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Public awareness and acceptance of carbon capture and utilisation in the UK

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ABSTRACT

This paper presents the results of a UK survey of public opinion on carbon capture and utilisation (CCU). The survey of 1213 adults was carried out using a questionnaire developed as a part of this research. The aim was to establish the extent of people's awareness and acceptance of CCU and to elicit the importance they put on different sustainability issues relevant to CCU. The survey findings suggest that there is a very low level of public awareness of CCU — only 9% of the respondents expressed confidence in knowing what it was. The study indicates that, while the general public are willing and able to express preferences for sustainability issues relevant for CCU, a relatively high rate of 'don't know' responses indicates that respondents were unable to comprehend certain aspects. As public acceptance is vital for successful implementation of novel technologies, the current unfamiliarity and poor understanding of CCU among the general public may hinder its future deployment. However, low levels of awareness and understanding of CCU also mean that there is a considerable potential for public perception to be shaped by relevant stakeholders.

Keywords: Public acceptance; Public awareness; Carbon capture and utilisation; Sustainability; Climate change mitigation technologies

1. Introduction

Carbon capture and utilisation (CCU)[1] is a broad term which covers a range of technologies that capture and convert carbon dioxide (CO_2) into viable commercial products, such as construction materials, chemicals and fuels. Together with carbon capture and storage (CCS), CCU has been receiving increasing attention in recent years, particularly in the context of climate change as these technologies are being perceived as promising options for greenhouse gas (GHG) emissions mitigation (Styring et al., 2011).

It is easy to see the appeal of CCU from a climate change perspective: by capturing CO_2 emitted by various industrial plants and using it to manufacture fuels, chemicals or materials, the CCU technologies not only have the potential to reduce CO_2 emissions but could also lower the costs of climate mitigation and shift some of the costs onto willing consumers who would readily pay for the resulting goods and services (IPCC, 2005; IEA, 2014). Moreover, CCU can also result in value-added products that create jobs and economic benefits and may offer other non-climate benefits, such as industrial waste stabilisation or gains in competitiveness (Styring et al., 2011; Mun and Cho, 2013; Stolaroff et al., 2005).

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[1] Carbon capture and utilisation (CCU) is also known as carbon dioxide utilisation (CDU) but for the purposes of this article it will be referred to as CCU.

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Although some are already in industrial use, most CCU technologies are still at a relatively immature stage of development (GCCSI, 2011; Fraga and Ng, 2015). As the CCU technologies move from the development to execution stages, their public recognition and acceptance will become increasingly important for their successful implementation (VCI and DECHEMA, 2009). An important consideration for any new technology is an understanding of the public's viewpoint since in many countries this can influence the direction of its future development and deployment. As it has been well documented, people not only need to be convinced of the advantages of a novel technology, but also have to accept the perceived impacts it may have on their everyday lives (see, for instance, Fischhoff et al., 1978; Gardner et al., 1982; Baird, 1986; Alhakami and Slovic, 1994).

However, little is known about public awareness and understanding of CCU (Jones et al., 2014, 2015). In an effort to fill this knowledge gap, this paper presents the results of a survey which aimed at establishing the extent of people's awareness and acceptance of carbon capture and utilisation in the UK.

The survey was conducted using a questionnaire developed by the authors as part of the project "A Comprehensive and Coordinated Approach to Carbon Capture and Utilisation (4CU)". One of the aims of 4CU is to develop a methodology for evaluating the sustainability of CCU, focusing on technologies for converting CO_2 to fuels. The evaluation takes into account environmental, economic and social aspects of CCU. The survey of public opinion on CCU presented in this paper constituted an integral part of the methodology development, providing the researchers with an insight into what stakeholders think about carbon capture and utilisation and informing its sustainability assessment. For more information on the 4CU project, visit www.4CU.org.uk.

2. Research method

A survey using an on-line questionnaire and a subsequent descriptive/inferential analysis were used to capture and explore the emerging opinions of CCU within a (non-expert) cross-section of the UK population ($n = 1213$). The specific objectives of the survey were twofold:

- to establish the extent of people's awareness and acceptance of CCU; and
- to elicit the importance the general public place on different sustainability issues relevant to CCU and to gauge the level of public understanding of these issues.

A survey by an on-line questionnaire was selected in this research because of the need to consult a reasonably large sample to ensure that the public's views are as representative of the UK population as possible. For this reason, and taking into account the time and resources available to the project, interviews or focus group discussions were considered unfeasible. It was also deemed impractical to have an open-ended questionnaire due to the complexity and assumed public's unfamiliarity of the subject, so the questions were designed to focus on specific aspects with the respondents being able to choose among multiple-choice answers.

The questionnaire was developed in several steps. First, through an iterative process of discussing, brainstorming and analysing various techno-economic, environmental and social issues with a number of experts from academy and industry, a list of sustainability issues deemed to be relevant for CCU was identified. This was then used to develop a pilot questionnaire, containing a set of questions designed to gauge the importance and relevance of the selected environmental, economic and social sustainability issues to CCU stakeholders. This pilot was tested on a small sample of expert stakeholders ($n = 16$), including representatives from industry and academia. The outputs from this expert consultation were then used to inform the development of the full questionnaire that was eventually used in the survey.

The questionnaire included 24 questions divided into three sections:

- Section 1 focused on people's understanding of the issues related to climate change. It consisted of six questions designed to assess how informed the respondents felt about climate change, in particular about causes and consequences of climate change and the ways in which we can combat climate change.
- Section 2 asked nine questions about CCU with the aim to examine people's awareness and acceptance of CCU as a climate change mitigation technology.
- In Section 3, the participants were asked five questions about the sustainability issues related to CCU. They were presented with a list of techno-economic, environmental and social issues (which were previously identified by experts as possible considerations when assessing the sustainability of CCU) and asked to express their opinion for each of the listed issues.

The questionnaire also included a range of questions to determine the demographics of the sample. The full questionnaire can be found in Supplementary Information (see Appendix A).

The survey was conducted on-line using the services of TNS, a research agency which has access to a large cross-section of UK population. A sample of $n = 1213$ adults aged 16+ and demographically representative of the UK population was surveyed in February 2015. Selected demographic characteristics of the sample are shown in Table 1.

Care was taken to ensure that other research in the TNS research omnibus at the same time was dissimilar from this research in an effort to minimise any potential for crossover influence on responses. The representativeness of the data was controlled through sample design, quotas and weighting adjustment. Data were weighted for the following characteristics: age, sex, region, social grade and tenure. The results included here are based on the weighted data.

The following sections summarise and discuss the main results of the survey, focusing on public awareness and acceptance issues. Note that the results regarding the sustainability issues (Section 3 of the questionnaire) are subject of a forthcoming paper and are not discussed here.

3. Results

3.1. *Awareness of and attitudes toward CCU*

One of the key findings of the survey was that the awareness of CCU is very low—only 9% of respondents expressed confidence in knowing what CCU was.

The respondents were asked if they had ever heard of CO_2 capture and utilisation and whether they knew what was meant by it (Q6, Section 1 in the questionnaire). As shown in Fig. 1, whilst over a third of the respondents (36%) indicated