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What is the Socio-Political Scaffolding CCS Needs to Thrive? Case Study from Finland.

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Abstract

The adoption of CCS depends on many societal issues beyond technological and economic viability. This paper maps these issues based on multiple data sets from two research projects in Finland, looking at social, cultural, and political issues. The analysis takes advantage of various data sets collected within the projects, including interview data, media corpuses, stakeholder workshop materials, and secondary survey data. The goal is to explain the social and political support systems that CCS requires to fit the energy systems and the society at large. The result is a socio-ecological systems mapping that should provide CCS projects and policy-makers a tool for revealing the potential pitfalls in a range of societies.

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Keywords: CCS; Social issues; Political issues

1. Introduction

The slow pace in global CCS developments can partly be explained by technological factors and price, but social, political and economic issues still remain. Energy regimes are stable because they have been institutionalized into the fabric of societies, and a novel technology such as CCS and actors speaking for it need to make their mark on the supporting scaffolding, framework that enables energy regime change and sustains the development of new

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technologies.

We analyse the situation CCS finds itself in the Finnish context based on data from two large-scale research projects in Finland, with data sets on a wide range of issues including public acceptability, media treatment, failed retrofit projects, novel carbonation technology developments, and stakeholder workshop materials. The goal is to highlight the complexity of the interplay between energy regimes, often with high involvement from publicly owned energy companies, research funding bodies, regulators, legislative bodies, civil society and the general public at large.

The projects are Risk Governance of Carbon Dioxide Capture and Storage (RICCS), a consortium between University of Helsinki and Aalto University, and Carbon Capture and Storage Program (CCSP)[1], a consortium consisting of 17 industrial partners and 9 research partners from Finland. RICCS analyses two main cases in Finland: the cancellation of a proposed retrofit of a coal-fired power plant at Meri-Pori and the budding developments of mineral carbonation and the trajectory from a lab-scale experiments into demonstrations and commercialization by researchers at two Finnish universities - Åbo Akademi is working on serpentine carbonation methodologies and Aalto University and Åbo Akademi work on precipitated calcium carbonate methods. The main objectives of CCSP are to develop CCS-related technologies and concepts and frameworks and to establish international CCS co-operation. Furthermore, within CCSP key stakeholders of the Finnish CCS policy development have been interviewed and Finnish print media perception of CCS have been analysed.

CCS in Finland faces unique circumstances in that there are no storage locations within the country [2], even though regional options for storage under the southern Baltic Sea which are not in the Finnish territorial waters are currently being mapped. Still, many of the developments and challenges for CCS are the same as elsewhere. Key issues are the implementation of the EU directive that favors some CCS solutions over others, low level of public support in the form of national funding and low strategic importance either as climate or energy tool, public indifference and lack of interest from media.

The goal of the paper is to continue to lessen the observed discrepancy between stakeholder views of the challenges CCS faces (heavily focused on lack of political frames providing financial support) and those experienced in actual projects (where local publics and other on-the-ground project realities come into play) [6], and demonstrate a methodology that can show how various social, political and economic challenges are intertwined into a complex system.

2. Method & data

2.1. Data

We use a socio-ecological systems framework together with an institutional economics perspective to demonstrate how legislation, media and public attention, and the projects themselves are tangled as parts of the larger system. The analysis draws on interview, document and workshop data sets collected by the projects, including interviews with key stakeholders from a project viewpoint as well as social acceptability viewpoint, media data from Finnish newspapers and professional journals, legislative documents on Finnish CCS issues and general energy and climate issues, and results and feedback from an expert workshop with more than 30 participants organized by the two projects with the goal of further identifying key challenges.

Table 1. Data sets

Data set	Description
Interviews	Total 25 stakeholders, 45 min-1,5 h in-depth interviews
Media	Total 240 articles
Survey	Eurobarometer data set,

	Hofstede cultural dimensions indices	
Workshop	Circa 30 stakeholders	

The goal of the analysis is to highlight situations where interactions between social, economic, political and technical rules and actors form obstacles for individual CCS projects as well proliferation of the technology in general. The key argument is that the various issues are highly interlinked and cannot be separated into simple technological, administrative or social acceptance problems. For example, public inattention to projects can translate into political indifference over the technology, further translating into lessened public funding.

2.2. Socio-ecological systems framework

The adoption of novel technologies into the mesh of society is a complex issue, in the systemic sense of disorganized complexity: the problems are defined just as much in the interactions between the parts of the system as they are defined within the parts. For example, in CCS adoption, any technological solutions have to match carbon emission regulations and market that are further embedded in societal governance solutions, if they are to be adopted. There are no universal solutions, as societies differ on these issues. However, there are certain dynamics that are usually shared between different systems.

We adopt the socio-ecological systems framework developed by Elinor Ostrom and colleagues [3]) in order to deal with this complexity. This framework provides a generic inventory of subsystems and variables that need to be mapped to make socio-ecological dynamics visible. The organization of the framework is based in empirical results from hundreds of studies ranging from small-scale communal resource systems to large-scale modern governance settings and divides the subsystems or variables under scrutiny into four subsystems, resource system, governance system, users, and their interrelations. Table 2 shows the various variables or issues to be measured and the data sets used.

Table 2. Key variables for measuring socio-ecological system dynamics in CCS

Resource system	Data	*Governance system*	Data
Human-constructed facilities	WS	Government organization	I
Productivity of system	WS	Network structure	I, WS
Predictability of system dynamics	WS	Operational rules	I
		Collective-choice rules	I
Resource units		Constitutional rules	I
		Political stability	I, WS
Interaction among resource units	I	*User system*	
Spatial and temporal distribution	I	Socioeconomic attribute of users	S
Resource unit mobility	I	Norms/social capital	S, M
Economic development	I, WS	Knowledge/mental models of system	S, M
		Demographic trends	I
Interactions		*Outcomes*	
Deliberation processes	WS	Social performance measures	I, WS, M
Networking activities	WS	Ecological performance measures	I, WS
Information sharing	WS		

Data sets: I = Interviews, WS = Workshop, M = Media, S = Survey

3. Analysis

3.1. Governance system

Governance is a broader concept that covers more than governing organizations and actual legislation; it refers to the networks of public and private organizations involved in policy-making and implementation, as well as various institutional rule systems that define how decisions are taken. For CCS, the key issue is the institutional fit between the technology, the operational rules governing its use, the collective-choice rules that govern how energy production and use is governed, and the constitutional rules that define the roles and procedures in decision-making processes.

The fit between the operational rules and the wider institutional setting in Finland was found to be poor (Kainiemi et al. 2013). Even though the implementation of the EU CCS directive itself was fairly straight-forward and provides good support for power plant capture implementation, the policy framework offers poor incentives in climate strategy and innovation policy.

As CCS technology is still in the development phase in Finland agreements and regulation in the field are either missing or were deemed incomplete by the some of the Finnish key stakeholders [4] Predictability and continuity in the environmental politics both at the national and international level were regarded as important features of CCS policy. The same concern is evident when evolving the CCS issue from a national level to a global level e.g, climate targets and whether there will be a global climate agreement or European regulation only were issues that raised some questions. It is a question of market size. Would the EU remain as one market area or could there be a global climate protocol?

3.2. User system

The end-users of energy, consumers, interact with CCS systems through political and media interfaces. Their reactions are shaped by deep social issues and further mediated by national culture [8] The mental model or the terminology and structure the general public uses to think about CCS makes a difference, and reactions around the world have been quite different.

In general, the print media attention of CCS related issues have been very low in Finland. On the basis of the print media data set (N=226) gathered from ten Finnish newspapers in the time period from 1 January 1996 to 31 August 2012 four phases were identified. These phases were categorized according to the frequency of media references to CCS. In the first phase of practically no coverage, 1996–2003 carbon capture is mentioned only a few times and for some years not a single reference to the topic was found. The second time period was the years 2004–2006, a period of rising awareness of the possibilities for carbon capture. The third time period 2007–2010 can be interpreted as the peak of media attention. During the peak the CCS-related discussion is the most frequent, but still not amounting to more than some 40 articles each year. The fourth time period covering the years 2011–2012 can be seen as one of diminishing interest in CCS. The downward trend is surprisingly sudden and abrupt and clearly seen in the data. The most obvious reason for this was the cancellation of the Meri-Pori plant [5].

An analysis of Finnish newspaper coverage of CCS revealed various ways to define and discuss uncertainty and risk[7]. The articles assign different meanings and interpretations to uncertainties depending on how well the probabilities and outcomes are quantified. Specific technological issues are amplified and understated in media discourse. In Finland, the key risks in media were systemic, like the economic viability and funding mechanisms for CCS and carbon lock-in. Technological risk issues such as leakage were mostly discussed in the social context of public opposition.

Secondary data were used to evaluate the effects of social capital and socio-economic status and national culture in Finland and other European countries. Previous research has been ambivalent on the effect of increasing knowledge on acceptance of CCS. Our results suggest that the effects of socio-demographic status (age, gender, education) and issue specific knowledge are smaller than the macro-level cultural differences from more individualist to more collectivist societies and so forth. Also, we find that the concept of public acceptance is not unidimensional, but rather a more complex construct, including at least the separate dimensions of views on benefits from CCS and views on uncertainties and whether they are in the range of societally acceptable.

3.3. Resource units

The socio-ecological aspects of CCS relate to the definitional struggle on what is discussed with relation to each of three parts of CCS. In the Finnish setting, where underground storage is not feasible but multiple research groups are in the process of developing mineralization storage options, this is especially congruent. Labeling and classification is important for governance reasons, but it also guides the decisions at companies. Flexible CCS systems require good technological and economic fit between capture, transport and storage.

The main arguments of the subcategory *technology and technological development* relate to (1) uncertainty of CCS technology, (2) declined energy efficiency due to CCS and (3) path dependency. Uncertainty of CCS technology in general was raised especially by the representatives of NGOs. There was a common suspicion that, regardless of all promised emission reductions, CCS technology could miss them and be merely support for the continuation of the coal industry. One reason for skepticism was the huge amounts of gas which should be processed and stored. Declining energy efficiency was the most general unwanted issue in relation to CCS. This issue was raised both by the representatives NGOs, energy industry and authorities.

The development of technology and its relation to regulation was also raised as an issue. The concern was that if the development and preparation of regulations and legislation were based only on certain kind of CCS technology, this might hinder innovations and the development of new kinds of technologies as the technology developers might be given a signal that new technologies are not involved in emissions trading. A kind of path dependency was feared a due to too narrow definitions and lack of incentives for further technology development. [4]

3.4. Resource system and interactions

The future developments of various technologies are commonly assessed through various road-mapping and scenario-making. Our workshopping exercise was geared towards similar goals but designed with an eye on the uncertainties and lock-ins. Some road-mapping is done with the goal of defining desirable futures or make them accessible to other parties, while we focused on the negatives or roadblocks on the way to CCS adoption.

The result was a stakeholder evaluation of the sources of uncertainty in the Finnish sector, and the networking and information sharing needs that have to be tackled. Many stakeholders perceived their own expertise field to be developing along a known trajectory, while other areas were seen to be highly uncertain. Individual technologies and technological issues were brought up and discussed, but in general the key driver uncertainties were the governance, user, and resource unit system factors identified above. The financial support for CCS, either through the EU Emission Trading Schemer or similar, or direct governmental funding, has to be present, but that support depends heavily on how the issues elsewhere are solved and what are the meanings and valuations given to these solutions.

On the basis of the stakeholders interviews their attitudes towards the investments, investment risk and public subsidies needed for CCS were classified into three categories: (1) Negative and critical attitudes against investing in CCS above all. This includes both investments in implementation and in R&D funding. The main concern behind this was that investments in CCS development could displace limited investments in other mitigation measures seen more efficient and sustainable than CCS. (2) Investment in CCS only on market terms, meaning that an investor should have a chance to choose between feasible options. This attitude excluded any major public investments in CCS as the financial situation was deemed so bad. (3) The third attitude was a concern about national means to arrange and share the investment risks in CCS. [4]

3.5. Outcomes

The current outcomes for CCS in Finland and lackluster, as they are in many other parts of Europe. One reason for this is the lack of understanding of the socio-ecological challenges described in the previous sections, both in the scientific community and within individual projects. Thus, we will develop a better socio-ecological indicator system that will be available as a tool by the end of the projects.

4. Discussion

This paper used a range of social science data sources to apply a generic socio-ecological systems framework to the field of CCS in Finland. The findings indicate that feasibility analyses for CCS require accounting for a wide range of issues, and especially the mechanisms in which the less easily quantifiable social issues affect technological and economic feasibility analyses.

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