Energy Research & Social Science 21 (2016) 114–122

Contents lists available at ScienceDirect

Energy Research & Social Science

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

Original research article

Comparative socio-cultural analysis of risk perception of Carbon Capture and Storage in the European Union

Farid Karimi*, Arho Toikka, Janne I. Hukkinen

Environmental Policy Research Group, University of Helsinki, PO Box 16, 00014 Helsinki, Finland

ARTICLE INFO

Article history:
Received 14 August 2015
Received in revised form 27 June 2016
Accepted 29 June 2016

Keywords:
CCS
National culture
Risk perception
The general public

ABSTRACT

The transition to a sustainable energy regime is not just an engineering question, but a social and cultural issue as well. In this paper, we consider one contested technology still in development, Carbon Capture and Storage (CCS), from a socio-cultural perspective. CCS is widely deemed to be a necessary bridging technology to a low-carbon economy, but the technology needs to pass considerable hurdles before widespread use. The importance of cultural issues in CCS deployment has been acknowledged, but research on the large-scale cultural patterns is lacking. To fill this knowledge gap, we combine aggregated individual level measurements of technology opinions with indicators that characterize national cultures. We use survey data from a Eurobarometer together with prior cross-cultural data to show that nation-specific cultural issues can be used as a macro-level approximation of public reactions to CCS technology. Public reactions incorporate cultural factors such as the degree of separation between groups, strength of institutions over space, time and social roles, and society's tolerance for uncertainty and ambiguity. On the basis of the analysis, we provide a richer frame for analysts wishing to understand why and how societies and societal actors challenge and contest technologies and energy regimes.

1. Introduction

Carbon Capture and Storage (CCS) has been proposed as a promising technology to mitigate climate change and facilitate a leap towards sustainability. CCS means the removal of carbon from the atmosphere and storage in carbon sinks. Since the early 2000s, CCS has become the centre of attention in many countries. Given the deceptively abundant amounts of fossil fuel, CCS is considered a medium-run option for reducing CO_2 and dealing with climate change [28,17]. The technology is a transition measure to sustainable energy, because from the policymakers' viewpoint, especially those from fossil-fuel possessing countries, it is an easy way to sustainable development in comparison to other options [28,17,32]. In Europe, the Netherlands and UK are prominent examples of countries where CCS has been pushed by governments and companies alike.

CCS has raised controversy as well. Opponents such as Spreng et al. [64] argue that it is a "double-edged sword" and leads to technological lock-in that hinders the development of renewable energies. Social opposition has slowed down CCS development. For example, the Shell Carbon Capture and Storage project in Barendrecht in the Netherlands, which was planned to store 10 million tons of CO_2 over a period of 25 years starting in 2011, was cancelled as a result of opposition by the local community [36]. The implementation of the EU CCS Directive encountered opposition in Germany where states were against the proposed on-shore demonstration storage sites. Technologies are culturally embedded, which cannot be overlooked when considering the trajectory of a technology from an innovation to a major component of the energy regime.

While plenty of research on the technical issues related to CCS exists, many authors have called for further research on its socio-cultural aspects. Vercellia and Lombardi [76,4840] claim that 'if social culture does not develop in parallel with technology, when CCS will reach the commercial stage it might be felt as an imposition and thus refused'. Most socio-cultural research has focused on local contexts and case studies with relatively few large-scale international comparative studies. Notable exceptions are Reiner et al. [51], the Accsept project [2], Oltra et al. [45], Itaoka et al. [30] and the Eurobarometer survey on CCS [13], the data set we use in this analysis.

The Eurobarometer data set enables us to view the socio-cultural aspects of CCS development from a novel perspective, namely,

* Corresponding author at: Environmental Policy Research Group, University of Helsinki, Helsinki, Finland.
E-mail addresses: farid.karimi@helsinki.fi (F. Karimi), arho.toikka@helsinki.fi (A. Toikka), janne.i.hukkinen@helsinki.fi (J.I. Hukkinen).

http://dx.doi.org/10.1016/j.erss.2016.06.024
2214-6296/

national culture. Although some cultural theorists are sceptical of aggregating cultural features on the basis of nation states, environmental and technology policies tend to be aligned with national characteristics. From a policy perspective, then, it would make sense to uncover the variation of risk perception and reactions to CCS technology across countries. The Eurobarometer data does precisely this. It measures individual knowledge, individual opinion and background socio-demographic variables, and enables us to make comparative analyses of how people perceive the risk and react to technological developments, and how these perceptions and reactions differ between countries.

In this paper we demonstrate that macro-scale cultural issues are one explanatory factor in how individuals (on average) perceive the risks and benefits of new technologies. We show that dimensions of national culture have consequences for CCS development beyond the level of local communities immediately affected by projects. Projects are embedded in larger cultural contexts, and countries with different social settings need to be accounted for when developing an understanding of the relationship between risk perception and the acceptability of CCS technology. We understand public acceptance as a complex mixture of individual perceptions of risks and benefits that can be analysed quantitatively. We use measures of national culture in combination with survey data on acceptance – in the broad sense of individual reactions to hypothetical or real projects and technologies – to demonstrate this argument.

We understand culture as 'the collective programming of the mind that distinguishes the members of one group or category of people from another' [19,9]. National culture is not uniform, and it is not perfectly measurable, but commonly available indices of how complex issues such as uncertainty, power, and individualism are manifested in different countries and are available as an approximation. If one wants to compare the differences between a small number of countries based on some other explanatory factor, like the status of CCS or knowledge of CCS, these cultural differences are a potential confounding factor in the country comparison. We argue that deeper and more long-standing issues shape the immediate and observed risk perceptions and other explanatory factors such as trust, one of them being the macro-culture we analyse here.

We address two questions: How does national culture influence the risk and benefit perceptions of CCS? To what extent is public reaction to the implementation of CCS predictable in a cross-cultural comparative framework? To answer the questions, we employ survey data from the Eurobarometer on Public Awareness and Acceptance of CO_2 capture and storage, a large scale survey conducted in twelve European countries. We operationalize the cultural factors with Hofstede and Minkov's [25] cultural dimensions theory, a six-dimensional summary of national culture used in an extensive assortment of fields including cross-cultural psychology, cross-cultural communication, political science and risk research [48,6,82,80,4]. We correlate the average opinions in each country with its cultural dimensions as defined and measured by Hofstede and Minkov to understand the rationale behind reactions to CCS implementation in different countries.

2. Background

2.1. CCS and earlier research on socio-cultural issues

In this section we provide an overview of recent research on the socio-cultural aspects of CCS. In particular, we aim to specify the following key concepts: risk perception, public acceptability, cultural factors, and national culture. We conclude the discussion with a hypothesis of the relationships between the concepts that will guide our empirical research.

Not enough is known of the relationship between the pattern of laypeople risk perception and macro-level cultural factors affecting it. For instance, Ashworth et al. [3] show that despite sharing the same concerns and having been exposed to the same information about CCS, citizens from different countries tend to adopt different perceptions of the technology. Similarly, Pietzner et al. [50] conducted a representative survey in six EU countries to assess public awareness and perceptions of CCS and concluded that public perceptions and awareness of CCS vary considerably in different countries. L'Orange Seigo et al. [38] review of 42 research articles on public perception of CCS recommends further research on the role of social context and values in the deployment of CCS.

Cross-cultural factors have been overlooked in CCS research, and in public perception studies of CCS the emphasis has mainly been on supplying information, communication, knowledge dissemination and trust (e.g. [71,27,29,67,68,8,30,12]). These are crucial elements but they do not reveal the full picture, as the unexplained country differences noticed in the studies reviewed above show. Despite extensive research on the social and political issues of CCS [43,41,72–75], and many authors referring to the role of cultural features in the perception and/or deployment of the technology, few studies incorporate explicit cultural variables. For instance, Bradbury [7] discusses public perception of CCS by analysing six CCS projects in the US. Her broad conclusion is that for the deployment of CCS, 'differences in social and cultural framework' have to be accommodated. Similarly, Oltra et al. [45] studied public reaction to CO_2 storage sites in five EU countries and note that culture is one of the factors influencing risk perception, but do not elucidate further. Wallquist et al. [79] recommend further research on the role of value-based trust in various contexts and on other beliefs that explain variance in risk perceptions of CCS. The Social Licence to Operate framework, which has recently been applied to CCS and extended to regional and national contexts, measures the level of ongoing approval and societal acceptance by local communities [16]. Zhang et al. [86] show that various aspects of approval and factors affecting approval vary by context, and suggest that further research is needed on how culture affects these issues.

The meaning and dimensionality of laypeople responses to CCS vary in social research. Some studies have worked with the contested notion of unidimensional public acceptance [78,29]. The notion of single accept/refuse dimension has been criticized for misrepresenting complex assemblages such as the ways in which public opinion arises in social processes [65] and misrepresenting the negotiation between multiple societal goals and the use of a variety of technologies to reach those goals, and the distribution of harms and benefits related to such alternatives [85]. Issues such as trust towards actors and governance structure the public's response to projects [27]. Public acceptance is, then, a property of a particular decision, not a property of a technology. For example, Wallquist et al. [78] measure acceptance on a continuous scale from 'not at all acceptable' to 'totally acceptable'. While this measure is sensible in comparisons between related technologies, as used in Wallquist et al. [78], it does not predict actual response to a proposal, as the respondents are not asked to consider issues such as trust, funding, ownership, risk aversion and so forth that would be included in a specific decision. Others have simply queried people if they would favour the use of CCS or particular parts or varieties of it in their local community [15] or country [59].

Other studies have opened up the concept of acceptability with two- and multidimensional models. Such latent variable approaches have been used with survey data. Itaoka et al. [29] find two latent dimensions, general acceptance and geological storage acceptance. Tokushige et al. [71] surveyed Japanese university students in a confirmatory factor analysis based on a six-factor acceptance model: public acceptance, risk perception, benefit per-