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Results from the project 'Acceptance of CO_2 capture and storage: economics, policy and technology (ACCSEPT)'

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Abstract

ACCSEPT was a two-year research project (2005-2007) funded under the 6th research framework programme of the European Commission. The project leader was Det Norske Veritas (DNV), and the partners were Baker and McKenzie, the Energy Research Centre of the Netherlands (ECN), the Institute for European Environmental Policy (IEEP), Tyndall Centre for Climate Change Research, and Judge Business School of the University of Cambridge.

There were three main focuses of the project: a Europe-wide survey of stakeholders and their opinions on CCS; stakeholder consultation through two workshops; and research into the economics, regulation, legal and social aspects of CCS. The project website is www.accsept.org, where all the outputs and related material can be found.

This paper summarizes the conclusions of the work.

Keywords: carbon dioxide capture and storage; public acceptance; energy policy

1. Context: the role of CCS in mitigation

It is generally recognised that CO2 reductions of between 60 to 80% are required by 2050, compared to 1990, for industrialised countries such as those of the EU. Non-CCS mitigation technology like renewable energy is absolutely necessary and could in theory take on the job alone – but there is little evidence of this being on track to

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happen. Current trends and projections show an increased use of coal in the EU over the coming decades, and globally, fossil emissions continue to rise even above IEA baseline projections.

CCS can therefore help bridge the gap between increasing fossil fuel use and decreasing CO2 emissions. A logical conclusion is that the options are either to use CCS or to eliminate using fossil fuels nearly altogether - failure to do either one means climate disaster. Given the latter seems unlikely, we need to pursue CCS as quickly as possible.

2. CCS is geologically feasible within the EU, though storage volume estimates may be inaccurate

There are numerous potential geological storage sites in Europe. However, as yet there is no robust methodology for calculating CO2 storage volumes. Estimates of storage volumes can differ by a factor of 30. Conservatively, millions to billions of tonnes of CO2 can be stored: sufficient volume for CCS to be regarded as a major option even if the larger estimates of storage volumes prove to be over-optimistic. Some of the reservoirs are within reasonable transport distance of major sources of CO2, but other sources of CO2 are not in close proximity of suitable storage formations.

Other EU 6th FP funded projects are examining the geological storage capacities of reservoirs within the European Union, including GeoCapacity, CO2GEONET, CCS-SCEN and CO2ReMoVe. These projects will likely provide a more reliable basis for estimating CO2 storage capacity within the EU and more widely.

Until more reliable methodologies are available, it is prudent for the geological community to err on the side of caution when presenting estimated storage volumes.

3. Risks of CCS can be appropriately assessed, but management is key

Risk is inevitably in any industrial undertaking: that it is present CO2 storage should be taken in context and not impede development *a priori*. Existing knowledge on risks should guide initial decisions about site location and exploitation, while ongoing monitoring and evaluation should be robust enough to draw further conclusions. But risk is more than about the physical characteristics of a storage site: management decisions about storage are as important as, if not more important than, physical risks. Because geological sites *can* be found and managed safely in such a way as to all but rule out leakage, does not mean they *will* be found and managed in that way. There is a need for proper guidelines, incentives and oversight to ensure desired site selection and management.

Overall, in looking at the risks of CCS, one has to consider the risks both of implementing it and of *not* implementing it: the precautionary principle applies as much to employing CCS to avoid global warming as it does to avoiding leakage from CCS.

The basic conclusion is that because the risk from climate change due to fossil fuel emissions is larger and far more difficult to manage than the risk from CCS, the risk of leakage from storage should not impede CCS development overall.

Nevertheless, whatever the physical reality of risk, if stakeholders are not convinced, storage will face acceptance problems. Defining risk in either qualitative or quantitative terms is difficult for new and relatively untested technologies such as CCS. Going beyond defining risk to communicating conclusions about risk is an added layer of complication. It is imperative to find a common language for the characterisation and communication of risk both among professionals and between professionals and the public, which is not a challenge confined to CCS, but where CCS proponents will need to succeed.

4. Frameworks are emerging to permit CCS under international and European law

There are no insurmountable legal barriers to CCS deployment in the EU. However, a number of issues or 'gaps' in the present international and European framework need to be addressed. The long-term storage of CO2 and the need to implement a robust liability regime presents the most significant challenge. Appropriate risk allocation and the need to incentivise CCS projects means that a bespoke legal instrument is likely to be required.

It is vital to strike the right balance between encouraging investment and maintaining the high procedural standards necessary to ensure the environmental integrity of CCS. The CCS Directive under discussion by the

European lawmaking institutions should sufficiently address the barriers – though many details will be left to Member States to work out, so continued attention will be necessary.

5. Despite optimism, there is poor data on costs

Existing information on the costs of implementing CCS is poor and potentially misleading. Much of the detailed information is held by the private sector and is confidential, and studies often use data from just a few sources, creating the false impression that many studies converge on similar cost estimates. Most studies assume pre-2005 oil and gas prices and do not take account of the rising costs of materials, particularly steel prices; this affects IGCC in particular.

Those closely involved in developing a particular technological option frequently need to attract policy attention and resources, and this may lead them to underestimate the costs, leading to information bias. Whilst confidence in CCS has been growing rapidly, the risks of seepage are still uncertain, as are the scale-up costs for CO2 capture from a fully-fledged power plant. The uncertainty surrounding the course of future policy development generates large uncertainties regarding the costs of CCS development.

Unless these different sources of uncertainty are taken into account by all decision-makers, modellers, policymakers and the private sector alike, poor decisions on CCS may be taken, resulting in disappointment and harming the reputation of CCS.

6. Economic incentives will be necessary to get CCS off the ground

There is a risk that CCS will not be deployed at a sufficient scale sufficiently rapidly to meet climate change objectives without the implementation of economic incentives and/or regulation. The EU Emissions Trading Scheme is unlikely to be sufficient in itself as an incentive. Potential EU-level policies to complement the ETS include a portfolio standard, an emission standard for power production, an obligation to capture and store CO2 from all fossil-fuel-fired power production and other large point sources. Member State policies could include investment support for demonstration projects, guaranteed CO2 prices to enable domestic implementation, and feed-in subsidies for CCS-based electricity supply. Although potentially controversial, without a firm commitment through public finance policy it is unlikely that CCS will play a significant role any time soon.

Another important aspect is a coordinated CO2 infrastructure across several projects and countries, which may be more efficient than leaving it to individual efforts. The institutional design of such a network should be considered, especially if analysis indicates that CCS could be deployed at a large number of facilities. Since the eventual deployment of CCS may be contingent upon the success of such a pan-European network, the role of the EU in coordinating such a CO2 pipeline network may be important. Natural gas could serve as a useful precedent, although the problems and lessons learned, will need to be taken into account.

7. CCS is acceptable to most European stakeholders, though NGOs and parliamentarians show more reservations

ACCSEPT conducted a public survey across the EU, with the instrument translated into 12 languages. There were 512 respondents, including representatives of academia/research, energy industry, government, NGOs, and parliaments.

The majority of the sample was at least moderately supportive of CCS and believed that it had a role to play in their own country's plans to mitigate carbon emissions. Respondents tended to regard the risks of CCS as being moderate or non-existent. 51% thought there would be no negative impacts arising from investment in CCS upon efforts at improving energy efficiency and reducing energy demand; 44% thought there would be *some* effect; very few thought such effects would be large.

Environmental NGO respondents were much more concerned about the risks associated with CCS and the implications for renewable energy than other stakeholders. Energy sector stakeholders were the most optimistic regarding the role of CCS, including a low perception of the risks and generally not sharing the NGO respondents' concerns. Government and research / academic stakeholders tended to have a similar response to that of the energy

stakeholders Parliamentarians were typically somewhere in between the opinions of the energy and NGO respondents.

8. Not much is known about perception among the general public

Comparative information on public perceptions of CCS in the EU27 countries is not available, though national studies exist (i.e. NL, UK). Those studies which *have* been conducted tend to indicate a lukewarm acceptance of CCS CCS is considered more acceptable when it is combined with other elements of a low-carbon strategy. The concept of CCS as a 'magic bullet' is unlikely to be acceptable to many stakeholders and large sections of the public. Studies also tend to show that acceptance of CCS as a mitigation option increases when more information is made available on CCS (relative to a baseline of no information).

Where storage is offshore, it is likely that CO2 pipelines may elicit the greatest concern. For onshore storage, it may be the storage site itself that emerges as the focal point for opposition. CCS will be perceived more negatively if held responsible for rises in consumer electricity bills.

Existing efforts at communicating CCS to the public have in general not been well coordinated or effective. A more proactive and interactive approach to public communication and engagement would be desirable and will require additional resources to be devoted to developing more accessible materials.

9. Coal Supplies may be more limited than often assumed, so CCS for coal may have a more limited applicability than expected

It is commonly stated that coal supplies are sufficient to last for 'hundreds of years', but recent re-evaluations shows there is more uncertainty. Given a likely increase in the demand for coal, supplies might diminish even more rapidly. The uncertainty surrounding coal supplies does not imply that CCS should not be implemented, however, because many hundreds of coal-fired power plants will likely be constructed worldwide over the next several decades, and CCS can be deployed progressively and more efficiently with the build-up of know-how. It can also be applied to biomass in the future. What it does imply, however, is that the window for development of CCS for coal may close sooner than expected, which implies attention to the follow-on strategy should begin sooner rather than later.

10. Little is known about the scale or scope of negative externalities

CCS has potential negative externalities, e.g.:

- greater utilisation of coal with associated impacts,
- greater demand for water for cooling and running the capture process;
- an extensive CO2 pipeline infrastructure with space claims and risks;
- potential conflicts with other users of geological storage reservoirs, etc.

Overall, the range of potentially negative externalities associated with CCS have not yet been thoroughly investigated but require detailed scrutiny to ensure that negative impacts can be averted or ameliorated.

11. The Clean Development Mechanism is unlikely to play a large role until CCS costs fall and CER prices rise

The debate around CCS in the CDM has so far mainly focussed on technical and procedural issues, which can be resolved relatively easily. The resistance to inclusion of CCS in the CDM is related to more fundamental issues, however, which have their origin in different beliefs and convictions, including:

- new and risky technology should be tested first in industrialised countries before being implemented in developing countries;
- CCS might displace adoption of more sustainable project types within the CDM, such as renewable energy;
- A sense of scientific, technological and economic uncertainty.

The potential for CCS under the CDM is unlikely to be very large in the first Kyoto commitment period, unless gas processing potential combined with CCS can be fully and rapidly exploited. It is unlikely that power-sector CCS

will be deployed in the CDM before 2012, but once CCS in the power sector has been proven, the potential for its deployment under the CDM could be large if the high growth rates of coal-fired power production are maintained in China and India. For the CDM to make CCS economically feasible, however, CER prices must increase substantially, and storage potential needs to be available and demonstrated.

CCS might be economically feasible under the CDM at an earlier stage, if opportunities in the field of Enhanced Oil Recovery (EOR) exist, though data are scarce. Meeting the criterion of 'additionality' for EOR-CCS will be difficult under the current high oil prices. There might also be scope for agreement on CCS in the CDM if they include a component of renewable energy, i.e. significant contributions from biomass.

12. Diversion from other mitigation options should be avoided

One of the principal concerns of NGOs and the public is that CCS development might derail the growth of renewable energy sources. Under every scenario modelling future stabilisation at 550 ppmv or below, there is a need for drastic increases in renewable energy, with or without CCS. Naturally, to reach the same reduction target, addition of CCS to the mix decreases the role of other low carbon energy sources. But if one assumes we need CCS (economically or politically), then there is no necessary conflict between CCS and renewables.

Negative outcomes *would* result if attention to CCS derails renewables in such a way that CCS is relied upon more than is desirable, or, even worse, we are unable to meet mitigation goals. CCS could detract from energy efficiency and renewables if there is:

- Diversion of funding for Research, Development and Demonstration (RD&D) toward CCS;
- Diversion of government incentives;
- Diversion of private sector investment; or
- Diversion of attention by government and policy makers.

As yet, however, there is little actual evidence that funding or policy attention has been diverted to the detriment of other options, though it is really too early for such an effect to have been detected. When it comes to diversion of political attention, that effect may indeed be difficult to identify – it will be important to remain attentive to ensure that all mitigation options are supporting in the measure of their potential, as viewed through the lenses of social, environmental and economic considerations.

13. Conclusions: public acceptance research highlights issues that need to be addressed

The ACCSEPT project examined the technical, legal and regulatory aspects of CCS through the lens of public opinion. Acceptance is a key condition for the broad use of CCS as a mitigation option, but is often viewed as too nebulous to be addressed head on at either project or policy level – or when it is addressed, is treated largely as an issue of opinion management rather than constructive engagement.

It is important to recognize that CCS enters the energy and climate change arena with several disadvantages form the perception point of view: it is related to fossil fuels, which are at the heart of the problem, it is new and not fully understood, it involves waste disposal, and it is presently high-cost. The burden of proof is therefore high – a challenge that has not yet been addressed at large scale in any major way by the limited project efforts to date.

On the other side of the coin, CCS offers an important alternative to help fight climate change. Insofar as this is seen as a serious problem requiring urgent attention, the question becomes one of weighing the options on all their pros and cons. The ACCSEPT project identified many of the questions being asked by stakeholders and the public at large that have to be addressed forthrightly if the balance of evidence favoring deployment of CCS is to be heard and acted upon.