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Engineering and Politics:

Embedding Carbon Capture, Transport and Storage (CCS) in Norway

Thesis for the degree of Philosophiae Doctor

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Preface

The work outlined in this dissertation was carried out at the Department of Interdisciplinary Studies of Culture, Norwegian University of Science and Technology, NTNU. The thesis is written as part of the research project "Public Acceptance of Post Carbon Strategies: Patterns of Attitudes and Engagement". The project was financed by the Research Council of Norway and managed by Knut H. Sørensen, NTNU.

After a number of unexpected detours, each part of the thesis had different mental battles. Writing appears as a reclusive, lonely endeavor. It is, but simultaneously nobody is ever alone. Despite that, or actually because of it, a PhD thesis is also not possible without others. These years had been the most amazing as well as the most challenging trip with both ups and downs. It opened up totally new perspectives and helped me to put the pieces up together.

The most important person throughout all these years has been my supervisor Knut H. Sørensen. I will never forget our first meeting in his office and my first question: "Skal jeg låse døra?" (Shall I lock the door?). Once I became conscious of the laughter, I realized that 'å låse' (to lock) does not mean 'å lukke' (to close). Henceforward, our meetings were full of laughs and 'cross cultural' comedy at its finest. He challenged (and at least survived) my 'being German'. Thank you so much for always being there for me, for your understanding and for your emotional support.

In addition, I am indebted to Robert Næss. Regardless of the growing responsibility for his own work; he was always willing to take time for adding new ideas and comments to my papers or teaching me interview techniques. He has really inspired me academically but even more important as a person, thank you so much. Thank you, Marianne Ryghaug, for your support and guidance throughout this process.

Since I have chosen not to use full names for the informants in this thesis, I would like to thank them anyway for taking the time to talk to us. Without them sharing their thoughts, critiques and opinions, the thesis would not have been possible.

Finally, I have to thank the three men in my life: Björn, Stinus (3) and Nooka (1). Thank you for your love, understanding and encouragement particularly during the last-leg of this long travel. Thank you for generously giving me the time and freedom to complete my thesis beside the changing table and at the kitchen table. Special thanks to my children for coping with my absent-mindedness. And guys, it requires no discussion at all, since I am the only girl in the family, that I am the boss at home.

Last but not least, I want to thank my mom for her strong encouragement and belief in me. I could not thank her and Rudolf enough for all that they have done, and continue to do for me.

Oppegård, September 2014

Alexandra Klimek

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1. Overview and synthesis

On Monday, 1 January 2007, Jens Stoltenberg held his second televised New Year speech as the red–green coalition Prime Minister. He started his speech by talking about poverty, unemployment and the elderly, but soon referenced the climate: 'We must take our share of responsibility. Greenhouse gas emissions must be reduced'.[1] 'A historic speech' was the headline in Norway's second largest newspaper.[2] In the speech, the Prime Minister dedicated much time and attention to the problems of CO_2 emissions and global warming and highlighted the planned gas power plant at Mongstad. There, the government had decided that CO_2 capture should be in place by 2014.

'When President Kennedy said that Americans would land on the moon within 10 years, they had not been in space yet. They got to the moon within 10 years. They set themselves a goal. And they reached it'. Stoltenberg continued: 'our vision is that within seven years we will put in place the capture technology. This will be an important breakthrough in the efforts to reduce greenhouse gas emissions in Norway. This is a major project for our country. It is our moon landing'.

Stoltenberg compared the Mongstad project, which had been criticised for being both too expensive and unrealistic, with the Apollo moon

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[1] Prime Minister's New Year speech in 2007. All translations are the author's, except where otherwise noted
http://www.regjeringen.no/nb/dep/smk/aktuelt/taler_og_artikler/ statsministeren /statsminister_jens_stoltenberg/2007-4/statsministerens-nyttarstale-2007.html?id=440349.

[2] Bellona: A historic speech (Bellona: - En historisk tale), VG 08.11.2013 http://www.vg.no/nyheter/innenriks/artikkel.php?artid=146971.

landing project. Carbon capture, transport and storage (hereafter CCS) is considered one of the main options and perhaps the most prominent technology for reducing the amount of CO_2 entering the atmosphere in the short and medium run. Stoltenberg's speech shows the political importance attached to CCS in Norway.

This thesis is concerned with some aspects of the ambitious goal of realising CCS in Norway, and emphasises both the efforts and lack of efforts to embed CCS in Norwegian society. Usually, the development and deployment of CCS technology is considered an innovation problem focused on technological challenges, including the difficulties of merging a wide range of disciplines and industries. Here, I engage with efforts to pave the way for the development and deployment of CCS that relate to scientific, social and political communication.

In the near future, we will see if the outcome of the demonstration plants will prove CCS to be technical feasible or whether 'the development of further fossil-fuel-derived energy capacity must be recognized as making current objectives of climate change mitigation unattainable' (Markusson et al., 2013, p. 110). Internationally, CCS development and deployment has grappled with insufficient political will and inadequate governmental action, which has led to a stagnation of CCS activity. While governments should take a leading role by providing money and R&D grants, technological development must also be supported by the public. Here, I analyse some efforts to secure such support.

Consequently, this thesis studies efforts to socialise CCS. Bijker and d'Andrea define socialisation as 'the processes involved in the

production, use and circulation of scientific research and its products in an inseparable connection with its social context' (2009, p. 62). Socialisation efforts may be more or less successful. Successful socialisation should pave the way for innovations or for new ways of developing more environmentally friendly practices. CCS is an example of such an innovation. As Sørensen (2013) argues, socialisation efforts are needed as an ongoing concern to support the embedding of technologies that may mitigate climate change. What efforts are made to socialise CCS in Norway?

The socialisation approach used in this dissertation exceeds an economic framing and a unilateral focus on technological or political barriers. It is broader and more concerned with the possibility that the appropriation of science and technology by both societies and social communities may be facilitated (Sørensen, 2013, p. 14). Bijker and d'Andrea present socialisation as ongoing processes in a number of socialisation areas. In this thesis, I am particularly concerned with the first-mentioned three areas: scientific practices, scientific mediation and scientific communication.

The choice of these areas is based on their importance with respect to the ways in which science and technology development intersects society. Knowledge of CCS technology is not created behind closed doors in laboratories; rather, it is made through scientific practices in the wider society (Felt and Wynne, 2007). For this reason, it is argued that scientists and engineers should take a leading role in communication and engagement (Felt and Wynne, 2007; Nowotny et al., 2001). However, Bijker and d'Andrea claim that, frequently,

socialisation work is not conducted in (for instance) scientific institutions, NGOs and government agencies.

> [I]n Europe, the 'agents of socialisation' seem to be few; they often work in a hostile environment, where resistance and hindrances limit the 'systemic' impact of their action; the degree of acknowledgement that they receive from public institutions varies country by country, but overall it appears to be limited; they prevalently act in an 'atomised' way, or create short and scarcely visible operation chains. (Bijker and d'Andrea, 2009, pp. 22–23, emphasis in the original)

The above quote suggests that socialisation efforts with regard to CCS in Norway may be fairly limited. This is investigated in this thesis.

The 'agents of socialisation' referred to above include scientists, research groups, university administrators and civil society organisations, and sometimes governments and local administrations. These agents are particularly concerned with closing the gap between science and society. Bijker and d'Andrea (2009) emphasise that most actors are not aware of their role as active agents. The thesis asks: How does this apply to CCS in Norway?

The dissertation does not deal with all aspects of the socialisation of CCS in Norway. Rather, I focus on two arenas in which the socialisation of CCS may take place: the news media and networks of technoscientists[3] engaged with CCS R&D in Norway. The news media is considered the most important source of public knowledge about new science and technology, and also provides an important arena for

[3] I follow Latour (1987) in using the concept of 'technoscientists' to avoid making strict and less meaningful distinctions between scientists and engineers, or natural scientists and engineering scientists.

political debates and sense-making with regard to CCS. Journalists may be agents of socialisation, but the news media also allows other actors' opinions to be articulated to a considerable degree.

The second arena includes research centres that engage with the development of CCS. Here, I am particularly interested in the socialisation activities (or lack thereof) of the research centres' technoscientists. For example, do the technoscientists perceive themselves as active agents of socialisation? Further, how do they perceive the lay public's attitudes toward and understanding of CCS? These are important considerations that bear on their motivation to engage with the public. I provide a more extensive discussion of the socialisation of science and technology and technoscientists' constructions of the lay public later in this overview essay.

In the next section, 'The politics of CCS in Norway', I provide contextual information about the development of carbon capture, transport and storage technology in Norway. The third section provides summaries of the research papers that make up this dissertation, which identify further issues to pursue in the overview essay. I then turn to previous research on socialisation in the fourth section, 'The demand of socialisation'. The fifth section introduces some relevant theoretical perspectives that may help the navigation. I use STS approaches to elaborate on the concept of socialisation. I then introduce three theories or concepts to clarify the focus of the thesis: mediatisation, science communication and imagined publics. The input of each of these into the concept of socialisation is discussed in section six. The seventh section provides a cross-cutting analysis of the three papers in the

thesis, and synthesises these papers using the introduced theories and concepts. Finally, I present the methodology used for the studies.

First, I discuss the Norwegian context of CCS, with an emphasis on its political role.

2. The politics of CCS in Norway – A brief overview

Norway is often called an energy nation, since its economy is so strongly based on resources such as petroleum, gas, hydropower and other forms of renewable energy. The petroleum sector is the largest industry in Norway and provides a large portion of the national income. Nevertheless, Norway has – seemingly – tried to combine its role as a major exporter of oil and gas with an ambition of becoming a world leader in environmental and climate policy. This combination has turned out to be challenging, but the Norwegian government has invested a lot of resources into the development of environmentally friendly energy technologies, including CCS.

To understand CCS technology development in the Norwegian context, one must first recognise that, in Norway, the technology is treated as a unitary phenomenon. This is unlike what is observed in many other countries. Globally, public interest in CCS has mainly focused on (onshore) storage parts, which have been considered controversial (see, e.g., Wallquist et al., 2012; Kräusel and Möst, 2012; Ashworth and Quezada, 2011; Terwel and Daamen, 2011). In the Norwegian public debate, it is common for CCS to be used as a generic term that does not distinguish between capture, conditioning, compression, transport and storage.

Further, CCS has, for a long time, been part of political life in Norway. There have been good studies of the political emergence of CCS (Tjernshaugen, 2007; Tjernshaugen, 2008; Tjernshaugen and

Langhelle, 2009; Tjernshaugen, 2011; Meadowcroft and Langhelle, 2009), which have addressed the question of why CCS in Norway (relative to CCS in other countries) has received unusually early and strong political support. To describe the historical rise of CCS in Norway, I draw on Tjernshaugen's (2011) definition of 'political support', which states that political support is 'a central place for CCS on the national climate policy agenda, strong statements of commitment to a CCS strategy by political leaders, and finally policy measures to foster technology development and commercial applications' (Tjernshaugen, 2011, p. 228). CO_2 mitigation has been a high priority item on the political agenda since 1989, when Norway established national targets for CO_2 emissions. As early as the 1980s, Norway's Labour Party Prime Minister at the time, Gro Harlem Brundtland, made CO_2 emissions a political issue.

Extensive emissions from the petroleum sector augment the contribution of Norway's oil and gas export to CO_2 emissions in other countries. This is not unproblematic for a country that sees itself as a leader in international environmental policy (Nilsen, 2001; Sydnes, 1996). Thus, for quite some time, Norway has had conflicting energy policy and climate policy objectives.

The goal of both achieving economic growth and stabilising CO_2 emissions was put forward in White Paper 46 (Stortingsmelding nr. 46 1988–89). Other studies have pointed to the fact that the offshore industry had great potential to become more environmentally friendly, but that this would have been costly (Lindeberg and Christensen, 1990). New technologies for reducing CO_2 emissions became necessary for energy compromises between political parties and other

stakeholders. Early on, the ENGO Bellona Foundation recognised CCS as a possible technology for environmentally friendly oil and gas production. Frederic Hauge, the founder of the ENGO Bellona Foundation, was quoted in a 1989 interview as saying that 'carbon dioxide cleaning will in the future require technological innovation if a reduction or a stabilisation is preferable'.[4]

In the early 1990s, mineral oil, gasoline and emissions from offshore production began to be taxed. This first CO_2 tax was an instrument for reducing emissions. However, it was considered expensive for Norwegian industry to cut emissions 'at home', and lobbies against the CO_2 taxation of industry were successful. From this, two dilemmas arose. First, the government – together with the oil and gas industry – assumed that the existing technology for capturing CO_2 from offshore gas turbines would make the whole process too expensive. Second, the government scaled down its emissions reductions, nationally (Tjernshaugen, 2011).

The government stopped efforts to reduce carbon emissions in 1995. White Paper 41 (Stortingsmelding nr. 41 1994–95) justified this with reference to the expansion of the oil industry and the absence of an international climate regime. In fact, the white paper recommended the development of effective measures to stabilise Norwegian CO_2 emissions and, at the same time, recommended the expansion of Norwegian gas exports. The idea behind this was that Norway should

[4] 'NORWAY WASTE POLLUTION will be destroyed' (FORURENSNINGSNORGE AVFALL skal destrueres) *Aftenposten A-magasinet*, 19.08.1989.

demonstrate internationally that its gas production could have positive effects on international emissions; however, this produced a conflict over the environmental consequences of gas-based power in Norway (Hovden and Lindseth, 2002).

In Norway, there has been an ongoing discussion since 1990 over whether Norway should build gas power plants with conventional technology or whether plants should be built with technology for cleaning CO_2 (Næss, 2007). Early on, CCS technology was promoted by the largest independent research organisation in Norway, SINTEF, and the Bellona Foundation, with reference to the possibility for new gas power plants without CO_2 emissions. In 1997, the Labour Prime Minister Thorbjørn Jagland's cabinet addressed the question of whether gas power plants should be built in Norway. With the technology available at the time, it would have been impossible for power plants to be built without CO_2 emissions. Consequently, Jagland postponed the project for several months.[5] In the summer of 1997, the government established formal requirements for all power plants to be prepared for future CO_2 capture and for companies to engage in CCS research (Tjernshaugen, 2007).

After the change of government at the end of 1997, the conflict over gas power remained the key driver of the CCS support policy, and government funding became a suitable policy instrument. In 2001, Bondevik's Second Cabinet began working on an energy and environment policy proposition. This led to the establishment, in 2004,

[5] Gas power plants: Jagland asks Naturkraft delay commencement (Gasskraftverk: Jagland ber Naturkraft utsette byggestart) *NTB news agency*, 09.05.1997.

of the state enterprise Gassnova SF to provide advice to the Norwegian Ministry of Petroleum and Energy about CCS and the onshore use of natural gas (van Alphen et al., 2009). The enterprise was expected to contribute to finding solutions to ensure that technology for the capture and storage of CO_2 could be implemented and could become an effective climate measure.[6]

The Bellona Foundation worked actively to get the Norwegian Parliament to request the Ministry of Oil and Energy to initiate assessments of the economic aspects of using CO_2 for enhanced oil recovery (abbreviated EOR) (Jakobsen et al., 2005, p. 19). However, the elections in 2005 resulted in a new government led by Jens Stoltenberg, which raised the profile of CCS to Norway's metaphorical 'moon landing' project (Tjernshaugen and Langhelle, 2009). CCS technology became the centerpiece of a political deal to unite the government's energy policy where financial support for large-scale technology development was promised. As a political compromise, the technology was hard fought, but success was achieved. From that point on, all new gas-fired power projects were to be based on CO_2 cleaning. CCS technology was presented as a possible tool for reducing CO_2 emissions and for defending proposals to build gas power plants onshore.

Significant investments in CCS have been made and the technology has been presented to the Norwegian public as a way of both resolving the controversy over gas power plants and contributing to climate change mitigation. This has given CCS a particular role as a technology of

[6] http://www.gassnova.no/en/about-us, accessed 2014-08-12.

political compromises. 'Simultaneous negotiations between the three governing parties, and between Statoil and the government, about the timing and stringency of CCS requirements – a process that brought the red-green coalition to the brink of breaking up – concluded with a two-step plan' (Tjernshaugen and Langhelle, p. 16).

The Labour Party, the Conservative Party and the Progress Party agreed to reduce emissions internationally, while the Socialist Left, the Centre, the Liberal, and the Christian Democratic parties (the green parties) argued that emission reductions should be carried out domestically (Gullberg, 2009). In the end, all political parties except the Progress Party made a cross-party compromise on climate policy in January 2008.

One of the main points of this compromise was that Norway should aim to become carbon neutral by 2030, rather than 2050. Further, it included plans to build a test centre for CO_2 capture technologies at Mongstad, which would be ready for operation in 2010. Later, the project was postponed to 2011 and then finally opened in May 2012. The second step of the government's plan was to fund full-scale, post-combustion capture of CO_2 from the co-generation plant, operative from 2014. In spite of major investments and a technology policy that tried to force innovation, one postponement followed the other.

The climate policy compromise also led to the establishment of eight Centres for Environment-friendly Energy Research (FMEs)[7] through the Research Council of Norway in 2009. All eight centres were

[7] For more information, see www.forskningsradet.no/prognettenergisenter/Forside/1222932140 86.

technologically aligned. The aim was to establish time-limited research centres to conduct concentrated, focused and long-term research of high international calibre in order to solve specific challenges in the energy sector.

Two of the centres focused on CCS: the BIGCCS Centre – International CCS Research Centre; and Subsurface CO_2 Storage – Critical Elements and Superior Strategy (SUCCESS). The BIGCCS Centre develops knowledge, methods and solutions for safe, efficient and inexpensive CO_2 management. Together with SUCCESS, the centre is also expected to help determine Norway's offshore storage capacity for CO_2. The main objective of SUCCESS is to examine reliable ways of storing CO_2. The centre also seeks to identify the best methods of injecting CO_2 and will monitor the safety of underground CO_2.

Another point pushing CCS development in Norway was the fact that the technology could be part of an international tool for mitigating climate change. Several facts were important in making CCS a political instrument of compromise in Norway. The perceived need to smooth the controversy over Norway's role as an oil and gas producer in the face of important environmental issues produced early and strong political enthusiasm for CCS in Norway. In comparison to other European countries, where CCS seemed virtually absent from the climate debate in the 1980s and 1990s, CCS made political history in Norway right from the start (Shackley et al., 2007; Meadowcroft and Langhelle, 2009). This is because CCS was vital to the energy and environment political compromise.

Thus, the Norwegian context appears to be interesting and appropriate for an analysis of the socialisation of CCS. This is due, in part, to the political precariousness of CCS in Norway, as already argued. Further, Norwegian science policy has put a lot of weight on public engagement. Norwegian science policy documents are concerned with the need for new links between science and society while focusing on knowledge sharing between scientists and the lay public. Another factor is that CCS technology is not – yet? – a controversial technology in the Norwegian context. Karlstrøm and Ryghaug (2014) found that people in Norway are relatively positive toward CCS, though they are even more favourable toward new renewable energy technologies. Thus, Norway should provide a fairly favourable context for the socialisation of CCS. This has been explored in the three research papers that form the core of the thesis, to which I now turn.

3. The three research papers

The core of the thesis consists of three research papers. In the following, I provide a brief summary of the papers and their main arguments. The papers are titled:

1. The 'media' paper: Embedding and dis-embedding carbon capture and storage (CCS): Studying socialisation of technology through newspapers
2. The 'imagined lay publics' paper: Benign ignorance? Carbon capture, transport and storage experts imagining lay people's knowledge and attitudes in Norway
3. The 'engagement' paper: 'It's not my job' – How CCS scientists view public engagement

Paper 1: Embedding and dis-embedding carbon capture and storage (CCS): Studying socialisation of technology through newspapers

Norway, with an economy that is largely dependent on the export of oil and gas, tries to maintain an image as being at the forefront of sustainable development. CCS has enjoyed strong political support in Norway. In this paper, we analyse efforts to embed or dis-embed CCS by studying Norwegian newspaper articles about the technology.

Paper 1 deals with identifying 'agents of socialisation' (Bijker and d'Andrea, 2009) in Norwegian newspaper coverage of CCS from the years 2000 through 2013. It also explores the role of the media as an arena of socialisation. By reporting on CCS technology, the media shapes the picture of the technology and different actors try to position

themselves, since there are considerable cost overruns, delays and redefinitions of the project.

The analysis is based on the use of the newspaper database Retriever, which allows users to search across articles in all Norwegian newspapers. We began the work of collecting newspaper articles by looking at a smaller number of articles in order to identify effective search terms. The search profile (CCS OR CO_2 sequestration OR CO_2 storage OR CO_2 capture - CO_2 cleaning) led to the identification of more than 7,000 articles from the 14-year period.

We sampled these items and split the articles into two groups: those in support of CCS and those critical of the technology. This mapping of pro and contra arguments was then used for open coding and as the basis for sampling criteria to determine a smaller number of articles for detailed analysis. We used the concept of a storyline to describe the main codes, and we identified at least three storylines – two pro CCS and one contra CCS:

Storyline 1: 'CCS as a fascinating technological challenge'

Storyline 2: 'CCS as a frustrating political challenge'

Storyline 3: 'CCS as a harmful and useless challenge', with three sub-storylines:

Storyline 3a: Techno-economic challenges

Storyline 3b: Environmental challenges

Storyline 3c: Climate scepticism

The overall impression was that Norwegian newspaper articles were pro CCS. The main critique in the articles related to a sense of ineffective governance of the CCS project, which had led to cost overruns and delays. The two pro CCS storylines shared the approach of emphasising that CCS was a necessary contribution to climate change mitigation. We further identified a limited socialisation effort. We interpreted efforts that went beyond explaining the need for CCS as a socialisation strategy as the possible effects of drawing attention; nevertheless, it was difficult to discern particular strategies of CCS socialisation.

With respect to the identity of socialisation actors, current policy suggests that scientists and engineers have an important role to play. Scientists and engineers working with CCS were indeed present in the newspaper articles, but only marginally. This was also true of the representatives of the industry engaged with developing CCS. The most prominent socialisation actors in the Norwegian news media were policy-makers and NGO representatives. Our findings further suggest that newspapers engaged only moderately in the socialisation of CCS.

Paper 2: Benign ignorance? Carbon capture, transport and storage experts imagining lay people's knowledge and attitudes in Norway

Paper 2 attempts to provide an overview of scientists' and engineers' imaginaries regarding Norwegians' knowledge, attitudes and engagement with CCS technology. As expected, we found that the CCS experts perceived the general public to be fairly ignorant about CCS

technology. However, these beliefs did not lead the experts to fear public protest and resistance against CCS implementation.

In 2009, two fairly large research centres were established to develop CCS: the BIGCCS Centre and SUCCESS. Both were given the status of Centres for Environmentally-friendly Energy Research (FME), and included partners from research institutes, universities and industry. We chose to interview technoscientists engaged with these centres, and we collected data through a combination of individual and focus group interviews between June 2011 and November 2011.

We were mainly interested in interviewees' conceptions and imaginaries of the general public and used grounded theory as inspiration (Charmaz, 2000; Corbin and Strauss, 2008). Open coding helped us identify themes and main ideas in the interview material. We continued to break down the data into distinct concepts and, after identifying several concepts in each interview, we began to build categories. The overall categories that emerged in relation to the public knowledge level were, for instance, 'low', 'nothing' and 'not enough'.

As a last step, selective coding helped us identify the most important categories and link them into explanations. The concept of 'imagined lay persons' suggests the importance of studying technoscientists' constructions of the general public. The parallel concept of 'imagined publics' observes how such perceptions may have greater effects on the actions of technoscientists than 'real' publics have. The interviewees distinguished between understanding the technology and grasping the wider context of the technology, and they were more concerned with the latter. Thus, the knowledge deficit, which was related to the context

of CCS, was seen to be caused by weak news media coverage and lack of clarity in Norwegian climate policy.

We observed three narratives of the way in which Norwegians relate to CCS: (1) the narrative of benign ignorance, (2) the deficit narrative and (3) the narrative of informed support. These narratives could be read to identify three different publics, and it does not seem unreasonable to believe that the Norwegian public may actually be differentiated into these three categories. However, the interviewees did not think in terms of publics in particular (PiPs, see Michael, 2009). The technoscientists did not introduce any suggestion of particularities into their narratives, but instead referred to a generalised idea of the public. A shared feature of the three narratives was their emphasis on the importance of understanding why CCS is needed and on the need for public support for CCS development.

These two concerns were linked in different ways, both positively and negatively, or not at all. What we observed with respect to knowledge deficits among the public, was that it was not seen by the technoscientists to lead to protest and resistance against CCS implementation. What differs from the findings of other studies (e.g., Anderson et al., 2012; Wynne, 2006; Cook et al., 2004; Gross, 1994; Ziman, 1991) is the main image of the public as positive and supportive. The concepts of both imagined lay persons (Maranta et al., 2003) and publics (Walker et al., 2010) turned out to be useful for reminding us that such imaginaries exist and may be performative. Nevertheless, we also found disagreements across the community of technoscientists about how the public should be characterised.

Paper 3: 'It's not my job' – How CCS scientists view public engagement

Since relatively few studies have focused on the involvement of scientists as active 'agents of socialisation' (Bijker and d'Andrea, 2009), the third paper focuses on how CCS technoscientists viewed their role in science communication and public engagement. The aim of science communication is usually understood to be to remove knowledge deficits and thus counter perceptions of the public as ignorant and resisting. How was this considered by the CCS technoscientists? Three questions formed the point of departure: How effective had the institutional pressure been to inform and engage? Could an imagined lay public dynamic be observed? Did the scientists and engineers remain reluctant or passive?

The interview data was collected at the BIGCCS Centre and SUCCESS. As Centres for Environmentally-Friendly Energy Research (FMEs), both included participants from research institutes, universities and industry.

In total, we interviewed 35 people, which amounted to a substantial portion of those engaged with CCS R&D in Norway. Since we were interested in the interviewees' descriptions of their public engagement activities and their understandings of public engagement, we identified themes and main ideas through open coding.

The data were analysed, step by step. After identifying several concepts in each interview, we looked for similarities, then grouped these similarities into categories. The categories that emerged from the data were, for example, 'positive towards public engagement', 'more active'

and ‘not engaged’, in relation to CSS. Selective coding helped us identify the core variables of the data and link categories into explanations.

A hierarchy was developed and a small number of the most important categories were chosen to represent the key imaginings drawn from the raw interview material. We mainly focused on interviewee responses to two main issues raised in the interviews: first, interviewees’ accounts of their public engagement activities; second, interviewees’ perceived challenges of public engagement. The impetus of the imagined lay public dynamic was dormant. While my informants perceived the public as mainly ignorant, they also considered the public to be positive or neutral on CCS. With respect to institutional pressure, we found the Research Council of Norway to be more effective in encouraging scientists to engage.

Above all, we found that science communication and public engagement activities were seen as tasks for somebody else. The interviewees were reluctant with respect to engaging or informing the public themselves. ‘Somebody else’ were colleagues, communication departments, journalists or politicians. Their arguments in defense of this disengagement, such as a lack of communication skills and insecurity over handling news media, were familiar from previous science communication studies. The interviewees’ emphasis on the responsibility of politicians and policy-makers to explain the importance of CCS was striking. This emphasis was grounded in what could be recognised as a purification effort to distinguish between scientific/engineering and political/symbolic issues.

The purification effort was important to many interviewees and added to the complexity of science communication. Many interviewees said that they would engage if they could. They felt that such engagement was too difficult, since knowledge sharing related to scientific and engineering aspects of CCS was not expected to be their field of expertise.

Seen together, the three papers raise important questions regarding the socialisation of CCS in Norway. Clearly, other actors more actively engage with the socialisation of CCS than do technoscientists. To understand the underlying dynamics, I explore more closely the concept of the socialisation of technology. I do this in two steps. First, I present and discuss concepts and empirical studies that provide better insight into why technoscience, in general, and CCS, more specifically, must be socialised. Then, in the ensuing section, I discuss the concept of the socialisation of technoscience in more detail.

4. The need for socialisation of technology

Traditionally, what I describe as socialisation of technology was considered mainly a cognitive challenge. While the concept of 'public engagement with science' (PES) represents the idea of trying to create acceptance of new technoscience through democratic participation initiatives, the more traditional approach of 'public understanding of science and technology' (PUST; Yearly, 2005) is based on the idea that potential resistance toward new technoscience among the public may be countered by increasing their level of knowledge of the technoscience in question, such as biotechnology or CCS. Underlying both PUST and PES initiatives is the common perception that the lay public tend to be critical or even resistant toward new technoscience. This tends to be attributed to conservatism and shortsightedness, but also to lack of trust and influence with respect to the development of technoscience.

Thus, it is important to note that resistance has often been understood as a result of a lack of knowledge. The obvious response to this is education. The PUST approach, reflecting a deficit model of science communication, suggests, as a rule, that 'the more you know, the more you love it'. The most well-known critique of this position is made by Brian Wynne (1992), who emphasises the expertise of Cumbrian sheep farmers – compared to scientists – about sheep behaviour, hill farming ecology and contaminated grassland. This case illustrates how scientific knowledge neglects lay knowledge.

Another weakness is in the implied supposition that knowledge travels in a linear fashion from science and engineering to the public. 'Linear models produce stories with too-well-defined beginnings and endings. Narratives about public understanding of science like traditional narratives about innovation appear to be too conventional in this respect' (Sørensen et al., 2000, p. 237).

The public engagement position is that, to overcome distrust and lack of involvement, there must be new types of dialogues between technoscientists and the public, including engagement experiments and other such initiatives. This possibility has been addressed by prominent social theorists such as Stenger (1999), Nowotny et al. (2001) and Latour (2004), who are interested in the technosciences and their performances in society. Ideas about new ways to communicate with the general public have been proposed. The role of public upstream engagement is emphasised by policy-makers as well as by social science theory, in the field of PES (Miller, 2001; Wilsdon and Willis, 2004; Stilgoe, 2005).

Public engagement, a normatively argued and supposedly symmetrical two-way process, should involve publics early in the development of technoscience. The public engagement approach often builds upon public understanding efforts, moving toward more comprehensive public dialogue opportunities.

With respect to CCS deployment, several studies have analysed public attitudes and public acceptance and thus efforts at socialisation and lack of such efforts (e.g., Sharp, 2005; van Alphen et al., 2007; de Best-Waldhober et al., 2009; de Coninck et al., 2009; Ha-Duong et al., 2009;

Johnsson et al., 2009; Shackley et al., 2009; Anderson et al. 2012; Markusson et al., 2012; Terwel et al., 2012). Due to this, I begin by giving an overview of studies that have focused on the general public's state of knowledge, strategies to overcome possible knowledge deficits and comparisons of CCS technology to other renewable energy technologies. This helps clarify the need for socialisation efforts.

PUST reflects the assumption that the public are deficient in knowledge. Several surveys have been used to assess the public's state of knowledge and attitudes toward CCS, in order to explore this assumption. Also, observations in local communities where CCS technology has been deployed have tended to reveal that the public have relatively little knowledge about CCS. Interestingly, a connection between little knowledge about CCS and little knowledge about climate change has been made in several studies.

In a survey from 2003, Curry et al. (2005) found that fewer than 5% of respondents had heard of CCS and, in 2006, Curry et al. (2007), in an update of the study, again found that only 5% had heard of the technology. Knowledge deficits have also been observed in other countries, such as Japan (Itaoka et al., 2004; Uno et al., 2004; Tokushige et al., 2006), the UK (Shackley et al., 2004), the Netherlands (Huijts, 2003; De Coninck and Huijts, 2005; Daamen et al., 2006), Australia (Miller et al., 2007) and France (Ha-Duong et al., 2009). Since the cancelled Barendrecht project, findings have suggested that the level of knowledge in the Netherlands has increased (Terwel et al., 2012).

Several studies of public acceptance and attitudes toward the technology have compared CCS with climate mitigation. Mostly, respondents have been asked to rate climate change mitigation alongside other societal goals (Palmgren et al., 2004; Curry et al., 2007; Sharp et al., 2009). A common finding has been that other societal issues and environmental concerns are ranked higher.

A lack of understanding of the connection between climate change, CO_2 emissions and CCS technology or challenges posed by anthropogenic climate change, in general, might imply generally low attitudes toward CCS deployment (Ha-Duong et al., 2009; Sharp et al., 2009). Shackley concludes that 'support depends, however, upon concern about human-caused climate change, plus recognition of the need for major reductions in CO_2 emissions' (2005, p. 377). Johnsson et al. (2009) also point to the fact that respondents often disagree in their assessments of the seriousness of climate change threats. If the public do not 'feel' threats, then they must trust technoscientists. It seems that the assumption that the great attention for CCS in the media indicates that everybody should know what climate change is about, is incorrect.

There is a widespread belief that more information about CCS technology will increase public awareness. A lot of studies have pointed to the need for a neutral and transparent information strategy. Lipponen et al. (2011) identify not only technological, but also financial and regulatory frameworks. Further, for successful CCS implementation, both public engagement and international collaboration are crucial. These frameworks include knowledge sharing. Several recommendations are made in the IEA CCS roadmap

for what is required to achieve a solid foundation for the deployment of the technology. The roadmap identifies that 'lack of understanding and acceptance of the technology by the public and some stakeholders also contribute to delays and difficulties in deployment' (IEA, 2013, p. 5). Bradbury et al. (2009) very clearly suggest the overriding importance of social factors in planning and implementing CCS projects. They argue that, above all, management of safety risks is the critical factor for positive public attitudes.

Also, Dütschke (2011) suggests that societal support includes political support for industry activities, scientific research and transparent presentation of data. Communication strategies must be open and must use trusted channels to ensure that decision strategies are transparent. There are crucial social issues embedded in the apparently technical questions related to CCS (Russell et al., 2012).

The public are often seen as passive recipients of knowledge. While Andersen et al. (2011) explain that the term 'acceptance' implies passivity, only a few studies have discussed an active public that can benefit from engagement and the so-called social contract approaches (e.g., Roberts and Mander, 2011). Both have claimed that the public need to be consulted on such issues and that there is a broad consensus that the public appreciate being asked for their opinion rather than being told what to think.

Also, Ragland et al. (2011) and Oltra et al. (2010) highlight the possibility for joint action and enhanced development of knowledge and understanding by upstream engagement. Oltra et al. (2010) recognise a clear lack of knowledge and assert that understanding lay

views on CCS should be the first step in the design of science and technology communication exercises.

A gap between CCS progress at the technical and social levels and the importance of public opinion is probably underestimated in current social representations. 'Concerning CCS, the involvement of civil society at an early stage, preferably before decisions are taken, will be a priority of any project or policy that does not want to run the risk of being suddenly stopped by public opinion opposition' (Vercelli and Lombardi, 2009, p. 4,838). CCS is better understood in the context of climate change or the responsible use of fossil fuels (Vercelli and Lombardi, 2009). CCS implementation calls for a deeper understanding of the meaning of single actions with respect to the challenge of climate change mitigation, and for understanding how they are all linked together, influencing one another, and in which direction, wanted or unwanted.

Another commonality of these studies has been the comparison of CCS to other forms of renewable energy, such as solar, wind, hybrid and biomass (Palmgren et al., 2004; Shackley et al., 2005; Reiner et al., 2006; Curry et al., 2007; Sharp et al., 2009; Ha-Duong et al., 2009). It is no surprise that people have often been found to prefer technologies that they are more familiar with than CCS.

In connection with anthropogenic climate change and the comparison of renewable energy technologies, willingness to pay has often been connected to public attitudes (Palmgren et al., 2004; Curry et al., 2007). Further, Kräusel and Möst (2012) emphasise the argument that CCS mitigates climate change. However, they find that this argument does

not seem persuasive and sufficient in the context of CCS awareness. Shackley (2005) identifies a lack of awareness among the general public and an opinion shift from unawareness to light positivity toward the concept, after they have received information.

Itaoka et al. (2011) suggest that the public's understanding of the effectiveness of CCS has the most positive influence on their general acceptance of CCS. Amikawa et al. (2011) describe a few important factors for achieving better acceptance of CCS; namely: (1) increased public perception of global warming and CCS, (2) an opinion that connects both positive and negative arguments and (3) distributed information on what the public is concerned with. These are typical aims of socialisation.

Several research papers (see, e.g., Dütschke, 2011; de Best-Waldhober and Daamen, 2011; Stigson et al., 2012) have suggested that renewable energy technology may be much discussed in elite circles such as those of scientists and engineers, but is nearly absent among the general lay public. This observation points to those responsible for sharing knowledge. Since scientists and engineers are perceived to be knowledgeable and lay people are perceived to have a knowledge deficit, scientists and engineers should perform more education activities.

Moreover, 'the public does not participate in the creation of scientific knowledge' (Felt and Wynne, 2007, p. 55). Thus, the public is not considered a scientifically 'useful' source. '[S]cientists, who hold the knowledge, have to instruct and educate the public' (ibid., 2007, p. 55). This tends to result in questions concerning public trust. Public trust in

environmental NGOs in the assessment of environmental risk is much bigger than trust in politics or industry (Curry et al., 2007; de Coninck and Huijts, 2005; Shackley et al., 2005; Curry et al., 2005; Gough et al., 2001). This may mean that, actually, NGOs are well placed to be socialisation actors – if they want to take on that role.

All of the studies of attitudes toward the technology among scientists, stakeholders and the public have had at least one thing in common: the scientists (and, with them, stakeholders and policy-makers) have been portrayed as knowledgeable and the public have been portrayed as ignorant. Nonetheless, constitutive boundary conditions – such as, for example, the technological development of equipment, storage and transportation issues – have not yet been determined and the future implications of CO_2 storage are still uncertain.

Studies have highlighted the general public's need to learn about the technology and the greater picture with respect to climate change and anthropogenic global warming (for instance, Russell et al., 2012; Terwel and Daamen, 2011). Ways of achieving positive awareness and understanding include both PUST strategies of providing information and fostering public education and PES activities of developing participatory action. Such initiatives involve more than simply improving information strategies to persuade people to change their minds, because such changes are very difficult to achieve in this fashion.

Rather, issues of public understanding and acceptance must be integrated into processes of new technology development. This is the main rationale behind socialisation efforts. However, the barriers to

communication and interaction between technoscientists and diverse publics are highly complex, and depend on a combination of social, cultural, educational and practical factors. Thus, it may be difficult to understand the sources of scepticism, resistance or rejection of the new, particularly to the scientist who is convinced that what he or she has provided is a clear contribution to the common good.

Another challenge to socialisation relates to the sites from which socialisation may be performed. In contrast to the classical disciplinary organisation of knowledge production, the new ways are characterised by large heterogeneity in the organisational structures involved, the temporary character of the research groups, the transdisciplinarity of the approaches and the increased importance of the potential applications in the course of knowledge production. While the public's lack of knowledge was observed in all reviewed papers, the role of scientists was given little consideration.

The concept of the socialisation of technology invites us to remedy this situation and go beyond the dominant idea that the main problem is a knowledge deficit among the general public. As we have seen in the overview of studies of the relationship between the general public and CCS, some research has suggested needs other than improved knowledge for the socialisation of CCS, such as engagement initiatives but also insight into the challenges of climate change mitigation. In the following section, I provide a more detailed presentation of the term 'socialisation' and its use in the thesis, in order to broaden readers' understanding of what may be involved in the socialisation of technology such as CCS. The presentation ends by highlighting three theoretical concepts that are particularly useful in analyses of the

socialisation of CCS, based on the three papers in the thesis – namely mediatisation, science communication and imagined publics.

5. Understanding the socialisation of technology

Generally, the concept of 'socialisation' as used here departs from recent assumptions of a changed relationship between modern technoscience and society. This change is claimed to have made it more difficult to embed new technoscience in society (Bijker and d'Andrea, 2009; see also Nowotny et al., 2003). The concept of socialisation of technoscience has emerged from the field of science and technology studies (STS), and it may be helpful to examine some of its intellectual roots.

An important feature of STS – in particular, technology studies – is the critique of technological determinism and the idea that technology is made so-to-speak outside of society (e.g., MacKenzie and Wajcman, 1985). 'It is often believed that at the beginning of the process of innovation the problems to be solved are basically technical and that economic, social, political, or indeed cultural considerations come into play only at a later stage' (Callon, 2012, p. 78). Rather, the development of technology should be seen as a continuous co-production of technological knowledge and social concerns.

The concept of socialisation invites us to study such co-production with respect to technology innovation and deployment. As Callon and many other STS scholars emphasise, technology is social from its inception but that does not mean that it will be embedded in society. With the concept of socialisation, we are reminded of the need to understand how new technology may become embedded (or not) in society and,

above all, what activities may be needed to achieve its embedding. Below, I discuss some further features of the concept before turning to STS (in particular, technology studies) in order to relate it to other important ideas.

Some scholars have argued that such socialisation efforts meet with more challenges than they did previously. This may be linked to concepts such as 'knowledge society', 'risk society' or 'late modernity' (e.g., Beck, 1992; Giddens, 1991), which suggest a changed relationship between technoscience and the general public. For example, Nowotny et al. (2003) claim that the public have less trust in technoscience than they did previously. Their recipe is to make technoscience socially robust and thus more transparent. They also argue that there is an increased demand for the democratisation of science policy and technoscientific development, wherein the public are given a more important role with respect to the production of knowledge. Bijker and d'Andrea argue that socialisation is 'a way to strengthen democratic legitimacy for policy making on science and technology' (2009, p. 72).

In turn, such democratisation may help to embed new technoscience (such as CCS) in society:

> In sum, science and technology risk to be more and more socially marginalised and to appear as a 'foreign body' to the social system, in the very moment in which they are taking a driving role for the economic and social development and are establishing closer and multifarious connections with society. (Bijker and d'Andrea, 2009, p. 18)

Bijker and d'Andrea propose two social processes of the construction of a relationship between science, technology and society that front this integration challenge.

The adaptation of science and technology is related to the needs and expectations of society and its members. The search for identity acquires greater control over itself and over social dynamics that are increasingly embedded in the research. Bijker and d'Andrea identify processes wherein the actors involved construct relationships between science, technology and society; these processes include scientific communication and mediatisation.

Socialisation is not regarded as a linear and unitary process, but as an approach to identifying areas and ways in which actors may construct the relationship between society and particular technoscientific results. This construction may be done on both the adaptation side and the identity side of science, technology and society. Bijker and d'Andrea name six areas of socialisation: scientific practice, scientific mediation, scientific communication, evaluation, innovation and governance. These areas represent fields in which socialisation processes take place and which may involve a broad diversity of actors. Further, socialisation is a process that must be actively stimulated at the level of practice.

Above all, Bijker and d'Andrea expect scientists and engineers to be active agents of socialisation and to build technoscience to meet social demands. However, they also argue the need for a broader perspective and for developing specific socialisation policies that 'should explicitly address social concerns, and take into account how science and

technology can be beneficial for society' (2009, p. 78). While traditional science and innovation policies often focus singularly on funding and outcomes, the socialisation perspective emphasises that the development of technoscience should be stimulated, but in a way that is socially accountable.

Socialisation actors take part in the development of socialisation policies and/or engage in socialisation processes and policies. In principle, such actors may include any person or institution at the intersection of technoscience and society. However, Bijker and d'Andrea place the main responsibility for socialisation with scientists and engineers. Further, they claim that there are too few socialisation agents and that 'they often work in *hostile environments*, where resistance and hindrances limit the "systemic" impact of their action' (2009, p. 22f., emphasis in the original).

The thesis empirically examines these assumptions in the Norwegian context, with respect to CCS. What kind of socialisation actors in the area of CCS may be observed, and how do they approach socialisation challenges? In particular, how do technoscientists working to develop CCS perceive the need for socialisation activities and what strategies do they pursue? The answers to these questions may help us develop an improved understanding of what socialisation entails. The next section, 'Why socialisation matters', discusses some STS and STS-related approaches and how they may clarify the concept of socialisation as a tool for further analysis. Since STS offers several – sometimes overlapping – possibilities of theorising processes of technological change, I start with the concepts of 'users matter' and domestication theory to underline the need for socialisation. I then turn to the social

construction of technology (SCOT), the social shaping of technology (SST) and actor-network theory (ANT) to look further into the connection between the co-production of the building of society and the shaping of technology.

Why socialisation matters

Oudshoorn and Pinch (2003) point to the importance of understanding user–technology relations. They introduce the idiom of 'users matter', which may be described as evolutionary. This approach highlights the specific role of users in the development of technology, in general, and means that the outcomes of processes of innovation may not be predictable. The approach illustrates how users and non-users influence, shape and co-construct technology and related practices.

Oudshoorn and Pinch examine how these often less visible groups of users influence technology. Using the example of the development of the Moog synthesiser, Pinch shows how inventors, manufacturers and musicians actually invented uses for the object. This illustrates how a market of new users may be created, and demonstrates that many actors may contribute in different ways to the socialisation of a technology.

Another approach that focuses on the importance of users is domestication theory, which is a tool that describes, and analyses sense-making with respect to technology, as well as the construction of related practices (Sørensen, 2006; Silverstone and Haddon, 1996). 'As a starting point, domestication was used as a metaphor for the transformation of an object from something unknown, something wild and unstable, to become known, more stable, tamed' (Sørensen, 2006, p. 46). This emphasis on the importance of studying use also aims to

empower users by demonstrating how important they are to the outcome of technological change.

Sørensen further argues that domestication theory invites a focus on the construction of a set of practices related to the technology, the construction of meaning and the learning of practices, as well as to meaning. Thus, domestication results in embedded technology while detailing the implications of the embedding processes. Socialisation may be seen to facilitate the domestication process by providing input into users' development of practices, meanings and skills. This suggests that practices, meanings and skills are important objectives of socialisation. Consequently, we may think of socialisation and domestication as twin concepts. The first points to efforts to facilitate processes of embedding; the other shows how users appropriate technology to conclude the embedding (Sørensen, 2013).

An important catchword in domestication theory is 'enactment', which leaves the actors vague (Mol, 2002) and may occur in many different areas. While some technologies are domesticated quickly, other technologies meet with difficulties in domestication or do not become domesticated at all. Mobile phones and cars are examples of technologies that have been widely domesticated, while nuclear power has not been domesticated in many countries (see Sørensen 2006; 2013). Domestication may also be read as a measure of acceptance or a way of conceptualising public engagement (Sørensen, 2013). In this respect, domestication theory may be used to shed light on the activities of the general public and the ways in which technoscience may or may not integrate into daily life and practices.

Oudshoorn and Pinch (2003) argue that the social construction of technology approach has drawn attention to users' roles as relevant social groups and agents of technological change. To underline the need for the socialisation of technoscience and how it happens, the SCOT approach has been used in a series of case studies (e.g., Bijker, Hughes and Pinch, 1987; Bijker and Law, 1992; Bijker, 1995), in which the interaction between technology and society with respect to a complex interplay of interests has been analysed.

SCOT assumes that, while various artefacts are potentially useful for similar purposes, human action determines the success or failure of their deployment. Users and even non-users influence the development of technoscience through their interactions. Sociotechnical change in social construction studies highlights the process of, for instance, a technology moving from 'interpretative flexibility to stability' (Oudshoorn and Pinch, 2003, p. 544). By interacting with a technology, users and non-users shape both its deployment and the society into which it is deployed.

Quite similar to the social construction of technology approach is the social shaping of technology (MacKenzie and Wajcman, 1985; Bijker and Law, 1992). The social shaping perspective emphasises that technological innovations are not the outcome of a predetermined path shaped by purely technical or scientific logic. Rather, there is a two-way shaping or co-production of technology and society. The approach highlights the role of users and non-users in innovation processes. Williams and Edge (1996) describe this as the presence of 'choices', to highlight the multitude of options for how innovations may develop;

this, in turn, shows the possibility of technological outcomes that could be different from those actually realised.

Social construction and social shaping approaches demonstrate, above all, how social concerns, needs and interests are part of the innovation process from the beginning. From this perspective, socialisation is a process that starts in the laboratory but must be extended beyond. An iconic example of this is the invention and innovation of the electric light bulb by Thomas Edison, who advertised the invention and its advantages before he started the painstaking process of inventing (Hughes, 1987).

Actor-network theory goes beyond this. The theory, developed by Bruno Latour, Michel Callon and John Law, emphasises the importance of human actors but includes non-human actors, such as material objects, in the analysis on an – in principle – equal footing. From this perspective, the development of technology is the assembling of a network of human and non-human actors, technoscientists, material objects, financial institutions, users and so forth. Here, socialisation is part of the process of building actor-networks – for example by getting people interested in and willing to actually use a particular technology.

ANT is a framework that considers the constant making and re-making of actor-networks. This performance involves building social relations and places – for instance, a technology within networks – which provides another conception of socialisation. Such insights invite a concern over the term ‘embeddedness’ and the related concept of the socialisation of technology as characterisations of the becoming of

artefacts as sociotechnical processes resulting in sociotechnical entities that are used.

The becoming of a technology involves socialisation, but, traditionally, socialisation is rendered invisible due to what is often called the 'black-boxing of technology'. ANT, as well as SCOT and SST, has so-to-speak tried to open such 'black boxes'. This implies investigation of the ways in which social aspects and material elements are co-produced. 'The impossible task of opening the black box is made feasible (if not easy) by moving in time and space until one finds the controversial topic on which scientists and engineers are busy at work' (Latour, 1987, p. 4). This observation points to the role of controversy as a methodological tool for revealing issues of socialisation – for example, whose needs one should cater for – but not necessarily efforts related to informing the public about a technology after the main controversy has been settled, or attracting users.

Traditional ANT considers technoscientists fairly accomplished agents of socialisation (see, e.g., Latour, 1987), in line with the argument of Bijker and d'Andrea. Callon (1987) calls them 'sociologist engineers' and claims that they rather define and redefine the sociotechnical world. Analysing the development of the electric car in France in the 1970s, Callon observes that engineers were concerned with social and technical problems at the same time. 'The project conjectured not only that the technoscientific problems could be overcome but also that French social structure would change radically' (Callon, 1987, p. 84). Law (1987) uses the term 'heterogeneous engineering' to describe the process used by engineers to contribute to the design of both the technology and the social world. CCS technology innovation could be

considered the effect of the interaction of heterogeneous elements, as these are shaped and made part of an actor-network.

This brief discussion of some of the main STS approaches has shown that each perceives efforts that – in this dissertation – are differentially described as socialisation. Through the social construction and social shaping of technology perspective, socialisation is realised partly by technology being constructed or shaped to accommodate social interests and partly by users reshaping the technology to fit their needs. Traditional actor-network theory understands socialisation efforts to be the processes through which accomplished technoscientists assemble actor-networks to succeed with innovations. In both cases, technoscientists are accorded a primary role.

Sheila Jasanoff (2004), in her outline of co-production as the central idiom of STS theory, widens this perspective. She describes co-production as something achieved by employing what she calls 'ordering instruments'. Jasanoff presents four such instruments: (1) making identities, (2) making institutions, (3) making discourses and (4) making representations. Making identities is described as a way of putting things back into familiar places. With respect to the general public, this may, for example, involve providing an identity as citizens supporting the development and deployment of CCS. The making of institutions may be important for creating and/or empowering agents of socialisation. With respect to CCS technology in Norway, the two centres for CCS research that are analysed in this dissertation are sites through which society may gain access to repertoires of problem-solving and managing dissent (Jasanoff, 2004).

The third ordering instrument, making discourses, is about producing new language to facilitate or reinforce understanding of a particular piece of technoscience. With respect to socialisation, it also raises questions about the allocation of tasks. Who has to 'develop persuasive ways of speaking about the problems'? Finally, the aim of making representations is to make scientific knowledge socially robust.

Making identities, institutions, discourses and representation may be seen as important socialisation efforts that go beyond the perspectives of SCOT, SST and ANT by, above all, pointing to policy-makers, NGOs and public agencies as possible socialisation agents. Further, the ordering instruments may serve as tools for detailing what is involved in socialising, in this case, CCS.

In the following, I explore such ideas with a particular focus on socialisation as a communication activity. I do this by introducing and discussing three concepts that appear as a fruitful point of departure with respect to the empirical focus of the thesis: newspapers as an arena for the presentation and discussion of CCS and socialisation activities among technoscientists engaged in R&D of CCS. These concepts are mediatisation, science communication and imagined publics.

The concept of mediatisation is introduced to explore the extent to which and how Norwegian newspapers make CCS a topic of media coverage. Do newspapers take an active role in the socialisation of CCS? The other two concepts are used to explore how CCS technoscientists engage with the socialisation of CCS. Science communication designates a field of research that studies technoscientists' efforts and lack of efforts to communicate their results

to a public wider than their peers. The concept of imagined publics points to the way science communication efforts may be shaped by technoscientists' ideas about the audiences they try to reach.

6. Different ways of socialisation

The relationship between the general public and science and technology is considered, by some, to be in a critical phase, observing '[p]ublic unease, mistrust and occasional outright hostility' (House of Lords Select Committee on Science and Technology, 2000, Introduction). In general, emerging technologies, such as carbon capture, transport and storage (CCS) technologies may be seen to challenge the public's core values and perceptions of risk. This is part of the context in which socialisation activities are given particular concern – not just scholarly, but also politically.

In this section, I introduce and discuss mediatisation, scientific communication and imagined publics as conceptual tools for better understanding what may be involved in the socialisation of CCS and other technologies. I begin with mediatisation, starting by giving an overview of previous studies of CCS in the news media. This is meant to serve as a context for the presentation of the term mediatisation.

Mediatisation

Paper 1 focuses on the identification of 'agents of socialisation' (Bijker and d'Andrea, 2009) in Norwegian newspaper coverage, and newspapers' translation of the technology, as indicated by different storylines. However, while there have been many studies of the social acceptance of CCS, my focus on mediatisation provides a unique foundation on which to build an understanding of the extent to which and how Norwegian newspapers make CCS a topic of media coverage.

As a point of departure, I use a study that focused on the possibility of influencing public support through the way technology is portrayed in the media. Though the study was a survey analysis, the results highlight the influence and importance of the media. A variety of framings for CCS were detected and, as Sharp (2005) argues, both positive and negative media framing was found to influence public opinion.

Also, Scheufele and Lewenstein (2005) highlight the relation between public attitudes and the media. A large number of studies have constituted the media as an important source of information on the meaning of science and technology, and thereby as a kind of keystone for CCS deployment with respect to public awareness. One media study was conducted as part of the Ohio River Valley CO_2 Storage Project. The study claimed to observe a primarily favourable and balanced portrayal, wherein positive reports described the research as 'promising' (Bradbury and Dooley, 2004). In addition, the study highlighted a prominent phenomenon. Uncertainties that were interesting issues of debate for scientists became issues of contention among local publics, who were asked to host the new technology in their own backyards (ibid., 2005, p. 8).

Media analyses of emerging technologies – or, more generally, of global warming – are valuable, in that 'the way in which the media report any new technology can radically affect the success of its implementation — how it is received by the public and other stakeholders as well as decision-makers in government and business' (Mander and Gough, 2006, p. 6). Mander and Gough (2006) conducted a content analysis of printed media during a 212-day period in the United Kingdom, the United States, Canada, New Zealand and

Australia. The majority of articles on CCS presented a neutral or positive view of CCS, while the country with the most negative reporting on CCS was Australia.

In 2007 a Dutch media portrayal of CCS identified positive attitudes toward CCS by industry, the government and environmental NGOs (van Alphen et al., 2007). The events in 2010 in Barendrecht may have changed this. The plans for a carbon capture and storage site was cancelled by the Dutch government in early November 2010. Van Alphen et al. (2007) advised that, at that time, acceptance could be achieved through public participation. Putting CCS into a broader context would also help communicate additional benefits for the public.

Meadowcroft and Langhelle (2009) point out that, despite an interwoven international climate change debate, CCS technology challenges and achievements have been, to a high degree, nationally contextualised. This supports the assumption that the news media plays an important role in influencing public awareness as well as the deployment of energy technologies such as CCS (Feldpausch-Parker et al., 2013). Nerlich and Jaspal (2013) even note that the fluctuation in political and institutional support and stakeholder debate concerning CCS in the UK makes this national context a unique object of study. In these ways, the media can be analysed as a reflection of different meanings and values among the general public and stakeholders in both research and industry.

An important finding presented by Ashworth and Quezada (2011) is that media analyses of new and controversial technology often demonstrate that the framing of information is more important than the

valence of content. ‘Framing’ is a concept embedded in media research and refers to a broader possibility for opinion making through subtle communication features and accounting for social appropriation. In particular, research on emerging technologies such as nanotechnology and biotechnology has highlighted the media’s significant role in influencing public attitudes.

Recent research on the media coverage of CCS technology has been conducted in Europe, the US and Canada. A potential leakage of CO_2 in 2011 in Saskatchewan formed the starting point for an analysis of risk perceptions of emerging technologies and demonstrated how the news media and experts frame events differently. Boyd et al. (2013) also found that CCS professionals and the news media presented very different interpretations of the potential leakage.

The vulnerability of emerging technologies was used by experts to emphasise the importance of building additional demonstration plants to allow for more social and technical learning (see Stephens et al., 2011). The news media, on the other hand, focused on the uncertainties of the scientific assessments and the difference of opinion among stakeholders. Boyd et al. (2013) argued that the case of the alleged leakage points to challenges with respect to how CCS experts may choose to present risks. They also observed disagreements over what should be learnt from the incident, which suggests different viewpoints on necessary socialisation measures.

Interestingly, the study also identified that the leak allegations were followed by a lack of reporting in the UK and Australia, possibly due to higher CCS activity. An analysis of CCS representations in two UK

newspapers in 2011 identified a cycle of hype and disappointment (Nerlich and Jaspal, 2013). 'It will be difficult to reignite interest in CCS in this context, both in terms of media and public attention, and in terms of policy and investment. Regional confidence in national CCS policy in particular will be difficult to recover' (ibid., 2013, p. 35).

Boyd and Paveglio (2012) undertook a media content analysis of the mentioning of CCS in two leading Canadian national newspapers and two major Western regional newspapers from 2004 to the end of 2009. Canada has already successfully begun to implement seven large-scale CCS projects, all under construction, in the planning and operational phases. Boyd and Paveglio (2012, p. 14) observed that '[i]n the case of CCS newspaper coverage we found instances where media producers seemingly omitted frames and information about CCS that are frequently mentioned in broader societal discourses by academics, politicians and industry professionals'.

A study of Japanese newspapers' framing of carbon capture technology identified a very positive and technocratic belief in the technology's development. The newspapers described – in very optimistic terms – the development of CCS technology and promoted CCS as a promising technological fix for climate change (Asayama and Ishii, 2013).

The idea of 'media as a vehicle for knowledge transfer' (de Best-Waldhober et al., 2012) may be moderated by the fact that CCS is often mentioned in relation to specific projects, such as Barendrecht. The study of de Best-Waldhober et al. (2012) also found that the effects of both CO_2 and the technology, itself, in the entire chain were rarely discussed in the news media. However, Dowd et al. (2010) undertook

content analyses of international media coverage to identify the underlying knowledge and attitudes of journalists about CCS technology. They found that challenges, problems, risks and arguments against CCS represented 18% of the total global media coverage (Dowd et al., 2010, p. 82). Observed obstacles to CCS included high risks and costs, ineffectiveness and competition with renewable energies, unknown long-term effects and less storage capability.

The overall finding in a lot studies has been that the media presents CCS in positive or 'balanced' ways, while risks and uncertainties seem to be undercommunicated. Further, CCS technology is often linked to climate change and a broader economic perspective. An added perspective was introduced by a recent analysis in Norway and Sweden that focused on two specific companies involved in CCS deployment and their portrayal in the media between 2005 and 2009 (Buhr and Hansson, 2011). The scholars observed that the companies produced regular media statements either to foster legitimacy or to respond to criticism of CCS. Moreover, the media coverage was observed to be not necessarily linked to technological success or failure.

Arguably, the news media allows for scientific communication in two ways: translation and framing. The mass media can be understood as a channel for mediating policy and scientific/technological innovation, on the one hand, and for reflecting the opinions and trends in society, on the other hand. The media may be a sphere of translation in which both science and technology can be transformed into interesting and understandable issues. Translation provides a conceptualisation of what occurs when technoscientists present their knowledge or technologies:

‘I will call translation the interpretation given by the fact-builders of their interests and that of people they enroll’ (Latour, 1987, p. 108).

As Callon (1981, p. 211) concludes, translation bridges gaps between science and society while involving convergences and homologies by relating things that were previously different (1981, p. 211). Thus, translation highlights the potential role of the media as a channel through which scientists may reach the public. Active translation through the media is a potential way to find a common denominator and bridge the epistemic asymmetry between science and the public.

The media can be regarded as providing a process by which ‘the identity of actors, the possibility of interaction and the margins of maneuver are negotiated and delimited’ (Callon, 1986, p. 203; see also Callon, 1981). The process of making things interesting can also be described as the attempt to translate science and technology into daily life. Therefore, the concept of translation is closely attached to the concept of socialisation agents and thus the way in which an actor perceives the action of another actor and is provoked to respond.

Another analytical concept that is related to the study of agenda-setting in news media is framing. Framing is based on the assumption that the way the media presents, for instance, new technology has an influence on the public’s resultant understanding of that technology. To some extent, framing is related to the concept of translation. Framing is ‘a necessary tool to reduce the complexity of an issue, given the constraints of their respective media related to news holes and airtime’ (Scheufele and Tewksbury, 2007, p. 12).

Nisbet and Money (2007) argue that the reduction of complexity implies not only the possibility of simplifying issues but also the possibility of giving parts of an issue greater emphasis. This, in combination with both attribute framing and outcome framing, provides an interesting viewpoint with respect to CSS technology. Attribute framing sheds light on particular aspects of an issue (Spence and Pidgeon, 2010).

As Spence and Pidgeon argue, framing is a commonly used technique in political debates, often to influence evaluations (2010, p. 687). In contrast to attribute framing, the approach of outcome framing highlights a particular issue with respect to either/or: either you take part/support/avoid or you lose/suffer/are excluded.

A supplement or alternative to framing is the concept of 'mediatisation', which, according to Hjarvard (2013, p. 1), 'has proved useful to the understanding of how the media spread to, become intertwined with, and influence other fields or social institutions'. To study mediatisation is to analyse the role of the media and mediated communication in societal changes.

We may think of mediatisation as a process through which the news media may contribute to embedding, dis-embedding or re-embedding social – or, better, socio-technical – relations, such as those that might emerge from efforts to deploy CCS. This emphasis on the transformative properties of the news media is very useful as part of the study of the socialisation of CCS. If we were to use the framing concept to approach CCS, our main focus would be on sense-making

processes between the news media and the public. What image of CCS is communicated to the public through news media?

The concept of mediatisation is a more radical approach that helps to characterise the kind of influence that the news media exerts in contemporary society. According to Hepp (2013), we can observe that, when the news media mediatises a phenomenon such as CCS, it displays moulding forces that shape society. This means that, when we see mediatisation as a form of the socialisation of technology, we assume that the news media increases the effectiveness of the socialisation efforts of other actors.

What is added? Clark (2009) claims that mediatisation means that social organisations, structures or industries take on the form of the media. In the case of CCS, this implies that CCS is understood at least partly as a media phenomenon – as something that owes its meaning, and perhaps also its sociotechnical features, to the news media.

The above overview of research into the way in which news media has related to CCS suggests that we cannot yet conclude with respect to the mediatisation. In some cases, it seems that news media has contributed to making CCS controversial. However, there is a lack of evidence that news media has exerted 'moulding forces' with respect to CCS. I shall return to this issue with respect to Norwegian news media.

Communication activities are challenging for scientists and scientific institutions. Mediatisation and critical journalism notwithstanding, technoscientists remain a vital source of scientific knowledge and expertise. However, as I have discussed above, if technoscientists are to become a relevant source of scientific knowledge, this knowledge must

be translated. We should not assume that the translation of technoscience is easy; it involves considerable reflections and decisions regarding what should be communicated and how.

Typically, the more specialised a scientist, the greater his or her communication problems (Nielsen and Heymann, 2012). Tøsse (2012), having studied communication strategies among climate scientists, identifies yet another difficulty and faults the frequent, implicit assumption that science communication takes place in a situation in which all parties have a positive interest in learning. Actually, technoscience may be controversial, and this complicates translation.

What do we know about how technoscientists engage with science communication? I now turn to this issue.

Science communication

As previously noted, there has been some concern over the low level of knowledge about new technoscience and the risk that this could produce negative attitudes, which could further lead to protest activities. Such concerns have produced efforts to engage the public in the early stages of technological development processes (Lupion et al., 2013; Ashworth and Quezada, 2011; Lipponen et al., 2011; Oltra et al. 2010). 'Communication with public is essential when any emerging technology aims to be deployed, particularly if there is some perceived risk associated with that technology' (Lupion et al., 2013, p. 7,372).

Communication may not always be what is lacking. In the famous case of Barendrecht, it turned out that the local community did not primarily protest against carbon storage technology, but against rigid top-down

decision making (see Brunsting et al., 2011; Desbarats et al., 2010; Feenstra et al., 2010). In other locations, positive attitudes have been observed. For example, in Hontomin in Spain it was found that 60% of the population saw a planned CCS project as beneficial for the region. This was seen as a result of the project's action being well integrated into local activities (Lupion et al., 2013). Similar observations have been made with respect to a CCS project in Illinois (Hund and Greenberg, 2011).

The studies reviewed above point to the importance of technoscientists engaging with the public and communicating science. It is often suggested that there is a relationship between a knowledge deficit, scepticism and open protest regarding CCS, even if the case of Barendrecht suggests that other problems may be more pressing. How may we understand the dynamics of technoscientists communicating and engaging with the public regarding the technologies they develop?

A premise of my study, as mentioned several times, is that if emerging technologies are to become successfully embedded in society, they must be socialised. This means that their meaning, risks and benefits must be communicated, and technoscientists, as agents of socialisation, has been expected to take a leading part in such efforts (see also Felt and Wynne, 2007; Nowotny et al., 2001). Felt and Wynne offer a further motivation by arguing that science is closely intertwined with society. This means that knowledge created in laboratories remains central, but it is created in a frame in which it is nourished by actions from citizens and mutual enrichment (2007, p. 55).

These views are probably not widely accepted among technoscientists, even if science communication is seen as important. This may be related to the understanding of what science communication is. Palmer and Schibeci (2012) describe the two dominant models of research on science communication. The first is the deficit model, which considers the public to have a low level of understanding; this deficit needs to be overcome in order to facilitate what scientists consider rational decisions. The second model tends to be described in terms such as 'dialogue', 'interactive', 'two-way' and 'consultation'.

The overall assumption of science communication is that technoscientists should reach out to the general lay public, offering understandable knowledge. 'The term "science communication" encompasses communication between: groups within the scientific community, including those in academia and industry; the scientific community and the media; the scientific community and the public' (Office of Science and Technology and the Wellcome Trust, 2001, p. 316). The report further concludes that some scientific developments are so fundamental that they require national debates. Thus, politicians and technoscientists should not make decisions without wider public discussion (ibid., 2001, p. 317).

However, public engagement activities often become 'a sort of goodwill exercise' (Neresini and Bucchi, 2011, p. 64). Neresini and Bucchi studied institutional characteristics that determine engagement activities and concluded that public engagement initiatives are not considered very relevant by research institutions in Europe. Moreover, Palmer and Schibeci (2012) studied research funding bodies in Europe, North America, South America, Asia, Oceania and Africa and found

that deficit models prevail. These findings suggest that, at best, technoscientists engage in the dissemination of scientific knowledge to fill knowledge deficits among the public. However, a 2004 survey among scientists in the United States found that 42% claimed they did not engage in public outreach. More than three quarters of the interviewees said they did not have the time to do so. A few also mentioned that they did not want to carry out engagement activities and that they did not care about them (NSF, 2004, pp. 7–4).

Thus, science communication activities seem to have gained limited ground. According to Davies (2008), who interviewed scientists: 'public communication was generally framed in very negative ways: it is seen as a difficult, perhaps impossible, task, as well as a dangerous one that requires extreme caution to prevent audiences from misunderstanding or misusing scientific information' (p. 427). The existing research literature offers various reasons why technoscientists are not engaged in science communication. While some studies have identified a lack of training (Gascoigne and Metcalfe, 1997; Poliakoff and Webb, 2007; Roper et al., 2004), others have highlighted the difficulty of finding time or the lack of professional rewards from such communication activities (Burchell et al., 2009; Gascoigne and Metcalfe, 1997; Poliakoff and Webb, 2007; Royal Society, 2006; Thwaites, 2009).

Hartz and Chapell (1997) found that scientists complained that neither the news media nor journalists contacted them. 'Twenty-six percent of the scientists who responded said they had never been interviewed by a reporter; 45 percent said they are interviewed only "every few years". Just 4 percent said they talk to journalists once a month or more often'

(p. 22). In addition, Davies (2008) found that descriptions of communication as difficult and dangerous contributed to a sense of the public as not only ignorant, but also unfit to manage science. She claims that the scientists she interviewed thought that caution was required in public communication because people tended to be uncritical, would often misunderstand and might be biased in their interpretation of scientific information (p. 428).

Poliakoff and Webb (2007) found that scientists, in general, were positive toward participation in public engagement activities and that they thought colleagues and friends/family approved of such participation. However, the scientists still believed that many colleagues avoided public engagement activities. Many scientists also felt that their research was unsuitable for engagement activities. Other studies have shown that science communication is perceived as a task for non-scientists (Bauer and Jensen, 2011). In many countries, a new sector of the culture industry has emerged to engage the public with science.

Similar observations of 'outsourcing' or specialisation have been made in other studies. Thwaites (2009) calls such actors 'professional communicators'; Zorn et al. (2010) use the term 'expert facilitator'; and Horst (2013) observes different types of scientists engaging with science communication: experts, research managers and guardians of science. Horst expects that research managers, representing a professional research organisation, will become more widespread science communicators. Science communication is not to be done by all scientists.

Many believe that there has been an extensive increase in science coverage (see Schäfer, 2009, p. 477). Schäfer uses three concepts to describe these ongoing changes: (1) 'extensiveness', in that science is said to be increasingly represented in the mass media; (2) 'pluralisation', in that media coverage of science is becoming increasingly diverse in terms of actors and content, and (3) 'controversy', in that media coverage of science is becoming increasingly controversial (Schäfer, 2009, p. 478). However, these changes of extensiveness, pluralisation and controversy do not necessarily mean that more technoscientists are participating in science communication.

Communication is an interactive process that is shaped by participants' views of each other. Davies (2008) observes that the models of the communication process used in science communication are co-constructions of the publics that are communicated to. According to Blok et al., 'relatively little is known about how experts and lay-people conceive each other's identities and competencies' (2008, p. 192). Research on imagined publics or imagined lay persons may correct this view. Further, it seems obvious to assume that scientists' motivation to communicate science and engage with the public is influenced by their understanding of the need for such activities, rather than by any formal requirements. This must be studied more closely.

Imagined publics

The concepts of 'imagined lay persons' (ILPs; Maranta et al., 2003) and 'imagined publics' (Walker et al., 2010; Barnett et al., 2012) have been used to describe how technoscientists think about people who

could engage with their results or become educated about new scientific knowledge. The advantage of these concepts is that they 'provide a more sophisticated conceptualisation in considering how imagined lay persons are part of the way in which lay–expert interactions are framed and circumscribed and encounters are anticipated' (Walker et al., 2010, p. 934).

Maranta et al. suggest that 'when the experts imagine the position of the lay persons in their expertise, they unilaterally predetermine the ILPs' competences' (2003, p. 152). They continue:

> Indeed, depending on how the subjectivity and agency of the public is anticipated and internalised into organisational strategies and working practices of different actors within and across sectorial networks, this imagined public might be of greater long-term significance than the 'real' versions of specific publics encountered in meeting rooms and community halls. (Walker et al., 2010, p. 943)

How is the general public imagined? A consistent finding is that scientists tend to describe them as uninterested and not eager to learn (Burningham et al., 2007). Active interaction between scientists and engineers and lay people is often absent, even if both have implicit imaginations of each other. Maranta et al. argue that the deficit model implies a standard assumption of a lay person who knows little but is curious and eager to know about science (2003, p. 154). Nevertheless, Walker et al. (2010) warn that the imagined public of technoscientists is 'a real and present danger' to the development of projects, as well as to achieving business aims. Imagined publics are not real publics, even if technoscientists may act as if they are.

The concept of 'the public' is tricky. Michael (2009) warns about this when he proposes that we should consider two different types of public: the public in general (PiG) and publics in particular (PiPs). The idea of PiPs is relevant when we consider local knowledge and behaviour toward technology deployment and implementation. For example, people living close to a proposed CCS storage site or a CO_2 transport terminal may be expected to react to CCS differently than people living far away. The public in general is, on the other hand, usually presented as an undifferentiated whole. Maranta et al. also argue that a crucial quality of imagined lay publics is that they tend to be envisioned as functionally differentiated. 'The assumptions about individualised ILPs are quite specific since the experts assume certain motivations and interests that drive ILPs to engage with the information object' (Maranta et al., 2003, 159).

'The public' is, in many ways, a fragile and provisional concept, with phantom-like qualities (Latour, 2005; Lippmann, 1925; Marres, 2005). However, Walker et al. (2010) argue that we should not expect this to become transparent and self-evident when analysing how phantom publics become imagined and, in this sense, real and influential.

As mentioned above, technoscientists commonly imagine publics to have a lack of knowledge. This lack of knowledge is seen to cause public mistrust in, and possibly also public resistance to, technology (Barnett et al., 2012; Walker et al., 2010; Wynne, 2006; Barnes et al., 2003; Maranta et al., 2003). In this situation, one may ask what kind of information ought to be communicated, and how do technoscientists actually construct lay publics in this state of (lacking) knowledge? Are technoscientists led to the belief that the public are often irrational

(Cook et al., 2004; Davies, 2008; De Boer et al., 2005; Krystallis et al., 2007; Michael and Brown, 2000; Moore and Stilgoe, 2009; Petersen et al., 2009; Young and Matthews, 2007) or inappropriately self-interested (Burningham et al., 2007; Young and Matthews, 2007; see also Besley et al., 2013)?

Mediatisation, science communication and imagined publics in the socialisation of CCS

To summarise, the thesis studies the socialisation of CCS in Norway with an emphasis on two arenas: the news media and CCS R&D institutions. The role of the news media has been explored through the concept of mediatisation, which invites an exploration into the ways in which the news media has attempted to shape the way in which CCS has been embedded in Norwegian society. However, we should not take it for granted that CCS has been mediatised in the Norwegian context. Moreover, we must ask how the news media has tried to shape the public understanding of CCS.

With respect to R&D institutions engaged in the development of CCS, I have highlighted the importance of studying their science communication activities in order to analyse their socialisation efforts. Previous research into science communication has suggested that technoscientists working to develop CCS may be reluctant to engage with the public and to inform the public about what CCS technology is meant to achieve. On the other hand, the concept of imagined publics may – as we have seen – identify an important set of motives for becoming active in socialisation. This is related to the common finding

that imagined publics tend to be seen as lacking in knowledge and thus prone to scepticism – if not outright hostility – to new technologies.

In the next section, I pursue these ideas as a point of departure for discussing prominent features of the efforts made to socialise CCS in Norway. What can we observe by looking at the ways in which CCS has been referred to in the news media? What are the arguments of CCS technoscientists regarding the need to communicate and otherwise engage with the public?

7. Socialisation efforts related to CCS in Norway

As discussed above, CCS has played an important role in Norwegian politics, particularly with respect to climate, environment and energy issues. Arguably, there has been outspoken political efforts to socialise CCS in Norway for quite some time, peaking with Prime Minister Stoltenberg's speech in 2007 when he proclaimed the development of CCS to be Norway's metaphorical 'moon landing project' (see Paper 1).

Paper 2 provides a description of experts' imaginaries of the general lay public's relationship with CO_2 capture and storage technology in Norway. The final paper sheds light on how the interviewed CCS scientists and engineers observed their role with respect to science communication and public engagement.

In the research literature, as we have seen, there have been several partially overlapping efforts to theorise socialisation of technology. In STS, the idea of socialisation is closely related to the idiom of co-production of technology and society and the efforts needed to embed new technologies in society. In this sense, socialisation is a two-way process wherein efforts to embed also lead to changes in the technology one is trying to embed. Pinch and Bijker's (1984; 1987) classic study of the bicycle provides an iconic example of this.

Policy-makers and the scholarly literature have given scientists and engineers a major role in socialisation (e.g., Felt and Wynne, 2007; Bijker and d'Andrea, 2009). As previously argued, this makes science

communication a major concern with respect to socialisation, and results from this area of research have raised serious questions about the extent to which technoscientists actually take on this role. In this dissertation, science communication has been analysed with a particular emphasis on the ways in which CCS technoscientists perceive their audiences – above all, the general public – and in light of this, how they engage with science communication.

A main point of departure is the concept of imagined lay persons (Maranta et al., 2003), which proposes that science communication is shaped by a belief in an ignorant public that may be critical or at least not supportive due to this lack of knowledge. The need for public engagement with new science and technology, a currently popular vision in policy circles as an important socialisation strategy, may be inhibited or at least distorted by science communication based on imagined lay publics. Is this the case among Norwegian CCS scientists and engineers?

On the other hand, the news media may also engage in science communication, and the news media is commonly considered the most important source of public knowledge about new science and technology (see, for instance, Paper 1). Thus, the mediatisation of CCS may be a very important – perhaps dominant – aspect of the socialisation of CCS. Technoscientists may play a role in the mediatisation of CCS, but so might politicians, industrial actors, concerned citizens and so forth. Media coverage may also indicate whether CCS is considered controversial and, if so, how.

Thus, this dissertation has studied the socialisation of CCS in Norway through, above all, three main concepts: mediatisation, science communication and imagined lay publics. How may we draw upon these concepts to synthesise an understanding of the central features of this socialisation process? To begin, we have learned from Paper 1 – the analysis of CCS in the Norwegian news media – that CCS has actually been the object of substantial socialisation efforts. An important feature of these socialisation efforts is how CCS in Norway has been treated as a unitary phenomenon, in contrast to what we observe in many other countries.

Internationally, public interest in CCS has mainly related to storage, which has been considered controversial (Wallquist et al., 2012; Amikawa et al., 2011; Ashworth and Quezada, 2011; Mander et al., 2011; Terwel and Daamen, 2011; Kuijper, 2011; Wassermann et al., 2011; Huijts et al., 2007). Further, from the news media articles analysed in Paper 1, we have learned that CCS has been mainly framed as a political issue related to climate mitigation and Norway's position as a leading producer of oil and gas.

Scientific and technological aspects were seldom mentioned in newspapers during the period of study, and few efforts were made to identify or explain how CCS may have concrete consequences for individual citizens (see Paper 1). Thus, it is tempting to characterise the socialisation of CCS in Norway as mainly political. Would this characterisation be correct?

In the following, I use the three papers that form the core of the dissertation to further explore the issue of how CCS has been socialised in Norway. The analysis is particularly focused on the following issues:

1. Who are the main socialisation actors with respect to CCS, and what have their main efforts been?
2. What are the main challenges of socialising CCS in Norway, and how has CCS been communicated to the general public?
3. How may we understand the role of CCS scientists and engineers in the socialisation efforts?

Who socialises CCS in Norway?

The papers have allowed us to identify some of the main agents of CCS socialisation in Norway. Above all, Paper 1 suggested who the most important agents of socialisation have likely been, judging from their visibility in the Norwegian news media coverage. Most striking is the way in which the development and deployment of CCS has been a long-standing political issue in Norway, which means that politicians have made important efforts to socialise CCS by providing meaning to the technology. A strong political optimism, voiced by former Prime Minister Jens Stoltenberg (but also by many other politicians), has resulted in a series of political talks and interviews that has represented a considerable socialisation effort.

Paper 1 showed that, overall, CCS was given a very positive meaning in the news media. The technology was presented as a tool for reducing national greenhouse gas emissions and, further, as a viable and technically feasible answer to global emission problems. Hence, the technology appeared not only as a technical solution for reducing CO_2

emissions; it was also translated into a kind of Norwegian fairy tale to motivate public support. A lot of national prestige was placed in the technology.

While politicians focused on the importance of the technology with respect to the Norwegian economy and its role model function for demonstrating environmental awareness, we observe in Paper 1 a more energetic socialisation effort undertaken by the environmental organisations ZERO and the Bellona Foundation. These organisations shared the technological optimism of the politicians but were critical toward what they considered slowness in the actual realisation of CCS. This led these organisations to present CCS as a frustrating political challenge because it held such large social promises with respect to climate mitigation.

The socialisation strategy adopted by the environmental organisations ZERO and the Bellona Foundation was, above all, to translate the technology into an environmentally friendly tool for using fossil fuel. This made successful implementation of CCS critical to short- and medium-term climate change mitigation, which was why the environmental organisations appeared impatient in the news media, asking for greater speed in building CCS. This was also evident in Paper 1.

The dominance of the political support, coupled with technology determinism, made CCS technology appear unavoidable, proven and, therefore, a constructive response to the challenges of climate change mitigation. Together with the strong political support for CCS, the

extensive input into newspapers of both the Bellona Foundation and ZERO can be seen as an important socialisation effort.

What, then, about industry? Statoil, the company with which the government entered into an implementation agreement to develop CCS, is a leader in CCS technology, and operates some of the world's largest projects in this field. In Norway, there is the Snøhvit licence, which separates carbon dioxide from feed gas, and the Sleipner asset, which started the first large-scale offshore CO_2 separation and injection into a geological formation. Nevertheless, Statoil has been reluctant to engage in news media and the coverage or mentioning of CCS. Rather, the company informs the public about their CCS projects on their online homepage, which has much less public visibility. Thus, Statoil has made very limited socialisation efforts – at least according to what was found in the media analysis.

The public enterprise Gassnova was established in 2007 to manage governmental interests related to CCS. On their online homepage, Gassnova states that they will contribute to finding solutions to ensure that CCS technology can be implemented and become an effective climate measure.[8] The agency also provides advice on all aspects of CCS to the Norwegian Ministry of Petroleum and Energy and seeks to promote cooperation between industry and researchers. Like Statoil, Gassnova mainly informs the public about CCS via their online homepage, as well as their weekly newsletter, which presents an overview of national and international news concerning CCS. According to the analysis of media references to CCS, Gassnova also

[8] http://www.gassnova.no/en/about-us - 27.12.2013.

holds a low media profile and contributes – only to a limited extent – to the socialisation of CCS. Similarly with Aker Clean Carbon, a subsidiary of Aker Solutions, which is a prominent company working to develop CCS. Overall, Paper 1 suggests that industry has been reluctant in its socialisation efforts and preferably communicates through websites or newsletters with quite limited outreach.

From the perspective of Bijker and d'Andrea (2009) and Felt and Wynne (2007), we would expect CCS technoscientists and the two national Centres for Environmentally Friendly Energy Research (FMEs) focusing on CCS to be visible agents of socialisation. However, Paper 1 suggested that these agents play a fairly modest role in news media presentation. This is confirmed by the findings in Paper 3.

Paper 3 focused on technoscientists employed to develop CCS and gave a fairly detailed picture of their impressions of their engagement and science communication activities. Clearly, activities with the aim of sharing knowledge with the public were not high on their daily agendas. The technoscientists did not perceive themselves as active agents of socialisation and had no visible leading role in educating and engaging the public. Rather, they expected somebody else to take on this role.

This indicates that socialisation of CCS in Norway – at least to a substantial degree – has been a political undertaking. The most prominent undertakings, judging from paper 1, have emerged from politicians and the two active NGOs; Bellona and ZERO. The implications of this are difficult to assess. However, it is interesting to

note that while according to paper 1, the main political effort has been to emphasise that CCS is needed to mitigate climate change, the interviewed technoscientists think that politicians do too little to explain this (paper 2).

The main challenges of socialising CCS in Norway

Arguably, it should be fairly easy to socialise CCS in Norway, given the low level of public controversy over the technology (Paper 1), the strong political support and important political role of CCS as well as the promises of being a technology of climate change mitigation. However, the interviews with the technoscientists (Papers 2 and 3) complicate the issue. While the scientists did not fear protests and mainly thought that the Norwegian public supported the development of CCS, they also felt that the public knew too little about CCS. In this manner, they articulated communication about CCS as what we should consider an important socialisation challenge.

Drawing on the discussion in section 6, we have seen that the CCS technoscientists felt they had a translation problem. For example, most of them argued that the technoscientific issues of cleaning and storing CO_2 were far too complicated for lay people to understand (for details, see Paper 2). Seeing the technology as difficult to understand and thus difficult to explain, they did not see science communication – understood as the popular dissemination of technoscientific knowledge about how CCS works – as a viable and interesting strategy.

Rather, science communication was more or less reconceptualised as a demand for political communication or for providing the public with knowledge about why CCS was needed (Paper 3). CCS was translated

into an issue of how to argue the importance of CCS, side-stepping what the technoscientists considered their core expertise. Most of them told us that they thought the translation of CCS – which they considered an important socialisation challenge – was somebody else's task. Questions regarding benefits, risks and the general meaning of the technology were assumed to be something that, above all, politicians and the news media should take care of.

In the interviews, many technoscientists voiced frustration with respect to both politicians and the news media. They criticised the current Norwegian climate policy for being unclear about the seriousness of human-made global warming, the need for climate mitigation action and thus the importance of CCS. The news media were criticised similarly. The interviewees argued that climate policy and media coverage should be more accurate and informative. How serious was the translation problem seen to be? Paper 2 identified three narratives of the consequences of this situation. The first, 'benign ignorance', was dominant and implied a downplaying of the translation problem. Since Norwegians were environmentally conscious, they were assumed to be supportive of CCS. The second, the 'deficit narrative', emphasised the above translation concerns, while the third, 'informed support', represented a disagreement with respect to the public understanding of CCS – the scientists thought the public were reasonably well informed.

Thus, translation was seen as a socialisation problem, but, to the majority of interviewees, it was not very pressing and the problem was mainly seen to belong to someone else. Also, the findings in Paper 3 suggested that the CCS technoscientists did not see socialisation as something they should be concerned about and work with. Arguably,

from a broader perspective, such attitudes constitute one of the major challenges to socialisation. I return to this point in the next section.

According to Paper 1, there was little critique of CCS as a climate change mitigation concept in Norwegian newspapers over the period of time under analysis. The two dominant storylines were both supportive of CCS. None of the storylines consciously addressed socialisation challenges, though the two dominant storylines included arguments that explained the need for CCS. For example, the environmental NGOs, the Bellona Foundation and ZERO, presented CCS technology as a strategy for 'climate friendly' use of fossil energy. Still, judging from the way in which CCS was presented in the newspapers, there was little interest in public engagement and dialogue as an effort to identify what the public may have been concerned about. Bellona and ZERO were most worried about the slowness in realising CCS, while the newspapers in the most recent period were particularly concerned with cost overruns, delays and a possible lack of competence with regard to running CCS projects.

Thus, it seems that – from a CCS socialisation perspective – the most important challenge is the lack of recognition of the need to perform socialisation. With the broad political compromise regarding large government grants in support of CCS, politicians may not need to worry about socialisation, much as the technoscientists believed in benign ignorance. We could also relate this to the question of whether CCS has been mediatised. Has the news media made an effort to shape the embedding of CCS in Norwegian society?

Paper 1 suggested that the answer to this question is negative: CCS has not really been mediatised in the Norwegian context. While this conclusion may be debated on the basis of the criteria one applies with respect to mediatisation, the analysis in Paper 1 showed that the Norwegian newspapers were not very engaged in CCS, other than as an issue of potential political mismanagement. The lack of mediatisation should be added to the list of socialisation challenges – not because the newspapers made no effort to frame CCS, but because they did offer some interpretative frames. However, these frames – such as political mismanagement and cost overruns, and even CCS as a technology for the clean use of fossil fuels – addressed the issue of what CCS meant to Norway and Norwegians in quite abstract ways. To put it in perspective, one could think about the mediatisation of cars, which is and has been massive and concrete.

The role of scientists and engineers: The hesitant socialisers of CCS

Before I explain the perceived role of technoscientists in the socialisation of CCS technology, I want to highlight their conceptualisations of the general public (as demonstrated in mainly Paper 2). These conceptualisations were developed through reference to the concepts of 'imagined lay people' (Maranta et al., 2003) and 'imagined publics' (Walker et al., 2010). The focus of Paper 2 was on providing an understanding of CCS technoscientists' imaginaries of the general lay public's relationship with CO_2 capture and storage technology in Norway. The concept of imagined lay people (Maranta et al., 2003) forms the basis of the assumption that scientists' constructions of the general public are based on an epistemic

asymmetry between experts, who know about the science or technology, and lay people, who do not.

Walker et al. (2010) argue that imagined publics may have greater effects on the actions of technoscientists than do 'real' publics, not the least because experts tend to link knowledge deficits to possibilities of protests and resistance. Did the interviewed technoscientists fear resistance to CCS implementation? A consistent and unsurprising finding in Paper 2 was that the interviewees painted a picture of an uninformed general public. However, they introduced an interesting distinction between understanding the technology and grasping the wider context, as discussed in the previous section.

The interviewees, as shown in Paper 2, did not think it reasonable to expect the public to hold an adequate understanding of the technology, due to its complexity. As discussed above, the scientists were more concerned with a lack of understanding of what might be achieved through the implementation of CCS – a reduction in CO_2 emission that would mitigate climate change. None of the interviewed experts worried about critical attitudes toward the technology. To the extent that the public were seen as not positive, Norwegians were considered passively expectant. Also, several interviewees constructed an 'out of sight – out of mind' narrative about the public's perception of the potential risks involved in storage (Paper 2). In this way, it became clear that the interviewed technoscientists were more concerned with the public understanding of climate science than of CCS. They saw the socialisation of climate science as more pressing than of CCS.

The imagined public observed by Maranta et al. (2003) or Walker et al. (2010) was ignorant and thus possibly critical and even resistant. The analysis in Paper 2 showed, in contrast, that the majority of interviewees constructed the public as benignly ignorant of CSS; some even viewed the public as informed supporters of the technology. This shows that the concept of the imagined public is a useful tool for analysing how technoscientists think about the public's relation to their research, but we must be careful about generalising their observations. At least, it is clear from my research that knowledge deficits may be interpreted quite differently. It is also interesting to note that my interviewees did not share a single, coherent interpretation of the public with regard to CCS; rather, they held diverse views.

An important point of departure for this dissertation is the argument that new technoscience must be socialised and embedded in society. Further, as argued by Bijker and d'Andrea, technoscientists are given the particular responsibility of becoming socialisation actors. Underlying this argument is the fear that there is a link between knowledge deficits and the potential for resistance and protest. The findings in Paper 2 suggested that this fear was not very prevalent in the technoscientists I interviewed. Consequently, one might expect that the technoscientists were not very motivated to engage in socialisation measures unless they felt an obligation to do so out of science policy expectations.

Paper 3 confirmed that there was little interest in public engagement, including traditional science communication, among the CCS technoscientists. To discuss this finding more broadly, it may be useful to again note that two models have dominated research in science

communication (Palmer and Schibeci, 2012). The first is the so-called deficit model, wherein the public are seen to have a low level of understanding that must be overcome to avoid resistance or protests. The second model is 'variously called the "dialogue", "interactive", "two-way" or "consultation" model' (ibid., 2012, p. 2).

Drawing on the concept of imagined publics, I would expect that scientists' motivation to communicate science and engage with the public would depend on whether they see the need for such activities, rather than on any formal requirements. The deficit model represents a particular dominant example of experts' imaginaries of lay people. This was identified in Paper 2.

The deficit model leads to a particular model of communication. Bijker and d'Andrea (2009) highlight the anticipated leading role of scientists and engineers in science communication. They also outline socialisation challenges that prevent science and technology from working: 'Socialisation agents most of the time are not aware of their role and the opportunities to contribute to socialisation' (ibid, p. 75). Scientists and engineers are, on the one hand, expected to engage in such heterogeneous engineering; but, on the other hand, there is the assumption that they may not do so, after all.

Paper 3 showed that the CCS technoscientists were positive about public engagement but reluctant to take part in such initiatives. To some extent, the findings in the paper are in line with common observations from other studies of science communication. Important barriers were said to include a lack of time, a lack of proper competence and inexperience in dealing with the news media.

However, a prominent and widely used argument was that, counter to the expectations voiced by, for example, Bijker and d'Andrea, the technoscientists did not consider public engagement (including science communication) their job. Again and again, the interviewees mentioned that 'other people' were more responsible for providing information about CCS. 'Other people' included politicians, NGOs and even social scientists.

Thus, the responsibility for doing science communication faded away; more precisely, science communication was transformed with reference to the way in which CCS technology was turned into a political issue. The interviewed technoscientists thought that science communication was primarily about the context of CCS – why it was needed and what it was supposed to contribute – and communication of such issues would be outside their field of competence.

This raises some important issues regarding the socialisation of technoscience: What is it, and who should do it? In the public engagement literature, there is a tendency – which is clearly reflected in Bijker and d'Andrea (2009) and Felt and Wynne (2007) – to claim that technoscientists hold a particular responsibility for engaging in such activities. However, this presupposes that technoscientists are competent translation actors. While there are some iconic examples, such Thomas Edison and others (see Latour, 1987 for more examples), these examples are not very typical. Technoscientists are normally not trained to do such work, despite Callon's (1987) claim that engineers are better sociologists than are sociologists, with respect to interpreting the social aspects of technology. The problem is that social scientists are not normally trained to socialise technology.

Thus, one conclusion from this dissertation is that we must reconsider what the socialisation of technoscience implies and what skills are needed to do such work. We cannot reasonably expect technoscientists to be the main socialisation actors.

Conclusion: how to study socialisation of technoscience

In this dissertation, I have used the concept of socialisation to analyse efforts that in effect are directed at the embedding of CCS in Norwegian society: news media's engagement with CCS and activities among CCS technoscientists. The concept has proved useful as a tool to identify such efforts but also to observe lack of engagement. The latter feature is due to the fairly strong normative basis of earlier theorising with respect to socialisation of technoscience, above all the strongly voiced expectation that technoscientists and technoscientific institutions should play a major role in performing socialisation efforts.

This normative feature reflects on a widespread assumption in STS; the laboratory as a primary institution of modern society and technoscientists as the dominant actors in the development of technoscience. While this assumption is weakened in more recent contributions, like Latour (2005), it remains central in the theorising related to socialisation.

The findings of my thesis suggest that this assumption should be weakened and that the study of socialisation of technoscience should cast the net wider when looking for effective socialisation actors. News media is an obvious candidate, but as Paper 1 shows, politicians and NGOs may be even more important.

I have analysed socialisation of CCS by – in particular – leaning on three concepts; mediatisation, science communication and imagined lay publics. This reflects an understanding of socialisation as being above all a set of communication activities. The concept of mediatisation proved useful to show that news media's engagement with CCS was limited; newspapers did not seem to exert a 'moulding influence' on CCS but rather more as reporting from a distance.

The concept of science communication was helpful because the considerable literature on the topic suggests more cautious expectations with regard to technoscientists' communication activities. My findings are mainly in line with the literature regarding the reasons technoscientists give for not engaging with science communication. However, in my case, it was striking how the CCS technoscientists argued how communication about CCS – and consequently socialisation efforts – was the responsibility of other people, like politicians and news media.

I have used the concept of imagined publics (or imagined lay people) as a way of studying the motivation of technoscientists to engage with the public and to see if the perception of public knowledge about and attitudes towards CCS would influence their professional efforts. Previous findings regarding imagined publics have resulted in a model where assumptions about public knowledge deficits lead to fear about lack of support and even resistance and protest. Thus, technoscientists are supposed to be motivated to engage with the public or to adopt their technologies to avoid such situations.

My findings, in particular with respect to what I chose to call 'benign ignorance', suggest a different dynamic: technoscientists assuming a knowledge deficit but also positive attitudes towards, in my case, CCS. This means that the imagined publics of the CCS technoscientists had little effect on their activities. They did not feel a need to engage with the public or to change their ideas about how CCS should be designed. Clearly, it would be useful with more research about imagined publics, above all to study how different contexts may influence how the publics are imagined.

Previously, I suggested the concept (or idiom) of co-production of knowledge and society (Jasanoff, 2004) as an overarching approach to studying socialisation. With respect to the present study of the socialisation of CCS in Norway, a brief effort could be made to assess what has been achieved. Jasanoff suggests considering four ordering instruments when studying co-production: (1) making identities, (2) making institutions, (3) making discourses and (4) making representations. On the basis of Paper 1 in particular, some suggestions regarding these instruments may be made.

First, with respect to making identities, the most striking observation is how two NGOs – Bellona and ZERO – have developed a kind of CCS identity. A similar observation could be made with respect to quite a number of politicians who have supported CCS developments. Also the technoscientists working with CCS had a CCS identity. However, Paper 1 suggests that such identity-making has not reached the Norwegian public – at least not yet.

Second, institutions have been made, above all Gassnova and the two research centres I have studied. However, this is a fairly upstream and not very effective making of institutions. Third, the CCS discourse has in this dissertation been observed to be limited at best. The public image of CCS as provided by Norwegian newspapers is more of a technology that is struck by delays and cost overruns than a technology for climate change mitigation. Finally, with respect to the making of representations, this is more difficult to assess but probably meets with the same challenges as the making of discourses.

Thus, it is tempting to conclude that the socialisation of CCS has not – yet? – been very successful and that a co-production still has not been achieved. This conclusion should be read with some care. First, from an STS perspective, it is clear that the development of CCS is a social process and that social elements are part of the development part from its very beginning. In this sense, the socialisation of CCS is ongoing but it is in no way concluded.

Second, we have to acknowledge that the concept of socialisation of technoscience or CCS is not used by any of the involved actors. It is an analytical concepts introduced by me, and I interpret the accounts of the actors into this concept. This should not be a problem, since I have tried to provide information about this process of interpretation. However, the lack of recognition of socialisation as phenomenon or the need to embed CCS in society – is at least indicative of lack of concerted efforts.

Third, one may ask if there are so-to-speak different levels or stages of socialisation. I do not think that my data allows for much discussion of

this issue, which calls for further research. Possibly, such discussion is best done on the basis of historical data.

My fairly negative overall conclusion with respect to the overall socialisation of CCS is supported by the latest development with respect to CCS in Norway, taken place after the main parts of this dissertation were completed. Briefly, the 'Norwegian moon landing' was meant to be a metaphor for the building of the world's largest facility for full-scale CO_2 capture, and was meant to make Norway a world leader in CO_2 emission management. In spring 2012, a test facility at Mongstad was put into operation – two years behind schedule.

At the end of 2012, Prime Minister Stoltenberg hinted that Mongstad would possibly never get a full-scale CO_2 purification system. Since Mongstad was not part of the Labour election campaign that year, the Head of Greenpeace Norway Truls Gulowsen summarised that 'silence is a sign it was a crumbling promise made seven years ago based on incorrect facts. No one wants to promise this type of thing again, which is rather sensible'.[9]

On 8–9 September 2013 a parliamentary election was held in Norway. The election ended with a victory for the Conservatives and Erna Solberg became the new Prime Minister. After cost overruns and delays, the full-scale project at Mongstad was halted and the new government sought to build a full-scale plant in another location. Frederic Hauge, leader of the Bellona foundation stated that the

[9] Dark side of the moon for Norway, *Aftenbladet* 08.11.2013.

cancellation was 'one of the ugliest political crash landings we have ever seen'.[10] Some of the environmental organisations in Norway, strong supporters of the technology, spoke of the event as the worst form of incompetence from a government and total failure with respect to climate policy.

The whole project was dogged by delays and finally there was a volley of reproaches that the government had withheld information. The overall impression was that the deployment and implementation of full-scale CO_2 capture was much more controversial after the election. Nevertheless, socialisation through media has not stopped since discussion of the future of the technology has been put on hold. There may still be a 'Norwegian moon landing', but it will certainly not be at Mongstad.

[10] Norway drops carbon capture plan it had likened to 'Moon landing', *Reuters*, 20.09.2013.

8. Methodology

The data used in this dissertation came from two main sources. First, since mediatisation of CCS was considered a potentially important aspect of its socialisation, a news media analysis was undertaken. This study was also expected to indicate whether CCS was considered controversial in the Norwegian context and, if so, how. Second, I conducted interviews with technoscientists working with the development of CCS.

Media analysis

The news media analysis focused on printed and online newspapers that were available via the online archive Retriever (www.retriever.no). Retriever provides rapid access to all online and printed newspapers and magazines in Norway and makes complete monitoring possible. The media landscape changes constantly, but Retriever provides easily accessible data for qualitative, as well as quantitative, media analyses.

The data collected included Norwegian newspaper articles that had been published between 1 January 2000 and 31 December 2013. Qualitative content analysis was chosen as the main tool, because it could more effectively answer the research questions than could quantitative approaches. We were interested in how CCS technology had been framed and translated through the news media by agents of socialisation. However, simple quantitative analysis was performed to gain an overview of how the presence of CCS as a news item had changed over the period studied.

As a first step, we tried to form an overview to select what was important and to develop main categories for further analysis. Basic rules for category building are that 'categories must not be forced on the data; they should emerge instead in the ongoing process of data analysis' (Kelle 2007, p. 193). Inspired by Corbin and Strauss (1990), the basic principle of my newspaper analysis was identifying who had been communicating CCS and with what objective. In addition, we were interested in how CCS technology had been framed and translated by the different actors. Finally, we explored the issue of the mediatisation of CCS.

We began the work of collecting newspaper articles by looking at a smaller sample, in order to identify effective search terms. After gaining a first impression of the newspaper coverage, relevant articles were identified through the search profiles. This resulted in the following search profile: CCS OR CO_2-håndtering OR CO_2-lagring OR CO_2-fangst OR CO_2-rensing (in English: CCS OR CO_2 sequestration OR CO_2 storage OR CO_2 capture - CO_2 cleaning). This profile turned out to be effective and led to the identification of more than 7,000 articles over the 14-year period.

These search terms were the most frequently mentioned terms with respect to CCS technology. In addition, they allowed us to cover the whole chain, from sequestration to capture and purification. We did not include 'transport' in the search because it did not add much. From 2000 to the end of 2013 there were about 100 newspaper articles that dealt with the transport of CO_2. These 100 articles were already in the data because they included the search terms 'carbon capture and storage' or 'CO_2 capture'.

Figure 1 provides an overview of the number of articles found in each year of the period. Between 2000 and 2003, CCS was a rare topic in Norwegian newspapers. It began to take off as a newspaper issue in 2004, and peaked in 2007 with nearly 1,400 articles. From 2008 onwards, there was more variation; however, as we see, CCS remained an important concern.

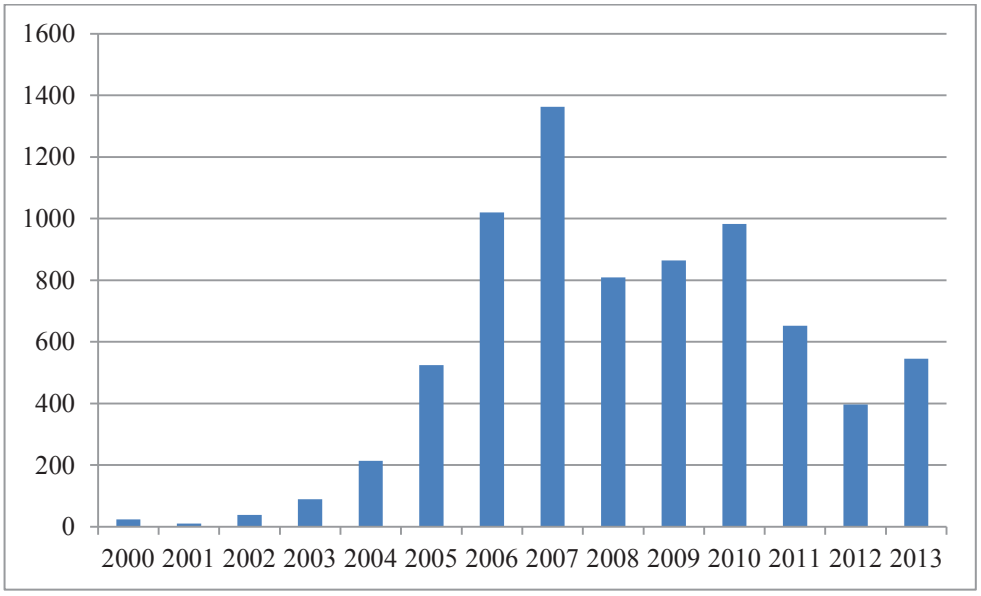

Figure 1: Overview of the number of articles found in each year of the period studied.

Table 1 gives an overview of the most relevant newspaper sources over the period. In addition to the weekly magazine of The Norwegian Society of Graduate Technical and Scientific Professionals (Teknisk Ukeblad), the major Norwegian newspapers were the main sources of articles about CCS.

Table 1: Overview of the most relevant newspaper sources over the period

Year	Newspaper source
2000	*Dagens Næringsliv* *Aftenposten*
2001	*Adresseavisen* *Teknisk Ukeblad*
2002	*Aftenposten*
2003	*Teknisk Ukeblad* *Stavanger Aftenblad*
2004	*Teknisk Ukeblad* *Stavanger Aftenblad*
2005	*Bergens Tidende* *Stavanger Aftenblad*
2006	*NTBtekst* *Bergens Tidende*
2007	*Aftenposten*
2008	*NTBtekst* *Aftenposten*
2009	*NTBtekst* *Bergens Tidende*
2010	*NTBtekst* *Dagens Næringsliv*
2011	*Teknisk Ukeblad* *NTBtekst*
2012	*Dagens Næringsliv*
2013	*NTBtekst* *Dagens Næringsliv*

The analysis first attempted to identify the general tendency of the content of the articles. It proved fruitful to begin by sorting them according to whether they were supportive or critical of CCS. A large number of articles were excluded from further analysis because CCS

was only mentioned in passing. In addition, some articles were published in several newspapers simultaneously, and, in these cases, only one version was used.

Since we sorted articles into categories of either support or criticism of CCS, this mapping of pro and contra arguments was then used for open coding and also as sampling criteria for selecting a smaller number of articles to analyse in greater detail. Each code was represented by at least two articles, and we focused on articles with distinct arguments to represent the general tendencies. This reduced complexity and made it possible to begin axial coding. Open coding starts by 'scrutinising the field note, interview, or document very closely; line by line, or even word by word. The aim is to produce concepts that seem to fit the data' (Strauss, 1987, p. 28). Axial coding 'consists of intense analysis done around one category at a time in terms of the paradigm items' (Strauss, 1987, p. 32). This approach allows for a general understanding and attempts to avoid forcing categories on the data. After identifying pro and contra arguments, we proceeded to specify the arguments.

We chose to use the concept of a storyline to describe the main codes. A storyline 'provides the narrative that allows the scientist, environmentalist, politician, or whoever, to illustrate where his or her work fits into the jigsaw' (Hajer, 1995, p. 63). A storyline can contain 'elements out of many different social arenas that provide participants with a set of symbolic references, creating a common understanding of and a set of arguments in relation to a given technological solution' (Næss 2007, 86). The axial coding resulted in three main storylines – two pro CCS and one contra CCS. These consisted of:

Storyline 1: 'CCS as a fascinating technological challenge'

Storyline 2: 'CCS as a frustrating political challenge'

Storyline 3: 'CCS as a harmful and useless challenge', with three sub-storylines:

Storyline 3a: Techno-economic challenges

Storyline 3b: Environmental challenges

Storyline 3c: Climate scepticism

The two pro CCS storylines were distinguished by the way in which their arguments departed from either a focus on technological challenges or a lack of political support. The pro arguments subsumed many codes, such as (for example) 'Norwegian moon landing', 'solving the world's climate challenges', 'reduce CO_2 emissions' or 'export possibilities'.

The third critical storyline was more complex because it was less well developed in the newspaper articles. Thus, when presenting this storyline in the empirical analysis we chose to split it into three sub-storylines because most articles belonging to the third storyline tended to focus on techno-economical complexities, environmental concerns or climate scepticism. There was no unified line of critical arguments, such as those that were found in the two pro CCS storylines.

After identifying pro and contra arguments, the analysis aimed to specify the underlying arguments. Regarding the selection of newspaper articles for detailed analysis, we ended up with articles that had mostly been published after 2006. The articles that had been

published prior to this date were characterised as either introductory or – above all – only having very briefly mentioned CCS. We also worked to find spokespersons for each storyline as a basis of identifying the main types of socialisation actors in the articles.

Science communication

The second set of data consisted of semi-structured interviews, which could be considered expert interviews. Initially, we planned to conduct these as focus group interviews, in order to utilise the reflexive capacity of this form of exchange. However, it proved difficult to organise focus groups, so we ended up with a mix of individual interviews and focus groups interviews that were focused on the topics of science communication and imagined publics. Our experience was that the data from individual and focus group interviews are interchangeable in many ways. Both are moderated, focused qualitative methodologies, but they have different strengths and weaknesses. While focus group interviews run on group dynamics, individual interviews focus on a single person. Since group discussions better simulate real-world dynamics, they can be used to easily gain an overview and explore consensus or lack of agreement.

Nevertheless, it turned out that the focus group and individual interviews complemented one another well. The individual interviews helped to convey the different respondent segments. Our aim, in individual interviews, was to gain a mix of detailed personal understandings; in focus groups, we aimed to develop a more general understanding of the research topic. Thus, the focus group interviews helpfully complemented the original dataset of individual interviews. I

analysed the two datasets as a whole, since they were mutually informative and showed substantial overlaps in the information they produced.

Further, the focus group and individual interviews converged in their constructions of the general public and the views they produced about science communication; this enhanced the trustworthiness of the findings. Altogether, 24 interviews (I) and five focus groups (FG) were conducted between June 2011 and November 2011. The FGs had two – and at one time three – participants. The interviews lasted between 20 and 80 minutes.

Due to participants' shortage of time, three interviews were conducted over the telephone. During the telephone interviews, I recognised the same difficulties that Christmann (2009) wrote about. The experience was that 'interview partners considered duration of 15 to 20 minutes too long' (Christmann, 2009, p. 166) and further 'that telephone interviews are regarded to be more anonymous and less personally embarrassing' (ibid., 2009, p. 168). Thus, in these interviews, I was never sure if the interviewee's attention was exclusively directed toward the interview questions (Christmann, 2009, p. 177).

If the interviewee broke for a thought, it is possible that I may have disturbed these thoughts or interrupted with a new question. The absence of face-to-face interviewing made it difficult for me to recognise social cues. I agree with Christmanns' conclusion that telephone interviews are not useless, per se, but that their effectiveness depends on the kinds of questions that are used in the study. The telephone interviews were an interesting supplement in which I, due to

a shortage of time, formulated easy questions and received compact answers. Thus, these interviews helped me to identify important recurring thoughts and higher ranking aspects. In total, 35 technoscientists were interviewed.

Table 2 shows that I interviewed both non-Norwegians and Norwegians; non-Norwegians constituted a substantial portion of the technoscientists working with CCS.

Table 2: Overview of the interviewees, according to age, gender and nationality

	Interviewees
Age 20–30	3
Age 31–40	13
Age 41–50	10
Age >51	9
Men/Women	24/11
Norwegian/Non-Norwegian	26/9
N	35

The interview guide contained questions about personal attitudes, media coverage and the general public and was designed to start a theme-focused conversation. The interviews were taped and transcribed verbatim. Three interviewees and the participants in two focus groups did not agree to be recorded. In these cases, notes were taken and no substantial differences in the quality of the information were observed. For reasons of anonymity, I grouped the interviewees according to their positions and gave them fictitious names. Due to internationalisation in

the research field, four interviews and one focus group discussion were conducted in a language other than Norwegian (namely English and German). Quotations from the German and Norwegian interviews were translated into English by the author.

The expert interview can be characterised as a non-standard interview, in which the interviewer uses a prepared list of open questions as a basis for conversation. If, in an interview, the interviewer must collect individual information, this form of interview is recommended. The expert interview is supposed to contribute to the reconstruction of a social process. Expert interviews are therefore generally guided interviews and normally follow the same rules. The guided interview is a special communication process and a social science method of collecting data.

Methodological literature on expert interviews is sparse. One book about how to interview experts, by Bogner, Littig and Menz (2009), states that 'The "expert" has edged into the centre of theoretical interest from both a theory of society and a democratic theory perspective as well as from the sociology of knowledge, scientific or technical research standpoints' (Bogner et al., 2009, p. 3). This second approach therefore also reflects many of my own experiences. Bogner et al. specify that 'talking to experts in the exploratory phase of a project is a more efficient and concentrated method of gathering data than, for instance, participatory observation or systematic quantitative surveys' (2009, p. 2). Littig asks, 'what makes these particular groups [members of the elite or an expert] so interesting from a social or political science perspective' (2009, p. 99)? There is little consensus over who is an expert, and the expert status can be regarded as a social and methodical

construct. The determination of who is an expert thus depends on the particular issue. Interviewing experts is a special type of interviewing, because experts, in this sense, are members of the functional elite.

The obvious interpretation of the term ‘expert interview’ would be that it is an interview with these elites, who have specific information because of their position. The persons involved in expert interviews are therefore experts because they can offer their special knowledge of social contexts for the analysis. Based on these characteristics, it is possible to more clearly define the investigations in which expert interviews are used or not used. In the following, I explain how I used the terms ‘expert’ and ‘expert interview’.

My interviewees were experts in matters of their working position as technoscientists participating in R&D with respect to CCS. The respondents were not interviewed as persons, as such, but as representatives of organisations working with parts of CCS technology included in the two CCS research centres; thus, they acted only as informants. Interviewees were selected because they were part of two recently established national Research Centres for Environmentally Friendly Energy Research (FMEs) focusing on CCS: the BIGCCS Centre and SUCCESS. These are the most important research communities working to develop CCS in Norway.

The BIGCCS Centre develops knowledge, methods and solutions for safe, efficient and inexpensive CO_2 management (www.bigccs.no), and is working to determine the extent of Norway’s offshore storage capacity for CO_2. Through various methods, the main objective of SUCCESS is to find reliable ways of storing CO_2. The centre will also

identify the best methods of injecting CO_2 and monitoring the safety of underground CO_2 (www.fme-success.no). The interviewed technoscientists were employed at research institutes, in industry and at universities, and held key positions in the involved organisations with respect to CCS R&D. Table 3 provides an overview of the organisations where the interviewees were employed.

Table 3: Overview of the organisations to which interviewees belonged

	Industry	**Research Institutes/ Universities**
BIGCCS Centre – International CCS Research Centre	✓ ConocoPhillips Skandinavia AS ✓ Aker Solutions AS ✓ Det Norske Veritas AS ✓ Gassco AS ✓ Hydro Aluminium AS ✓ Shell Technology Norway AS ✓ Statoil ✓ TOTAL E&P Norge AS ✓ GDF Suez	✓ CICERO Center for International Climate and Environmental Research – Oslo ✓ Norwegian University of Science and Technology (NTNU) ✓ SINTEF Foundation
Subsurface CO_2 Storage – Critical Elements and Superior Strategy (SUCCESS)		✓ Christian Michelsen Research

In sum, eight interviewees were employed at a university or in research institutes associated with a university. These were mainly PhD students and researchers. The majority of the interviewees had been educated as engineers and were employed in the non-university sector. Sixteen interviewees held managerial positions in the R&D area, such as director, manager or (vice-) president.

Their field of activities included building, closing critical knowledge gaps relating to the CO_2 chain, developing novel technologies and addressing challenges related to CO_2 storage, such as storage performance, sealing properties, injection, monitoring and marine consequences. Mainly, the interviewees worked with R&D related to cost-effective CO_2 capture and safe underground storage.

One advantage of the expert interviews was clear in the beginning. Due to their key positions in the organisations, they sometimes advised me on additional potential interviewees with relevant expertise. It was relatively easy to encourage and motivate people to participate and talk about the scientific and political relevance of their research. 'According to popular definition, experts are equipped with explicit specialist knowledge gained through specific training which provides them with an in-depth understanding of a particular topic or field and enables them to provide clarification or resolve specific issues or problems' (Froschauer and Lueger 2009, p. 220).

The function of the expert interview is to gain insight into an expert's technical expertise. Experts also have a special, sometimes exclusive, position in the social context. In my study, the aim was to analyse their constructions of the general public with respect to their position. Here,

a differentiation between declarative knowledge and theoretical knowledge was important.

Experts such as technoscientists are a medium through which the knowledge of a situation is gained. Thus, they are not the 'object' of the analysis – the real focus of interest – but are 'witnesses' of an investigated process. The ideas, attitudes and feelings of experts are interesting, and experts are crucial insofar as these perceptions affect the conceptualisations of the general public.

While the objective of traditional expert interviews is to focus on expertise in a certain field of activity, experts are seen as 'crystallisation points' (Bogner et al., 2009, p. 2). The aim of the present case was to reconstruct technoscientists' knowledge about lay people. Thus, the interviewees not only indicated (for instance) other potential expert interviewees, but they also – after I had asked questions about the media and the general public – relegated me to the press office or the communication department, when applicable.

With respect to the interview guide and the interviewee responses, I noted a lot of hesitations and advice to talk to 'other people'. I interpreted these hesitations as an indication of some reservation with respect to what the interviewees actually knew about the issues raised in the interviews. Clearly, their relationships with the public were not usually discussed, and they held slightly diverging views. For instance, there were conceptual misunderstandings during some interviews. I asked my interviewees who they saw as the main supporting actor or main opponent of CCS; Engineer Sims asked me to be more precise: 'If

you could be more specific in your questions, I would be able to sort of reply with more focused answers'.

In the beginning of each interview, I explained my focus on public engagement and my wish to examine their views about the general public. In the last session of the interview, when I explicitly asked about the general public, the social side effects of technology development and implementation came to mind when I asked whether the general Norwegian public were positive or negative toward CCS. Engineer Sims reminded me: 'as I said before, if you could ask me a specific question I give my comment on that. Any particular incidents or topic'.

Vice-President and Head of Energy Research Activities Palmer was irritated by the question regarding the general public's attitude toward CCS, and he advised me to talk to his corporate communication office. Engineer Sims again concluded that 'I am not the right person to ask'.

Terms such as 'public', 'sharing information' and 'knowledge transfer' often led to misunderstandings. Using Scientist Armstrong as an example, he was not familiar with the term 'public'. He asked if I was referring to society, specific parts of the public or the general public. Often the interviewees misunderstood the term 'general public' and frequently just referred to their nearest colleagues. R&D Manager Steele answered, for instance, that newspaper articles were frequently discussed at work; he concluded from this that he and his colleagues were very active in knowledge sharing with their colleagues. Also, Senior Advisor Technology Williams missed the point when stating – in relation to the newsletters sent to interested persons – that 'we are

trying to impart knowledge or information both internationally and nationally via newsletters'.

The hesitations and misunderstandings served as important resources for further textual analysis. I polished the analysis and, for reasons of clarity and readability, removed all hesitations from the interview quotations used in the paper. Nevertheless, I paid attention to them and interpreted them as reservations, due to the fact that I had asked questions about things they normally did not think about.

Analysis

The analysis of the interview data with respect to Papers 2 and 3 was guided by the aim of identifying how the interviewees constructed the general public and their own perceptions. My analysis of the data was inspired by grounded theory (Charmaz, 2000; Corbin and Strauss, 2008). In practice, this meant that I mainly focused on the grounded theory informed method of open coding. Open coding is a process of breaking down data into separate units (Goulding, 1999). Thus, themes and main ideas were identified and compared through selective coding.

With respect to Paper 2, grounded theory methods (Charmaz, 2000; Corbin and Strauss, 2008) such as open coding and, later, selective coding helped me identify more general explanations. In Paper 2, I was mainly interested in conceptions and imaginaries with respect to the general public.

How did the interviewees perceive the public's knowledge about CCS and the involved technological challenges? I analysed interviewees' perceptions of the general public's knowledge level and their

assumptions of public attitudes toward CCS. In doing so, I identified themes and main ideas with the help of open coding. The interview material was analysed step by step, and I read each part of the interview material to identify the more general categories that these quotations, for instance, highlighted.

By breaking down the data into distinct concepts, I was able to identify several concepts in each interview. I started to build categories, which helped me find similarities and differences. The overall categories that emerged regarding the public knowledge level were, for instance, 'low', 'nothing' and 'not enough'. Regarding the knowledge level, we mainly worked with the question of why the public do not know enough. The categories of public attitudes that emerged from the data were, for example, 'positivity', 'environmental consciousness' and 'knowledge deficit'.

These categories and the related arguments helped me figure out different characterisations of the general Norwegian public. Finally, selective coding helped me identify the most important categories and link them into explanations. Thus, a hierarchy was developed and the quotations presented in the analysis highlight the key imaginaries drawn from the raw interview material.

With respect to Paper 3, I analysed the data similar to the data in Paper 2. I was mainly interested in the interviewees' evaluation of their own engagement activities and their understanding of public engagement as such. During the analysis, I identified themes and main ideas through open coding. The interview material was analysed step by step through observing, naming, categorising and describing phenomena found in

the data material. I read each paragraph to identify the more general categories that these quotations, for instance, highlighted. My aim was to determine the interviewees' most important imaginations and conceptualisations.

I analysed the material and built categories, which were carefully founded and revised throughout the analytical process. I continued to break down the data and, after identifying several concepts in each interview, I started to build categories to find similarities and grouped them into categories. The categories that emerged from the data were, for example, (with respect to the relation toward CCS) 'positive towards PE', 'more active' and 'not engaged'.

Regarding the understanding of public engagement, I worked mainly with arguments pertaining to why and how the interviewed technoscientists were engaged or not engaged. Selective coding helped me figure out the core variable of all the data and link categories into explanations. A hierarchy was developed and a small number of the most important categories were chosen to represent the key imaginaries drawn from the raw interview material.

These categories and the related arguments helped me figure out different patterns of the general Norwegian public's relationship with CCS technology and the interviewed technoscientists' understanding of public engagement activities. It was now possible for me to relate the central categories that were found through open coding to the storyline. How did scientists and engineers perceive their own activities regarding engagement and knowledge sharing? How did they explain their

absence? If they were not engaged, who was perceived to take a leading role in knowledge sharing?

Strengths and weaknesses

My intention in this thesis has been to study some efforts to socialise CCS in Norway, with newspapers and interviews with technoscientists working with CCS R&D as the main sources. The data are of qualitative character. Could I trust these data, these statements, to inform me in any way about what was really going on? What had I found? What had I heard? What had I read?

First, there is a question of whether or not I have been able to capture empirically the Norwegian socialisation process from the two sources. Given my theoretical point of departure it should be clear that I do not seek statistically generalizable facts. Rather, I have been concerned with particular socialisation phenomena and particular ways of engaging with socialisation challenges. The newspaper articles were analysed with respect to identify efforts to embed or dis-embed the emerging CCS technology in Norway. Media, as a starting point for the dissertation, shape the public image of the technology and different actors try to position themselves through statements made to newspapers. The pursuit of emerging topics in this way is also in line with the ideals postulated in grounded theory. Due to that the task was to discover and interpret the links between different understandings and imaginations.

The interviews have been conducted in different geographical-specific regions of the country. For instance different cities along the south-*west coast*, representing the most important *region* for *oil* and gas

exploration and development, the capital city Oslo and Trondheim, a centre of gravity for technological development in Norway. I interviewed 35 persons in total, both non-Norwegians and Norwegians. In Norway non-Norwegians constituted a substantial part of the technoscientists working with CCS. However, it proved that with respect to the analysis of the interview data focusing on science communication and imagined publics nationality had no consistent effects. The same is true with respect to gender. There were no clear gender differences. Even if the number of interviewees is not large (35), it still constitutes a fairly large share of the technoscientists working with CCS in Norway.

It should be noted that the construction of the public that emerged through the interviews was not coherent. It was with some reserve that the interviewees offered their views of the Norwegian public's relationship towards CCS since they seldom discussed this topic, and they held slightly diverging views. Even if they do not have to be shared across a community of technoscientists, it was possible to identify dominant narratives. Since there were disagreements about how the public should be characterized, further research is needed to understand the mechanisms that may produce such disagreements, and how these disagreements may affect technoscientists' work. I believe that the interview data I used are suitable, and that they can, in fact, lead to conclusions about the Norwegian socialisation process.

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Appendix

Interview guide: Imagined publics

Warming-up

1. Work. What? Where? How long?
2. Background/ Education
3. Sex/ Age

Context/Personal attitude

4. What aspect of CCS are you working with (type of project)?
5. What are you views regarding the future of CCS? Will Norway succeed (why/ why not)?
6. What are the main challenges with CCS?
7. What are the main obstacles to success for CCS in Norway? Is this different in other countries – how?
8. Who do you see as the main supporting actors of CCS? The main opponents? How do you perceive the role of the Norwegian government and politicians?
9. What are the arguments in favor of CCS? Against CCS? How do you assess these arguments?

Public/Media

10. What do you think about the way news media cover CCS? How is CCS portrayed? Is this fair?
11. Are you or your colleagues engaged in the way news media cover CCS? How? Why/why not? What do you think is important to say about CCS? Who do you see as your main audience?
12. Do you think the general public is positive or negative (or indifferent) to CCS? Why?
13. Do you think CCS will meet with resistance when it is going to be implemented? In case, by whom? What kind of arguments do you foresee?
14. Do you as scientists involved with CCS prepare for resistance? How?
15. What does it mean for your work when CCS is debated in the media? Are you discussing this among colleagues? How? What are the main views?
16. Do people know enough about CCS? What should they know more about? Do you as scientists have a role in this?