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Trade-offs in assessing different energy futures: a regional multi-criteria assessment of the role of carbon dioxide capture and storage

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ABSTRACT

We examine the responses of stakeholders from the public and private sectors to future energy scenarios for the year 2050 for the North West of England. The main focus of the paper is to examine the stakeholders' reactions to the mitigation option of capturing CO_2 from power stations and storing it in suitable off-shore geological reservoirs. Five energy scenarios were developed which involved a range of levels of CO_2 capture and storage (CCS): Fossilwise, Nuclear Renaissance, Renewable Generation and Spreading the Load high and low scenarios. A multi-criteria assessment method (MCA) was used as a way of elucidating stakeholders' views on the desirability or otherwise of each scenario against nine stakeholder-derived criteria. We found that stakeholders were either *business-focused* or *environment/society-focused* with respect to weighting of the criteria. Scoring of the scenarios did not follow such a straightforward pattern. Most respondents scored and weighted strategically and tended to express a clear preference for a form of energy generation. The results suggest that there is unlikely to be a wide-ranging consensus amongst energy stakeholders on the desirability of specific future forms of energy generation. On balance, the results support the inclusion of CCS within scenarios of a low-carbon energy system.

1. Introduction

It is now widely recognised that large-scale reductions in carbon dioxide (CO_2) emissions are required during this century in order to limit the extent of climate change modification. The UK Government in its Energy White Paper of 2003 set itself a target of a 60% reduction in CO_2 emissions by 2050, based upon a global target of stabilising atmospheric CO_2 concentration at 550 parts per million unit volume (ppmv) (DTI, 2003; RCEP, 2000; Anderson et al., 2005). More recent research suggests that 550 ppmv may well be too high a value and that 450 ppmv is perhaps a more appropriate target, given the ambitions of the UN Framework Convention on Climate Change to stabilise atmospheric CO_2 concentration at a level which avoids dangerous levels of climate change (DEFRA, 2004; Meinshausen, 2006). In that case, emission reductions of at least 80% might be required by 2050 from countries such as the UK (Anderson et al., 2006).

The most widely known approaches and technologies for CO_2 emissions reduction are reducing energy demand (e.g. through energy efficiency and behavioural change), renewable energy technologies and nuclear power. In the last 10 years, however, a new technology has emerged which offers an alternative route to large-scale CO_2 emission reduction. This is through the capture of CO_2 from large point-sources such as power stations, refineries and chemical works and the storage

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of that CO_2 in supercritical form in suitable geological reservoirs (IPCC, 2006; Gale and Kaya, 2003) (see Fig. 9). Decarbonised energy carriers, such as electricity and hydrogen, can therefore be made from fossil fuels with 80–90% of the CO_2 captured. Such energy carriers can be used for transportation as well as for a myriad of other energy supply applications. If CO_2 is captured from the combustion of biomass, a net reduction of CO_2 from the atmosphere is possible (e.g. Rhodes and Keith, 2005; Read and Lermit, 2005), so 'making room in the atmosphere' for carbon-based liquid fuels used in premium applications such as aviation.

The benefits of CCS include that it 'buys time' by allowing us to cut emissions fairly rapidly. Because of the cost of CCS, its widespread adoption would require putting an economic value on the abated CO_2. This is already happening through the EU Emissions Trading Scheme, which began in 2005, though the current trading price of a tonne of CO_2 (24€ at the time of writing) is too low by itself to justify investment in CCS, or indeed in most other low-carbon supply options (the current cost of CCS is between 40 and 90€ per tonne of CO_2) (Gough and Shackley, in press).

Hence, an additional incentive would be required in order to facilitate investment in the CCS option, just as currently occurs in the UK with respect to renewable energy through the Renewables Obligation. The Carbon Abatement Technology (CAT) Strategy was published by the UK Government in June 2005 and made provision for up to £25 million to support a demonstration plant using CCS (DTI, 2005).

Although CCS is a promising new technology, it involves diverse and complex engineering problems, especially concerning the re-design of the power plant necessary to allow capture of the CO_2 and its consequent transport, delivery and storage at suitable reservoirs. Important questions presently remain unaddressed such as how to conduct an adequate assessment of the risks arising from the leakage of CO_2 from geological reservoirs. The risks incurred at other stages in the CO_2 capture and delivery system also require further investigation and assessment. The regulatory and legal framework for the implementation of CCS is at a nascent stage and needs to be much further developed. The potential technological, economic and other socio-political advantages and problems with CCS have been extensively discussed in recent publications, in particular in a recent Special Report of the Intergovernmental Panel on Climate Change (IPCC, 2006).

2. The objectives of this study

In this project, we set out to address how a range of stakeholders from the public and private sectors in the North West of England perceived the role of CCS in the long-term future of the region's energy sector. We were especially interested in asking the following questions:

- How do different energy scenarios for 2050 compare in terms of their perceived benefits and disadvantages against a set of pre-defined criteria?
- How do different types of stakeholders (private sector, public sector, non-governmental organisations) evaluate the scenarios and what does this tell us about those stakeholders and their thought processes regarding different energy futures?

We used a multi-criteria assessment (MCA) methodology (Stirling and Mayer, 2001; Stewart and Scott, 1995; Brown et al., 2001; DTLR, no date) to examine the trade-offs between different scenarios of the future of the energy system regionally. Each of the scenarios has a different role for CCS, ranging from no contribution, to a major contribution to 2050. We decided to focus the study upon a region because it is a scale for governance which can, potentially, overcome the problems that have arisen between the centre and the local levels in the UK in the last few decades (Stoker, 2004, cf. Wilbanks and Kates, 1999). For example, the region has a specific characterisation in terms of its portfolio of power stations, its opportunities for renewable energy development and in terms of the availability and closeness of suitable off-shore geological storage sites for CO_2. A regional focus also reduces the complexity of considering energy scenarios at the national scale, for example, the respondent can focus upon a handful of power stations rather than having to grapple with hundreds of power stations at the national scale.

We created the framework of the scenarios, and the criteria for their assessment, through an earlier project, which is described elsewhere (Gough and Shackley, 2006). It was necessary to use scenarios of the energy system because: (a) we were looking at the long-term (to 2050) and over these periods of time the energy system will change, possibly dramatically and (b) given that CCS is just one element in a complex energy system, it is necessary to create alternative visions of the relative extent to which CCS will be employed in a new energy system.

3. Methodology

We selected a range of key regional stakeholders to perform the multi-criteria assessment. The aim was to conduct detailed in-depth interviews (typically lasting 1.5–2 h) with a range of stakeholders from across the region rather than to undertake a less detailed survey of a larger number of stakeholders. The stakeholders were selected to represent key interests and expertise from the energy business, government and NGOs. The following list details the organisational affiliation of the interviewees. We have used the letters in attributing comments or information in the paper to these interviewees. A and A* are work colleagues who conducted the MCA together and came to a consensus score between them. We have included them as a single individual in the data analysis (as A) but have distinguished between them where quotations have been employed.

A: renewable energy business manager;
A*: renewable energy business manager;
B: renewable energy business development manager;
C: nuclear energy business manager;
D: environmental regulator;
E: environmental non-governmental organisation manager;