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What role for CCS in delivering just transitions? An evaluation in the North Sea region

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Abstract

This paper assesses the role of carbon dioxide capture and storage (CCS) in addressing challenges in the energy transition in regions reliant on carbon-intensive industries for employment and as an economic base. The assessment is based on semi-structured interviews with relevant stakeholders and experts in the Aberdeen area in Scotland, the Rotterdam harbour (or Rijnmond) area in the Netherlands, and in Norway. The interviews explored challenges around the role of CCS in regional 'just transitions', or how to make the transformation of regions relying on carbon-intensive industries to a low-carbon society fair. While significant differences in responses between the Aberdeen area, the Rijnmond area and Norway were found, a common understanding showed that for CCS to contribute to a just transition it has to (a) make a contribution to climate change imperatives; (b) help to mitigate the economic and employment effects arising from declining or maturing industries; and (c) be undertaken in a manner that helps to redress (or at least does not increase) uneven vulnerabilities and inequalities in society. Five key themes that characterise the opportunities and challenges for CCS from a just transition perspective were drawn from the interviews: Skills for a just transition, transition as an opportunity, responsibility, scale of action and viability. We recommend that these are added to earlier work on barriers and enablers of CCS in areas relying on fossil industry.

Keywords: ACORN Project; Carbon dioxide capture and storage; Just transition; Regional policy; Stakeholder understanding; Regional development

1. Introduction

This paper assesses the role of carbon dioxide capture and storage (CCS) in addressing climate change and sustainability challenges in cities and regions that consider carbon-intensive industries as their economic and employment base. Cities and regions are increasingly seen as sites for solutions to contemporary environmental issues, as evidenced by chapter 4 in the IPCC SR1.5 report (de Coninck et al., 2018), and the creation of Sustainable Development Goal 11 (UN-Habitat, 2018) specifically to address sustainable cities and communities. Yet this notion of 'sustainable' cities and regions may be particularly problematic for areas that remain dependent on fossil fuel extraction (e.g. coal, oil, and gas) and other high-emitting industries (e.g. steelworks and petrochemicals) for not only

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employment and economic benefit, but also identity and sense of belonging. Trade unions, national- and regional governments and academics are hence showing increasing interest in understanding what 'just transitions' mean at the city and regional level (Adams et al., 2016; Evans and Phelan, 2016; Haggerty et al., 2018; Simmons et al., 2018; Weller, 2018).

When understood in this way, the aim of just transition at the regional level is to ensure locations – and the workers within them – traditionally dependent on carbon-intensive activities are not left behind, and even equally involved, in the move to clean energy and a sustainable economy. Although CCS is a technology that can smoothen the transition away from fossil fuels by allowing continued use of fossil fuels in a low-carbon manner, it has thus far received only limited attention within just transitions thinking (Edwards, 2019). The purpose of this paper is therefore to consider how, if at all, stakeholders and citizens at the regional level understand CCS as being a technology that could help them transition to a more economically, socially and environmentally sustainable future. Means to do so would include the re-use of existing infrastructure, the possibility to draw on existing technical knowledge within the region for subsea activity, and the potential to reduce emissions from industries such as steel while keeping them in business (Alcalde et al., 2019).

In this work, two areas bordering the North Sea with high-emitting industries and potential for CCS activity are assessed - Aberdeen and north-east Scotland, United Kingdom; and the Rijnmond and Rotterdam harbour area in the Netherlands. Further insights and broader applicability are evaluated through exploratory research conducted in Norway. We argue that CCS has the potential to fit into some – but certainly not all – visions of a just transition, and that whether, and the extent to which, CCS is viewed as contributing to a just transition within a region is likely to be highly dependent on local contextual factors.

1.1. Just transition: scholarly context

Newell and Mulvaney (2013) hold that a just transition refers to the need to consider equity and justice within efforts to create a low-carbon society, including for those whose livelihoods depend on a fossil fuel economy. As Newell and Mulvaney explain, just transitions thinking is increasingly aligned with global discourses of climate justice (Jasanoff, 2018; Swilling et al., 2016). Heffron and McCauley (2018) sketch out a formalised framework for a just transition, which incorporates justice in distribution, process and restoration; universal recognition; consideration of the spaces in which events are happening; and consideration of the timeframes over which actions are happening. There is hence increasing interest within academia in the just transition as an overarching, unifying narrative for equitable responses to climate challenges.

As a point of departure for this paper, however, we focus on what a just transition means at the local and regional level – that is, how to consider not only workforces (Bennet, 2007) but also wider regional economies and the people who depend on them (Evans and Phelan, 2016) in localities heaving dependent on carbon-intensive industries. Notably, this is also the understanding of just transitions used by many NGOs and opinion shapers working in the case study contexts discussed in this paper and also internationally, for instance Friends of the Earth Scotland, (Friends of the Earth Scotland, 2018), and the International Labour Organisation (International Labour Organization, 2015). Within this understanding, the key question to address is to find ways to ensure locations hosting carbon-intensive industries, and the workers and communities within them, are not left behind and are guided towards alternative forms of economic activity as unsustainable and/or carbon intensive practices are phased out nationally and globally (Baer, 2016; Miller et al., 2013). Imagining such a transition from now into the future has indeed been identified as a key challenge facing oil and gas in north east Scotland (Mabon and Littlecott, 2016); coal in New South Wales, Australia (Evans and Phelan, 2016); and coal on the West Coast of New Zealand's South Island, (Baxter et al., 2015). Rosemborg (2015) identifies driving investments, social dialogue, skills and training and social protection as factors to be considered for successful industrial transformation to sustainability which retain a focus on workers. At the local and regional level at least, extant literature suggests there is an appetite for 'solutions' to the just transition challenge. The skills and infrastructure utilisation linked to CCS has potential to fill this gap (Alcalde et al., 2019).

Nonetheless, it is imperative to reflect on the linkage between the local and regional levels on one hand, and the more global discourses of just transitions on the other. Muller (2018) for instance questions whether support for carbon-intensive localities can be compatible with a global imperative to decarbonise, cautioning that arguments over just transitions can mask the fact hard choices have to be made, construct a false ethical equivalence between localised just transitions and global climate imperatives, and slow down necessarily urgent climate change action. In this regard, CCS faces a critical challenge. As above, a key concern of the just transitions movement is the fossil fuel economy, and it has been illustrated elsewhere that a perception of CCS as somehow 'supporting' the fossil fuel industries leads some actors to adopt a more cautious stance towards the technology regardless of its climate mitigation potential (Mabon and Littlecott, 2016; Mabon and Shackley, 2015). For this reason, some cast doubt on the potential of CCS to be credited with contributing to a just transition (Edwards 2019). As such, a core issue to consider with regard to the place of CCS in a just transition is whether citizens and stakeholders are willing and able to view CCS as a tool to utilise the infrastructure and skills already present in carbon-intensive regions and meet global climate goals, or whether CCS is viewed as perpetuating a problematic fossil fuel economy.

With this in mind, we now set out a research methodology that allows exploration of the role of CCS in a just transition, both in terms of its contribution to regionalised and localised transitions, and also its place within broader discussions on an equitable response to climate change.

2. Methods

This paper draws on in-depth semi-structured interviews with key regional planners, policymakers and opinion-shapers (e.g. trade unions, environmental NGOs, social welfare providers) in regions reliant on carbon-intensive processes for employment and economic benefit, and where there is interest in and/or technical potential for CCS deployment. Two localities are taken as a focal point for in-depth enquiry: Aberdeen and north-east Scotland, United Kingdom, which is reliant on oil and gas extraction but has the geological and infrastructural potential for CCS; and the Rijnmond and Rotterdam harbour area in the Netherlands, with a breadth of potential industrial applications for CCS and interest in the technology within the city. The wider implications of our findings on the place of CCS in a just transition are then explored through insights from respondents from across Norway – another country with significant reliance on a fossil fuel economy yet with notable interest in CCS deployment.

As the research was carried out as part of the scoping study for the Acorn CCS project in Scotland, and hence provided an opportunity to evaluate stakeholder responses to a real-world CCS project close to deployment (as opposed to CCS as an abstract concept), the interviews and analysis were structured around the situation in Scotland first. Subsequent interviews were then carried out in the Netherlands, to give insight into another region where CCS deployment is a distinct and feasible possibility. The more country-wide and less region- or city-specific case of Norway was added to understand more generally how CCS can fit into the social and political landscape of a country with both notable technical potential for CCS yet also an economy strongly linked to fossil fuels. Additionally, whilst not the main focus of this paper, workshops were organised after the interviews in Scotland and the Netherlands to both validate the results and potentially gain additional insights. The paper therefore initially focuses on Scotland, which is then extensively compared to the situation in the Rotterdam area, and finally Norway in iterative fashion.

In-depth interviews were undertaken with the people listed in Tables 1, 2 and 3. Overall ethical approval for the research described within the paper was obtained from the institution coordinating this element of the research programme (Robert Gordon University, UK) prior to the commencement of data collection. In line with standard ethical procedures, participants are not named and their organisation is given a generic title so as not to make their identity apparent. Some interviews were conducted with an additional participant, in these cases, the reference for quotation will be identical. The interviews were carried in the period from May through September, 2018.

Table 1. Overview of interviewees in Scotland

Title	Reference	Organisation	Sector	Rationale for interviewing
Climate and sustainability officer	S1	Local government	Government	Local government official from region with close dependency on high-emitting industries, where CCS processes may help to balance local economic benefit with climate goals.
Regional officer	S2	Trade union	Civil society	Trade union with strong vocal presence in the Scottish Just Transition movement, particularly around the oil and gas sector in north-east, and concern with balancing jobs with climate.
Policy officer	S3	Research group supportive of CCS	Research/advocacy	Understanding of national (Scottish) policy landscape for CCS, and also understanding of civil society attitudes towards technologies such as CCS through previous experience.
Communications officer/journalist	S4	Research group supportive of CCS	Research/advocacy	Understanding of societal (public and stakeholder) awareness of CCS, and of the potential opportunities and challenges associated with different framings for CCS. Also experience of environmental campaigning.
Senior figure	S5	Oil and gas-focused academia-industry institution	Academia/industry	Long professional career in oil and gas industry, and high-profile figure in national debates around productivity in maturing North Sea basin.
Head of environment and green transition	S6	Environmental think tank	Civil society	Leading think tank in UK in Just Transition space, with strong social justice focus alongside climate and environmental concerns. Less 'local knowledge' of Aberdeen so able to offer alternative perspective.
Environment and climate officer	S7	Trade union	Civil society	Trade union developing national position on Just Transition, and in process of understanding roles of different technologies (e.g. CCS) within this.
Project officer	S8	Innovation centre	Research	Awareness of the role of cities and regions in facilitating low-carbon innovation, good analogous knowledge of what has made deployment of low-carbon technologies work in different contexts.

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136 Table 2. Overview of interviewees in the Netherlands

Title	Reference	Organisation	Sector	Rationale for interviewing
Campaigner	NL1	Environmental organisation	Civil society	Environmental organisation involved in climate tables and strong opinion on CCS
Sectoral officer	NL2	Trade Union	Civil society	Trade union concerned with employment within the energy transition
Policy officer	NL3	Local Government	Government	Local government official that advises and supports on the energy transition in the port of Rotterdam
Policy researcher	NL4	Environmental protection	Government	Agency that monitors environment but also advises on various topics such as CCS
Researcher	NL5	Oil and gas	Public company	Involved in technical work on CCS project

		authority		
Communications officer	NL5	Oil and gas authority	Public company	Involved in public acceptance on CCS project
Strategy officer	NL6	Port Authority	Public company	Port authority is highly involved in the energy transition, partner in a CCS project
Project Manager	NL7	Consultancy	Research	Experience and involvement in CCS projects
Concept developer	NL8	Developer	Research	Developer of integrated CCU project in the area
Energy and climate officer	NL9	Lobby	Industry	Industry representative, involved in energy and climate plans
Governmental affairs officer	NL10	Oil and gas company	Industry	Industry perspective on the energy transition
Engineer	NL10	Oil and gas company	Industry	Industry perspective on the energy transition

Table 3. Overview of interviewees in Norway

Title	Reference	Organisation	Sector	Rationale for interviewing
Senior Manager	NO1	Metal producer	Public company	Industry representative, involved in all issues with industrial emissions
Administrator	NO2	Innovation centre	Research	Advocate of technology use for reducing environmental impacts in onshore industry
Senior advisor	NO3	Trade union	Civil society	Head of theme in the Norwegian Labour Unions
Senior advisor	NO4	Research council	Government	Responsible for prioritising and monitoring R&D funding in selected themes in Norway
Senior advisor	NO5	Environmental protection	Civil Society	Advocate of environmental action including mitigating global warming

Interviews followed a semi-structured format, whereby the interviewer sought to cover a set list of questions but had flexibility within this to probe/follow up as required in order to elicit further information. Figure S1. shows the discussion schedule used during the interviews, which was developed iteratively by the project team members.

Thematic analysis of interviews was undertaken in order to identify overarching themes and draw out similarities and differences between the three regions. Key themes were then drawn out of the interviews. The 'codes' to represent these themes were likewise developed collaboratively by the research team, drawing in researchers working in the three national contexts (Scotland, Netherlands and Norway). The codes and sub-codes developed are listed in Figure S2. Each region was analyzed separately by the local researcher(s). While the same question and theme guides were used, analysis was performed slightly differently in each region. In Scotland, interviews were analysed according to a qualitative content method, whereby key points and indicative quotes from each interview were recorded for each of the codes, in order to provide information corresponding to the pre-determined research questions. In the Netherlands the interviews were fully transcribed and coded with the same codes. In Norway the overall stakeholder engagement process only reached the initial round of interviews, and further processing of the responses was therefore not undertaken. In particular, the offshore oil and gas industry in Norway was difficult to engage, most likely due to a persistent buoyant optimism and positive industry outlook on oil and gas recovery on the Norwegian continental shelf. For this stakeholder group, there was little interest in any transition. However, a brief discussion of overall impressions from these interviews is included below

Nonetheless, the overall objective of the interviews was to elicit information corresponding to pre-determined research questions (Cho and Lee, 2014), according to a coding scheme agreed on by all researchers prior to the analysis phase, as opposed to a more 'grounded' approach where codes and themes arise out of the data. As such, each country's data was analysed in a way that yielded insights under the same analytical categories, and hence fed into a wider understanding of the place of CCS in a just transition.

It is also worthwhile noting some limitations of the research design and areas for further enquiry. First of these is the relatively small sample size. Although each country covers key sectors linked to CCS, a larger sample could have allowed for more granularity to consider, for example, the views of local government officials interested in climate change versus the views of local government officials interested in regional economic development; or the different views towards CCS which might be held by different types of environmental groups. Given the comparatively low levels of awareness of and engagement with CCS at the local and regional level in each of the countries studied, the participants sampled to an extent represent sectors and institutions already engaging with CCS issues and hence able to give informed insight into the complexities of CCS deployment. Nonetheless, further research in each context as CCS plans start to become more specific and concrete, and hence as stakeholder awareness increases, may wish to explore the differences in perspectives which can exist within sectors. Furthermore, the research team are all familiar with the local CCS landscape in the regions the research was undertaken, and as such are aware of where alternative or more nuanced viewpoints outside of the dataset may lie (see e.g. Section 3.1. on differing Scottish environmental NGO views towards CCS, and Section 3.3. on Norway oil and gas sectors and their thoughts on CCS and a just transition).

3. Findings and analysis

3.1. Background to CCS in Scotland

Scotland has had over a decade's worth of experience of attempts to deploy CCS technologies. An early proposed project was led by BP, who planned to build a gas-fired power station equipped with CCS at Peterhead and store the captured CO2 in the Miller Field in the North Sea, before abandoning their plans in 2007. The Scottish Power-led Longannet project, which planned to capture CO2 from the Longannet coal-fired power station and again utilise North Sea storage, was similarly cancelled in 2011 after the UK government failed to reach agreement with the operating companies. This was despite the UK Government offering a £1 billion 'prize' for the UK's first commercial-scale CCS project. Thereafter, the UK Government-led CCS competition was resurrected, and the Peterhead CCS project (a cooperation between Scottish and Southern Energy and Shell to capture CO2 from the gas-fired Peterhead power station and store in the Goldeneye field operated by Shell) was one of two final candidate projects across the UK before UK Government funding was withdrawn in 2015. Most recently, the Acorn project – led by Pale Blue Dot Energy – has sought to progress CCS in Scotland at a more incremental scale, with a vision to start with relatively small-scale capture and then build out to a range of CO2 sources. Storage in the North Sea is scheduled to commence in the early 2020s. Research to date – including for this project – suggests that society at large in Scotland is supportive of, or at least neutral towards, CCS. However, as described below, some environmental NGOs such as Friends of the Earth Scotland are beginning to raise concerns over oil and gas companies' interest in CCS to delay action or deflect from ongoing North Sea production. Moreover, the Scottish Government in 2019 established a Just Transition Commission[†], tasked with advising on a fair net zero economy. As such, Scotland has (a) a long experience with CCS development if not deployment; (b) growing awareness of the need for a just transition; yet also (c) increasing skepticism of the links between North Sea infrastructure, operators, and climate change imperatives.

The in-depth interviews undertaken in Scotland helped to identify knowledge gaps which perhaps need to be addressed if CCS and technologies like it are to be considered part of a just transition. The schematic in Figure 1 illustrates the complexity of the climate challenge faced in emission intensive regions, and reflects issues raised during the interviews. As is now elaborated through the following sub-themes, the implication of the above is that for CCS to form part of a just transition for the north-east and areas like it, it needs to:

(a) make a contribution to climate change imperatives;
(b) help to mitigate the economic and employment effects arising from declining or maturing industries; and
(c) be undertaken in a manner that helps to redress (or at least does not increase) uneven vulnerabilities and inequalities in society.

[†] See https://www.gov.scot/groups/just-transition-commission/ for aims, scope, composition and publications.

Whilst these may appear to be 'obvious' factors which are applicable to any technology associated with a just transition and not only CCS, they are especially important to emphasise in the context of CCS. The reason for this is that, as outlined in Section 1.1., there is in Scotland and indeed elsewhere an emerging scepticism among some influential environmental NGOs towards CCS. This scepticism is based on the view that oil and gas operators use CCS as a means of delaying climate action (see e.g. editorial piece by Dixon (2019)). As such, the Scotland findings illustrate that it is even more imperative that stakeholders can see the three factors above are addressed through CCS if it is to have a part in a regional just transition.

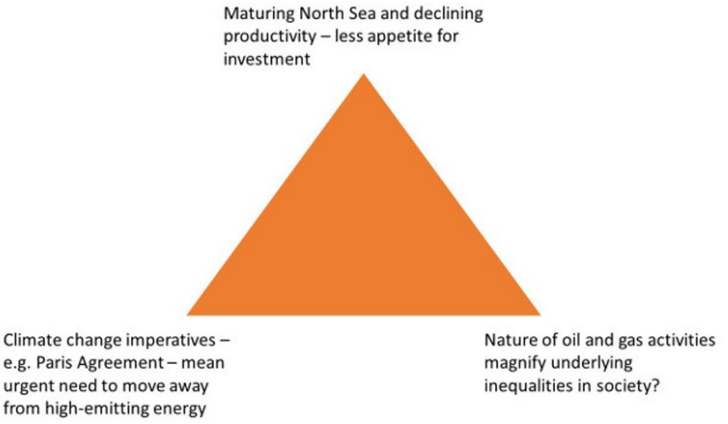

Fig. 1. Conceptual figure summarising key challenges identified in Scotland interviews which CCS deployment needs to balance in order to be part of a just transition

3.1.1. Skills for a Just Transition

The first key theme emerging from the interviews relates to a significant need for a more quantitative understanding of the jobs and employment potential of CCS and similar technologies, and of how the skills currently present within the North Sea workforce match up to CCS. It was broadly agreed this sort of knowledge was currently lacking, but would be necessary to help make an informed decision of what could contribute to a just transition:

I suppose we're seeing it particularly through the jobs lens I guess, so the employment that's being sustained particularly in the oil and gas industry could be sustained in the CCS industry, and I think we also need to talk more about transitions which haven't been managed, particularly the collapse of open-cast mining and the environmental damage that has done (S3)

At the same time, however, there was broad recognition that the skills currently present within the offshore industries could lend themselves well to low-carbon innovation. In particular, a number of interviewees argued that the cognitive and problem-solving skills associated with oil and gas extraction could be drawn on as a force for good to facilitate deployment of new technologies such as CCS, respondents noting the significant levels of innovation that have been required within the oil and gas industry so far to achieve production in the North Sea (interviews with S2, S5). In other words, jobs relating to technologies like CCS could be framed in terms of diversification, allowing people to 'think like an engineer.'

Nevertheless, two additional barriers (in addition to the need for more concrete mapping of skills and opportunities) arose in the interviews. The first of these is the continuing high salaries associated with oil and gas activity, which may act as a blinder to other outlets for technical and engineering skill and make 'low-carbon' jobs appear less appealing in the short term at least (S2). The second is difficulty in garnering support for climate change action and a

low-carbon transition from trade unions, who in some cases may find it difficult to come out in support of pro-climate actions if they are perceived as threatening jobs in carbon-intensive sectors:

We're cautious, because we represent different groups of workers in different industries, you know, so we support the concept of just transition definitely, but it's the old dialectic of the argument isn't it, you can't just say shut everything down and move to this, there's a transition period […] We want to link it to workers' rights and anti-poverty strategies and all the rest. (S2)

3.1.2. Transition as an opportunity

The second key theme emerging from the data is the idea of a low-carbon transition as an opportunity for carbon-intensive regions. Within this, CCS was discussed as a technology which could act as a point of departure for discussion on how climate imperatives could be turned into an advantage, even if the technology itself might not provide employment for everyone currently involved in carbon-intensive industries.

For example, an interviewed trade union official (S2) referred to the 'Lucas Plan' when pressed on how climate imperatives and the needs of workers in carbon-intensive industries could be balanced (the Lucas Plan refers to a plan proposed by trade unionists within Lucas Aerospace to respond to threatened job cuts by diversifying the company away from military production towards making socially useful products). Within this framing, CCS may act as one of a basket of industries and technologies, along with, for example, production of wind turbines at fabrication yards and development of community heat and power systems (S1), which are able to use the skills and infrastructure of carbon-intensive industries as a force for good to meet climate goals. The same respondent made this point in relation to offshore wind in north-east Scotland:

When you look out at the snowdrops, as I call them, which are now getting plugged in off the coast, Trump doesn't like, you know, someone has constructed them, the same process of construction […] they are constructed somewhere, in the same way, on a micro-way because it's not the same scale, it's the same process of construction that you constructed one of them, that you constructed and built the platform, the oil platform (S2)

Perhaps more challenging to implement in practice, yet still significant, was the argument proposed by some interviewees that a truly 'just' transition also ought to act as an opportunity for deeper reflection on how society is structured and who controls energy markets and infrastructure:

You need to deal with […] the transition more broadly defined insofar as there are winners and losers. You know, white van men who drive diesel vans for work are losers. People who make electric car parts are winners. And in the economy that's a transition. But unless you've got a way to make sense of that at the macro level, you just create resistance. You get the Daily Mail and the Sun[‡] and the unions actively stopping the policy part of it, which means the rest of it doesn't happen. (S6)

In this context, for CCS deployment to be considered part of a just transition, it would have to form just one part of a larger suite of measures aimed at transforming operators' relationships with the communities around them (S1) and government's relationship with the private sector (S7). This leads on to the third and fourth themes, who ought to benefit from a transition and who ought to be responsible for taking action.

3.1.3. Responsibility

This third theme concerns the idea of responsibility, specifically, responsibility for ensuring CCS contributes to a 'just' transition by finding ways to deploy CCS in the public interest. Previous and current negative experience with major private sector operators, who were perceived as profiteering from government support through taxation regimes and planning support, led in cases to suspicion of the motives of operators and developers who may be involved in

[‡] The Daily Mail and the Sun are red top tabloid newspapers

CCS development and deployment (S1). At the time the research was being undertaken, at a Scotland and UK level debates over fracking were continuing, and the actions of one of the major companies involved (and in particular a senior public figure within those companies) acted to fuel interviewees' suspicions as to whether large-scale fossil fuel companies could have any place within a just transition. Nevertheless, there was also pragmatic recognition that the data, infrastructure and skills held by operators currently connected to oil, gas and petrochemicals would be crucial if CCS and wider decarbonisation were to be achieved over the timescales required:

You can't just wait to 2030 for that to happen, so you can see the whole energy transition playing out over the next decade, so of course that has implications for the oil and gas industry. Probably more of an opportunity than a threat, because by pretty well every scenario I have seen, oil and gas will play a critical role in the energy mix for the next thirty or forty years […] the operators will still need to operate oil and gas fields (S5)

The concept of public ownership of wind was raised frequently as an analogue for how energy-related low-carbon infrastructure could be developed in the public interest:

One of the things you can get all the unions to agree on is more public, more democratic accountability of energy and the economy more generally. So if you had a publicly-owned energy company, for example, then you could put everything into that and then you would be able to talk about just transitions because you would be moving people across rather than just moving them from company to company (S7)

Whilst a public ownership model of this nature may be more difficult to implement directly for CCS, it nevertheless illustrates a clear expectation from interviewees in Scotland that steps are taken, through policy and regulation, to ensure government regulates CCS in a way that harnesses the skills of private sector developers yet also allows benefits to accrue primarily to society at large. The scale of 'government' this refers to forms the basis of the next area of enquiry.

3.1.4. Scale of action

A fourth emergent theme relates to the scale of action at which a just transition should be envisioned. Thus far, perhaps due to the financial and technical demands faced, CCS has broadly been discussed as a technology whose development ought to be led at the national level. In the interviews, however, the importance of municipal and regional governments in developing a vision for a low-carbon future in carbon-intensive regions came across strongly.

In particular, there was a sense that it was at these smaller scales of governance where momentum could be built for technologies which would allow high-emitting industries to decarbonise in a controlled manner, for instance the cluster in Teesside and potential for a cluster in the Grangemouth area (S3). The significance and importance of local and regional government in visioning a just transition was also illustrated by the fact that local government (e.g. planners, environmental departments) has a significant role to play in turning 'rhetoric into reality' through granting planning permission, working out the specifics of CO2 transportation and utilisation and so on. Equally, however, it was suggested there is a need to better understand what it is that makes some regions and locales more willing and capable to take the lead in setting out a vision for their own future, and to facilitate opportunities for region-to-region learning (S8). Moreover, it was also noted that there may need to be coherency and consistency between different levels of government, to ensure that local government hopes and expectations for infrastructure like CCS are not confused with directives from national government:

I think that we're just entering a period where there will be, or where there will have to be, a massive transition in attitudes, for both the industry and also throughout local authority organisations in order to keep up with everything that's going on. Because they are releasing sometimes contradictory regulations which we all have to keep up with, and again it's another thing where even within the council there isn't a holistic approach, it doesn't run like a holistic organisation and all of that has to be tacked before you can kind of make any progress (S1)

3.1.5. Viability

The fifth and final thematic area links to the viability of CCS. Respondents were all able and willing to talk at length about what a just transition might involve. Yet with the exception of those with pre-existing technical knowledge of the technologies, most interviewees required some prompting or explanation to reflect on how specifically CCS could form part of a just transition. For instance:

We need to look into pensions divestment, we need to look into energy policy more generally, so particularly what are the key, one of the things that relates to this, what are the key sectors where there is green jobs potential, and not just jobs but good unionised jobs. But CCS hasn't really come up as a key thing. (S7)

Another barrier frequently raised during interviews was low awareness of what CCS entails and how/where it may be deployed (e.g. potential industrial uses); and also negative perceptions over the feasibility of CCS given high-profile cancellations at Longannet and Peterhead. Questions also arose about the extent to which existing infrastructure could be adapted or reused for CCS purposes:

There's an awful lot of old stuff out there which already has or already will disappear. These things are designed for 25 years life, many of them are operating outside the kind of design parameters and kind of getting retrofit. So by the time we get to the back end of next decade, the 2030s, a lot of these facilities won't be there […] So will carbon capture work? The good news is there are plenty of oil and gas fields so for storage there is plenty of space, some of the existing pipelines can be converted, they kind of go one way and you and put them the other way, but the main thing is the investor, which invest in oil and gas, doesn't necessarily invest in carbon capture and storage. (S5)

Furthermore, many respondents expressed scepticism over the involvement of private-sector operators, who can in cases come to be viewed negatively through actions in other industries (e.g. fracking), in a just transition:

The government says we don't subsidise fossil fuels, no but you do point about ten economic levers making it easier to get them out the ground and burn them and use them, you know, and you definitely could un-point those if you wanted. You could definitely not provide economic subsidies or those sort of things (S6)

3.2. Background to CCS in the Netherlands

The Netherlands is familiar with CCS. There have been two major CCS project attempts in the past decade and a half, both of which failed and were widely publicised. The first one, started in 2007, meant to store the CO_2 of an oil refinery in depleted gas fields in the area of Barendrecht. The project was eventually cancelled in 2010 after strong opposition by local stakeholders. Insufficient early communication with, and inclusion of local stakeholders, leading to a lack of mutual trust between stakeholders had been cited as the main reason for the failure of the CCS project (Feenstra et al., 2010). The onshore resistance led the then Minister for Economic Affairs declare that CO2 storage in the Netherlands would only be permitted offshore.

A second CCS project known as ROAD went into development in 2009, to capture CO_2 from 250 MWe of a new coal power plant in the Rotterdam harbour by 2015. The permit for building the coal-fired power plant was seemingly granted under the condition that it would be CCS-ready. Significant EU subsidies from the European Economic Recovery Package (€180 million) and the Dutch government (€150 million) were committed by the public sector. The initiators of the project, the power plant operators, decided to withdraw from the project in 2017 at time of the final investment decision citing excessive financial risk, in part because of a persistently low carbon price and an uncertain future for coal power plants (Smit, 2018). They were proven right as in October 2017, a new government came in and committed to closing all coal-fired power plants in the country by 2030.

Both projects contributed to decreased trust in the CCS project developers as well as the government, and the public opinion on CCS, especially onshore, is negative. A recent increase in earthquakes in the North of the Netherlands due to natural gas extraction has not improved the situation.

In 2019, the Dutch government finalised a climate agreement, outlining how to reduce emissions in order to comply with the Paris agreement. After extremely high expectations for CCS in the 2017 government agreement (20 MtCO2 of CCS by 2030, of which 18 Mt in industry and 2 Mt in waste incineration), the final version aims for a reduced, but still significant amount of CCS, 7.2 Mt in industry and 3 Mt in electricity production 2030. Among industry, the general sentiment is that the consumption of fuel and other emission-intensive products will continue for the foreseeable future, and for some, CCS may be the only viable way to strongly reduce emissions by 2030:

We believe fossil fuels will be needed for a very long time, to the extent we see options to expand our [refining] activities" – "But are there other options than CCS? […] Alternatives are not achievable before 2030. (NL10)

Against this backdrop, a recent, third CCS initiative, Porthos, has formed. Porthos aims to develop a flexible CCUS infrastructure backbone to transport CO_2 from the Rotterdam harbour to empty gas fields in the North Sea with a capacity of 2-5 Mton/yr. Initial feasibility studies have been completed and companies have been called to send an expression of interest. The project is geared up for a final investment decision in 2020. At time of the interviews, the Porthos feasibility studies were ongoing, and the majority of interviewees had no or limited information on the project. Thus far the project seems technically feasible and there has been no significant public opposition.

Preliminary results from the in-depth interviews in the Netherlands are in part similar to the findings in Scotland, but there is one major difference. The majority of stakeholders believe that the impact of CCS on regional employment and identity is limited in the scope of the broader transition. The interviewees in the Netherlands mostly relate the concept a 'just transition' to two other aspects: (a) The fair distribution of burdens and benefits between industry, government and consumers, while mentioning the need to maintain economic viability of the industry in an international playing field; and (b) ensuring that CCS is part of a transition towards a fully sustainable and decarbonised industry. We will elaborate on the differences and similarities under the five sub-themes.

3.2.1. Skills for a Just Transition

Similarly, to the interviews in Scotland, there is broad recognition that the technical skills in the industry are largely transferrable to any sort of activities related to CCS. The need for better understanding of changes in employment in the energy transition is also mentioned. However, both are seen in the context of a broader energy transition, which also includes alternative technologies to reduce GHG emissions. Despite the need for more understanding, it is believed the impact on employment will be limited. The reasoning is that the size and diversified nature of industry in the Rotterdam harbor area will mitigate changes in employment because the technical skills are more broadly transferable and the transition will be gradual.

It seems like some jobs might be lost, other jobs will come back. In a slightly different form, but it is personnel with a technical background, and it remains technical work. (NL2)

In Rotterdam, many types of industry developed, along with secondary and tertiary activities. It is not like there is a single coalmine that shuts down and everything will be finished, it will move much more gradually. (NL5)

Innovation activities may even lead to a net gain in employment. In addition, the industry is capital-intensive, rather than labour-intensive.

Well, the chemical industry is not very labour-intensive. There's plenty of people at work, but it's mostly capital intensive. (NL9)

This is also reflected by the stance of trade unions; they do not see direct conflict between climate action and employment in this specific industry, even though they do advocate for a "Just Transition fund" for the coal industry where workers are presumed to be at risk in the energy transition.

3.2.2. Transition as an opportunity

Some respondents noted potential negative impacts on employment and economic benefits of the harbour on a macro level. A mismanaged transition could be costly and reduce the attractiveness of the area for future investments or continued operation by the industry. However, as is the case in Scotland, the energy transition is also seen as an opportunity. In addition to the current benefits the area offers as the largest harbour and industrial complex of Europe, CCS specifically could be a key part of an appealing industrial ecosystem by providing infrastructure for relatively cheap GHG emission reductions.

But with so many industries in a small area it could be advantageous for the energy transition, because you can make one investment, such as CCS, which a lot of companies can use. (NL6)

CCS infrastructure could also spur the development of other technologies that reduce GHG emissions such as blue hydrogen and expansion of CCU.

If you want to do hydrogen at large scale, you probably need to use blue hydrogen to reach green hydrogen. For that, you need CCS for a while. (NL9)

Shared infrastructure is not new for the area, for example, residual heat is being recycled between facilities where possible, and further waste heat and CO_2 is already being captured and used seasonally in nearby greenhouses. The accessibility of the Rotterdam harbour coupled with the proximity to storage locations could also make it a hub for CO_2 storage, receiving shipments of CO_2 from locations without close access to viable storage.

3.2.3. Responsibility

There are also analogues with Scotland under the theme of responsibility. A previous CCS project on coal power plants, ROAD, was ultimately cancelled, even though the permit for the power plant was granted under the condition reduced CO_2 emissions through CCS. This resulted in the perception that CCS was merely a sales pitch for new power plants, while no one took responsibility for the GHG emissions.

At the same time, we felt sour, because it was kind of a sales trick in order to build a new coal power plant. (NL1)

Before that, an onshore CCS project was cancelled after prolonged public opposition by the locals, mostly resulting from lack of communication and inclusion in the project. Both of these events created a lack of trust in developers of CCS, a negative perception of CCS in general and doubt CCS could be part of a Just Transition.

The question of responsibility for decarbonisation and enacting a just transition often led to the question of who pays. The mantra that the polluter should pay does not translate into real-world application clearly. Firstly, the extent to which the producer or consumer is responsible for GHG emissions is debatable, and second, even within those groups, there are issues in distributing the responsibility.

Who is the polluter? And is that even a good question to ask? The Refinery, the steel factory, or the person that uses a liter of gasoline or a pen or a piece of steel? (NL5)

On the consumer side, passing on the cost to individual products could disparately burden people with lower incomes, as a larger portion of their income is spent on GHG intensive commodities and alternatives may require larger investments.

a lot of products will become more expensive as a result of the transition, if you don't level the costs, people with less money will suffer more. They have to spend a larger portion of their income on energy intensive products. (NL6)

Having a government pay through, for example, income tax, could alleviate this problem. And while it is recognised that the industry shares at least some responsibility and is in position to directly implement solutions to decarbonise, they are constrained by international boards and competition. While there is no common answer, a fair distribution of burdens and benefits between and within industry, government and consumers is essential to a just transition.

3.2.4. Scale of action

The scale at which action needs to be undertaken in order to implement CCS is also linked to the discussion on responsibility. Leadership in the energy transition is expected from the government in the form of regulation and incentives such as a carbon price and providing infrastructure, and as a facilitator, and in central planning:

I think that the government should take the lead in that. I'm not a fan of too much regulation by the market. Some tasks need to be taken up by the government. Implementation can be left to the market, but the regulation, frameworks and planning should be left to the government. (NL7)

This is reflected in the process of drafting of the Dutch climate agreement. The climate agreement is based on discussions at five sectoral tables where stakeholders from the private sector, civil society organisations and subnational authorities are consulted in a typical 'polder model' fashion.

However, it also agreed that the local or regional authorities have a role in translating national policy into solutions that fit the local situation by facilitating different parties.

We [the municipality] think about policy barriers, if we should and how we can remove them, … we can connect the port authority, industry, businesses, the city, civilians, politics and NGO's. (NL3)

In the Netherlands, the harbour and industrial area is managed by the Rotterdam Port Authority, a company owned by the municipality and the state. Porthos is a public-private initiative by the Rotterdam Port Authority together with the Dutch oil and gas exploitation and transport companies. Porthos aim to provide a CCS transport infrastructure and storage for the Rotterdam industrial area. Both the climate agreement negotiations and the Porthos project demonstrate consistent action between multiple levels of government. Whereas the failed Barendrecht CCS project demonstrates the necessity to involve local governments in order to realise such projects.

3.2.5. Viability

There were questions on the viability of CCS and its role in just transition in Netherlands, but different issues were raised. Compared to Scotland, awareness of CCS and the deployment thereof was high. All respondents had knowledge of the basics of CCS and a few had more in-depth technical knowledge. Similar to Scotland, the cancellations of earlier projects led in part to negative perceptions of the feasibility of CCS (see section 2.2.4. for the Barendrecht and ROAD case). Economic viability is also still an issue. While carbon allowance prices in the ETS have increased, its insufficiently high level and the lack of other supporting measures result in an unprofitable business case.

A returning theme in the Dutch interviews was that CCS is considered as as a less than ideal, but necessary technology in order to reduce GHG emissions in line with the Paris Agreement. It must other forms of decarbonisation.

CCS, in our vision, is a measure that should be implemented when there is no other alternative available. (NL3)

Opinions differed on whether CCS should be temporary, mostly because it might be used for negative emissions later.

But whether we should get rid of capture technology, I don't know. It might be we could still make use of that. … All scenario's point out that if things keep going the way they are, we are going to need large amounts of negative emissions, that means you're stuck with BECCS. (NL4)

3.3. Findings in Norway

This final section of the findings links the outcomes from Scotland and the Netherlands to exploratory interviews undertaken in Norway. Norway has two working CCS projects that began operating in 1996 and 2008 respectively. Both projects are operated by Equinor, which has concrete plans for a third offshore CO2 storage site that will be available for third party suppliers of CO2. As such, Norway represents a setting where CCS may have higher visibility within societal debates on climate change, and hence where stakeholders might have more understanding of how CCS could link to just transitions thinking. This makes Norway a valuable case for trialing some of the ideas gained around CCS within a just transition in Scotland and the Netherlands.

3.3.1. *Industrial stakeholders' response to CCS in Norway*

Several contrasts concerning the links between industry and CCS were observed when comparing responses from Norwegian interviewees with Scottish and Dutch responses. These are explainable by two factors which are unique to Norway's industry. First, on one hand, there is continued optimism in future activity in the Norwegian offshore oil and gas sector (Norwegian Petroleum Directorate, 2018), compared to the greater skepticism over the future of, for example, the UK sector of the North Sea (see Section 2.1). It should therefore come as no surprise that oil and gas industry stakeholders in Norway expressed no interest in the potential of 'Just Transition'. This may go some way to explaining why the original goal of mapping a number of stakeholders in this sector was not achieved, in that the need to consider transitions away from oil and gas is not seen as pressing a challenge as it is in Scotland or the Netherlands. Secondly and on the other hand, Norwegian industry has a large onshore metallurgical industry sector, which is a significant GHG source. This metallurgical industry has a recent history of successful adaptation to more intense international competition. This has strengthened their culture of technology uptake to promote improved process performance. There is hence a culture, due to international competition, of adapting rapidly to new ideas, which can explain why the metallurgical industry in Norway seems relatively positive towards engagement with a just transition.

Similar to the Netherlands, the interest in CCS at present within Norway seems to come more from industrial sectors than from oil and gas. It is also worth noting, however, that these metallurgical companies' interest in just transitions comes against a backdrop of wider contributions to climate change mitigation. Norway's aluminium, ferro alloy and silisium industries have important contributions in the transition to renewable energy in the form of light-weight metals to increase energy efficiency in transport, steel for wind turbines, and silicon for making PV wafers. They have in common that they produce process GHG emissions mainly through reduction of ore or other raw materials. They also have in common that most of them are owned by international, global companies that compete with large producers in low-cost countries with lower environmental regulatory requirements.

Indeed, two representatives of the metallurgical industry (NO1, NO2) gave clear indication that despite this context, local Norwegian metallurgical producers see their future competitive advantage in leading on low-emissions production, including reducing GHG emissions. An interest in CCS hence comes alongside wider engagement within this industry with the production of climate change mitigation technologies, something not visible to the same extent in Scotland or the Netherlands. Metallurgical representatives in Norway (NO1, NO2) also stated their preference that industry itself leads this process, but with sufficient support from politicians and regulators to ensure that their competitiveness is not compromised. They see CCS as a key technology to achieve this. Their perspective was described independent of any views on what the fate is of the offshore oil and gas industry, and the associated onshore supplier industries. Whilst the metallurgical industry representatives' awareness of sustainability goals was high, they were unaware of the term 'just transition'. This reflects interview outcomes from both Scotland and the Netherlands, where participants may discuss views in keeping with the ethos of a just transition without necessarily using the term or being aware of its existence.

What the Norwegian industry interviews add to the outcomes from Scotland and Netherlands is an understanding that 'industry' is not uniform, and that different industries will engage differently with CCS depending on their current context and also their wider engagements with climate change mitigation. If CCS is to play a greater role in just transitions, the Norwegian experience hence illustrates the value in identifying – and engaging with – sectors of industry already connected to climate change mitigation, who may be more sympathetic to the need to transition away from high-emitting practices.

3.3.2. Civil society responses to CCS in Norway

Similar to the outcomes from Scotland and Norway, civil society actors in Norway reported mixed views towards CCS. From a trade union perspective, Norwegian respondents were positively disposed towards CCS. Yet in contrast to Scotland, where trade union representatives were broadly supportive of just transitions thinking yet not engaged with the potential of CCS within a just transition, the Norwegian Labour Organisation (NO3) has identified CCS as an integral technology for achieving a just transition, and views CCS as leveraging the skills and capacity of the current offshore industry as the basis for its development.

On the other hand, while the representative of a Norwegian environmental NGO (NO5) was keenly aware of the concept and intentions of a just transition, CCS was not a part of their activist agenda. Instead, their emphasis was on an aggressive scaling down of current oil and gas exploration activities to begin the final winding down of the oil and gas industry in Norway. This mirrors the findings from both Scotland and to an extent the Netherlands, whereby environmental NGOs may not be directly opposed to CCS *per se*, but rather simply may see the technology as a distraction from the goal of rapid and coordinated shutting down of the carbon-intensive oil and gas industries.

The representative of the Norwegian Research Council that was interviewed (NO4) was the only participant that expressed the view that the offshore oil and gas industry should continue to invest and plan for a long future in Norway, while building up a new offshore CO2 storage industry. So in the terms of her framing, the just transition did not depend on a timely replacement of the fossil fuel industry, but rather on CCS as complementary to ongoing oil and gas activities. This mirrors the responses from the industry-academia institutional representative in Scotland, positioning CCS as one part of the place of the oil and gas industry in a low-carbon transition.

The representatives of the NGO (NO5), the labour organisation (NO3) and the Research Council (NO4) expressed the opinion that elected officials and public servants should lead on planning and decision-making regarding a just transition to a low-emissions economy.

Key here is that among the Norwegian respondents, a breadth of views exist as to whether or not CCS has any place in a low-carbon future (Corporation), 2019). These vary from environmental NGOs, who may see CCS as not fitting with the goal of rapid de-escalation of oil and gas activities; through to research and development organisations viewing CCS as one way of promoting innovation within the oil and gas sector into the future. This reflects the outcomes from both Scotland and also the Netherlands, and serves as a reminder that CCS may be compatible with some – but certainly not all – visions of a just transition to a low-carbon society.

4. Conclusion

Five aspects of CCS and a just transition were evaluated in the interviews: skills for a just transition, transition as an opportunity, responsibility, scale of action and viability. While significant differences in responses between regions were found, a common understanding showed that for CCS to be part of a just transition it has to be embedded in a narrative where by CCS (a) makes a contribution to climate change imperatives; (b) helps to mitigate the economic and employment effects arising from declining or maturing industries; and (c) is undertaken in a manner that helps to redress (or at least does not increase) uneven vulnerabilities and inequalities in society.

For CCS to play a role in a just transition debate, it is particularly important to reiterate the necessity of meeting these criteria in the context of CCS, where more pro-environmental stakeholders may be suspicious of what they perceive as linkages to oil and gas operators and where stakeholders related to industry (e.g. trade unions, industries not closely linked to CCS) may feel they lack understanding of how CCS fits with existing skill sets and infrastructure. As such, whilst these three criteria may be 'obvious' for other industries, in the case of CCS it is crucial these criteria are explicitly met.

The key opportunities and challenges for CCS within a just transition emerging from the interviews, based on the above findings and discussion, may be summarised as follows:

- The need for a stronger empirical evidence base of the skills present within carbon-intensive industries and how CCS can match up to these, as well as communication of this knowledge to key stakeholders such as trade unions and environmental organisations.
- Positive framing of CCS as it being just one part of a wider suite of measures that could help society transition to a more economically, socially and environmentally sustainable future. In addition to carbon reduction, this transition also needs to consider how to govern energy infrastructure in way that benefits society.
- The importance of a narrative which clearly positions CCS as being developed and deployed to the benefit of citizens, communities and workers, and not to 'support' or sustain private sector fossil fuel industries. Negative perceptions of operators and developers, fueled by the recent actions of a small number of high-profile companies and the individuals within them, have had the effect of increasing opinion shapers' scepticism of the ability of private-sector energy companies to act in the interest of communities or wider society. There is hence a need for strong regulation and policy to harness the capabilities and experience of the private sector, but doing so in a way that retains the public interest case;
- A need for deeper and further engagement with local authorities acting as facilitators for CCS deployment. In climate change literature more widely, there is increasing recognition of the importance of local government in putting climate change rhetoric into practice. Understanding what can make some regions more innovative than others, and harnessing this capability, may facilitate CCS deployment in specific regional contexts;
- Ongoing work to demonstrate the viability of CCS to stakeholders and opinion-shapers, who may be sceptical as a result of previous failed projects. Smaller-scale initiatives such as Acorn have a significant role in proving the viability of CCS to reach deployment and form part of a Just Transition.

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