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Viewpoint

What can we expect from Europe's carbon capture and storage demonstrations?

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RESEARCH HIGHLIGHTS

- Presents possible scenarios for EU CCS deployment.
- Examines role of CCS demonstration in determining role of CCS in EU decarbonisation.
- Examines key factors influencing CCS deployment raised by CCS demonstrations.
- Successful CCS demonstrations needed to maintain CCS an option.
- Significant, timely deployment requires coordinated building on demonstrations.

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ABSTRACT

Carbon capture and storage (CCS) on electricity generation and energy intensive industry is expected to play a considerable role in achieving the European Union's decarbonisation goals. EU CCS demonstration project funding has been created to encourage development and accelerate commercial CCS deployment by providing funds to bridge the capital gap for early commercial-scale CCS installation. Eleven CCS project proposals currently remain at least nominally active, but reduced funding and other constraints suggest at best delivery of around a third of these. To explore how these demonstrations impact on the scale of subsequent CCS deployment in the EU three simple scenarios for post-demonstration CCS activity and deployment (none, limited and considerable) are considered and examined in the context of key factors that have influenced the demonstration programme. Without strong political support for post-demonstration deployment including measures such as strategic storage validation and CO_2 pipeline planning, and a clear process to make CCS commercially attractive to investors on a timeline consistent with climate ambitions, even a positive result from the demonstration programme is unlikely to enable CCS to deliver as expected.

1. Introduction

The EU has considerable ambition for carbon capture and storage (CCS) to play a major role in decarbonisation efforts. The EU Commission's Energy Roadmap 2050 (European Commission, 2011)—outlining EU energy policy options required to achieve the goal of 85–90% cut in CO_2 emissions by 2050 envisages a 19 to 24% contribution to total reductions by CCS in all but the very high renewables scenario. To make such a contribution, CCS deployment is envisaged in the period 2020–2030, with CCS applied to all coal and gas power plant by 2030, and around half of the EU's heavy industry by 2050.

However, attempts to launch the technology at commercial scale in the EU through public co-funding of CCS demonstrations projects are struggling. At present, operating commercial-scale CCS is limited to a handful of facilities globally—mostly gas processing (e.g. Statoil's Sleipner gas platform, Norway) in which the CO_2 capture is a well-established and integrated process. None of these are located in the EU.

To try to launch CCS application to fossil power plant and energy intensive industries (e.g. steel and cement manufacture) publicly co-financed CCS demonstration project programmes are underway in much of the developed world including the European Union—"up to twelve"[1] , UK—"four projects"[2], USA—"five to ten", Canada—"up to six", Australia—"three to five" and Norway—"one to two" (GCCSI, 2010). To date, only four full-chain

[1] The announced ambition of the European Council in 2007—now expected to deliver at best around a third of this number of projects.

[2] The UK Government competition is separately run to the EU funding mechanisms, but demonstration projects in the UK are at least partially expected to be included in the EU ambition through co-funding.

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commercial scale CCS demonstration projects (two in Canada and two in the US) have so far taken positive final investment decision and commenced construction (Scottish Carbon Capture and Storage, 2009).

The EU CCS demonstration programme is designed principally to inform on two fundamental subjects: the technical possibility of CCS and the cost of the technology. It will also strongly indicate the stakeholder (government, business/industry and publics) acceptability of the application of CCS at scale (Scott et al., accepted for publication). Composed of two funds—the New Entrants Reserve 300 (NER300) of the EU Emissions Trading Scheme (EU ETS), and the European Economic Recovery Plan (EERP)—it aims to include the full range of currently available capture technologies (pre-, post-, oxy-combustion for electricity generation and methods applicable to industrial capture) and storage solutions (on and offshore depleted hydrocarbon fields and saline aquifers) and be applied on both power and industrial plant. The results are intended to provide technical understanding and initial cost discovery for commercial scale CCS (European Commission, 2009).

Eleven EU CCS project proposals currently remain at least nominally active (Table 1), but reduced funding and other constraints suggest delivery of at very best around a third of these, and likely someway behind the originally envisaged timetable of operation by 2015.

Now that much reduced practical shape of the EU CCS demonstration programme is emerging, we can revisit and reflect on the outcomes that are looked for: what is realistically achievable from the CCS demonstrations as they stand today? What issues will remain to be explored? To explore this, three basic scenarios for post demonstration CCS deployment in the EU—none, very limited and considerable are presented. These are then considered in the context of major influencing factors raised by and/or facing CCS demonstration in the EU: public opinion, CO_2 transport and storage infrastructure development, the carbon market and emissions reductions mandating, enhanced oil recovery, and gas power generation. What has the demonstration programme told us about these factors to date? How much will they impact upon deployment of CCS subsequent to the demonstration programme, and to what degree might a successful demonstration outcome (or otherwise) be able to influence these factors?

2. Basic EU CCS deployment scenarios

Broadly, there are three possible scenarios for commercial CCS (non-) deployment following different demonstration outcomes—none, limited, and considerable—briefly outlined below.

2.1. None

Demonstrations show large-scale deployment of CCS to be too technically challenging. This scenario might arise because for instance capture processes prove unsatisfactory at commercial scale, because storage at the scale required is shown to be technologically unreliable, or because government, industry and other stakeholders fail to create a sufficiently encouraging environment for continued CCS activity (Haszeldine, 2009). Under this scenario, there is no CCS expansion beyond the first (essentially unsuccessful even if completed) demonstration projects, and the current considerable "wedge" (Pacala and Socolow, 2004) of CCS in EU CO_2 emissions reduction scenarios will need to be reconsidered. Electricity generation has alternatives, though their deployment on the scale required to fully replace fossil fuel generation currently seems very challenging. Industrial emissions would (unless the facilities closed) remain an insoluble problem without unprecedented innovation.

2.2. Limited

Technical issues prove resolvable and storage is shown to be viable. However, the overall costs of CCS in especially power generation are in almost all cases commercially unattractive compared to alternative options. Prohibitive costs might arise from, for instance, additional as yet unforeseen technical costs, financial structure and liability problems and/or public and political rejection of preferential (cost-effective) plant, pipeline and storage sites (De Conick et al., 2009).

In this scenario, in the initial post-demonstration period CCS would at best be used very minimally in the power sector as a bridging technology (Hansson and Bryngelsson, 2009). This might take the form of retrofitting CCS on a very limited number of existing coal power plant where its installation is a sensible

Table 1
Current EU CCS demonstration projects. Abbreviations: post—post combustion capture; oxy—oxyfired capture; pre—pre-combustion capture; EERP—European Economic Recovery Plan funding; NER1—New Entrants Reserve 300 round 1 funding; UK—UK CCS commercialisation programme funding; and FEED—Front End Engineering and Design.

Country	Project	Capture	Storage	Funding	Status comment
UK	Peterhead (gas)	Post	Offshore—depleted gas	NER1? UK?	Storage site FEED completed
	Drax (coal)	Oxy	Offshore—aquifer	NER1? UK?	
	Don valley (coal)	Pre	Offshore—CO_2-EOR	EERP (€180 mn)	Cancelled following withdrawal of UK Government support (October 2012) (UK Government, 2012a)
	Teeside (coal)	Pre	Offshore	NER1? UK?	
	Captain (coal)	Pre	Offshore	UK?	Not an applicant to NER round 1
Netherlands	ROAD (coal)	Post	Offshore—depleted gas	EERP (€180 mn)+NL (€150 mn)	All FEED completed and permitting near completion (2012)
	Green Hydrogen (hydrogen)	Cryogenic	Offshore –depleted gas	NER1?	
France	Floranges (steel)	Top gas recycling	Onshore—aquifer	NER1?	Host facility currently idled and facing an uncertain future (Oct. 2012)
Italy	Porto Tolle (coal)	Post	Offshore—aquifer	EERP (€100 mn)+NER1?	Subject to permitting challenge (overruled 2011)
Spain	Compostilla (coal)	Oxy	Onshore—aquifer	EERP (€180 mn)	Not an applicant to NER round 1
Poland	Belchatow (coal)	Post	Onshore—aquifer	EERP (€180 mn)+NER1?	
Romania	Getica (coal)	Post	Onshore—aquifer	NER1?	
Germany	Jaeschwalde (coal)	Oxy	Onshore-aquifer	EEPR (€180mn)	Project cancelled December 2011