BP Submission to HM Treasury Consultation on Carbon Capture and Storage

Executive Summary

- The UK has the opportunity to attain material and rapid reductions in carbon dioxide emissions through Carbon Capture and Storage (CCS) in the period before a global price of carbon emerges. In addition, the UK is well placed to realise the potential to benefit from the development of further material options for CCS in the power sector in the future. There is currently no other technology that can offer the UK such large CO2 savings so quickly.

- A 500MW plant using natural gas to deliver base load power with a target of 90% carbon capture will provide as much low-carbon electricity as the wind generation currently installed in the UK. But power generation with CCS requires a similar level of support to that currently given to renewables; otherwise, such a project is not economically viable. The lack of an appropriate support mechanism is the chief obstacle to the deployment of CCS in the UK.

- It is hoped that in the future the EU Emissions Trading Scheme (EU ETS) may allow CCS projects to benefit from credits which will provide sufficient incentive without any additional support from Government being required. However, the EU ETS currently fails to offer either the kind of long-term certainty required for major infrastructure investments such as CCS or the level of support these projects need.

- The other big issue which remains to be solved is the question over ownership of the long-term liability for the CO2 stored via CCS. It makes sense for this to rest with Government.

- The UK has the opportunity to lead in the development and deployment of CCS technology. As with the development of oil and gas production in the North Sea, there are likely to be considerable opportunities around the globe for UK energy and supply companies to compete for new business openings having picked up experience in our own market.

1.31 The commercial deployment of CCS in the UK

- What are the barriers to commercial development of CCS?

The key barriers are:

- Incentive: CCS is currently uneconomic without a level of fiscal incentivisation equivalent to that currently enjoyed by onshore wind and other forms of renewable energy via the Renewables Obligation. CCS requires a stable long-term fiscal environment offering this level of incentive in order to bring the first few projects to fruition. Later projects should be able to benefit from the infrastructure developed by the first-movers and improvements in technology costs, and we anticipate that the level of incentive required will be lower.
- Tax: Uncertainties surrounding tax treatment create potential barriers and we are fully aligned with the UKOITC (UK Oil Industry Taxation Committee) submission of 9 May. Tax breaks could form part of a suite of measures to support CCS projects.
- EU ETS: While the EU ETS may one day deliver a price for CO2 offering sufficient assurance for CCS projects to proceed without an additional incentive, this will not happen in the foreseeable future. Currently the market for CO2 is very unstable (this will improve as trades become more frequent); the phases are too short; the member states are not consistent in drawing up their allocation plans. In addition, CCS is not yet recognised under the EU ETS meaning that projects may even be penalised by the system rather than benefit from it as captured CO2 would currently be treated as emissions.
- Regulatory Regime: Existing UK, EU and international regulatory regimes were designed without CCS in mind (eg waste law, dumping at sea, etc). This means that currently it is not possible to carry out pure sequestration of CO2 (without Enhanced Oil Recovery (EOR)) using existing infrastructure (so that the shallower gas fields in the Southern North Sea are not available for CCS as they cannot provide EOR), and that new regulations are required to cover storage, monitoring and verification.
- Liability: The question of who should take on long-term liability for the sequestered CO2 needs resolving. Widespread deployment of CCS will not take place without certainty on any potential long term liability.

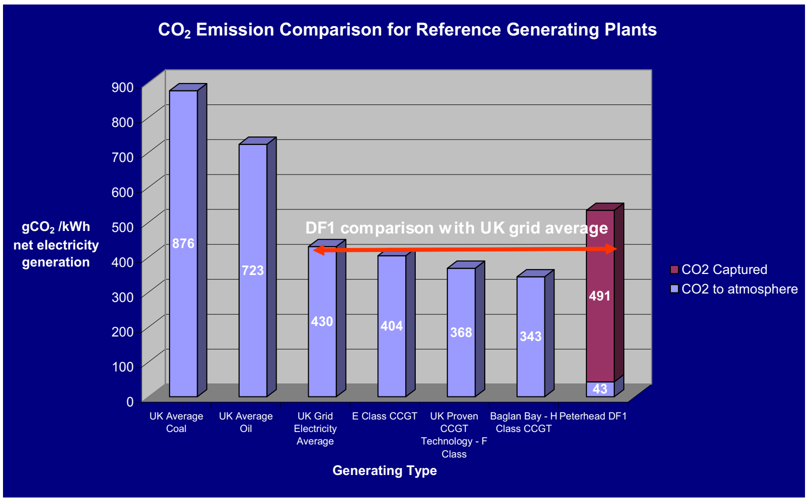
All the constituent parts, or blocks, of technology that are needed to make CCS work are already deployed at industrial scale in other projects in various parts of the world.

1.32 Potential carbon reductions

- What CO2 savings could be delivered by CCS, and how do these savings vary between different options for deployment, different fuels, and different kinds of technology at each stage of the CCS process? Can the life-cycle CO2 savings be estimated comparably with those of other technologies?
- How do the potential CO2 savings compare with other options for reducing carbon emissions?

Electricity generation accounts for 36% of UK CO2 emissions and, in principle, around 90% of this total could be avoided by widespread use of CCS across the fossil fuel power stations. Uptake may be limited by the additional capital and operating costs of the CCS units and the cost of developing suitable transport infrastructure. The savings are dependent primarily on the uptake of CCS in supplementing, replacing or retrofitting existing fossil fuel generating capacity and less on the choice of fuel or capture and storage technology. The amount of carbon captured by any particular combination of fuel and CCS technology will be subject to economic optimization and depend on local circumstances, but it is likely that the use of CCS will result in a reduction of 80 to 90% compared to the current UK grid average, or the existing stock of CCGT plants. Apart from opportunities at the power plant, this figure also allows for the CO2 emissions associated with the power needed to compress and transport the CO2 to its sequestration location.

Alternatives to CCS for low carbon electricity are wind farms, solar, and nuclear. CCS should be compared against these options alongside the criteria of whole life carbon dioxide emissions, the per-unit cost of generation (again considering whole life costs), environmental impact and social acceptability. It is considered likely that a portfolio of low carbon technology alternatives will be required to meet the UK's aspirational GHG target for 2050. Each one of these technologies individually has the potential to provide low carbon electricity and therefore reduce or avoid emissions compared to conventional generation.



'UK Average' Source: "Note on the UK Government's Proposed Approach to allocation of EU ETS allowances to the Electricity Generating Industry (Incumbents) for Phase II", DTI March 2006.

Two other potential advantages of CCS are that:

- material CO2 savings can be realised in a quicker timeframe than, say, via new nuclear build; and,
- it is possible to export the technology to third countries without any associated security/proliferation risks.

- What are the barriers to commercial development of CCS?

There are no technical barriers to deployment. However, as pipelines become available into the North Sea from other applications they must be used before they are decommissioned. The consequence of not using them is that making further projects viable will require investment in pipelines which would add considerable expense. Once CO2 conduit is created from one project it is likely further Co2 could be passed through it (as is the case for Miller) and subsequent project would require a lower incentive.

The technology elements are proven, but the concept and integration of the elements at scale are not. Some companies have participated in sufficient pilot and test programmes and studies in recent years and now conducted sufficient technical work to be prepared to carry the technical and operational risk etc. However, without a long term stable policy incentive that supports the higher costs associated with producing clean electricity and the long term nature of these investments, the industry will not develop.

1.33 Technology

- What are the different technological options currently available and in development for each stage of the CCS process - and what are the costs of these options?

The main options for low carbon power generation are: pre-combustion carbon capture, post-combustion carbon capture and oxyfuel combustion. Pre and post combustion could be deployed now, but the oxyfuel combustion technology still needs to be proved at the smaller pilot plant scale.

Pre-combustion carbon capture also provides a mechanism to access large volumes of hydrogen for other industrial applications associated with the hydrogen economy

- What scope is there for applying these technological options to different forms of power generation (particularly gas and coal) and other large-scale sources of CO2 emissions, and can they be installed on the basis of both new-build and retrofitting?

If a plant is taken out of action for re-powering both pre and post-combustion carbon capture can be retrofitted to existing power generating plant with gas plant. Retrofit to coal plant could only be done on a post combustion basis.

- At what level of market readiness are these various technological options?

The readiness for the application of pre and post carbon capture are fairly similar, although pre-combustion can be considered slightly ahead of post-combustion since there are numerous examples of the components available operating at scale. There are also plenty of IGCC (integrated gasification combined cycle) plants in operation which would suggest the concept is also applicable to coal.

- What limitations exist when it comes to selecting from the options at each stage to form a full CCS process?

The limitations associated with the pre and post combustion technology are a function of the technology risk associated with the scale of the project. .

1.35 Engineering and manufacturing capability

- What would be the costs and benefits of early adoption of this technology in the UK?

There is an opportunity for the UK to lead the world in this area. BP believes there are global opportunities for CCS technology to be advanced, particularly when we take into account the huge expansion of coal-fired power plants currently being constructed in China and India which will still be operating by the middle of this century. Indeed, BP has just announced a second project in Carson City, California where policy incentives are already in place and planned for the future.

There is a concern that by acting first the UK might have to provide greater support to CCS projects than it would if it waited until projects began in other countries first. This is very difficult to quantify as project economics are likely to vary considerably among projects. Also, over the next few years a number of opportunities will arise to make use of existing North Sea infrastructure to open up the province to both CCS and enhanced oil recovery so extending the life of what is a mature oil and gas province. However there will only be a narrow window of opportunity for the pursuit of these opportunities as operators will not be able to maintain infrastructure which is due for decommissioning for very long due to the high maintenance costs involved. Therefore, it is impossible to be confident that the UK would gain financially by waiting for others to move first and, in addition, not acting would also see the UK's carbon emissions continue at a much higher rate than if CCS technology had been encouraged.

Just as the development of North Sea oil and gas has led to UK energy companies and supply companies gaining invaluable experience which has been exported around the globe, UK leadership in developing CCS technology is also likely to promote the development of skills and knowledge which will be in demand worldwide for many decades. There will additionally be benefits to North East Scotland and potentially other parts of the UK connected to the UKCS (e.g. Teesside) or coal seams with the right geology. CCS also has the potential to extend the life and recoverable reserves of the North Sea, as well as other oil and gas provinces around the world. North Sea CCS is the catalyst which can stimulate investment in clean coal, by showing that CCS is possible, and it will also enable the UK to lead in providing electricity from Hydrogen – an important first step leading towards the 'Hydrogen Economy' of the future.

- Are there skills gaps that could create barriers to the development of CCS in the UK?

There are few specific skills gaps that will be a barrier to CCS deployment in the UK. The technology is broadly an extension of current processes and skills utilised in the chemical, utility and oil & gas industries. The issue is more how quickly industry is able to adapt existing skills and practices, building familiarity with the new applications and combinations of technology that are required for CCS.

The pace at which CCS is likely to grow in the UK will be affected by the experience of engineering contractors in the integration of the technologies into highly efficient and cost effective plant. It will also be affected by ability of the developers to broaden the experience of technicians in the power and chemical industries to take on flexible roles that span all aspects of these integrated plants.

1.41 Regulation, liability and public acceptance

- What scope is there to develop and use CCS within the current regulatory framework?

Offshore, there is currently no established framework, either legislative or procedural, for the licensing of a CCS project within the UKCS. In the absence of CCS specific legislative and procedural controls, regulatory requirements could follow the pattern established for regular oil and gas developments. The primary licensing authority would, in this context, be the Department of Trade and Industry in the UK. Amending the existing Petroleum Act model clauses or provisions of the Offshore Chemicals regulations could present a short term fix for the regulation of CCS within the UKCS, however ideally specific legislative and procedural controls will in time be developed.

If an existing depleted reservoir is proposed to be utilized for CCS, this would constitute a significant change of use and would require formal approval of the DTI to revise the original field development programme. However, it is not believed that the use of CO2 as an enhanced oil recovery agent would attract any contentious issues relating to licensing. The legislative and procedural controls implemented by the DTI and any other relevant authority within the UKCS ensure that the consultation, risk assessment, integrity management, consideration of habitat conservation, etc. issues relating to an application for such a project would address any relevant international conventions and EU Directives.

There is currently no international legislation which specifically covers the legal issues surrounding CCS. The international conventions and laws that may apply were not designed with CCS in mind.

The London Convention (and its recently ratified 1996 Protocol) and the OSPAR Convention are being considered by member states in light of CCS with some countries, such as the UK, playing a helpful and active role. It is generally recognized that CCS for EOR purposes, where the CO2 has been produced onshore, is permitted under the existing legislation, but capture and storage of such CO2 for pure sequestration purposes is not (unless the CO2 is transported to the offshore reservoir by a pipeline direct from onshore). Any changes to the language of the Conventions and Protocol could take considerable time and require ratification by a number of member states, whereas changes to the text of the relevant Annexes (which address those matters that can be placed in the sea and/or seabed) may be approved in a quicker timeframe.

Onshore, the existing regulatory regime should enable the development of CO2 capture and transportation (e.g. the Integrated Pollution Prevention and Control Directive (96/61/EC), as implemented by the Pollution Prevention and Control Act 1999 and the Pollution Prevention and Control (Scotland) Regulations 2000 ("PPC Regulations"); the Greenhouse Gas Emissions Trading Scheme Regulations 2005 ("GHG Regulations"); COMAH; and Pipeline Safety Regulations 1996).

- What regulatory framework would need to be put in place to support the development of CCS technology while also ensuring protection of human health and the environment?

Onshore, CO_2 is transported throughout the world in pipelines and so are far more hazardous materials. Therefore, with rigorous engineering standards and the keen involvement of the HSE we do not foresee an issue. Also we do not foresee CO_2 being compressed to a very high pressure until it gets to pumping station from where it goes immediately offshore.

Regarding the offshore transportation and storage of CO_2, risk to human health is extremely small and limited to sudden leakage from a geological storage site. Sudden leakage may be more likely to affect local biota (plants and animal-life on the sea-bed), but the probability of such a leakage is very small.

- What additional costs and considerations are created by the long-term liability implications attached to CCS, and how can these be best managed?

Given that the long-term liability is virtually certain to out-last the lifespan of the companies associated with the original CCS, it makes sense for this liability to rest with Government.

- What issues arise concerning (short-term) liability for CO_2 at particular points in the CCS process? Are there costs attached to these and what are they?

As stated above, we do not think that there is a high risk associated with a leakage onshore. Substances much more hazardous than CO_2 are transported regularly via pipelines, and, with rigorous standards in place, we do not foresee an issue until CO_2 reaches the pumping station to compressed at a very high pressure and sent offshore.

- What might be the likely public reaction to concerns about CCS, and how could concerns be addressed?

To date, most people's reaction has been that, given the choice and the accepted science on global warming, they would prefer CO_2 to be kept under the ground than emitted into the atmosphere. Based on the report into the cost of the renewables obligation by the Public Accounts Select Committee, the biggest issue is likely to be the cost to the consumer or state of any Government support for CCS. The best strategy for addressing this concern is probably to explain the benefits to Britain in assuming first-mover status in this new technology helping the UK to reduce its CO_2 emissions and extending the economic life (with associated employment benefit etc) of the N. Sea industry.

1.48 Cost

- What are the costs currently associated with the development of different potential CCS technologies and forms of deployment?

BP's work on CCS indicates that for gas there is little difference in cost between pre and post-combustion technologies, whereas for coal pre is much cheaper. Pre-combustion technology also requires very little land in comparison to post-combustion plant which would have difficulty finding sufficient space next to a number of existing power stations. Pre also adds to our learning about Hydrogen and, is available as a source of H_2 for industry and, potentially, transport.

- How might these costs change over time and what is the evidence for any estimates of this?

It is anticipated that the cost of CCS will come down with time and experience. Time alone will not bring the costs down – experience is the key and this relies on first investments being made.

- How might changes in the relative prices of coal and gas in the framework governing emissions of CO2 and other pollutants affect the costs and profitability of CCS?

Coal requires substantially more investment than gas as a fuel for power generation (with or without CCS). There is a point when the differential cost of gas over coal will mean that the levelled-out cost of electricity from coal becomes cheaper than that from gas.

An extra dimension will be the regulatory value or cost of CO2 generated. Coal produces considerably more CO2 than natural gas per MWh of electricity generation. Hence coal generation requires a higher level of capture, transportation and storage of CO2 than gas would. Consequently, there is much higher intrinsic cost associated with coal CCS and any regulatory CO2 costs (such as ETS) will greatly influence the coal versus gas debate.

- To what extent does EOR reduce costs and increase the commercial viability of CCS?

The potential for EOR to offset the costs of CCS and increase its commercial viability is likely to be very specific to individual field circumstances and vary with the oil price. Depending on these circumstances, project economics may make storage without EOR the more attractive option, the generator of the CO2 may need to pay the storage owner to take the CO2 or the CO2 may have a value the hydrocarbon producer is prepared to pay for. In general, EOR will be conducted once the bulk of oil reserves have been recovered and the balance of costs versus income is relatively poor. The CO2 transportation cost will depend on any conditioning costs (primarily dehydration), oil field location and the availability of pipeline infrastructure and the CO2 arrival pressure required to allow CO2 injection. As well as the volume of oil produced, the EOR benefit will depend on the extent of platform and well modifications required to allow the initial injection of CO2 (plus the re-injection of CO2 produced with the incremental oil) and the costs of maintaining the platform facilities for longer than anticipated..

An oilfield with easier operating conditions and lower reservoir pressure might require less investment and have a lower operating cost. However, the efficiency of EOR using CO2 is generally higher in reservoirs with higher temperatures and pressures.

- How does EOR using CO2 compare in cost terms to EOR using other means?

This is very situation-dependent, thus hard to generalise. The key inhibitor of EOR application generally is the need to purchase an injectant (eg CO2, natural gas and/or intermediates, chemicals) and then to be able to store it in the ground for a long time. In general, CO2 is advantaged in this respect because it may be available at a comparatively low cost (depending very much on the cost of capture and transportation) and it is a substance we wish to keep in the ground. In principle, if the cost of capture, transportation and storage monitoring can be kept low enough, then CCS will promote EOR and incremental oil production. While helpful, cost reduction alone is highly unlikely to make CO2 capture and storage attractive without fiscal incentivisation at some point in the value chain from power generation to sequestration.

- Is the use of CO2 for EOR appropriate on the UK continental shelf and at what stage in the life of a specific field is it appropriate to use EOR?

Oil fields are large geological structures and our understanding of them is limited by the few wells drilled into them for appraisal or oil recovery. As the oil is recovered from an oil field our understanding of the geology and the recovery processes improves due to the data collected during production. CO2 can increase the recovery of oil from most oil fields and can be deployed at any stage in the life of an oil field. However, CO2 EOR generally requires additional expensive investments over and above that required for pressure depletion (known as primary recovery) and water or hydrocarbon gas drive (secondary recovery). The injection of chemicals (such as surfactants or CO2) is known as tertiary recovery and (because it is more expensive than either primary or secondary recovery), its economic viability is uncertain until later in the life of an oil field.

Operators are reluctant to deploy CO2 EOR early in the life of an oil field because the extra oil recovered may not fund the incremental investment for the EOR project. Later in the life of an oil field, production data will allow the operator to better determine where the un-recovered oil lies and what processes could unlock that oil from the geology. The incremental costs and benefits of CO2 EOR (tertiary recovery), together with the risk of failure can be more accurately assessed later in field life and that is the main reason why CO2 EOR is generally deployed after primary and secondary recovery mechanisms have been used. CO2 EOR could be deployed earlier in the life of an oil field were the costs lower and the benefits higher.

1) primary recovery (pressure depletion) and secondary recovery (usually waterflood) are normally cheaper on a unit basis, so we do them first. The target for tertiary (EOR) processes is oil left behind by primary and secondary recovery schemes.

2) CO2 flooding is best suited to light oil at intermediate depth. For efficient (miscible) CO2 flooding, temperature and pressure have to be high enough and oil has to be light enough for the CO2 to dissolve easily in the oil. As a rough guide, this means reservoirs deeper than about 2000 m and oils lighter than 35 API.

- What are the costs associated with building capture-ready plant and how do they differ from the cost of constructing fully operational CCS facilities? To what extent can any additional costs be mitigated by decisions on design, location etc?

BP is only looking at fully operational CCS facilities. However, very little modification has to be made to a conventional plant to make it capture-ready. The great majority of the incremental capital and operating costs are associated with making the plant operational for CCS. In reality, capture-ready plant are no more than a conventional plant with several thousand of pounds of pre-investment. They are not the same as a CCS project and are always permitted without the CCS element, necessitating this at a later stage.

- Is the use of CCS currently a profitable option for businesses in the electricity supply sector and other sectors and, if not, what is the shortfall? Under what conditions might it become profitable?

For oil and gas businesses, CCS could be profitable in its own right when a value is associated with the capture and storage of CO2 and it is possible to sequester CO2 at very low cost using existing pipeline, platform and well infrastructure.

The economic viability of CCS in the electricity supply sector is entirely dependant upon a value/premium being placed on clean electricity or on CO2 emissions avoidance, in much the same way as for renewables (wind and solar). EOR can mitigate this dependency but, as stated above, is very case specific.

1.54 Is there a case for economic incentives for CCS?

- What is the impact of the current policy framework on the development of CCS?

There is no current policy to allow deployment.

- Are there any particular issues that need to be taken into account with regard to CCS when considering the use of policy mechanisms to reduce CO2 emissions in the UK economy?

It must be competitive with other forms of low carbon power generation.

Andrew Mennear
25th May 2006