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Is Britain Ready for Carbon Capture and Storage?

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ideas with impact

Carbon Capture and Storage (CCS) is a term for a set of technologies which captures up to 95% of the carbon dioxide released by coal and gas fired power stations; liquefies this carbon dioxide for transport and then stores it deep underground. By fitting such equipment, global power emissions could be slashed by 28% by 2050.

All the parts of CCS (the capture; the transport and the storage) have been in use for decades in other industries. However, they have never before been integrated in order to cut emissions. This is the challenge for Government.

Unfortunately, large scale demonstration of CCS technology in the UK is being undermined by incoherence and timidity in Government policy.

- Confusion over government policy and timescales means that the number of proposed CCS projects in the UK has halved in the past year, from 10 to 5.
- The 10 projects proposed in 2006/7 would have cut UK base load power emissions by 20%. The first would have been operational by 2009, five years ahead of the Government's latest deadline.
- By losing BP and Scottish and Southern's planned gas CCS plant at Peterhead, the Treasury has lost an estimated tax take of £1 billion in oil revenues, as the carbon recovered would have been stored in depleted oil reserves, thereby pushing out more oil (a process known as Enhanced Oil Recovery).

The Government is failing to encourage the development of a CCS industry in the UK. It is also failing to enable power stations to be ready for CCS once it is developed abroad (the idea of being "Capture Ready").

- "Capture Ready" is a concept for which there is currently no legal or regulatory definition. However, the Government has already made being "CR" a part of the planning process for new coal and gas plants, and has already granted permission to three gas fired stations on this basis. Such plants must have in place plans to transport and store the carbon dioxide as well as to merely have the space to retrofit equipment to capture it.
- The Government has made no consideration of the fact that fitting CCS equipment leads to coal and gas stations producing up to 25% less energy to the grid. Retrofitting technology to existing stations could therefore lead to blackouts in the future.
- The Government has failed to put in place a liability regime for the storage of carbon dioxide– exposing future Governments to the kind of costs and risks currently faced by the Nuclear industry. Carbon from CCS could well be seen as the new nuclear waste.

What is Carbon Capture and Storage?

CCS involves capturing the carbon dioxide released by coal or gas fired power stations; transporting it for sometimes hundreds of miles and then storing it underground.

In this way, gas and coal power stations could release up to 95% less carbon into the atmosphere. Unfortunately this costs money, not least in the drop in power station efficiency as a result of energy being used to power the capture process.

However in some situations, the stored carbon dioxide even can be used as a way to force out oil or gas from depleted reserves, a process known as "Enhanced Oil Recovery". This makes CCS much more economically viable as the revenue from the recovered oil can be used to offset the cost of CCS. In the UK, our rapidly depleting North Sea reserves, provide the perfect opportunity for both storage and to maximise the output of our reserves.

Before we can take advantage of this opportunity three main problems need to be overcome: logistics, profits, and regulations.

Capturing and storing the carbon dioxide is not as easy as it may sound. Carbon dioxide is captured before, during or after combustion; purified and compressed to form a liquid; transported by ship or pipeline for tens to hundreds of km before, finally, being stored underground in depleted oil and gas fields, coal seams or deep saline aquifers.

None of these technologies are new and indeed many have been used in industry for years. However, the difficulty is in integrating them: in working with multiple new business partners, across large areas, with a host of planning restrictions and little government guidance -and all at an affordable cost.

Why talk about it now?

Later this month, Government ministers will decide whether to approve the UK's first new coal station for 24 years. A further 7 coal-fired stations could be on the table.

Ministers claim that new coal stations will not harm the UK's environmental credentials precisely because of CCS: as John Hutton argued in March, "there's a belief that coal-fired power stations undermine the UK's leadership position on climate change. In fact, the opposite is true."

Will these new plants be CCS plants?

These new plants will not have CCS. There has been no integrated demonstration of CCS in the UK. This section will discuss why this is true. We will then go on to examine whether, in the absence of a homegrown CCS industry, new build power stations could be built “Capture Ready”: ready to retrofit carbon capture and storage technology once it has been developed elsewhere.

The Government Competition

Last year, the Government proposed a UK Competition to create an integrated demonstration of CCS in the UK. The winning project will need to demonstrate a fully integrated CCS plant, from capture through to transport and storage. The UK Competition closed on 31st March with an estimated 8 bids, only one of which will be built.

The Competition will fund one 400MW coal-fired power plant with post combustion capture, to be ready by 2014.

This is a very small plant. 400MW of thermal energy will be converted to 300MW of electricity after the capture penalty has been paid. Moreover, cautious wording permits only 50MW to be operational by end 2014, with the full capacity "as soon as possible thereafter". One unit for a power station is usually 500MW.

The competition also states that the Government will pay the additional costs of capture, construction, transport, storage and operation for 15 years afterwards.

Is the Competition enough to create an integrated CCS plant in the UK?

There are several astonishing features to this competition. We believe these will make developing a competitive UK based CCS industry extremely difficult indeed.

- The cost has no upper limit, and can be driven up by rises of materials costs worldwide.
- There is no coherent development of a supply chain to create CCS skills and expertise in UK industries. This is concerning, as past lessons from nuclear, onshore wind suggest that the UK can easily under-invest in the supply chain, so that a new industry goes abroad.
- There is no strategy to create a UK skill base in advance of CCS being required of several companies already licensed with “Capture Ready” gas plant
- The most concerning feature of all, however, is the fact that there is only one technology supported: just coal, and just post combustion, and with just one plant. This rules out dozens of numerous exciting relevant UK projects. These omissions include CCS fitted to a gas plant, such as a proposed BP and Scottish and Southern Energy project at Peterhead, which we will go on to discuss. It also rules out advanced coal-fired systems such as gasification to form liquid fuels such as hydrogen. Finally, in the development of any new technology, a PROGRAMME of demonstration is usually needed, through several cycles of improvement. If the UK Government is serious leading climate change mitigation, then such a programme must be urgently planned in the UK, EU and worldwide.

The present pace is secure, but lethargic in the face of the climate problem.

Could the Competition have actually hindered rather than helped the CCS industry?

CCS was originally floated by the Government in 2002. After strong political commitments at Gleneagles in 2005, industry excitement began to grow.

By May 2007, 10 projects were proposed for the UK –the largest number in the world. These were also the most diverse mix of projects in the world, and included post-combustion capture on retrofitted and re-powered coal plant, post-combustion on new coal plant, pre-combustion capture on coal new IGCC, and pre-combustion on gas.

If all these 10 projects had been built, 20% of UK base load electricity could have been decarbonised by 2015.

However, the Government began to get cold feet, dithering over whether to support CCS with explicit financial commitments, e.g. via the Renewables Obligation, and consistently changing the timetable – with the first plant now planned after 2014.

As a result, the Government's long timetable; cautious funding (for just a 400/50MW station) and decision to pick just one technology (coal, post combustion) has actually contracted demand in the CCS industry.

5 of the original 10 projects are currently viable – Peterhead has been withdrawn and reappeared in near identical form, with the same partners, in Abu Dhabi; and 4 projects do not qualify for the Government competition.

The Loss of Peterhead

This project would have taken an existing feed of natural gas into the Peterhead power station, derived from the northern North Sea. The gas would undergo chemical splitting, to produce hydrogen for combustion to make electricity. The separated CO2 would be liquefied under pressure, and piped using a unique existing CO2-compliant pipeline, to the Miller oilfield, where it would be injected to undertake Enhanced Oil Recovery and produce 5-15% additional oil from the field.

Using the existing North Sea pipelines would have saved £200 million of costs; the CO2 would have been piped to a secure storage site which had already stored oil, gas and CO2 for millions of years; and it would have produced 40 million barrels of extra oil. At a cost of around £100 million a year subsidy until 2013 (when the EU Emission Trading Scheme could include CCS), the Government has missed a tax take of £1,000 million from the extra oil, based on £50 a barrel (the current price). Even with 2006 Treasury predictions of $60.3 a barrel oil price, oil revenues would still have been far from negligible.

More importantly from an environment perspective, that CCS plant could have been operating in 2009 - five years before the Government's competition will even get off the starting block.

Why did Peterhead collapse?

Peterhead collapsed because the Government was unwilling to commit to a creative funding package.

One of the requests from BP was for a "decarbonised ROC" of £30 per MWhr, to take the wholesale electricity price to £60 per MWhr. This compared favourably with the Renewable Obligation Certificates (ROC) given for onshore wind power, resulting in a wholesale price of £70 per MWhr. If the decarbonised electricity was 400MW, at 8,000 hr/yr plant operation, then that would have require £96M per year of subsidy - and half of that would have been unnecessary when CCS becomes included within EU-ETS from 2013.

The re-emergence of the identical project, with the similar partners, in Abu Dhabi suggests that other Governments are willing to take a more creative approach.

We believe that the Government competition is far too timid. A clear signal that carbon reductions will be both mandatory and recognised is essential, e.g. through allowing CC&S to be eligible for the Renewables Obligation; a feed in tariff or best of all, for CCS to be funded by new tax for monies raised via the EU Emissions Trading Scheme. If the EU-ETS income is not spent on CCS, the UK taxpayers will have been charged more for carbon dioxide emissions from electricity, but not provided with the means to invest in decarbonising the electricity. **If the UK relies on this small-scale Competition alone, CCS will not be developed to the scale, or to the timetable, required.**

Can we build plants to be ready to receive CCS, when it is developed abroad?

New build CCS plants look highly unlikely, as we have seen above.

However, the UK Government speaks of new build coal and gas stations being built "capture ready." This implies that the CCS technology, when developed, can be simply strapped on to existing technology.

Indeed, in 2007, three new gas plant were granted planning permission on this explicit basis.

In reality, CCS is far more complex, as we have seen. Any retrofitted station would need to be able to retrofit each component: capture; transport and storage.

As a June 2006 study by MIT concludes: "A plant can be considered 'capture-ready' if, at some point in the future it can be retrofitted for carbon capture and sequestration and still be economical to operate....The concept of 'capture-ready' is not a specific plant design; rather it is a spectrum of investments and design decisions that a plant owner might undertake during the design and construction of the plant."

In fact, the Government has yet to develop a definition for a plant being “Capture Ready”, even though it has granted planning permission to three gas fired stations on this explicit basis.

It is essential that Government sets a clear framework for what Capture Readiness is; when it should be instituted and how industry can meet some of the costs. At the same time, this framework needs to be flexible enough to allow industry to come up with their own forms of CCS.

Steps the Government must take for Britain to be "Carbon Capture and Storage Ready."

(1) The Government must define what CR means as a matter of urgency, and before any planning approval is granted.

Such a definition should entail:

(a) A desk study of CO2 transport and CO2 storage specific to this power plant, in sufficient detail that outline planning applications could be made

(b) A design study of the plant, to answer:

- Is there space for new plant (CO2 scrubbers, compressors, and/or oxygen separation plant)?
- Is there space for additional infrastructure (electrical distribution, cooling etc)
- What extra pipe work is needed and what are connections to the main plant?
- Is there sufficient space for storage during building of the Capture plant?
- Are additional safety features needed?
- If CO2 capture reduces electricity output, typically by 20-25% for 2008 designs, is this acceptable for the site grid connection. In addition there remains significant cost uncertainty which not only exposes the Government to potentially huge cost liabilities but also prevents industry from moving forward with existing projects.

(2) The Government must make CR mandatory for any new build power plant of over 49MW, both coal and gas.

(3) The Government must set a strong and secure definition for when CR must be converted into CCS.

The skills and experimentation necessary to construct and operate Capture must be created within each of the power plant operating companies, starting immediately. This can be stipulated by Government.

(4) The Government must set a liability framework for CCS.

This includes providing clear guidance on the safety requirements of CO2 transport offsite, and providing licensing and monitoring requirements for CO2 storage.

Outline regulations must be drafted as a matter of urgency, with the expectation that more focused requirements will be in place when capture is required.

The Government has in place no clear guidance on how carbon should be transported and stored. Such doubt can easily lead to public fear over dangerous carbon leaks. Without public engagement and a clear liability regime, carbon from carbon capture and storage will be seen as the new nuclear waste, and CCS will become as unpopular as nuclear. A more appropriate site of actions would be for Government to decide on standards, and then make transparent information available to the public, concerning safety, small size of predicted leakage rates, financial liability.

(5) The Government must formulate a way to make CCS affordable for energy companies

For example, via carbon pricing; feed in tariffs or through using monies raised by auctions in the EU Emissions Trading Scheme.

In 2004, the Royal Academy of Engineering predicted that Carbon emission reduction costs of about £50/tCO2 would have added about 1-3p/kWh to the costs of electricity generation (compared to an existing range of 2.2-3.2p/kWh10). According to the report House of Commons Science and Technology Committee 2006, the use of CCS could add 1.1p/kWh to the cost of generating electricity from coal (at **£/GJ) and 0.9p/kWh to the cost of electricity from gas (at £3/GJ). P), with prices would be more expensive rising for earlier plants.

Without a clear and bankable signals that the industry will recoup their investments, CCS will languish. Such signals will be examined in a forthcoming Policy Exchange report, due in June 2008.