Climate value for money – funding carbon capture and storage demonstrations in the UK power sector

A paper from RSPB and WWF-UK

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Introduction

Last year the Committee on Climate Change recommended that the UK power sector should be almost completely carbon-free by 2030 to put us on a pathway to achieve the Climate Change Act target of at least an 80% cut in greenhouse emissions by 2050. As the biggest climate polluter the rapid decarbonisation of this sector is clearly important in its own right but crucially it could also offer a route to decarbonise other sectors such as transport and heating through electrification.

As part of the transition to a truly low-carbon, sustainable energy system carbon capture and storage (CCS) is often touted as a technology option which could play a bridging role in reducing emissions from burning coal and gas. However, whilst investments in renewable energy and energy efficiency offer inherent economic benefits by themselves (for example by reducing dependency on imported fossil fuels, generating electricity etc.), the application of CCS to the power sector offers no immediate economic payback**1**. Indeed, the process itself is inherently inefficient and is estimated to reduce the efficiency of coal fired power plants by around 10 percentage points resulting in more coal being burnt to deliver the same amount of electricity. In essence it is clear that CCS would not be considered were it not for the central role of coal burning in bringing about the climate crisis we currently face, and the need to avoid the emission of additional CO_2 from coal.

To be clear – we consider the best climate value for money, in terms of addressing emissions from the power sector, can be achieved firstly through the investment in energy efficiency and demand management measures, secondly through sustainable renewable energy technologies, and only thirdly through the demonstration of CCS.

In April, to help drive forward the demonstration and subsequent potential deployment of CCS technologies, the UK Government announced plans to fund up to four demonstration projects each of 300MW in size on coal fired power plants (and to require some level of capture on all new coal plants). The consultation on coal and CCS released in June includes options for how these projects may be financed with estimates of the cost ranging from between **£5.2 billion to £10.3 billion2**. Most of these costs will be borne by electricity consumers over a 20 year period (between 2011 and 2032)**3**.

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1 "Unlike many other low-carbon technologies, such as renewable energy or nuclear power, CCS produces no directly-accessible economic benefit at the moment – there is no electricity to see or heat to conserve. For industry, the benefit of practicing CCS is only realised if an economic value is given to avoided CO_2 emissions" – "Carbon Capture and Storage in China" An E3G report for Germanwatch, May 2009, http://www.germanwatch.org/klima/ccs-china.pdf.
The carbon price is currently not high enough to drive CCS. There are various estimates of the carbon price needed to drive early demonstration of this technology. For example McKinsey have cited €60-90 per tonne of CO_2 abated, Climate Change Capital around €127 and Deutsche Bank around €35.

2 "Impact assessment of coal and carbon capture and storage requirements in 'A framework for the development of clean coal' consultation document" DECC, June 2009, http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=Consultations\A framework for the development of clean coal\1_20090623122727_e_@@_cleancoalia.pdf&filetype=4

3 It is envisaged that the funding for the project that wins the current CCS demonstration competition will be supported by a combination of funding sources – the proposed new finance mechanism, EU funding and also public expenditure.

Criteria for funding demonstrations

NGOs consider it imperative that funds for CCS demonstration, a significant proportion of which will come from the public purse, be spent in a way which maximises the climate benefits and learning hence giving the best climate value for money. **To assist the Government in making the right decisions about which projects to fund, we therefore recommend that the demonstration programme should meet the following criteria:**

- It should lead to an immediate net reduction in greenhouse gas emissions from the UK power sector.
- Proposals for new coal plants which are considered as part of the demonstration programme should be able to meet a boiler based emissions performance standard of 300gCO_2/kWh from day one**4**. As well as the obvious climate benefits, this would also drastically reduce the liability on the public purse to pay for a future retrofit of CCS to the full generating capacity of the plant should CCS be proven.
- It should prioritise projects which can be in operation quickly thereby contributing early learning to the UK, EU and wider G8 CCS demonstration programme**5**.
- Storage must not lead to additional net emissions e.g. through enabling enhanced oil recovery activities.

The Government has also established a set of objectives that they would like their "*framework for the development of clean coal*" to meet. These are:

- Advancing the global development of CCS technology.
- Improving the affordability of CCS investment.
- Delivering a diverse and secure low carbon energy supply in the UK.
- Helping create jobs and economic opportunities for UK-based businesses in a new industrial sector.

Options for demonstrating

We believe there is a way to meet both the "*climate value for money*" criteria and the Government's objectives for "*clean coal*" by:

1. Demonstrating post-combustion carbon capture technology on an existing coal plant

Beyond the obvious immediate net reduction on power sector emissions that a retrofit would offer, a recent paper from Imperial College**6** presents several additional reasons as to why retrofitting existing plant, particularly during the demonstration phases of CCS, could be advantageous. These include:

- speed of implementation;
- limited costs;
- high learning value; and
- suitability to short project life. For example, first tranche generation demonstration projects are likely to be superseded relatively quickly as the technology improves and 'teething problems' are ironed out. Application of CCS to existing plant may therefore make a short demonstration project life (e.g. 10-15 years) economically more viable/attractive than if the

4 For further information see the joint NGO statement on coal and CCS - http://assets.wwf.org.uk/downloads/joint_public_ccs_statement_june_09.pdf , June 2009.

5 The EU would like to see 12 demonstration projects in operation in the EU by 2015 and the G8 have committed to 20 large-scale CCS projects to be in operation by 2020.

6 "Retrofitting CO_2 capture to existing power plants as a fast track mitigation strategy" Hannah Chalmers, Jon Gibbens, Mathieu Lucquiaud, Imperial College London, July 2009

technology were applied to a new build plant which may run (in the case of coal) for a further 30 years**7**.

The EUs Zero Emission Platform (ZEP) also proposes that a retrofit to an existing plant should be included in the portfolio of 12 EU demonstrations and state "*Retrofitting can provide for large applicability both within and outside Europe, as the only solution for CCS for the existing power plants. Retrofitting requires technical development and cost recovery"**8**.* The recent International Energy Agency report on CCS also states that demonstrating CO_2 capture through retrofitting at a coal-fired power plant "…*is an urgent need*"**9**.

Arguably the learning from a retrofit project on an existing sub-critical plant may also have more direct applicability and transferability to the situation in for example China (where plant are currently **not** being built 'carbon capture ready') than the learning gained from demonstrating post-combustion technology on a new, built for purpose 'carbon capture ready' supercritical plant in the UK. A recent paper for the Massachusetts Institute of Technology notes "*There is a large difference in CCS plant design for "purpose built" as opposed to retrofit. A new, purpose built plant allows multivariable optimization through management of the entire design process in a holistic fashion. With a CCS retrofit, compromises in cost and/or performance may be needed to enable implementation within an existing plant structure.*"**10**

Scottish Power's sub-critical coal plant at Longannet in Scotland is the only existing plant in the running in the Government's current CCS demonstration competition which will be awarded to one project. Scottish Power maintain that they can still meet the competition's operational deadline of 2014**11**. **The Longannet plant is due to continue operating up until around 2030 and whilst Scottish Power is investigating options for "upgrading" it to a supercritical plant we understand that these plans have been pushed back towards the end of the next decade.** Clearly if a full upgrade went ahead the life expectancy of the unabated and abated parts of the plant would be extended for another 30+ years. Conditional to our support for any retrofit project therefore would be a guarantee that CCS would be fitted to the full generating capacity of the plant should the plant ever be fully upgraded. Indeed we consider that any parts of the plant intending to uprgrade and therefore extend their operating lives do so whilst complying with an emissions performance standard of 300gCO_2/kWh from day one, dropping to nearer 70gCO_2/kWh depending on the progress of CCS abatement technology.

2. Prioritising pre-combustion capture and gasification technology for additional demonstrations which have the capability of capturing at least 90% of the CO_2 emissions from the full generating capacity of the plant from day one.

As pre-combustion technology is integral to the engineering design and construction of the plant itself, CCS coverage of the whole plant from day one is the most sensible option**12**. DECC also

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7 This point is also corroborated by the recent McKinsey report ("Carbon capture and storage: assessing the economics" McKinsey&Company, September 2008") which states "… *it is worth noting that retrofitting could be an attractive option for building a CCS demonstration project, because the capex required would be lower (and thus the risk smaller), and the construction time might be shorter. The shorter lifespan of a retrofitted CCS plant would most likely not be a problem, since the plant would in any case be expected to have a shorter life. And the impact of the possibly higher efficiency penalty would be reduced by the smaller size of the plant, the shorter life and lower utilization.*"

8 "EU Demonstration Programme for CO_2 Capture and Storage (CCS)" European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP), November 2008, http://www.zero-emissionplatform.eu/website/docs/ETP%20ZEP/EU%20Demonstration%20Programme%20for%20CCS%20-%20ZEP's%20Proposal.pdf

9 "Carbon capture and storage – full-scale demonstration progress update" International Energy Agency, 2009

10 "CO_2 capture and storage for retrofit applications" March 23 2009, http://web.mit.edu/mitei/docs/reports/langley-alexander.pdf

11 http://www.scottishpower.com/PressReleases_1908.htm

12 This was acknowledged in an email from Michael Jacobs, Special Advisor to the Prime Ministers to NGOs sent on 27th April following the UK Government announcement on coal which said "*Where pre-combustion technology is used, all (90%) of the CO_2 emissions from coal will be captured from the beginning - the technology can only operate this way. So there is no question of partial CCS to start and retrofit later. All coal use will have the CO_2 captured from the beginning.*"

acknowledge this in the coal consultation: "*For technical reasons, pre-combustion and oxyfuel capture technologies will need, as a minimum, to capture carbon dioxide from a single unit of a coal plant. For pre-combustion this could mean that a demonstration would need to be applied to a single coal gasification and turbine unit of around 450-500MW and for oxyfuel a single boiler or around 800MW*"**13**.

In terms of the capture part of the chain (which is the most expensive) the recent report from McKinsey&Company suggests that the cost of capturing a tonne of CO_2 reduces in line with the scale of the CCS demonstration plant. For example it puts the cost of capture at a 300MW demonstration (the size currently proposed by the UK Government for post-combustion capture demonstrations) at around €60 per tonne, this reduces to around €50 for a 500MW plant, and €45 for a 600MW plant**14**. In addition McKinsey state that the cost of different capture technologies is at this stage quite similar. This would seem to suggest that the funding of perhaps fewer, larger pre-combustion demonstrations would deliver better climate value for money than the funding of smaller scale post-combustion demonstrations.

Interestingly a recent AEA report for DECC also shows that whilst the capital costs for a new capture ready IGCC plant are more expensive (estimated at £990/kW) than those of a capture ready pulverised coal plant (at £836/kW) this situation is reversed for new plant with CCS. Under a CCS scenario the capital costs for a pulverised coal plant are £1457/kW and for an IGCC plant are £1273/kW**15**.

A further component of maximising the value for money in devising a CCS demonstration programme is the extent to which the technologies tested can contribute to the reliability of UK energy supply. One dimension of this is the extent to which pre or post-combustion CCS coal plants can contribute flexible, reliable, baseload or peak load capacity to the UK energy system. Regarding pre-combustion coal gasification, it is necessary to consider the wider issues of energy security, beyond simply electricity generation. Pre-combustion coal gasification could for example switch from generating electricity when demand for electricity is low to separating hydrogen, itself a versatile energy carrier. This hydrogen in turn could be injected into the existing gas grid as a means of reducing the carbon intensity of our current gas supply.

3. Considering the phasing of demonstration projects

The Impact Assessment accompanying the Government's "*clean coal*" consultation is based on a scenario where the first UK demonstration begins operating in 2014, the second in 2015 and up to two more begin in 2018. As there will likely be rapid learning from the first few operational projects (including those in other EU countries, and globally) it would seem sensible to stagger UK projects so that learning from early demonstrations can be used to inform future projects and indeed help determine whether there is a need for further demonstrations in the UK.

In addition - arguably, if the carbon price does begin to rise during the next decade the cost for funding an additional two projects may be slightly cheaper if a "*Contract for Difference*" between the cost of CCS and the carbon price in the EU Emissions Trading Scheme is the finance mechanism that is opted for.

13 "A framework for the development of clean coal: consultation document" DECC, June 2009, http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=Consultations\A framework for the development of clean coal\1_20090617164456_e_@@_cleancoalcondoc2.pdf&filetype=4

14 "Carbon capture and storage: assessing the economics" McKinsey&Company, September 2008

15 "Future value of coal carbon abatement technologies to UK industry" AEA report for DECC, December 2008, http://www.aeat.co.uk/cms/assets/MediaRelease/PR_190609.pdf