and EU level to allow the early commercial-scale demonstration of a range of CCS technologies.

About RWE npower

1. RWE npower, a division of the RWE Group, is a leading integrated UK energy company. We supply gas and electricity to more than 6.5 million customers in the domestic and business sectors through our retail business npower. We operate and manage our portfolio of more than 10,000GW of flexible, low-cost coal, oil and gas-fired power stations and are one of the foremost developers and operators of industrial combined heat and power (CHP) in the UK. npower renewables is a market leader in renewable energy dedicated to generating electricity using sustainable, environmentally-friendly resources.

2. RWE npower is developing options for new coal-fired power stations at Tilbury in Essex and Blyth in Northumberland and has submitted environmental "scoping documents" for both projects to BERR ahead of making applications under Section 36 of the Electricity Act. We are also designing and building the UK's first "carbon capture technology" pilot plant at Aberthaw Power Station. We have applied to pre-qualify for the Government's competition to demonstrate commercial-scale Carbon Capture and Storage (CCS) technology, scaling up to at least a 100MW demonstration plant which would form part of the new power station at Tilbury.

Role of Coal in the UK Energy Mix

3. Maintaining diversity of energy sources is critical to meeting the key objectives of UK energy policy in relation to security of supply, affordability and achieving climate change targets. Against the current background of steeply rising oil and gas prices, flexible coal-fired generation plant continues to play an essential role in meeting electricity demand in the UK. At the global level, new coal-fired generating capacity is a major contributor in satisfying the growing energy needs of major developing economies such as China and India.

4. The Energy White Paper (EWP) published in May 2007 states that:

> "Coal will continue to play a significant role in global electricity generation for the foreseeable future, partly because it is the most abundant global fossil fuel but also because it brings security of supply benefits. For example, coal-fired generation is a flexible electricity source that can respond effectively to changing levels of demand. It also helps to maintain a diverse energy mix." We agree with this strategic assessment and note that all the energy projections for the UK that support the EWP indicate a significant level of coal based generation.

5. Even as the target levels for renewable energy increase above those assumed in the EWP to meet the ambitious carbon reduction and renewable energy goals being set under the EU's Climate Change and Renewable Energy Action Package (the "Green Package"), there will be a growing need for a diverse energy generating portfolio that can respond rapidly to fluctuations in both demand and supply, particularly if the majority of the UK renewable energy is to come from fluctuating sources such as wind and tide, coupled with inflexible base-load nuclear generation.

6. Existing and developing environmental legislation will mean the closure of most, if not all, existing coal power stations by around 2025. It is important to recognise that if no new coal plants are built then the UK will be entirely dependent on imported gas to fulfil the role of flexible and reliable power generation.

7. Modern super-critical coal-fired power generation plant is considerably more efficient, operating with thermal efficiencies of up to 47% compared with existing UK plant which typically achieve efficiencies of around 35%. Consequently, new coal-fired plant can deliver CO2 reductions of 20–25% on a like for like basis without the use of carbon capture and storage technology.

Status of CCS Technology

8. CCS is a new technology to the power industry and there are many unknowns in terms of technical performance, costs, reliability and risk that need to be overcome if the technology is to be demonstrated at commercial scale. Until this happens it cannot be considered as an abatement technique that can be mandated by legislation on any fixed timescale. If it is mandated before then the likely result will be no new coal build as investors will be deterred by the high risk of creating stranded assets. Whilst this may seem attractive to some it will deter and delay CCS development. Operators of existing coal plants will not be easily persuaded to invest in CCS at existing sites that are inefficient by todays standards and approaching the end of their life. The successful development of CCS and its subsequent rapid deployment could be a vital part of delivering the twin long term goals of carbon reductions and security of energy supplies. This will be achieved fastest if new coal capacity is delivered in parallel with the development of CCS.

9. In this regard, RWE npower has developed a three phase R&D programme:

Test facility—RWE npower is currently commissioning a test facility at its Didcot power station for evaluating both oxyfuel and post combustion capture.

Pilot plant—RWE npower plans to design and build the first carbon dioxide capture pilot plant at a UK coal power station. It is anticipated that the plant will be fully operational by 2010 and will be located at Aberthaw Power station in South Wales. The pilot will enable RWE npower to develop a full understanding of both the technical and commercial issues relating to CCS and will allow the CCS concept to be tested in as close to real operational conditions as is possible.

Demonstration plant—RWE npower is planning further investment to support a capture and storage demonstration plant which will be located at Tilbury power station. This plant will act as a crucial test-ground for the potential of CCS technology as a means to generate low-carbon energy.

Support for CCS Demonstration

10. The recent Stern Review highlighted the strategic role that CCS technology could play globally to lower carbon dioxide emissions with a potential to contribute up to 28% of global carbon dioxide mitigation by 2050.

11. The European Council has agreed that Europe should aim for all new fossil fuel power generation built beyond 2020 to be equipped with CCS, subject to the technology being technically and commercially feasible. It has also recommended that the Commission work towards a series of up to 12 CCS demonstration projects by 2015. To facilitate the deployment of CCS in the UK and internationally the Government has announced its intention to launch a competition for demonstration of CCS.

12. RWE npower welcomes the Government support for a post combustion capture demonstration project and in this regard has submitted a proposal into the pre-qualification phase of the Government's CCS demonstration project. However, there is a need to recognise that the industry in the UK and across the EU is seeking to develop a range of CCS technologies including oxyfuel and Integrated Gasification Combined Cycle (IGCC) and support mechanisms need to address this issue, otherwise the opportunity to assist with the timely development of these technologies could be missed.

Delivering Climate Change Goals

13. RWE npower supports the UK Government's aim to demonstrate international leadership in mitigating the impacts of climate change. The UK has signed up to challenging targets for 2020 in terms of EU greenhouse gas emission reduction and renewable energy targets. However, in order to deliver these, the electricity industry urgently needs a long-term stable policy framework to underpin the significant investments that are needed in new capacity and transmission infrastructure.

14. The principle mechanism for delivering carbon reductions in the EU is the EU Emissions Trading Scheme (EU ETS). With adequate political support by Member States to deliver a robust framework post 2012, this has the potential to deliver the required decarbonisation of the energy supply chain at least cost. Although it should not be the role of the EU ETS to support emerging technologies such as CCS through the research, development and demonstration stages, it can be expected to remunerate them when they achieve commercial availability, provided the technology cost is lower than that signalled by the carbon market. Only by utilising technology neutral market mechanisms such as the EU ETS, coupled with addressing the barriers to delivery, such as planning, transmission access and R&D support, will the necessary greenhouse gas emission reductions be achieved with optimum economic efficiency.

15. The key to delivering the 2020 climate change goals is timely investment and the major challenge for the energy sector is in deciding what to invest in. Given the very high UK renewable energy target implied by the EU Green Package and known coal, oil and nuclear plant closures, it is quite credible that the new build requirement in the period between now and 2020 will approach today's total installed capacity, some 70–80 GW. In order to minimise risk, investors value stable regulatory frameworks and clear long term price

signals. In the current revision of the EU ETS, there is potential to provide both of these. Given a robust trajectory for binding carbon emission reductions, clearer price signals will emerge and energy investors will be able to select a range of investment options to manage the range of energy market risks.

16. The UK Government's energy strategy is based on utilising competitive markets to deliver ambitious carbon reductions, whilst maintaining security of supply and ensuring every home is adequately and affordably heated. The EWP rightly identifies the EU ETS as having a central role in the delivery of this strategy.

17. Some stakeholders advocate the need for mandatory CCS on new coal-fired power plant. Given, the current status of the technology, coupled with the need to ensure adequate provision of storage and transport infrastructure, we believe that this is inappropriate for the foreseeable future. It is likely to have the adverse effect of deterring and delaying CCS development damaging the prospects for the technology within the UK and the EU, and also at the global level, where deployment is critical if developing countries are to address the issue of rising greenhouse gas emissions from the use of coal as a key energy source. The immediate priority within the UK and at EU level has to be to ensure sufficient funds are made available to allow the early commercial-scale demonstration of a range of CCS technologies.

"Capture Ready" Power Stations

18. The term capture ready has been developed to describe the ability to retrospectively fit CCS technologies to future new power station builds. But without being prescriptive with regard to the CCS technologies applied, it is not practicable to describe in detail what "capture ready" means. Until such time as CCS technologies are developed to commercial scale we believe it would be counterproductive to develop and impose detailed and restrictive requirements on "capture ready" plant.

19. However, we fully accept that any operator contemplating new coal build must expect to either fit CCS in the future once the technology has been proven at commercial scale, or alternatively, to operate the plant in a more carbon constrained manner. The choice will depend on the cost of applying the abatement technology and the value of the carbon abatement it offers. The operator is therefore incentivised to make whatever arrangements they can to minimise the cost of future CCS retrofit. If they do not, then their future choices will be even more limited.

20. Essentially the main considerations are space on site for the necessary plant to capture and compress CO2, the ability to couple this into the proposed power plant and the potential availability of a route to transport the CO2 away from site into long term storage. Operators have to apply best available techniques (BAT) to minimise the environmental impact of power stations and there can be no justification for imposing tighter environmental emission standards until it is proven that affordable techniques exist to achieve them.

2 June 2008

Memorandum submitted by Scottish Power Limited

1. ScottishPower is one of the UK's six large integrated energy suppliers, and is owned by IBERDROLA, one of the world's leading utility groups and a particular leader in low carbon generation. Our sister company, ScottishPower Renewable Energy Limited, is the UK's largest wind power generator. We have electricity networks in South and Central Scotland, Merseyside and North Wales and some 5.2 million energy customer accounts. Our power generation assets include the Longannet and Cockenzie coal plants in Scotland and a number of gas fired stations in England.

2. This Memorandum relates to the Environmental Audit Committee's announcement of 22 May 2008 of a brief inquiry into Carbon Capture and Storage (CCS), with a particular focus on developments surrounding the Kingsnorth power station. Given our interest as a major electricity supplier, and an owner and developer of coal-fired electricity generation plants, we would like to offer some brief comments on the wider legislative and regulatory issues touched upon by this inquiry. The specifics of Kingsnorth are a matter for Eon as the plant's owner and not for ScottishPower.

3. In our view, the electricity needs of the UK are best served by a broad mix of generation sources, including renewable, fossil and nuclear plant. Coal-fired generation provides a valuable contribution to this mix, and has played an important role in the UK's physical and economic security of supply in recent years. In particular, it has proved an effective buffer against cost or availability problems in the gas market and it also has proved effective in responding to shorter term fluctuations in supply and demand. Even with the currently programmed major growth of renewables and a significant nuclear programme, coal will be a key component of generation for many years to come.

4. Clearly, coal fired generation brings with it an environmental cost. Emissions of sulphur dioxide are being reduced to very low levels through the flue gas desulphurisation investments that have either been completed or are currently being finished. Nitrogen oxides have also been much reduced, with a further tightening up programmed for 2015 under the Large Combustion Plants Directive. The remaining issue is the carbon dioxide emitted from coal.

5. The primary method for dealing with this is the emission trading system. This ensures that CO_2 emissions are zero sum. For every additional tonne of CO_2 we emit from our power stations, somebody somewhere has to emit a tonne less. ETS ensures that the abatement is made where and when it is most cost effective. So, if the gas market in the UK is tight in the winter, it may make sense to burn more coal in power stations in order to save the gas for heating people's homes and avoid pushing the price even higher; but in the summer, when there is more gas available, it may make sense to burn it in power stations and avoid the need to buy expensive carbon credits to support coal burning. Similarly, it may on occasion be sensible to buy carbon credits from elsewhere in Europe and burn coal in the UK, with its good import logistics; while at other times—for example if there is low cost LNG available—we may be able to burn more gas here and sell the credits into Europe. Either way, the environmental result is not affected.

6. Most of the coal power stations in the UK are around 40 years old. Since they were commissioned, technology has improved with the development of supercritical designs. These can produce significantly more electricity for the same input of coal and output of CO_2 and other pollutants. Supercritical generation can be delivered either by retrofit of an existing station or by building a new plant. Although ETS will ensure environmental neutrality whether or not supercritical units are built, the extra efficiency of a modern supercritical plant is on any measure a good thing. To the extent that it displaces output from existing old and less efficient coal stations, this will reduce emissions per unit of electricity generated. Furthermore, the modern units are likely to be more reliable once fully commissioned; as the existing fleet ages, we can expect an increasing level of unplanned outages. Accordingly, we think it would be unwise in terms of security of supply to prevent the modernisation of the UK's coal generation plant.

7. CCS is an emerging technology with the potential to facilitate significant reductions in CO_2 emitted to the atmosphere by fossil fuel power plant. The UK Government has launched a competition to develop the UK's first commercial-scale CCS process. The competition, as we see it, will help develop understanding of the issues and costs associated with commercial-scale operation and consequently assist in clarifying the framework within which CCS investment decisions may be made. The competition is at a very early stage and we expect it will take until around 2014 for the demonstration project to start yielding useful experience.

8. CCS is attracting global interest and several projects of varying scale are being initiated worldwide. These projects provide further evidence of the view that the technology offers potential but they are also indicative of the level of uncertainty surrounding it.

Capture Ready

9. We recognise that CCS could provide a valuable CO_2 abatement option in the future. For this reason, we have welcomed the Government's competition for funding to demonstrate the technology and submitted a pre-qualification entry. It is clearly sensible to consider how this technology might be deployed in existing fossil fuel plants and provided for in the planning and development of new-build stations. Such consideration must recognise the current limitations in our knowledge of CCS and in particular the current uncertainties about cost and performance at commercial scale.

10. ScottishPower would be comfortable with a requirement for new coal-fired power stations to be capture ready, providing that a reasonable and clear definition of capture readiness is developed. In principle, that definition should be the minimum needed to ensure that the design of the new plant does not rule out retrofit at a later stage; it would not be sensible to try to require elaborate preparation as the details of what might be retrofitted are not yet clear. Such an approach should not be onerous, as any sensible developer installing a new coal fired power station would wish to anticipate the possibility of fitting CCS should the technology become economic.

11. The main negative impact of a requirement for capture readiness would be to rule out certain sites for coal fired development, for example if there was insufficient land. This would need to be balanced against the benefits of ensuring that developers considered retro-fit of CCS in their designs. In the case of gas fired plant, we think that it would be premature to require CCS readiness as the carbon savings from carbon capture are significantly less and any CCS installation would be a much larger fraction of the cost and footprint of the station. A proposed requirement for CCS readiness for gas stations would need careful consideration to ensure that it did not inhibit their construction in a way which made it harder to close the forthcoming supply gap in Great Britain.

12. As far as the actual installation of CCS is concerned, we see this in the long run being driven by the ETS. Once CCS technology is established, and the cost of carbon rises, then the value of carbon saved will drive installation of CCS in appropriate cases. Where in the long term, the value of the carbon saved does not exceed the cost of fitting and operating CCS, then it is probably correct not to fit CCS to that particular installation, but instead accept that the cost of carbon is likely to reduce its utilisation.

13. In the medium term, we agree with the Committee that some form of support scheme should be considered that would assist CCS in the early stage of deployment. It is unlikely that the current competition will bring the technology to a stage where it could be supported by ETS alone, and some sort of bridging support is likely to be needed to ensure sufficient deployment to bring the costs down to an economic level.

14. We believe that mandatory implementation of CCS should be firmly ruled out. If CCS is economically viable in terms of the cost of the carbon saved under ETS, then—so long as the plant is capture ready—it will be in the operator's interest to install it. So mandatory retrofit would only have any significant impact in circumstances where it would not be economically worthwhile to fit CCS. We question whether Government would wish to take actions of this kind where the cost benefit assessment is negative.

15. Furthermore, the prospect of mandatory retrofit of CCS without financial support to cover the costs could make it harder for investors to commit to a coal fired power station. This is because the risk of having to pay the retrofit costs in circumstances where they were not economic would need to be factored into the investment case. It would be unreasonable to ask investors to shoulder that risk, and the result might well be that modern, more efficient coal fired generation projects did not go ahead. This could leave electricity supplies in Great Britain excessively dependent on imported gas. We doubt that this is in the public interest.

2 June 2008

Memorandum submitted by the Royal Academy of Engineering

1. The UK, along with the rest of the world, is facing an increasingly difficult challenge to maintain an affordable and secure energy supply while at the same time reducing its emissions of carbon dioxide in an effort to mitigate against the effects of global warming. Over the coming decade approximately 20GW of electrical generating capacity will be lost owing to the closure of aging nuclear power plants and inefficient coal fired boilers. If the lights are to stay on, these will need to be replaced quickly. A new generation of nuclear plants is becoming more of a possibility and renewable energy, primarily in the form of wind farms, is supplying an increasing amount of our electricity but both these options require time. The question remains as to whether coal has a role to play in the UK's future energy system.

2. In global terms, despite the current drive for renewable energy, fossil fuels are still expected to account for the bulk of the world's energy supplies for the foreseeable future. The International Energy Agency, for example, predict that in 2030 over three quarters of the world's primary energy supplies will come from fossil fuels with over a quarter from coal alone. Also, known coal reserves outstrip those of any other conventional fuel and large amounts of this coal are found in rapidly developing countries such as China. Therefore, It is clear that coal has a significant role to play in global energy markets for some time to come.

3. This might not represent a problem were it not for the fact that coal fired power plants emit more carbon dioxide per unit of electricity than any other type of generator. With concentrations of CO_2 in the atmosphere higher than at any time over the past half a million years and rising faster than ever, burning the world's remaining coal reserves and emitting the resultant CO_2 into the atmosphere will contribute significantly to dangerous rises in temperature and all the associated risks for both human society and the natural environment.

4. While it may be possible to reduce the UK's dependence on coal, it is unlikely that the rest of the world will follow suit. It would seem, therefore, that the only viable alternative is to develop and deploy carbon capture and storage (CCS) technologies as quickly as possible and establish a leadership position for the UK in this technology.

5. The various technologies associated with CCS are at different stages of development (some are proven at small scale and some are very new concepts) but progress is being made across the whole field. A number of alternative means of capturing the CO_2 are being developed, both pre- and post-combustion, and the geological storage of the CO_2 has also been trialled, although thus far it has predominantly been in enhanced oil recovery projects. What is lacking so far is a full scale commercial pilot project which will prove the overall viability of CCS. Support for such a demonstration plant is urgently needed if progress is to continue and in reality, given the complexity of the task, more than one will be required.

6. The Government's recent announcement of a competition to help fund a CCS demonstration plant in the UK is welcomed. Clearly, one of the main barriers to industry will be the high financial costs associated with developing the necessary processes and technologies and it is right that the Government should bear some of the financial risks in order to promote a technology which is in both the national and international interest. However, as has already been mentioned, implementing CCS on a wide-spread commercial scale is an enormously complex task and the competition should not be seen as the only support mechanism. For example, specifying only post-combustion capture in the competition neglects the various pre-combustion methods that could also have a role to play, but it does recognise that if rapid uptake of a CCS technology is to be stimulated in the developing world post-combustion is the most likely candidate.

7. If CCS is to have any impact on CO_2 emissions then ultimately many millions of tons will need to be safely transported and stored. This could lead to an industry on the scale of the current oil and gas industries and a massive investment in research and infrastructure. A great deal of work is needed to assess suitable geological storage sites that will be capable of safely storing the CO_2 for the required time spans and these sites need to be matched to appropriate locations for the power plants. Closely linked with this will be the legal and regulatory frameworks that will deal with health & safety, international agreements, standards and environmental impacts. Much work is already being carried out in this field and the UK Government must continue to be fully engaged in the process. In addition, a great deal of primary research is still required and the Government must continue to support this through the research councils, the Technology Strategy Board and the Energy Technologies Institute. Ultimately, UK plc should benefit from such investment by staying at the forefront of a burgeoning global CCS industry, although it is also vitally important for the UK to stay fully engaged with international initiatives such as the EU Framework programmes.

8. Given a sufficient level of support there is good reason to assume that CCS will provide a means to continue using coal to provide electrical power in the future. The engineering practicalities of its wide-spread implementation are by no means trivial and should not be underestimated but there is reasonable optimism that engineers and scientists will overcome these difficulties. Unfortunately, the one commodity which is in the shortest supply is time. Even the most optimistic proponent of CCS would not envisage any demonstration plant to be operational much before 2015, which would put wide-scale deployment as far away as 2020 or later after lessons from the pilot have been learned and digested. In the meantime, coal fired power plants are being built all around the globe and these will be in operation for many decades. If these plants are not built to be capture ready, then much of the work currently being carried out will be in vain. It is therefore crucial that any new coal fired power plants are built with the capacity to be retro-fitted with capture technology.

9. The Government was clearly aware of this fact when it limited its competition to post-combustion capture technologies and it would seem highly counter intuitive to consider coal fired plant to be built in the UK which was not capture ready. Not only would this be inconsistent with the UK's future energy policy but it would also send out the wrong signal to the rest of the world where the UK is looking to take a lead on climate change. This is an issue which is very pertinent at present in the case of Kingsnorth. The fact that Kingsnorth has entered the Government's competition is welcome news but in the event of it not being successful, every effort should be made to ensure that it is built with capture ready capabilities. In reality, despite some debate over the precise definition of what capture ready entails, ultimately all that is required to fulfil this condition is to provide additional land and satisfy a minimum of technical specifications and hence should not represent any onerous costs. Indeed, if a power station in the UK cannot be expected to meet such a condition then it is difficult to see how we could place similar demands on power stations in China. Conversely, if capture ready becomes the norm in western economies then it is likely that China will follow suit.

10. In summary, The Royal Academy of Engineering supports the development of CCS and has actively followed the issues in conjunction with other bodies such as the Royal Society and the IEA Coal Industry Advisory Board. We have a number of Fellows who are at the forefront of research in the field both in industry and academia. The Academy is keen to offer the Committee any assistance in their consultation but at this stage we would stress the urgency of bringing this technology on-line as quickly as possible as the window of opportunity is fast running out.

June 2008

Memorandum submitted by the Institute of Physics

1. The following items of background information about carbon capture and storage (CCS) are attached:
   - The report of a seminar on CCS organised jointly by the three societies in December 2007[30].
   - The RSC's position statement on CCS[31].
   - An unpublished draft of a report on carbon emission reduction in electricity supply, commissioned by the IOP. This report includes a chapter on CCS as well as other chapters relevant to the current situation, covering topics such as supercritical plants and combined heat and power (CHP).[32]

2. It is very important that CCS is developed as a part of a portfolio of measures to stabilise greenhouse gas concentration in the atmosphere. Globally, the supply of primary energy will continue to be dominated by fossil fuels until at least the middle of this century; both due to existing and newly built power stations. The UK and other Western countries are in a position to develop CCS technologies to be transferred, when mature and cost-effective, to countries such as China and India as a retrofit option on some of their plants, which otherwise will be locking us into emissions of CO_2 for decades to come.

[30] Not printed.
[31] Not printed.
[32] Not printed.

3. The very long-term environmental viability of CCS may not be substantial compared to similar-scale efforts in other areas such as energy efficiency and renewables. However, it is the only method of reducing the climate change impact of fossil fuels which continue to be used, so represents an essential medium-term measure. Most least-cost scenarios for the stabilisation of greenhouse gas concentration in the atmosphere in the range of 450–750 ppmv CO_2, show that CCS could contribute between 15% and 55% of the cumulative effort to reduce the greenhouse gas emissions globally until 2100.

4. All of the sources listed in paragraph one outline details of the three technological methods of carbon capture: pre-combustion, post-combustion and oxyfuel. Factors such as the concentration of CO_2 in the gas stream, the pressure of the gas stream and the fuel type (solid or gas) are important in selecting the appropriate capture system. Post-combustion approaches are required if carbon capture is to be retrofitted onto existing power plants. Other approaches, including oxyfuel or alternative solutions using algae, can be used to capture distributed CO_2, independent of a large point emission source.

5. The current BERR CCS demonstration competition[33] is limited to post-combustion technology. While this initiative may be effective in achieving the first facilities to retrofit to existing power stations, it is not sufficient to incentivise the longer-term development of power plants built with integral carbon capture, or to support the broader development of CCS. Even within the post-combustion approach, the choice to limit the competition to only a single demonstration is also very restrictive, and not the most effective way to ensure the technology reached its potential. Currently the CCS sector faces a steep learning curve, and government financial support should be provided for CCS in a way which does not pre-judge what the best technical approaches are going to be.

6. The cost of CCS will favour highly-efficient power plants. CCS increases the cost of generating electricity by 12–60% depending on energy prices[34]. It is forecast that, in the next decade, the cost for capture will be reduced by at least 20–30%, and the costs of transport and storage will also decrease as technologies become more mature. Modelling indicates that CCS may be deployed in electricity generation if CO_2 abatement prices reach £11- £15/(t CO_2).

7. A power plant with CCS using geological storage requires an associated energy consumption of around 10–40% of its output. It will be vital to monitor this and improve efficiencies.

8. Compared to new build power stations including CCS, the retrofit of CCS to existing power plants would increase costs and significantly reduce generating efficiencies.

9. In order for CCS to become an economically sustainable part of the energy market, various challenges must be overcome. Not only will significantly improved CCS technologies be required, but also a sufficiently competitive and relatively stable price for carbon under the EU Emissions Trading Scheme; a framework which treats CCS as a low carbon technology, recognizing that a plant using CCS produces CO_2 without releasing it into atmosphere; and a legal framework to deal with issues such as sub-sea sequestration.

10. CCS is not the only factor to consider in terms of the environmental impact of a new fossil-fuelled power plant. New plants operate at significantly higher efficiencies, and flue gas desulphurisation is now mandatory. Some background on the development of supercritical plants is given in the draft report listed in paragraph one. It is worth emphasising that CHP is by far the most efficient way to use fossil fuels, with efficiencies of up to 80%. CHP can be based on a variety of technologies including gas turbines, steam turbines, reciprocating engines and CCGT. It can also be used in combination with CCS.

The Institute of Physics is a scientific membership organisation devoted to increasing the understanding and application of physics. It has an extensive worldwide membership and is a leading communicator of physics with all audiences from specialists through government to the general public.

The Royal Society of Chemistry is the largest organisation in Europe for the advancement of the chemical sciences. Supported by a network of over 43,000 members worldwide and an internationally acclaimed publishing business, our activities span education, training, conferences and science policy and the promotion of the chemical sciences to the public.

The Institute of Biology is the professional body for UK biologists. Its members work in industry, research, education and healthcare, amongst other areas. It was founded in 1950, obtained a Royal Charter in 1979, and is a registered charity with over 13,000 individual members as well as learned Affiliated Societies covering every area of the biosciences.

2 June 2008

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[33] Formerly the Pollution Prevention and Control Regulations 2000 which implement the EC Integrated Pollution Prevention and Control Directive 96/61/EC and the Large Combustion Plant Directive 2001/80/EC.

[34] IPCC Special Report Carbon Dioxide Capture and Storage, Summary for Policymakers, A Special Report of Working Group III of the Intergovernmental Panel on Climate Change, 2005

Memoranda submitted by ClientEarth (CCS)

SUMMARY

1. ClientEarth is a non-profit environmental law, science and policy organisation incorporated as a limited liability company and registered as a charity in England and Wales. The charitable objects of the organisation include promoting and encouraging the enhancement, restoration, conservation and protection of the environment, including the protection of human health, for the public benefit.

2. We consider that:

- CCS needs to be introduced as quickly as possible;
- the EU Emissions Trading Scheme (ETS) is not enough to deliver CCS;
- US SO2/NOX emissions trading scheme worked because the emissions could be effectively, monitored, reported and verified-this is not yet the case with CCS;
- the 12 EU CCS demonstration projects are important;
- new "capture ready" coal power stations will delay investment in CCS technology;
- an Emissions Performance Standard (EPS) like the California EPS will help make CCS possible; and
- regulation of CCS, in the form of an EPS, should come before any subsidy for CCS.

CCS needs to be introduced as quickly as possible

3. According to Dr James Hansen of NASA and Columbia University, one of the world's leading climate experts:

> "The only practical way to prevent CO_2 levels from going far into the dangerous range, with disastrous effects for humanity and other inhabitants of the planet, is to phase out the use of coal except at power plants where the CO_2 is captured and sequestered."

4. CCS, the technology that captures and safely stores the CO_2 emissions from coal power plants in geological sites, is already understood but has not yet been demonstrated on a commercial scale[i]. The big obstacle is cost. Installing CCS technology is estimated to add up to 75% to the price of building a new coal power station.

EU ETS is not enough to deliver CCS

5. The EU is currently intending to use the "cap and trade" ETS as the way to deliver CCS and reduce the huge CO_2 emissions from new coal power plants. The ETS allows energy companies to trade CO_2 permits and find the lowest cost way of reducing CO_2 emissions. Once the EU has set a global cap and the CO_2 emission permits have been allocated to the energy companies that own the coal power plants the EU believes that no further regulation of the CO_2 permit market will be necessary.

6. However, to make a market solution work the risks and costs that will influence the price of a CO_2 emission permits need to be understood. The current uncertainty surrounding the cost and regulation of CCS technology will delay private sector investment in CCS. At the same time, the ETS is failing to deter investment in coal power plants. We understand that 50 new coal power plants are planned to be built shortly in the EU[ii].

US SO2/NOX emissions trading scheme worked because the emissions could be effectively, monitored, reported and verified

7. The ETS is often compared to the successful US SO2/NOX emissions trading scheme that has reduced the sulphur dioxide (SO2) and nitrous oxide (NOX) emissions that caused acid rain. The US acid rain scheme was successful because it was based on well understood technology, scrubbers, and trusted regulation. The SO2/NOX emissions could be effectively monitored, reported and verified. This ability to successfully monitor, verify and report resulted in public confidence in the scheme, highly accurate and complete emissions data and a high compliance rate[iii]. The key message from the success of the SO2/NOX scheme is simple, important and relevant to CCS technology: New coal power plants should not be built until it has been demonstrated that CCS is safe and that the geological storage of CO_2 emissions can be effectively monitored, reported and verified. Public confidence in CCS technology has also not yet been established.

CCS demonstration projects are important

8. The 12 EU CCS demonstration projects are extremely important. Some energy companies have predicted that the high initial costs of CCS technology, especially those associated with the capture of CO_2, are likely to fall over the medium to long term[iv]. Hopefully these predictions will be true. But we doubt that many energy companies will be prepared to commit to CCS until CCS has been demonstrated and they are sure that they are able to reduce the risk of unacceptably high costs.

New "capture ready" coal power stations will delay investment in CCS technology

9. The EU is now considering allowing new coal power plants to be built in a "capture ready" state[v]. This is an extremely bad idea. There is a huge difference between a new coal power plant with CCS technology and a coal power plant that is merely "capture ready". A coal plant with CCS technology would capture and safely store the vast majority of its CO_2 emissions. A "capture ready" plant will not. It will emit millions of tonnes of CO_2 into the atmosphere until the expensive CCS technology is retrofitted[vi].

10. In order to be "capture ready" a new coal power plant will only have to: have empty space next to it for the CCS equipment to be fitted in the future; be near a suitable storage site (such as an old oil field); and have a technical retrofit assessment report. A report prepared by the International Energy Agency titled "CO_2 Capture Ready Plants"[vii] makes it clear that "capture ready" does not mean very much. It states that:

> "[A] high degree of uncertainty is inevitable when making a plant capture ready. It is not clear when the underlying global politics of climate change mitigation may justify extensive use of CO_2 capture and storage and hence retrofitting. Neither, given the current rapid developments in capture technology concepts, is it possible to specify in advance which capture technology will be available to retrofit to a particular plant. The precautionary principle suggests, however, that doing nothing until these uncertainties are resolved is not the best option. Indeed, it is quite likely that clarity will only emerge when political and market conditions dictate that new fossil plants are built with capture and so the need for capture ready plants no longer exists!"

11. Only political and market conditions, not climate change, will justify private sector investment in CCS technology. Energy companies and their backers cannot be relied upon to voluntarily commit to expensive CCS technology. They are unsure what the best technology to use is and fear that their competitors will learn and profit from any expensive mistakes they might make (this fear is known as the "first mover" disadvantage).

An EPS like the California EPS will help make CCS possible

12. Instead of allowing "capture ready" power plants to be built the EU should follow the example of California and introduce an EPS. The California EPS requires that any new coal power plant that proposes to use CCS must meet an emissions standard of 500kg CO_2 per MWh[viii]. To meet the California EPS any new coal power plant would have to present a reasonable, economically and technically feasible plan that CCS will operate from the outset. The projected net emissions over the life of the proposed power station must also be pre-approved by the regulator[ix].

13. The great advantage of an EPS is that it will force energy companies (and Member States) to identify the real cost of CCS technology. As a result it will create a real price for clean electricity from coal and a real price for CO_2 emissions. If the EU had an EPS energy companies would have to show that they fully understood all the costs and risks associated with CCS technology before they were allowed to build a new coal power plant. An EPS would let the EU have clean energy now while letting the market chose which clean solution to build.

14. Uncertainty surrounding the price of CCS technology will not only affect investment decisions relating to new coal power plants. Most energy companies have a portfolio of different energy assets, including wind, nuclear, gas and coal. If the cost of coal with CCS technology is fully understood energy companies will be able to make realistic comparisons between coal and cleaner sources of energy. An EPS may make electricity generated from unclean coal more expensive but in turn this will encourage everyone to focus on using electricity more efficiently.

Regulation should come before subsidy

15. Only after CCS demonstration projects have been successful will we know if CCS can meet the EPS at a price that energy companies can afford (and to what extent they expect Member States to subsidise them). The EU and Member States have to take the first step and introduce regulations which must include an EPS. For example, it is unlikely that the insurance industry will price the risk for the geological storage of CO_2 until the EU has a clear liability framework for the storage of CO_2. Only after these regulations are in place and CCS has been successfully demonstrated will the EU be able to understand how much CCS really costs.

16. Proposals to reform the ETS by allocating double credits for CO_2 emissions from CCS projects or other subsidies to keep the price of CO_2 at a certain level are highly significant. These ideas recognise that CCS technology is different to other methods of reducing CO_2 emissions and that the ETS should treat them differently. However, if used without an EPS, these solutions would still fail to deliver CCS technology on all new coal plants and could lead to Member States paying too much for CCS.

Conclusion

17. Most private sector energy companies cannot be relied upon to take the long-term investment decisions that are now necessary to ensure the swift introduction of CCS technology. An EPS is necessary to help create a stable and realistic price for CO_2 emission permits. Until CCS has been successfully demonstrated, an EPS will prevent new coal power plants being built. However, it is the quickest way to deliver CCS on a commercial scale.

18. New "capture ready" coal power stations will not force energy companies to make important long term investment decisions. They will delay the introduction of CCS. This delay will make it more difficult for the EU to meet its climate change targets in 2020 and 2050. The longer the introduction of CCS is delayed the more likely it becomes that the EU will be forced to pay the substantial costs of subsidising CCS retrofits on "capture ready" coal power plants.

References

i At present the largest CCS project in the world is injecting 1 million tonnes of CO_2 a year from the Sleipner gas field into a saline aquifer under the North Sea. (Source: The Future of Coal an interdisciplinary study by the Massachusetts Institute of Technology.)

ii "Europe Turns Back to Coal Raising Climate Fears" New York Times 23 April 2008 http://www.nytimes.com/2008/04/23/world/europe/23coal.html?_r=2&hp&oref=slogin&oref=slogin

iii Fundamentals of Successful Monitoring, Reporting, and Verification under a Cap-and-Trade Program by John Schakenbach, Robert Vollaro, and Reynaldo Forte of the U.S. Environmental Protection Agency, Office of Atmospheric Programs, Washington, DC Volume 56 November 2006 Journal if the Air & Waste Management Association.

iv Global Mapping of Greenhouse Gas Abatement Opportunities up to 2030 Power sector deep-dive published by Swedish energy company Vattenfall June 2007

v Article 32 of the proposed CCS Directive.

vi It is estimated that the 1600MW "capture ready" coal fired power station that E.on is proposing to build at Kingsnorth will emit approximately 8 million tonnes of CO_2 a year into the atmosphere.

vii "CO_2 Capture Ready Plants" Technical Study Report Number 2007/4 http://www.iea.org/textbase/papers/2007/CO_2_capture_ready_plants.pdf

viii ClientEarth considers that the California EPS is too high and the appropriate emission standard should be 350kg CO_2 MWh to reflect the standard of the most efficient gas plant with heat capture.

ix California Public Utilities Commission Decision 07-01-039 dated 25 January 2007 Order Instituting Rulemaking to Implement the Commission's Procurement Incentive Framework and to examine the Commission's Procurement Incentive Framework and to examine the Integration of Greenhouse Gas Emissions Standards into Procurement Policies.

23 May 2008

Memorandum submitted by Confederation of UK Coal Producers

1. The Confederation of UK Coal Producers (CoalPro) represents member companies who produce over 90% of UK coal output. CoalPro is not opposed to the development of any form of energy but is opposed to an over-reliance on any one source of energy. CoalPro is pro-coal.

2. CoalPro is pleased to be able to respond to the invitation of the Environmental Audit Committee to submit views in relation to their inquiry into carbon capture and storage with a particular focus on developments surrounding the Kingsnorth power station. A summary of CoalPro's submission is set out below:

- The emerging generation gap requires a high level of new generation plant construction immediately.
- Non fossil fuel sources, including renewables, and energy efficiency will make some contribution but cannot close the gap.
- If now new coal is built, there will be a dangerous overdependency on gas.
- Gas is also a high-carbon fuel and will also require CCS if a low-carbon future is to be assured.

— New plant build cannot await the demonstration of CCS. There is not enough time. It will have to be built carbon-capture ready, whether coal or gas.

— CCS cannot be demonstrated at an existing, low efficiency coal-fired plant because of the energy penalty.

— Kingsnorth would be an ideal plant at which to demonstrate CCS.

— The Government's CCS demonstration programme is far too modest.

— If Kingsnorth, or any other coal-fired plant, does not win the competition, they must still be allowed to proceed as carbon capture ready, if the generation gap is to be closed without a dangerous overdependency on gas.

Background

3. The UK is facing a potentially critical shortfall in electricity generating capacity within the next decade. Under the Large Combustion Plants Directive, up to 11GW of coal plant will have to close by 2016 during which period a further 5GW or so of nuclear plant will reach the end of its life and also close. European limits on emissions of nitrous oxides, which may well be further tightened by the draft Industrial Emissions Directive, will require further investment by all remaining coal-fired plant if it is to continue after 2016. It is likely that at least at some plant, this investment will not take place. Total closures by 2016 may therefore amount to 20GW or more, up to a quarter of present total capacity. The existing Kingsnorth plant is one of the coal-fired plants that will have to close by 2016 under the LCPD.

Filling the Gap

4. CoalPro considers that the options for filling this emerging generation gap are limited. These are considered below.

5. Nuclear power is not an option. Whilst replacement nuclear power has the potential to make a significant contribution to low-carbon electricity generation from, say, 2020 onwards, it will not be available by 2016. Indeed, the investment in new plant to fill the gap, however that new plant is fuelled, to a degree "locks out" new nuclear plant thereafter.

6. To an extent, new renewable generation capacity will be what it will be.

Further incentives for renewables may increase the amount of capacity that will be built by 2016, but the difference will be one of degree, not of kind. It will not make any significant inroads into the emerging generation gap. In any event, whilst renewables will make an increasing contribution to low-carbon electricity generation in total, they cannot be relied upon to provide an assured source of electricity either for base-load demand or for peak demand.

7. Energy conservation and efficiency will also have some impact but, again, will come nowhere near filling the gap.

8. The LCPD contains some provision for ignoring the Directive's requirements in the event of a security of supply crisis. Whilst possible, this would mean the continuation in operation of a proportion of older, inefficient coal-fired plant and would be the worst possible outcome environmentally, both in terms of carbon emissions and in terms of emissions of other pollutants. It would represent desperation.

9. It follows from the above analysis that only a significant build of new coal or new gas can close the emerging generation gap. If investment in replacement coal-fired plant, such as at Kingsnorth, does not take place, or is prevented from taking place, then the gap will be filled, and can only be filled, by gas.

A Dangerous Overdependency

10. Work by the Future Generation Sub-Group of the Coal Forum and by the TUC's Clean Coal Task Group demonstrates that if no new/replacement coal-fired capacity is built, then by 2016 some 60% of electricity generating capacity will be gas-fired. Both of these analyses are publicly available. This represents a dangerous overdependency on a single source of fuel and, with the UK's own gas production now rapidly declining, presents very serious security of supply risks.

11. In any event, such a level of investment in, and such a level of dependency on gas will still lock the UK into a relatively high carbon future. Low carbon electricity generation requires carbon capture and storage to be fitted to all fossil fuel generation, gas as well as coal.

Carbon Capture and Storage

12. CoalPro accepts that all new fossil fuel generating capacity, both coal and gas, needs to be fitted, or retrofitted, with carbon capture and storage. However, the size of the generation gap and the speed with which it is emerging means that the construction of at least some new fossil fuel plant needs to begin before commercial-scale operation of carbon capture and storage has been demonstrated both in the UK and across Europe. There is not much time. To the extent that new build is urgently required in the immediate future, it needs to be constructed as "carbon capture ready".

13. CoalPro accepts that there is a "chicken and egg" issue here. However, the technology related to all of the individual elements of carbon capture and storage has already been proven at commercial scale in other industrial applications. The need for a fleet of commercial scale demonstrators across Europe relates not to the need to prove that the technology will work but how it is best applied in different situations. There are alternatives.

There is also a need to gain experience with different operating modes. For example, there is a need to gain experience in how a new, high efficiency coal-fired plant, equipped with flue-gas desulphurisation, selective catalytic reduction (to control nitrous oxide emissions) and carbon capture and storage can operate flexibly to fill the role that the existing coal-fired stations fill so admirably in meeting peak electricity demand.

14. It should be noted that carbon capture and storage cannot be demonstrated by retrofitting it to one of the UK's existing coal-fired power stations. These are relatively inefficient and the energy penalty is just too great. It needs to be demonstrated at a new or replacement, high efficiency coal-fired station using supercritical boiler technology.

15. Against this background, CoalPro is concerned that the UK Government's demonstration project is exceedingly modest. Two or three larger-scale projects are required if the UK is to provide an appropriate contribution to the European-wide effort of 12 or more demonstration plants. Such projects could then encompass more than one technology and include gas as well as coal.

16. For the reasons set out at paragraph 14 above, carbon capture and storage needs to be demonstrated, and subsequently applied and retrofitted, to new, high efficiency coal-fired plant. Ideally, such a plant would be one which is replacing coal-fired capacity which will close due to the LCPD. The Kingsnorth proposal is exactly such a plant.

17. Kingsnorth is an entrant in the government competition to develop commercial scale CCS technology. It may not win that competition. If it does not, the winner may well be a similar replacement plant, a number of proposals for which have been announced.

18. In that event, Kingsnorth, and other new/replacement coal-fired plants, need to proceed quickly if the emerging generation gap is to be closed without a dangerous overdependency on gas. For that reason, such plants need to be built "carbon capture ready" so that the technology, once demonstrated, can be quickly retrofitted. The same should apply to new gas plant. Even if no new coal-fired plant is built, a second dash for gas will still lock the UK into a high-carbon future, as well as resulting in dangerous security of supply risks. New gas must also be constructed carbon-capture ready.

19. It is clear from the above that preventing Kingsnorth, or other new coal-fired plant, from proceeding until CCS has been fully demonstrated represents no solution either to closing the generation gap or to achieving a low-carbon future.

Concluding Remarks

20. CoalPro will be pleased to discuss these matters further should the Committee wish to do so.

2 June 2008

Memorandum submitted by the TUC Clean Coal Task Group

1. The Clean Coal Task Group (CCTG) welcome this inquiry because the group is concerned by the slow progress towards building clean coal power plant in the UK with the consequential risks to security-of-supplies and costs of electricity that will arise due to over-dependence on gas.

2. The Clean Coal Task Group is a joint industry and trades union initiative focussed on:

- developing a framework for the successful deployment of clean coal;
- security of supplies and energy costs (and their consequences for fuel poverty and costs to industry) as well as emissions; and
- employment opportunities in power generation, mining and equipment supply.

Following the creation of the Coal Forum, we have continued to meet and provide input and advice to the TUC, the Coal Forum and, where appropriate, to other interested groups and bodies.

3. The CCTG recently published a Position Paper on "Clean Coal in the UK and Europe", see Appendix.[35]

4. The points which we would like to emphasise in the context of the inquiry are:

4.1 Clean Coal/CCS in a Diverse Generation Mix

The Coal Forum considered three scenarios for new coal power plants to replace the 11 GW of coal and oil power plants which are to close by 2016 (see "Overview of the Work of the UK Coal Forum, November 2006 to June 2007"—http://www.berr.gov.uk/files/file41186.pdf. These scenarios envisage Low (5GW), Medium (10GW) and High (15GW) amounts of clean coal plant being built by 2015, with the balance of the generation gap being filled by new gas plants. A typical power plant with two 800MW units would produce around 12,000 GWh of electricity a year. If all of the plants are fitted with CCS by 2025, CO_2 emissions from UK power plant would be reduced by 40 % by then, or sooner with the right regulatory and financial framework.

The consequence of the Low coal scenario is an increase in dependence on gas for electricity generation to around 52% (58% if no new coal is built).

To maintain the present proportion of coal in the UK power generation mix would require the "Medium Coal Scenario", ie 10GW of new clean coal operational by 2016. This would require 2GW of projects (at least one new or replacement power station) to start each year (2008 to 2012) to be ready for 2016. It is not feasible for plants to be built faster due to the capacity of the industry in Europe.

In order to meet the emerging energy gap, construction of these plants (and in parallel around 10 GW of gas CCGTs) needs to start quickly and faster than CCS can be implemented on them all. Many must therefore be built "capture-ready", as is now being stipulated in Section 36 consents for gas fired power plants.

The present proportion of coal in the electricity generation mix can only be maintained if power companies start to build new clean coal power plants now.

CCTG believe the government should decide which clean coal scenario (Low, Medium or High) would meet its objective for the Coal Forum and security of supplies, and issue a preliminary version of the National Planning Statement covering coal fired generation and CCS facilities.

4.2 CCS Demonstration

CCTG supports the EU's plans for 10–12 CCS demonstration projects in Europe by 2015 and a similar number in the rest of the world if CCS is to be commercialised and rolled out on the scale necessary from 2020. These demonstrations should cover coal and gas, a range of capture technologies and a range of storage locations. Because of the UK's location and well understood offshore geology, several of these projects should involve CO_2 storage in depleted gas fields on the UK Continental Shelf.

CCTG believes the government should include in its revision of the Carbon Abatement strategy a vision for the progress and roll out of CCS first to 10–12 demonstrations and then to full commercialisation by 2020 on the scale necessary to meet its global CO_2 reduction targets.

The government, alongside its very welcome (and successful) development of regulation for CCS, should accelerate its efforts to find ways to incentivise more CCS projects—both post combustion and precombustion—for coal and gas. Initially, for the first tranche of CCS projects, the government should commit to recycling a large proportion of the anticipated revenues from auction of CO_2 allowances to provide a guarantee of the carbon allowance price by a contract for differences.

4.3 CCS—Examples to the Rest of the World

British companies have a strong track record in China and India. Originally they supplied sub-critical power plants to China (direct supply contracts) but since 2002 have also licensed Chinese companies with supercritical technology. The UK is therefore in an excellent position to encourage the adoption of advanced supercritical, capture-ready and CCS technologies in these and other emerging markets. Alstom, Doosan Babcock and Shell are participating in the Defra/BERR Near Zero Emissions coal power plant for China project (NZEC). Shell is licensing gasification technology to China for coal to liquids plants.

It is extremely important that the Government—in parallel with its other actions on energy—sets an example of specifying capture-ready best available technology for coal-fired power plant (as well as gas). It should demonstrate a commitment to clean coal and thereby set an example to China, India and others including Indonesia, Taiwan, Libya, South Africa, etc, that will otherwise continue to build new plants with CO_2 emissions potentially "locked-in".

[35] Not printed.

In this context the TUC CCTG are concerned by the delays to the proposed E.ON Kingsnorth project. We believe that building capture-ready clean coal now in parallel with urgent actions demonstrating a range of carbon capture and storage technologies is the most valuable immediate contribution the UK can make towards cutting CO_2 emissions from fossil fuels globally.

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