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Title: Stakeholder and public perceptions of CO_2-EOR in the context of CCS – results from UK focus groups and implications for policy

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Abstract: Interest is growing in carbon dioxide enhanced oil recovery (CO_2-EOR) as an additional economic incentive for CO_2 injection and demonstration of storage feasibility. However, given increasing societal concern over fossil fuel energy, could CO_2-EOR unintentionally hinder conventional CCS by reducing support from neutral or cautiously supportive voices? This paper assesses how stakeholders and citizens respond to four scenarios for CCS with CO_2-EOR in the North Sea, and draws societal implications for deployment in other mature basins. Based on focus group data from Aberdeen, Edinburgh and London, we argue that scenarios emphasising maximising oil recovery may be met with scepticism or even opposition, and that there is an expectation for national governments to lead and ensure CO_2-EOR (and CCS more generally) are undertaken in the public interest. Nonetheless, our data also suggests a certain degree of pragmatism as to the embeddedness of fossil fuels in society, and thus that there may be qualified support for CCS with CO_2-EOR as making best use of existing fields whilst decarbonising the power and industrial sectors. However, for this support to emerge there is an imperative for coherent and credible policy that positions CO_2-EOR firmly within a managed transition towards a low-carbon economy.

Keywords: carbon dioxide capture and storage; CO_2-enhanced oil recovery; North Sea; public perceptions of CCS; stakeholder perceptions of CCS.

Research highlights:

- Empirical study into stakeholder and public perceptions of CO_2-EOR;
- Scenarios for CO_2-EOR in North Sea with CCS trialed with focus groups;
- Limited support for CO_2-EOR with maximising recovery focus;
- Qualified support for CO_2-EOR as part of managed low-carbon transition;
- Shows importance of credible and coherent energy and climate policies.

1. Introduction and background

The slower-than-anticipated progress of full-scale integrated carbon dioxide capture and storage (CCS) projects in recent years has opened up debates on whether carbon dioxide-enhanced oil recovery (hereafter CO_2-EOR) can help pave the way for CO_2 storage by giving an additional economic incentive for CO_2 injection and also demonstrating the technical feasibility of long-term CO_2 storage (e.g. Kemp and Kasim, 2013). However, of increasing importance given the recent prominence of the perceived deleterious effects of fossil fuels within debates on the future of national energy mixes (Corry and Riesch, 2012) is the role of public and stakeholder perception in influencing how CO_2-EOR in the context of CCS is viewed by policymakers. Whilst there is the potential for CO_2-EOR to stimulate CCS, could it therefore also be the case that CO_2-EOR may unintentionally hinder CCS by tipping the 'reluctant acceptance' or 'neutral' stance publics and key stakeholders may hold for conventional CCS (Littlecott, 2012; Mabon et al, 2014) towards scepticism or even opposition?

We assess this issue through data collected from focus groups undertaken in the United Kingdom between spring and autumn 2014, during which potential scenarios for deployment of CO_2-EOR in the North Sea were trialled with participants in order to gain feedback and stimulate discussion. At the time of the research the UK government CCS Commercialisation competition was under consideration, with both candidates (Peterhead in north-east Scotland and White Rose in Yorkshire) intending to utilise sub-seabed storage in the North Sea. With the UK CCS Commercialisation competition subsequently being withdrawn in autumn 2015, CO_2-EOR may theoretically at least be an alternative source of funding for moving towards storage deployment, and in any case remains an option elsewhere in the world. Price volatility has also brought into focus the future of oil and gas production and associated employment in the North Sea, with Scottish Green Party co-convener Patrick Harvie provoking debate in January 2016 by advocating a 'managed decline' of North Sea oil and gas extraction in tandem with a transition to a more sustainable employment base for north-east Scotland (Scottish Green Party, 2016). The findings of our data therefore have continued relevance to

both the future of the North Sea with respect to oil production versus climate change imperatives, and to CO_2-EOR with CCS beyond the immediate deployment of power sector CCS in the UK.

After reviewing literature on governance of CO_2-EOR and outlining our research method, we discuss three key questions arising from participants' responses: what is the purpose of CO_2-EOR; who benefits; and is CO_2-EOR appropriate in the sense of being technically or economically viable. We identify challenges and opportunities for policymakers arising from these participant questions, arguing that there may in cases be a certain degree of pragmatism among more environmentally-leaning stakeholders and citizens as to the realities of the role of fossil fuels in the energy system. We suggest CO_2-EOR has potential to appeal to a wide range of constituencies as a means of extracting remaining required oil in a more sensitive manner, but at the same time caution that governments must create conditions for credible scenarios for CO_2-EOR, situated firmly in the context of a managed transition for the North Sea and oil- and gas-producing regions like it, if CO_2-EOR is to garner societal support in this way.

2. Literature survey

Research into public and stakeholder perceptions of CCS is now well-established (see Ashworth et al, 2015), hence in the interest of brevity we focus on work into public and stakeholder views on CCS in the context of CO_2-EOR. Much thinking in this area concerns the potential of CO_2-EOR to make CCS more attractive to both stakeholders (for instance policymakers, investors and developers) and publics by giving additional economic incentives. In a comparison of policy stakeholders across four US states, Chaudhry et al (2013) found greater (albeit not universal) support for CCS in Texas – largely due to the possibility of using captured CO_2 for EOR in the state's oil fields. Research with stakeholders in Saudi Arabia (Liu et al, 2012) and China (Reiner and Liang, 2012) has likewise found there tends to be more enthusiasm for CCS when it is linked with the possibility of CO_2-EOR to boost yields from existing nearby oil fields. For publics too, Hovorka and Tinker (2010) believe CO_2-EOR offers advantages over sequestration in brine formations due to the potential for royalties, fees for

surface access and potential for jobs in host communities. In practice, Sacuta and Anderson (2014) note positive discussions around the Weyburn CO_2-EOR project, Boyd (2015) linking this to the role of the operators as major employers in the community.

Boyd (2015) also, however, sees trust in developers and local pride in technological innovation as factors informing support in Weyburn. It may hence also be the case that existing understanding of the organisations and technologies associated with subsurface operations in specific locations suitable for CO_2-EOR offers a starting point towards more general societal support for CO_2 storage. Both Melzer (2012) and Sacuta et al (2013) indicate positive experiences with CO_2-EOR on specific projects arising from public familiarity with oil infrastructure and processes may lead to broader social acceptance of CO_2 storage, Nunez-Lopez et al (2008) and Hovorka and Tinker (2010) both suggesting the value of CO_2-EOR in demonstrating the ability in practice to trap hydrocarbons over periods of geological time.

Nonetheless, CO_2-EOR is not universally portrayed as a bridge towards full CCS. Sacuta and Anderson (2014) stress the need to distinguish between CCS and CO_2-EOR in public engagement, Setiawan and Cuppen (2013) arguing in the context of Indonesia that stakeholders do not see a clear connection between CCS and EOR, instead associating CCS with centralised coal-burning power plants. Stakeholders or publics without so much exposure to oil extraction thus may not so readily see value in utilising captured CO_2 for oil recovery. Even where there is familiarity with oil operations, the links between CO_2 and EOR may not be viewed favourably – Melzer (2012: 12) warns incentivising operators to undertake CO_2-EOR may "be met with cries of corporate welfare given to an industry already burdened with image problems", Mabon and Shackley (2015) noting Scottish environmental stakeholders expressed concern that EOR utilising CO_2 captured from CCS processes may shift CCS from being a 'bridge' to renewables to a means of perpetuating a fossil fuel economy.

At the very least, positive experience in one location should not be taken to mean CO_2-EOR in the context of CCS will be supported more widely. Klokk et al (2010) indicate the possibility for

heterogeneity in stakeholder perceptions of CO_2 utilisation in Norway by suggesting the distribution of value and risk among value chain stakeholders ought to be researched further. Boyd (2015) warns of over-generalising from her Weyburn findings, noting perceived benefits and risks may differ depending on local contexts.

In sum, research to date into public and stakeholder perceptions of CCS in the context of CO_2-EOR suggests a more favourable stance towards CCS might be expected among both communities and stakeholders spatially proximate to existing oil extraction infrastructure, where there could be perceived economic and job benefits, and that familiarity with oil and gas processes in such locations could offer a pathway to wider societal support for CO_2 storage. Equally, though, the link between CO_2-EOR and CCS may not be clearly understood and a range of societal perspectives on CO_2-EOR can exist – including possible hostility towards 'prolonging' fossil fuel extraction. This research builds on these findings by considering how CO_2-EOR may be perceived in a mature oil-producing region that enjoys significant income and employment benefits, yet also one where there is also good understanding of and civic pride in alternative renewable energy sources (Warren and McFadyen, 2010) and awareness of climate issues.

3. Method

Seven discussion groups were convened between spring and autumn 2014 in several locations across the UK. The aim was to encapsulate a range of familiarity with/proximity to potential North Sea CO_2-EOR sites and associated infrastructure, and to capture a range of public and stakeholder perspectives. Three discussion groups were carried out in Aberdeen (one with members of the public, one with stakeholders with an interest in the marine environment, one with early career oil and gas professionals studying at a local university) due to its close proximity to current oil and gas production and a basin geologically suitable for sub-seabed CO_2 storage and/or CO_2-EOR; two in Edinburgh (one with members of the public, one with academics and other professionals with an interest in environmental issues but not working on CCS directly) due to its greater distance from oil production

and high visibility of environmental issues as a result of the city being the seat of the Scottish Parliament; and two in London (one with representatives of the financial sector, particularly 'green investment', and one with environmental NGOs) – whilst London is outwith Scotland, the clustering of 'green investment' stakeholders and NGOs made it a relevant site, particularly given the ability of national-level NGOs to shape public opinion (Littlecott, 2012).

Each group lasted two hours. After a short introductory presentation on climate change, the need for decarbonisation and the possible role of CCS, a 5-10 minute facilitated discussion solicited participants' initial thoughts on CCS as a whole system and energy/climate change more broadly. Participants then received a presentation on EOR (noting in particular that CO_2-EOR is just one form of EOR), with a slightly longer (10-15 minute) facilitated discussion to get initial reactions to CO_2-EOR. The researchers then presented four scenarios for CO_2-EOR in the North Sea (see below), before progressing to the main (30-40 minute) facilitated discussion on CO_2-EOR. As a conclusion to each session, participants were asked (a) which of the four scenarios they *wanted* to happen; and (b) which of the four they thought was *most likely* to happen. Research team members undertook all presentation and facilitation.

Each session was audio-recorded and transcribed, with transcripts anonymised to remove reference to particular individuals and (where appropriate) organisations. Through a review of relevant literature into public and stakeholder perceptions of CO_2-EOR, key themes driving perception of CO_2-EOR were identified (see Section 2 above). The transcripts of the focus groups were re-read, seeking to identify places where themes raised in previous research were either confirmed or challenged. Particular attention was paid to any new themes arising that may not have been identified in earlier studies. The data was thus analysed in an iterative way, reading first to identify relevant themes, and then refining these themes and concepts accordingly in light of their relation to findings from other studies. To increase the validity of conclusions drawn, the researchers read the transcripts independently of one another and then compared their findings afterwards. Additionally, the perceptions of each group on CO_2-EOR were plotted onto a matrix according to how strongly they

identified with the four scenarios presented (see Section 4.1) and what they saw as the barriers and enablers to CO_2-EOR (see Section 5).

Given continuing low public awareness of CCS (Ashworth et al, 2015) let alone CO_2-EOR, to stimulate discussion four different 'scenarios' were constructed for the future of the North Sea. These focused on (a) the extent to which CO_2 storage was deployed; and (b) the extent of climate ambition. These were loosely aligned with the economic scenarios developed by Durusut et al (2013):

1. Maximise recovery, limited climate focus – this was also termed the 'Wood Review' scenario for ease of participant identification. This scenario would aim to maximise oil recovery, injecting only enough CO_2 to recover as much oil as is potentially viable;

2. Maximise recovery, maximise climate focus – this was termed the 'CO_2-EOR' scenario. Under this scenario, oil would be recovered to a high degree, but large quantities of CO_2 would also be injected as part of climate change mitigation;

3. Limited recovery, maximise climate focus – this was termed the 'low carbon' scenario. This scenario would see limited CO_2 injection for CO_2-EOR purposes, but a high drive for decarbonisation, with a focus on offshore renewable development and CO_2 storage in the North Sea;

4. Limited recovery, limited climate focus – this was termed the 'decline' scenario. This scenario would see a decline in oil production in the North Sea, with nothing replacing it.

These scenarios were selected as they provided polarised positions for both climate focus and recovery ambitions, thus giving participants a sense of the markedly different contexts into which CO_2-EOR could be deployed. It was made clear from the outset that these scenarios were only 'caricatures',

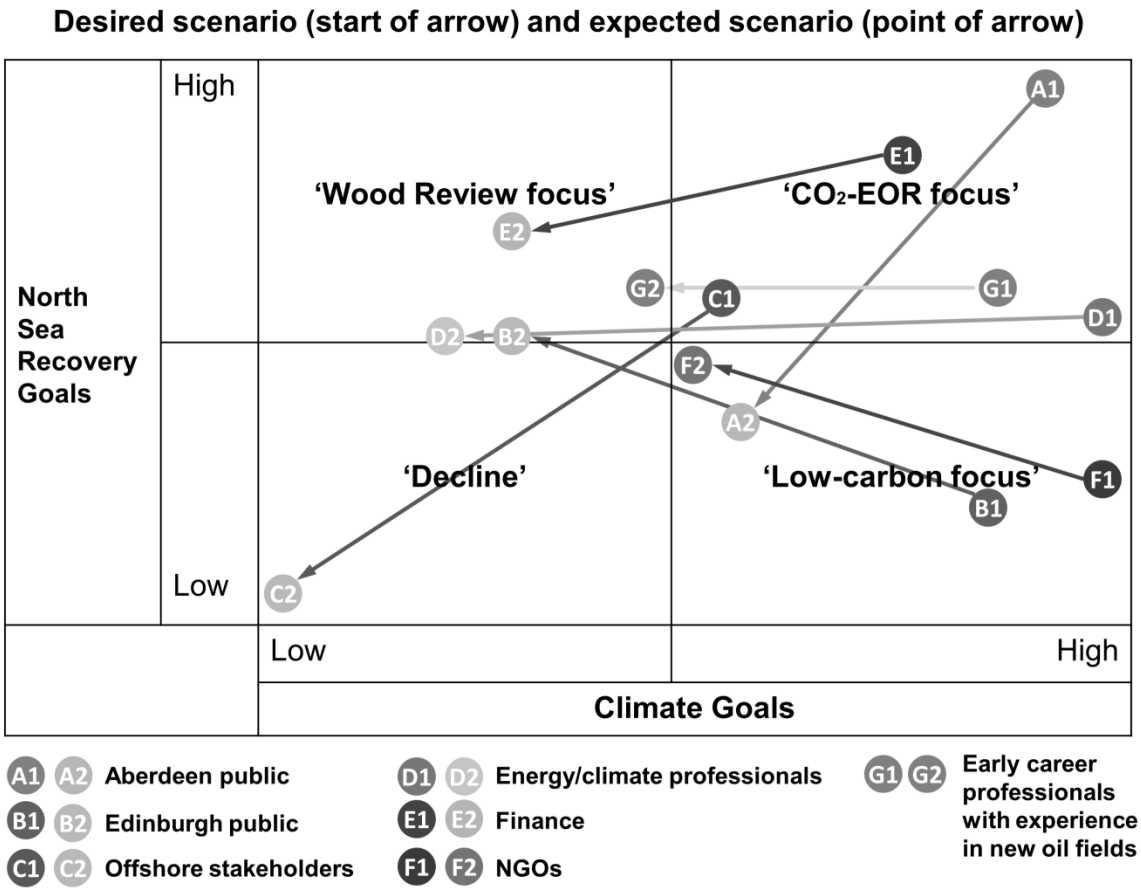
developed to provoke discussion within the groups on possible trajectories for the North Sea. Participants were encouraged to challenge the scenario framings and/or to suggest alternative conceptualisations of their own. The details within each of these scenarios were deliberately kept to a minimum during presentation, in order to encourage the participants themselves to consider the conditions that could lead to the emergence of such a scenario, and to think about the context (if any) in which such a scenario could be desirable. We now evaluate participants' responses to these scenarios, offer suggestions for how stakeholders and publics feel CO_2-EOR in the North Sea ought to be governed, and reflect on what the implications of this are for the governance of CCS more generally.

4. Results

4.1. Response to scenarios

We first provide a general overview of how the groups responded to the specific scenarios presented to them. As mentioned in Section 3, at the end of the session participants were asked which scenario they *wanted* to happen, and which they thought was *most likely* to happen. Figure 1 provides an overview of the general consensus within each group as to where their opinions lay on desired versus expected scenarios, showing also the difference between preference and expectation. Whilst there was no major debate or disagreement in this regard within any of the groups by the end of the sessions, it should be noted that these positions are a composite assessment of multiple views expressed in each focus group discussion and therefore not necessarily reflective of individual participant views or nuanced differences of opinion that may have occurred between participants within groups. Such differences are picked up on in the qualitative analysis of discussion transcripts following in Section 4.2.

Figure 1: desired and expected outcomes of CO_2-EOR scenarios from focus groups (adapted from Mabon and Littlecott, 2015)



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196

197 The first thing to note is that all groups tended to see scenarios with higher climate ambition as more
198 desirable (i.e. 'CO_2-EOR focus' and 'low-carbon focus'). Participants believed it was important for
199 policy to reflect a need to mitigate climate change via a transition to a low-carbon economy. This was
200 true even when stakeholders simultaneously were positive about the potential development of CO_2-
201 EOR. In part this can be explained by the fact the highest levels of CO_2-EOR deployment are
202 associated with action on climate change, given that this is the basis on which (in the UK at least)
203 significant volumes of CO_2 would be provided via onshore power or industrial CCS projects.
204 However, within the groups there was near-universal acceptance of the need for climate action, and for
205 North Sea objectives to be coherent with such climate mitigation. The strong preference for scenarios
206 with a high climate ambition provides an opportunity for policy makers to appeal to the aspirations of
207 multiple stakeholders. Framings that place CO_2-EOR within a wider view of North Sea transition into
208 the future are likely to be more favourably received. Conversely, approaches that only seek to

maximise North Sea recovery goals without attention to climate goals are likely to be viewed negatively, and may even in cases be a trigger for opposition to CO_2-EOR.

The second response to the scenarios was the clear gap between desired and expected outcomes across all stakeholder groups. This notably includes a retreat from climate change aspirations back towards what were perceived to be 'business as usual' objectives on fossil fuel extraction – aligned with the 'Wood Review' scenario. As well as reflecting participants' concerns over the effects on climate change mitigation efforts if CO_2-EOR was framed purely in terms of maximising recovery, this also hints at lack of confidence in and scepticism of governments' ability to drive long-term change over periods transcending electoral cycles. This was particularly true for stakeholders most closely linked to the pursuit of current objectives on oil and gas production. For instance, participants in the Aberdeen offshore stakeholders focus group strongly underlined the challenge of technical credibility of any proposed policy framework, given the lag-times and inertia of private sector investment cycles in North Sea assets. Their view was therefore that 'decline' was the most likely outcome rather than increased investment in either oil production or broader North Sea transition activities (including CO_2-EOR).

The combined impact of these two trends (desire for future-orientated objectives, but gap between desired and expected outcomes) suggests governing the deployment of CO_2-EOR in the context of CCS is a challenging area for policy makers where aspirations are difficult to deliver in reality. However, the broad support for scenarios with high climate goals does provide an opportunity for policy makers to develop longer-term and coherent objectives in association with diverse stakeholders as a means of addressing multiple concerns. We now turn to the participants' own responses to the scenarios to develop the above points and consider in more depth the conditions under which – if any – CO_2-EOR could be viewed as an acceptable and viable part of Scotland's energy transition.

4.2. Participants' own responses

As per Section 3, the scenarios presented to participants were intended to provoke discussion – of equal if not greater interest than establishing which of the four prescribed scenarios the groups favoured the most were the responses they raised themselves. The transcripts were analysed in relation to the themes emerging from extant literature into CO_2-EOR, and it transpired that the themes outlined in Section 2 did also emerge in our UK-specific data, namely: (a) CO_2-EOR as a means of bringing economic benefit and employment to communities reliant on oil extraction; (b) CO_2-EOR as a potential pathway to wider CO_2 storage; and (c) the possibility for CO_2-EOR not to be perceived as part of CCS and/or climate change mitigation. The responses from the UK focus group participants added extra nuance to these themes, however, raising additional questions around the wider context of CO_2-EOR deployment. Rather than automatically seeing CO_2-EOR as a pathway to CO_2 storage, participants questioned what the actual purpose of CO_2-EOR is. Likewise, rather than assuming CO_2-EOR would bring economic benefit to communities reliant on and familiar with oil infrastructure, questions arose over who would actually benefit from CO_2-EOR. And more than challenging the links between CO_2-EOR and CCS, some participants questioned the moral propriety of prolonging fossil fuel extraction whilst others questioned its very economic and technical viability. We thus consider these three overarching themes – what the purpose of CO_2-EOR is, who benefits, and whether it is appropriate in terms of being worthwhile or viable – in turn.

4.2.1. What is the purpose of CO_2-EOR?

Nearly all participants – stakeholders and publics – agreed human-induced climate change was occurring, and that changes to energy production and consumption were required to reduce climate risks. Within this, there was also good general agreement that CCS and associated CO_2-EOR could in principle be considered part of the suite of low-carbon energy sources that may be drawn on to mitigate climate change:

On a case to case basis per if you start to work out barrel costs, it doesn't make any sense to do CCS but if you then take a step back and look at the fact that the climate is changing and is going to have a

negative impact on a variety of things, including our economics, if you look at that scale surely we need to make these technologies as part of a portfolio of successful things, something to aspire to perhaps (marine biologist, Aberdeen offshore stakeholders, M)

[CO_2-EOR with CCS] will give you, you kind of, giving yourself more time to buy something else, another sort of energy source basically cause the way I have understood it is that if you are able to get more oil what seems to be over CO_2, into the atmosphere, then you are able to delay the climate change process, giving you time for the technology to develop which over time is a cleaner energy source (citizen, Aberdeen public, M)

There was less agreement on how CO_2-EOR and CCS would be deployed in practice, with discussion over whether carbon dioxide storage was indeed part of a move to a decarbonised energy system, or whether it gave means to uncritically perpetuate a fossil fuel-based economy. Some participants particularly worried about reliance on 'technical fixes' and short-term economic gain without wider reflection on societal governance and organisation or longer-term climate and energy issues:

[CO_2-EOR] has to be in that context of significant global leadership and sort of a shift towards a true transition rather than a just a technical fix in terms of CO_2 emissions (sustainability consultant, Edinburgh climate professionals, M)

If it's driven by climate and it's driven by a vision that says hey, this is going to make it more socially and politically acceptable to use these things as part of a transition, and there is a real defined transition (researcher, London NGOs, F)

Nonetheless, there was also recognition of the embeddedness of fossil fuels within contemporary society, both in terms of reliance on oil and also on coal- and gas-fired power stations for electricity (it is interesting to note that only limited mention was made of CO_2 emissions from industrial sources such as steel and cement works, and when these were discussed they were raised by stakeholders with

significant energy and environmental knowledge). Under this more pragmatic stance – which was also adopted by some stakeholders more cautious or critical of fossil fuels – CO_2-EOR combined with CCS was perceived as a means of decarbonising remaining thermal power plants, whilst also extracting remaining required oil in a more sensitive manner:

We think as part of the UK's climate targets for 2030, there is still room for some gas by 2030 and if you can capture some of the carbon from that good. If you can link that with industrial process emissions as well to capture some of that, we're supportive (economist, London NGOs, M)

Well I think, just trying to be pragmatic about it, ideally we probably wouldn't be using fossil fuels, we all agree that if we had that option, but we're clearly going to. Governments are not going to give up and we all live lives that are dependent on it, so I guess the question in that context of where does one aim for the most sensible outcome, putting aside any sort of aspirations of going back five thousand years in time and having a different life (finance stakeholder, London finance stakeholders, M)

As well as being part of a transition to a low-carbon energy system, there was also some (albeit limited) discussion of the role of CO_2-EOR in a transition to more socially sustainable ways of living. What is meant by this is giving a less sudden and more realistic trajectory away from employment in fossil fuel-based industries, especially in locations like Aberdeen where the local economy is heavily dependent on oil and gas industries. 'Social sustainability' in this sense also means a more gentle transition away from fossil fuels, with CO_2-EOR giving extra time to address issues such as intermittency and potentially high consumer bills perceived as being associated with a rapid transition to renewables:

I imagine this is part of a, you know, progressive policy to address fuel poverty and you know, bring a whole load of stuff together as part of that transition, and you say so [names operator] is making a lot of money but you know someone has got to operate the rig, that's, that's fine. If it is seen as being government bending over backwards, if it's seen to be allowing their friends in oil to make even more

money at the expense of people in Easterhouse, who can't afford to pay for anything, but that is a completely different situation so it is about the reality and the perception of that reality is crucial to this in terms of public acceptability, in my view (sustainability consultant, Edinburgh climate professionals, M)

This theme of what the purpose of CO_2-EOR in the context of CCS is – and in particular what advantages it may offer to society – leads into the second theme identified as driving perceptions. Namely, who benefits from CO_2-EOR?

4.2.2. Who benefits from CO_2-EOR?

Similar to findings into research on 'conventional' CCS (e.g. Mabon and Shackley, 2015), publics in particular expressed concerns over CO_2-EOR being used not for climate change mitigation, but for operators to continue generating large profits without reflection on the potential environmental and social effects of their practices:

I think you would have to find something really, really positive to offset that we are not subsidising oil companies per se but we are subsidising their research to help climate change or to extract more oil etcetera (citizen, Edinburgh public, F)

So okay this is [names operator], this the [names operator] that is literally pulling out of Aberdeen, four rigs offshore or something and they've set aside their money, for their putting down on, this is a company that, will we make a couple of bucks here as we are leaving sort of thing, the oil and gas thing, isn't it? (citizen, Edinburgh public, M)

At a rather more abstract level, questions were also raised over who ought to be allowed to benefit from EOR. Participants suggested that if CO_2-EOR were to be perceived as 'acceptable', those benefitting ought to be those from less economically developed nations, developers of other kinds of

low-carbon energy (in particular renewables), or communities that relied on oil and gas industries for employment and may be at risk were these industries to close down or decline rapidly:

An interesting question that comes up is should we be investing in CCS in other countries where they actually have moral permission to use fossil [fuel] for longer? Maybe that's the way we approach CCS because if we do it in the UK we know that it will have tighter regulations to make it more challenging (youth activist, London NGOs, F)

I was just wondering if that could be done in the North Sea but that value reinvested in other sources of our energy, wind turbines, tidal wave energy and so on, I think that is it important to have a balance of where our energy is coming from, and alternative sources as well (citizen, Edinburgh public, M)

I think you have also got to remember that the oil companies are in many cases rightly portrayed as pariahs but they make an awful lot of money that pays an awful lot of people's pensions, because they are shareholders and the main shareholders are pension companies, financial and the likes, it is not just Russia, or somebody sitting at the top counting all the cash that is made and you have to make sure that these companies remain profitable eh so you don't want to cut them off completely because so many people rely directly on them (citizen, Aberdeen public, M)

The key idea here is that CO_2-EOR ought to benefit society as a whole, rather than the profits of private developers. Within this, there is also a sense that CO_2-EOR and CCS should be used for purposes viewed as morally 'good', such as allowing less economically advantaged nations to develop economically; generating funds for research, development and deployment of renewable energy sources; and aiding communities heavily dependent on oil and gas industries for employment. Suggestions made as to how this 'ethical' use of CO_2-EOR could be facilitated included ring-fencing a share of the tax revenue generated through continuation of oil extraction, or the establishment of a national CO_2 storage company to oversee developments:

We thought for [the CO_2-EOR focus] to be done we would offer incentives, maybe a tax break or something like that. And we also thought that there would be more, there would be more tax because there's more oil, so we would set aside a portion of that to invest in the low-carbon focus, that was our long-term plan (student, Aberdeen young professionals, F)

Going back to the public body thing, I guess the remit for that public body makes a massive difference, because they could just sort of be in the pocket of the oil and gas industry versus a public body with a really robust remit and a priority to tackle climate change versus one who's not. In that situation it seems preferable to just being led by industry (youth activist, London NGOs, F)

Underneath these discussions on the 'right' purpose of CO_2-EOR in the context of CCS was an even bigger question on whether society even ought to be spending time and resources pursuing such developments. This issue of the appropriateness of CO_2-EOR formed a third cluster of discussion.

4.2.3. Is CO_2-EOR appropriate in terms of being viable and/or worthwhile?

What 'appropriateness' meant in the context of participants' responses concerned (a) if CO_2-EOR was technically, economically and politically viable; and (b) whether CO_2-EOR was ultimately worthwhile in terms of the positive effects it offered. This acknowledgment of the finite nature of fossil fuels, limited global progress on CCS and the perceived inevitable need to switch to renewable energy sources led some participants to question whether CO_2-EOR and indeed CCS as a whole system were even worth pursuing:

How much of a difference is that going to make globally if nobody else is doing anything else, if you are only storing the CO_2 in these fields there and the rest globally, the rest are going to say you know what we are not going to bother with this, would that make any difference to the climate then? Just

this wee pocket in the North Sea, storing you know the carbon storage and using it for enhance oil (citizen, Aberdeen public, F)

How much gas, how much oil is there left there, from what we've got at the moment? […] This government, the governments are very good at doing knee-jerk reactions like five years in front or ten years but we should be thinking about twenty or thirty or fifty years in front, where we are going with the thing before they start putting money into projects (Edinburgh public, M)

Opinions on the finite nature of fossil fuels tended to come from members of the public or less technically engaged stakeholders. By contrast, in the more specialised focus groups (especially offshore stakeholders and carbon finance professionals), concerns were raised over the viability of CO_2-EOR in relation to current political, economic and technical regimes:

CO_2-EOR still doesn't make economic sense because I can guarantee you that if it did make economic sense oil companies would already be doing it (energy analyst, Aberdeen offshore stakeholders, M)

I think on that point part of the problem is that the oil companies won't touch this, because it's just magma, you couldn't build a strategy round it at the moment (finance stakeholder, London finance, F)

90% of the platforms offshore won't be suitable […] viable with regards to what you might want to do it may be viable to do it, the small congested platforms and if you gotta put a whole new whole bridge next to it [laughter] it becomes even less economically viable (oil and gas engineer, Aberdeen offshore stakeholders, M)

By contrast, just as there was acknowledgment of the declining timeframe for continued use of fossil fuels in the context of acting on climate change and also the potentially large political and fiscal challenges required, there was also acknowledgment of the need for *some* continued fossil fuel use and the challenges of decarbonising industrial sources of CO_2-EOR emissions. Building on the above

points about CO_2-EOR forming part of a managed transition away from fossil fuels, it was also the case that ongoing oil extraction – and also other CO_2-intensive processes – were sometimes not seen as viable unless linked to CO_2 injection:

It depends what you're comparing it to. Comparing CCS to renewables is different to comparing CCS to a power plant with no CCS on it…one of the things I do think about CCS is that it is a good idea for industrial applications for chemicals and cement and paper and all that list of things (energy advisor, London NGOs, F)

When a company is applying for licences you can tie that to the licence and encourage companies to explore CCS technologies. In the end they are not losing, because they can use this carbon dioxide to pull out more oil. So the government gains and industry also gains, because they are getting to improve climate change, and industry is also going to get more oil out of the ground (employee of west African operator, Aberdeen young professionals, M)

Whilst many participants did not necessarily see CCS and CO_2-EOR as being viable in and of themselves, it was nevertheless suggested that CO_2-EOR injection had a pivotal role to play in bridging the tension between continuing oil recovery and climate change mitigation. Indeed, the fact that CO_2-EOR was only one type of EOR (and the only one with immediate climate benefits via CO_2 storage) was new information to many participants, including a number of the environmentally-focused stakeholders. A policy challenge that arose out of this was to find ways to encourage – or even mandate – CO_2 injection as part of ongoing extraction operations. Key to note as well is the perception that national governments are seen as having a responsibility to create the conditions in which CCS and CO_2-EOR become viable for industry, and to ensure such developments are governed in the public interest. The implications of our findings for the governance of CO_2-EOR in the context of CCS form the final section of our paper.

5. Discussion - implications for governance of CO_2-EOR

Any consideration of CO_2-EOR by policy makers will need to include an assessment of how it will be perceived by stakeholders, and whether this provides opportunities for policy options – or indeed risks that should be managed in advance. As a foundation for any such consideration, we present here an overview of key themes identified across focus groups, with particular emphasis on what the broader implications from this North Sea study may be for CO_2-EOR – and indeed CCS – more widely. Figures 2 and 3 illustrate the main barriers and enablers to CO_2-EOR identified across the focus group discussions, giving an indication of the extent to which these arguments arose in each group.

Figure 2: groups' perceived barriers to support for CO_2-EOR deployment (adapted from Mabon and Littlecott, 2015)

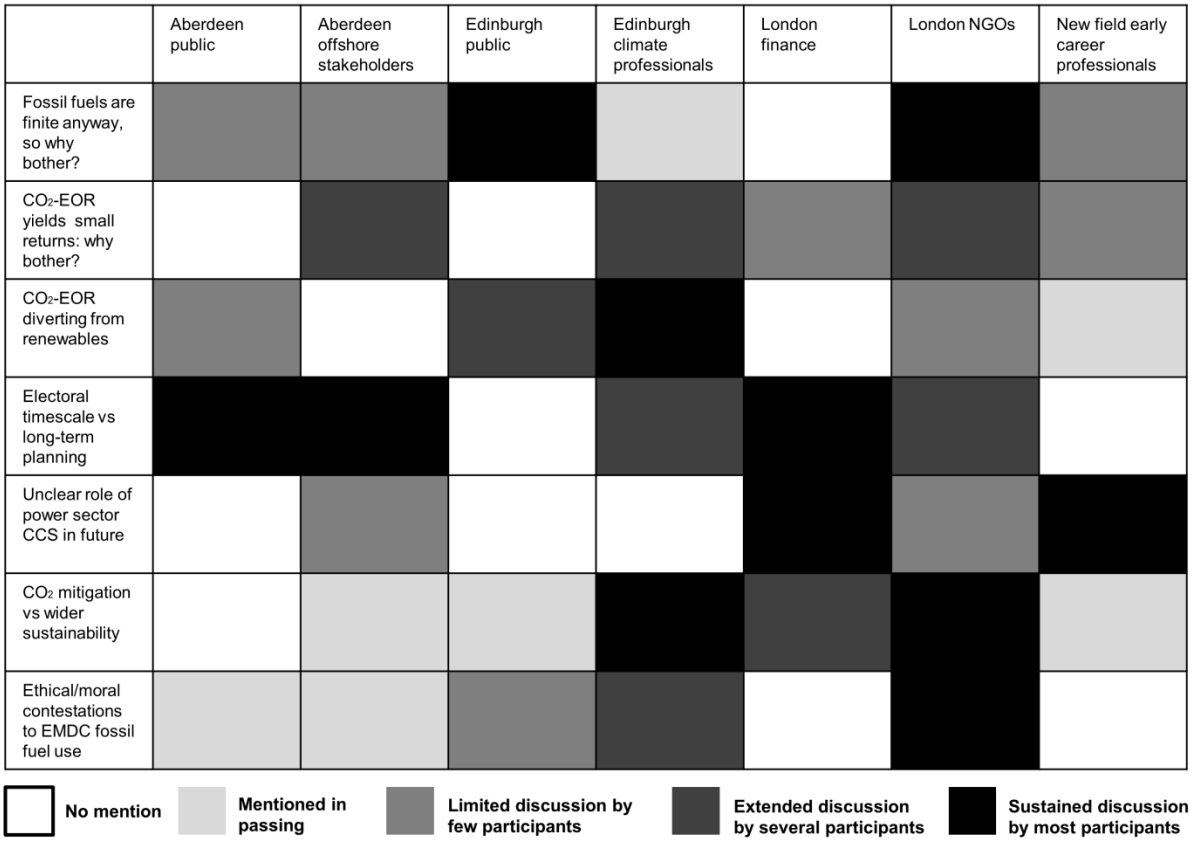
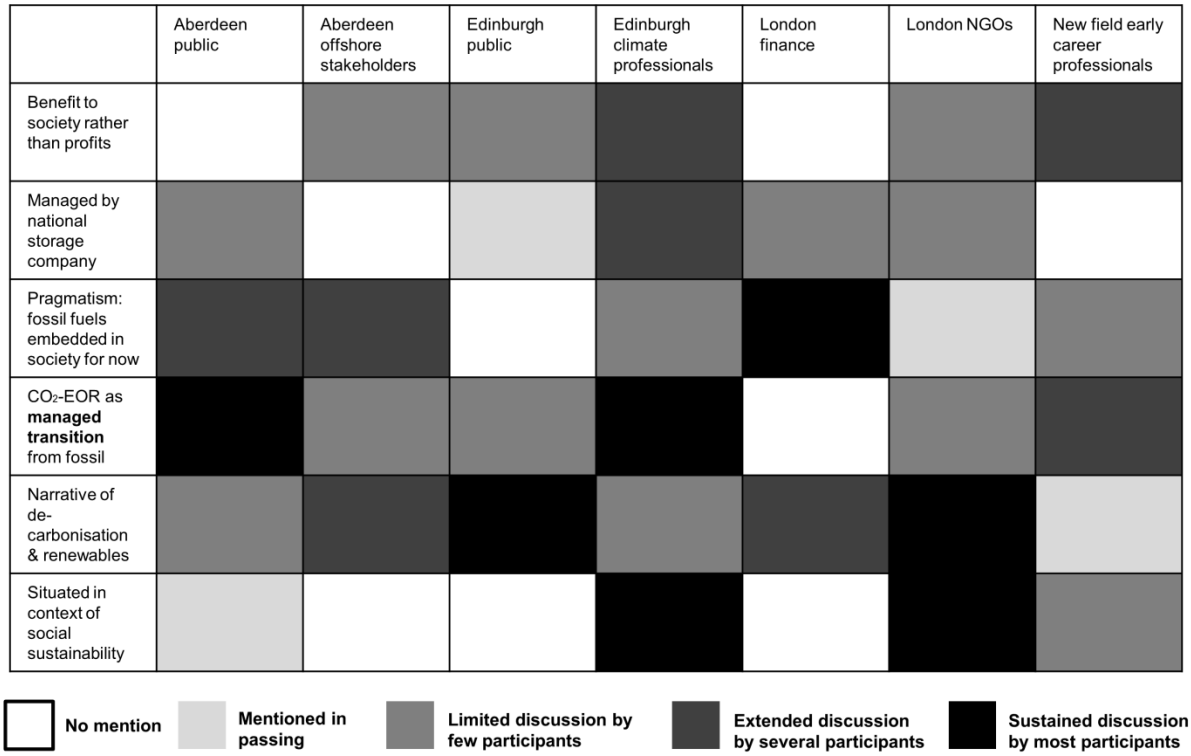


Figure 3: policy initiatives perceived by groups as engendering support for CO_2-EOR deployment (adapted from Mabon and Littlecott, 2015)



5.1. Barriers and challenges for CO_2-EOR deployment

One key barrier to CO_2-EOR deployment coming across strongly from the data was concern over technical and economic viability. Some stakeholders and publics did speak positively about CO_2-EOR prolonging the life of the North Sea whilst helping towards climate goals through associated CCS. This included not only those directly involved in oil and gas, but also others (such as fishers and shipping operators) who enjoyed mutually beneficial and economically positive relationships with oil and gas operators, and saw CO_2-EOR as a way of sustaining these relationships whilst meeting climate challenges. Nonetheless, whereas previous studies tended to show higher support for CO_2-EOR among stakeholders with experience of the oil and gas industries, in this study those with greater experience and knowledge of offshore operations were among the more sceptical of the likelihood of CO_2-EOR linked to CCS occurring in the North Sea. This stemmed from such participants' concerns over the technical suitability of existing North Sea infrastructure for CO_2 injection, and scepticism over

whether CO_2-EOR would ever be viable in the North Sea given the complexities and perceived investment risks involved. The fact these concerns come from stakeholders closer to the policy, economics and practice of CO_2-EOR serves as a reminder that scenarios for CO_2-EOR and CCS seen as socially desirable must be tempered with a recognition of what is viable given complex market and political realities.

Secondly, stakeholders with a more environmental focus tended to emphasise the links between EOR, CCS and what they viewed as the deleterious effects of a fossil-fuel based economy. At a general level, these stakeholders saw a risk that the usage of captured CO_2 for EOR could lead to 'mission drift', shifting from a bridging technology for a low-carbon energy future to a means of allowing continued extraction of oil without reflection from end-point users on the implications of perpetuating dependence on fossil fuels. The 'low-carbon energy future' such participants ultimately envisioned involved not only renewable energy sources, but also reduction in energy demand through behaviour change at the personal level and re-consideration of how society is governed more widely. This is in line with comments from Scottish non-governmental organisations which saw CO_2-EOR as a 'bad price to pay for a good thing' (Mabon and Littlecott, 2015), with a preference for other forms of CO_2 storage.

Thirdly, a topic of discussion across all focus groups was the perceived clash between short term decision making (linked in particular to electoral cycles) and the need for longer term planning for infrastructure deployment and the delivery of a credible North Sea transition plan. This reinforces the above finding about scepticism over the efficacy of policy interventions and the gap between desired and expected outcomes across all stakeholder constituencies – something that the UK government decision in autumn 2015 to withdraw support for the UK CCS Commercialisation competition will have done little to redress.

If CO_2-EOR is to garner public and stakeholder support, there is thus the need for policymakers to envision scenarios that positions CO_2-EOR within long-term, integrated thinking on the governance of

climate change and renewal of energy systems, in a way that perhaps transcends short-term political cycles. It is worth noting the expectation among participants that governments would lead on creating the conditions for CO_2-EOR to facilitate this transition, ideas such as the formation of a national CO_2 storage company or the creation of fiscal regimes being raised by participants themselves. Doubts over whether global oil, gas and coal markets would support the capture and storage of low-cost CO_2, even in the face of some existing climate change policies, further reinforces the need for policy that instigates CO_2 storage and shows coherence between energy provision and climate change obligations.

5.2. Opportunities for CO_2-EOR deployment

Concerns about the negative connotations of a fossil fuel-driven energy system reported in previous research were repeated – especially among more environmentally-focused stakeholders and citizens. However, our data illustrates there may nonetheless be cautious and qualified support for some CO_2-EOR if framed strictly in terms of producing and utilising remaining fossil fuel resources in a more controlled and sensitive manner (e.g. maximising use of existing domestic fields rather than further exploration in new and/or potentially sensitive environments), and regulated and governed in such a way as to be embedded within a transition to renewable energy sources and more sustainable forms of energy use and behaviour.

Our dataset also revealed a certain degree of pragmatism as regards the UK's current energy (electricity, heat and fuel) situation. Even among more cautious stakeholders such as environmental professionals and some citizens, there was a pragmatic recognition – which perhaps does not come across so explicitly in previous studies – that some oil would continue to be required during the transition to a low-carbon economy, and that CCS offered a means of decarbonising existing gas- and coal-fired power stations (and heat provision and industrial sources) during the transition. Publics too – including those in Aberdeen who may have been expected to strongly focus on the economic and employment prospects of CO_2-EOR – widely acknowledged the need for climate change mitigation and the move towards renewable sources of energy as part of this. Yet set against this in our data was

scepticism towards both the technical and economic viability of CO_2-EOR, and also the ability of policymakers and developers to deliver in the context of climate change mitigation. Alongside the goal of maximising economic return of oil reserves, therefore, for support for CO_2-EOR to emerge it ought to be the case that more than 'demonstrating' storage capability, there is from the outset a clear climate imperative for undertaking CO_2-EOR as part of CCS. Related to this but only raised peripherally in our dataset – perhaps as a result of the focus on North Sea transitions – is also the role CO_2-EOR could play in building capability and driving down costs for the capture and transport stages of the CCS chain, for instance by giving incentives for CO_2 sources to capture and/or connecting up EOR operators with a source of CO_2.

Returning to the points made in Section 5.1., crucial to the emergence of support for CO_2-EOR as part of CCS is the public interest case – benefitting society at large through climate change mitigation, job creation/retention and manageable energy costs. Key here is that regardless of whether or not oil and gas companies would significantly profit financially from CO_2-EOR in the North Sea or elsewhere, if operators come to be *perceived* as the primary beneficiaries of CO_2-EOR then support may be limited. This data thus suggests a role for governments in overseeing (or even directly delivering) CO_2-EOR and associated CO_2 storage plus CCS capacity building is crucial in building positive perception. Increasing volatility in oil prices and subsequent effects on North Sea jobs since the completion of the empirical research in this study – coupled with intensifying concerns over energy security and fossil fuel imports – could serve to further reinforce support for CO_2-EOR as part of a just transition for the North Sea, squaring climate change obligations with support for domestic oil production and its associated jobs.

This parallels Mabon and Shackley's (2015) exploration of CCS as potentially the 'lesser of two evils' – that is, citizens and stakeholders may view the pursuit of CO_2-EOR in relation to CCS in a way that is 'less bad' than the alternatives outlined above. There is thus an opportunity for policymakers to frame CO_2-EOR as making the most efficient use of existing domestic oil fields whilst simultaneously reducing atmospheric CO_2 emissions from electricity generation and industrial sources. To retain

574 credibility this must however be couched in a wider framework of transition and a clear pathway for
575 how CO_2-EOR will help to accelerate a move towards low-carbon technologies.
576
577 5.3. Limitations and directions for future research
578
579 It is important to acknowledge some of the limitations of our research technique and framework.
580 Given the limited time available to discuss CO_2-EOR in the context of CCS with participants, it was
581 necessary to take a focused approach to the discussion – in this case, we elected to follow scenarios for
582 the future of the North Sea. Participants' views on the North Sea and CO_2 storage may however be
583 influenced by a much wider range of political, social and economic forces that cannot be explored
584 fully within the bounds of a two-hour discussion. Methodologically, there is also a tension between the
585 flexibility of a qualitative approach and the inevitable subjectivity this introduces – particularly
586 because as per normal ethical procedures for social research (protection of participant anonymity and
587 confidentiality) the 'raw data' of the transcripts themselves cannot be included with the paper.
588 Processes such as assessing inter-coder reliability (Viera and Garrett, 2005) or more quantitative
589 analysis techniques for social data like emotional textual analysis (Vercelli et al, 2014) may offer more
590 systematic analysis for subsequent research, following on from broader-based studies like ours that
591 allow the key themes and ideas to be identified. Nonetheless, we believe the broad range of themes
592 raised by participants – from specific policy and finance matters to social justice through to ethical and
593 moral contestations – justifies a research design that allows participants to raise issues they themselves
594 deem to be of importance and understand the issue at hand on their own terms. This is especially true
595 when awareness of the more technical aspects of CCS may be low (see Malone et al, 2010) and hence
596 it may be important not to 'close down' discussion or pre-empt what participants consider significant.
597
598 Further research may wish to explore further what the end goal is of the 'managed transition' many
599 participants spoke about. Issues that may be assessed here include the kinds of low-carbon energy
600 technology that could be involved and the time frames/costs associated with their deployment, how
601 changes to governance and individual behaviours may be enacted in practice, and how CO_2-EOR may

facilitate this transition through contribution to physical infrastructure or financial returns to the government and/or private sector. There may also be value in going beyond this study's focus on storage to assess the contribution CO_2-EOR could make to the capture and transport parts of the CCS chain, particularly given the emerging interest in industrial emissions and the withdrawal of UK government support for full-scale power sector CCS. Such work could enlist further engagement with environmental NGOs and professionals, and also experts in energy analysis and energy systems.

It may also be worthwhile considering the difference between other parts of the world – where there is familiarity with CO_2-EOR and a ready source of CO_2 – and Scotland. Of particular interest in this regard is the fact that development of CO_2-EOR in, say, North America was initially an economic decision, whereas in Scotland the motivation is more likely to be climate change mitigation. It may thus be of value to explore how publics and stakeholders' perceptions of CO_2-EOR relate to their perceptions of coal/gas or industrial CCS, and to consider the extent to which policy and engagement lessons from CO_2-EOR in other parts of the world are transferrable to Scotland. Conversely, the difference in perception between onshore CO_2-EOR in North America and the mixed picture reported here for offshore CO_2-EOR in Scotland is a reminder that public and stakeholder reception may vary dramatically depending on socio-cultural background, which should be factored into any application of these results onwards to a non-Scottish/UK/EU context.

6. Conclusions

Whilst the context upon which the empirical data on which this paper is based – the potential for offshore CCS deployment in the UK – has changed with the withdrawal of UK CCS competition funding, our findings still hold relevance for the future of the North Sea, CO_2-EOR and CCS more generally. Within the UK, the need to decarbonise industrial sources remains, and CO_2-EOR *may* be one way of helping to fill the finance gap. Further afield, CO_2-EOR projects also continue to emerge globally, hence there is a need for understanding the societal implications of such deployments. The responses presented here suggest that if CO_2-EOR is to be deployed in the context of CCS, policy

makers will need to consider a broad canvas of policy options and public interest framings. It is important to repeat that a noticeably negative response was observed for a narrow 'Wood Review'-type focus on using CO_2-EOR solely as a means of maximising economic recovery of oil and gas. Instead, broader narratives of transition and future vision for a mature basin like the North Sea in the context of a need for action on climate change had greater appeal and were seen to provide a framing within which the scale of (public) investment in CO_2-EOR could be economically and socially justifiable. Further, the scepticism across stakeholder groups as to the deliverability of desired outcomes underlines the need for policy solutions to be technically robust as well as attractive to a range of stakeholders, and in many cases the expectation was that governments would lead on creating the contexts for this to emerge. This need for CO_2-EOR to be framed within broader narratives of decarbonisation and a managed transition away from fossil fuel if it is to garner societal acceptance is a key finding from the North Sea research, and one that ought to be further evaluated through similar enquiry elsewhere.

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