Energy Research & Social Science 46 (2018) 1–9

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Ambivalence, naturalness and normality in public perceptions of carbon capture and storage in biomass, fossil energy, and industrial applications in the United Kingdom

Gareth Thomas[a,*], Nick Pidgeon[b], Erin Roberts[c]

[a] Understanding Risk Group, School of Psychology, Cardiff University, 70 Park Place, Cardiff, CF10 3AT, United Kingdom
[b] Understanding Risk Group, School of Psychology, Cardiff University, United Kingdom
[c] Understanding Risk Group & School of Social Science, Cardiff University, United Kingdom

ARTICLE INFO

Keywords:
Public acceptance
Naturalness
CCS
Bioenergy
Risk perceptions

ABSTRACT

Carbon dioxide capture and storage (CCS) is a promising yet controversial climate change mitigation technology. While numerous studies have addressed perceptions of CCS in fossil energy applications, less attention has been paid to how other applications of the technology may be viewed by lay groups. This article reports on findings from a twoday deliberative focus group held near Drax power station; a coal-biomass co-firing power plant in the north of England. In so doing we adopt a broad, psycho-socially inspired conception of perceived naturalness in order to explore how perceptions of CCS in biomass, fossil fuel, and industrial applications are formed in the context of a range of potential technologies for supporting low carbon energy system transitions. In particular, we explore how perceptions of naturalness and interdependency shaped perceptions of different CCS applications. Our analysis illustrates how perceptions of CCS as threatening, uncanny disruptions to natural systems may shift when re-contextualised to include concerns relating to the intermittency of renewable energy, or be ameliorated through perceptions of industrial and bioenergy applications as supporting natural and economic interdependencies.

1. Introduction

Carbon dioxide capture and storage (CCS) occupies an ambiguous role in literatures on climate change mitigation as both a key technology for emissions reduction and a source of concerns relating to its feasibility and public acceptability. CCS refers to the process of capturing carbon dioxide (CO_2) from power plants and other industrial sources, transporting it by pipeline, compressing it and then burying it in deep geological formations. CCS is thus intended to permanently prevent CO_2 from reaching the atmosphere and contributing to climate change. CCS boasts numerous strengths as a CO_2 abatement technology. It can be built into new thermal power plants or retrofitted onto older facilities, and is viewed by some as offering a means to significantly reduce emissions in advance of more complex transitions to renewable energy systems [1]. Moreover, CCS is the only currently available technology for decarbonising fossil-fuel-intensive industries such as cement, fertiliser and steel manufacture [1]. Assessments conducted for the IPCC and other bodies have identified CCS as a low risk and cost-effective emissions reduction technology [2–4]. Scenario modelling focussed on limiting global average temperature rises to below 2 °C suggests that CCS could contribute one-sixth of total emissions reductions by 2050 [5]. Projected costs for maintaining a 2 °C limit were found to be 40% higher in scenarios where CCS was unavailable [5]. While the feasibility of such plans remain highly contested, it has also been suggested that combining CCS with bio-energy may represent a relatively benign means of generating electricity, while removing and permanently separating CO_2 from the atmosphere [6,7]. Given the hitherto slow progress on global emissions reductions, 'negative emissions' provided by bio-energy with CCS (BECCS) may provide a means of reducing atmospheric concentrations of CO_2 in scenarios where cumulative emissions over-shoot recommended levels [8]. Indeed, the recently stated goal of the Paris Agreement to 'pursue efforts' to limit temperature increases to 1.5 °C means that BECCS has gained salience in mitigation planning and may be essential if more ambitious targets are to be met [9].

Since the early 2000 s, a rich literature has emerged aiming to examine how various publics interpret CCS and engage in issues surrounding it [10]. Rationales for this expansion have varied. Chief among those cited have been previous socio-technical controversies that may be analogues for poorly-implemented CCS deployments, and

* Corresponding author.
E-mail address: thomasg39@cardiff.ac.uk (G. Thomas).

https://doi.org/10.1016/j.erss.2018.06.007
Received 30 November 2017; Received in revised form 5 June 2018; Accepted 7 June 2018

high profile project cancellations in Germany and the Netherlands where vocal public opposition played a key role [11]. More significantly, the growth of this literature represents the realization that:

> 'CCS enters the energy and climate change arena with several disadvantages from 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.' [12]

Whilst various elements of CCS systems have been found to be problematic, it is generally thought that the storage component raises the most significant concerns among lay publics. Such concerns have often been attributed to perceptions of risk, such as concerns that CO_2 injection and storage could induce seismic disturbances, cause explosive gas releases, or pose toxic hazards that may contaminate nearby freshwater deposits or ecosystems [13,14]. Other studies have focused on public concerns over the trustworthiness and competence of project developers [15], or on longer-term ethical considerations relating to the sustainability, distributional and inter-generational effects of long term geological storage [16]. It has been suggested that situating geological storage offshore, away from population centres, may reduce the potential for public concern and anxiety relating to CCS [17]. However, studies explicitly examining this issue have suggested that sub-seabed storage does not eliminate concerns regarding the unsustainable, fossil-fuel-driven nature of many proposed CCS projects, nor the desire to protect future generations and non-human living systems from unforeseen long-term consequences of CCS deployment [18,19].

Other researchers have provided thorough overviews of the existing research into perceptions of CCS and this study does not aim to replicate their efforts [cf. 10]. Consistent findings indicate that awareness of CCS among lay publics is generally low [20–22], and that CCS tends to be perceived less favourably than renewable alternatives unless carefully contextualised within wider processes of decarbonisation and energy system change [23–25]. Acceptance of CCS is often contingent on early engagement with relevant communities, and on local perceptions of its relative risks and benefits. These in turn can be mediated by a wide range of contextual factors including:

- Context-specific characteristics of a project associated engagement processes [11,12,26];
- Trust in government and industrial organisations [24,27,28];
- Environmental values and beliefs [23,29,30];
- Self-identity and worldviews [30–32].

Where relevant we refer to this literature below, however in this article we focus on a more specific set of issues that remain underexplored in light of recent upheavals surrounding the technology in the UK. These include the cancellation of the UK government's £1 billion CCS competition in 2015 and the subsequent abandonment of CCS demonstration projects at power plants in Aberdeenshire and North Yorkshire. Moreover, given the newfound centrality of BECCS in many scenarios for meeting ambitious CO_2 targets [7,9], relatively little research exists into how BECCS may be perceived. At present there appears to be no strong body of research examining perceptions of CCS in communities where projects have been cancelled [although see: 33] however, there is some evidence suggesting that the suspension and subsequent downgrading of CCS demonstrations has reduced community support for deployments in Illinois [34]. Given that trust in project actors has consistently been found to be a mediating factor in CCS acceptance [28,35,36], further examination of cases of policy instability are necessary in order to understand how cancellations may affect perceptions of the sincerity and competence of CCS proponents.

2. CCS, nature and risk perception

To the best of our knowledge, only two studies have addressed public perceptions of CCS in non-fossil-energy applications, both of which found participants to be more accepting of CCS in bioenergy and industrial manufacturing applications [37,38]. The capacity for CCS to protect employment in fossil-dependent regions has been identified as one of the core benefits perceived by members of the public in relation to both energy and industrial applications [39–41]. These benefits may be perceived even more strongly for industrial CCS, which can be presented as both protecting employment in existing industries, and providing infrastructure that may attract new investment and employment opportunities [42]. Deliberative research into decarbonisation priorities among lay groups in the UK has found participants to be more supportive of CCS in industrial applications than energy production, in part attributing this to unique employment and economic opportunities such industry is thought to provide [43,44]. Such findings mirror those from risk perception studies whereby potentially risky technologies are often sources of ambivalence that may be viewed more positively due to associations with employment in a given locality [45,46]. More broadly, they speak to deeply entrenched cultural narratives of industrial modernity and manufacturing employment [47,48]; which despite processes of de-industrialisation taking place in some advanced capitalist economies since the 1980 s, remain powerful markers of identity and social progress.

Distinct from CCS, bioenergy has itself been the subject of a significant body of perceptions research. Despite controversies over biofuels and bioenergy in the first decade of the 2000 s, more recent public perceptions work has shown mixed results. Some studies have shown low to moderate support, with others finding greater enthusiasm for the technology, provided it does not come into conflict with food production and other valued land uses [49–51]. More wide ranging ethical reflections on BECCS have noted similar issues, arguing that resource demands for BECCS feedstocks have the potential to adversely effect food and water availability, particularly in developing countries that are least responsible for, but most vulnerable to climate change processes [6]. Furthermore, given continued uncertainty over biomass availability and lifecycle emissions, several authors have suggested BECCS and other negative emissions technologies pose a moral hazard, potentially delaying urgent measures to reduce emissions, particularly in richer countries [52,53].

While no perception studies have explicitly addressed BECCS in the UK, Wallquist et al. [37] found that questionnaire respondents in Germany were more prepared to accept CCS deployments near their homes when bioenergy was described as the CO_2 source. This was the case when compared to both fossil energy and industrial emissions sources. The authors suggest this may be attributable to a halo effect around the term 'bio', the German translation of which equates to 'organic', carrying positive connotations with health and nature. However, given that study did not elicit the rationales underlying CCS perceptions, this explanation remains speculative. No previous research has explored this issue in the context of the UK, or attempted to qualitatively examine why BECCS may be perceived in more positive terms than fossil energy and (possibly) industrial CCS applications.

2.1. Perceived naturalness

Notwithstanding the lack of data specifically relating to BECCS perceptions, there are sound theoretical reasons for suggesting that associations with nature can shape technology acceptance. Scholars of risk perception have noted that humans tend to underestimate risks posed by natural hazards, attributing this phenomenon to values and beliefs about the benefits nature confer on humans [54–56]. More sociological accounts position nature and naturalness as a socially constructed form of normative evaluation, often rooted in long standing myths and cultural narratives that grant nature the status of moral agency, capable of punishing humans for transgressing its boundaries [57–60].

The implications of such insights for different CCS applications are