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The UK net-zero target: Insights into procedural justice for greenhouse gas removal



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ABSTRACT

Greenhouse gas removal (GGR) is increasingly seen as a key dimension of national and international climate policy. The need to deploy a portfolio of GGR technologies in order to decarbonise sectors with the ‘hardest-to-abate’ emissions, particularly to achieve net-zero emissions targets, has become increasingly evident in recent years. In May 2019, the Committee on Climate Change (CCC) published a report outlining a pathway to net-zero emissions in the UK, which comprised significant contributions from engineered and land-based removals. The target of net-zero emissions has since been enshrined in UK legislation, meaning that GGR will likely be part of the UK’s climate strategy. Plans for GGR deployment will therefore need to be set in motion in the short-term, in order to align with the timeframe proposed by the CCC.

Despite a growing body of research examining the role governance could and should play in GGR development and deployment, there is a gap in the literature relating to the social implications of removal activities. In particular, the roles of procedural justice (PJ) and social legitimacy (SL) have not been closely examined. This study comprises an analysis of relevant legislation, combined with a series of interviews conducted in the community of Selby (a proposed location for BECCS development) in order to investigate PJ and SL in the context of GGR. It is found that the existing legal framework operates PJ as a ‘tick-the-box’ exercise, failing to engage a wide range of interested stakeholders or to promote meaningful engagements. Moreover, the PJ landscape for GGR is unplanned and adapted from existing legislation and cannot meet the unique needs of this novel activity, such as the need to engage the wider national public given their interest in climate change mitigation. Research in Selby corroborates these findings, revealing a range of issues with engagement procedures, including disinterest or disillusionment with processes, a lack of accessible information, and a disparity between stakeholder expectations and GGR realities. Ultimately, it is only by conducting meaningful engagements, which adequately inform and include participants, that the role of social legitimacy can truly be understood and thus leveraged.

1. Introduction

Conventional approaches to climate change mitigation are proving progressively less capable of delivering climate targets. Since the submission of the first round of Nationally Determined Contributions under the Paris Agreement, researchers have noted not only the inadequacy of states’ climate commitments, but also the insufficient progress made towards these commitments (den Elzen et al., 2019; United Nations Environment Programme, 2018). There is an increasing recognition in the literature that, even if deep decarbonisation can be achieved for some activities, certain emissions will remain extremely difficult to

mitigate through conventional methods (Royal Society and Royal Academy of Engineering, 2018). Moreover, past and present emissions continue to ‘lock in’ further warming that conventional approaches will be powerless to remedy (Rabitz, 2016).

In June 2019, the UK passed legislation committing to bringing greenhouse gas emissions to ‘net-zero’ by 2050, becoming the first major economy to take this step to address climate change. Greenhouse gas removal (GGR) is increasingly recognised as necessary for the UK to meet its emissions goals (BEIS, 2017; Element Energy, 2018; POST Report, 2017; Royal Society and Royal Academy of Engineering, 2018). The May 2019 report by the Committee on Climate Change (CCC),

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which called on the Government to set a net-zero target, outlined a role for GGR in the decarbonisation of 'hard-to-abate' emissions, from sectors such as agriculture and aviation (CCC, 2019) – proposing that 'up to 175 MtCO₂ could be captured and stored in 2050' through engineered removals, while land-based removals could 'increase the net forestry sink to 22 MtCO₂ per year by 2050', under the intermediate 'Further Ambition' scenario. GGR has some important advantages over conventional mitigation; however, questions have been raised about its environmental and social legitimacy, due to both its potential to displace mainstream mitigation approaches, as well as a range of operational risks arising at ground level (Cox et al., 2018).

Commentators have stressed the importance of establishing robust governance arrangements in order to maximise the performance of GGR whilst minimising adverse impacts (Bellamy, 2018; Caldecott et al., 2015; Cox et al., 2018, 2; Fuss et al., 2016). The importance of putting such arrangements in place in the short-term, to prepare for longer-term deployment, has also been emphasised (CCC, 2019; Honegger and Reiner, 2018; Lomax et al., 2015; The Royal Society, 2009). However, an important but understudied aspect of GGR governance is the role it could play in promoting a *just* transition. Questions such as, 'What will be the benefits and trade-offs of GGR deployment for local and national publics?', 'What level of public buy-in or legitimation are required?' and 'How should stakeholders be engaged in GGR decision-making processes?' have not been fully interrogated. These seem particularly important when viewed in relation to the risks and resource demand of GGR deployment. This study argues that by securing procedural justice (PJ) in GGR decision-making processes, policy-makers and developers can build social legitimacy, which could in turn improve climate outcomes while securing a just transition.

2. Greenhouse gas removal: the role of governance, procedural justice and social legitimacy

2.1. Governance

Greenhouse gas removal involves the extraction from the atmosphere and long-term storage of greenhouse gases, and comprises a suite of different activities (Royal Society, 2018; Vaughan and Lenton, 2011). In recent years, GGR has come to be viewed as an essential pillar of climate change mitigation, particularly following the release of the IPCC et al. (2018) Special Report, which underscores the need to 'compensate for residual emissions and achieve net-negative emissions to return global warming to 1.5 °C following a peak' (IPCC et al., 2005, p.17). GGR solutions have several key advantages over conventional forms of climate change mitigation: enabling the mitigation of emissions from hard-to-abate sources; the extension of carbon budgets; reducing the overall cost of decarbonisation, and allowing emissions sources to be disaggregated from sinks, both spatially and temporally.

However, GGR also brings unique risks. Researchers have expressed serious concern about the possibility of mitigation deterrence; threats to global and temporal justice and democracy; and potentially greater climate risk if GGR were to fail (Corner and Pidgeon, 2010; Cox et al., 2018; Cox and Edwards, 2019; Markusson et al., 2018). A range of ground-level operational risks have also been identified for the individual GGR options (Royal Society and Royal Academy of Engineering, 2018). It has therefore been argued across the GGR literature that governance will play a critical role in ensuring that GGR technologies are deployed and operated in a way that minimises such risks (Bellamy, 2018; Buck, 2016; Caldecott et al., 2015; Fajardy et al., 2019; Fuss et al., 2016, 2018; McLaren et al., 2016; Moe and Røttereng, 2018; Royal Society and Royal Academy of Engineering, 2018). The implementation of governance systems that are sensitive to social and ethical concerns as well as political, legal, economic, environmental and scientific ones is expected to mitigate adverse or unexpected consequences of GGR deployment, and could in turn support better climate outcomes (The Royal Society, 2009; Heyward, 2019).

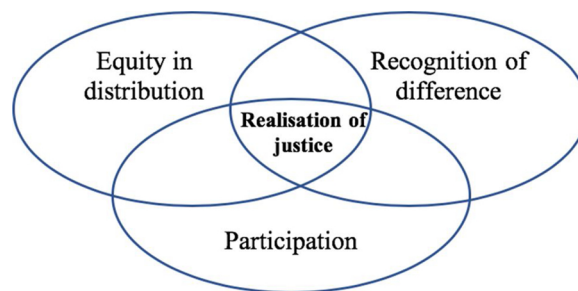


Fig. 1. The trivalent theory of justice.

Yet despite this shift in focus, the role of governance in securing a 'just transition' in relation to GGR deployment remains understudied. Given that all technologies must be deployed *somewhere*, an important area for social science research ought to be to explore the implications of GGR deployment for stakeholder communities, and the relationship of these communities with GGR activities, particularly in specific institutional settings. Noting both the relative immaturity of GGR, alongside the need for rapid, large-scale deployment, it seems paramount that justice concerns are addressed before it is too late.

2.2. Procedural justice

Justice is an important but an under-recognised dimension of GGR and is becoming more dominant in the climate policy discourse. The role of procedural justice within GGR governance is particularly important, yet PJ has received little attention in the context of GGR. It is worthwhile to explore the meaning of both of these terms before examining the role they can and could play as GGR solutions are developed and deployed.

2.2.1. Defining justice and procedural justice

There is no universally accepted definition of what justice is, partly because what people believe to be 'just' is inherently biased (Sen, 2010a). Untangling this complex web of ideologies and definitions is not within the scope of this paper. However, understanding the role of justice in relation to the development of GGR will underscore the importance of PJ within these developments.

The trivalent theory of justice has been described by Sen (2010) and Scholsberg (2004), with participation being articulated as a key element of justice alongside fairness and recognition. The trivalent theory (represented in Fig. 1) is perhaps the most applicable to the justice requirements for GGR developments, given the emphasis on each of its three pillars across the Oxford Principles (Rayner et al., 2013) and the Tollgate Principles (Gardiner and Fragnière, 2018).¹ However, fairness, recognition and participation are in themselves subjective concepts, and can be defined and used differently depending on the context in which they arise (particularly given the diversity of GGR activities). Moreover, justice is not inherently measurable and therefore its assessment can be difficult (McLaren, 2012b). However, assessments of PJ are arguably much easier, as they involve examining tangible procedures that usually have associated legislation or guidelines.

But where does PJ sit within the overall theory of justice? Joss and Brownlea (1999) argue that PJ is both 'a theoretical concept and a practical tool applied to public policy and decision-making'. McLaren (2012b) argues that PJ emerges from conceptions of distributional justice. However, Sen (2010) states that fair approaches to distribution rely on public participation and deliberation in the determination of fairness. It can therefore be considered a mechanism that enhances the provision of justice.

¹ Both of these sets of principles seek to provide guidance for the governance of geoengineering activities – of which GGR is often seen as a subset.

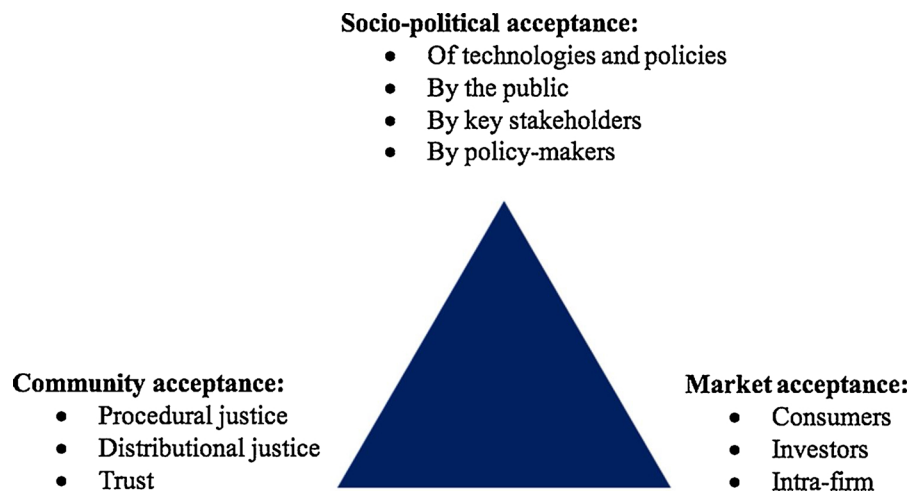


Fig. 2. The social acceptance triangle for renewable energy innovation (Wüstenhagen et al., 2007).

Many of the definitions of PJ converge on ideas about decision-making (Kim and Mauborgne, 1995, p.44; Joss and Brownlea, 1999, p.323; Adler, 2003, p.324; McLaren, 2012a, p.6). This research therefore adopts a definition of PJ that mirrors this. Following Joss and Brownlea's (1999) definition, this research will focus on:

- Public policy-making procedures;
- The relationship between decision-making procedures and acceptability;
- The legitimacy of the outcomes of these procedures.

2.2.2. Decision-making, acceptability and legitimacy

PJ is considered an essential prerequisite for acceptance (Mikunda and Feenstra, 2009). Cox and Pidgeon (2018, p.1) argue that, when developing and governing GGR, attention should be paid to 'urgent concerns regarding democracy, justice and acceptability'. Similarly, Hammond and Shackley (2010) posit that 'the sense of empowerment enjoyed by a community...has a strong influence over their willingness to embrace unknown technologies'. Public acceptance and engagement are considered important aspects of the governance of GGR, and upholding PJ in GGR deployment is necessary to ensure GGR's acceptability. Similarly, Joss and Brownlea (1999) argue that PJ has a strong influence on legitimacy, which in turn is the most decisive factor in determining decision acceptance. If PJ is linked strongly to acceptability and legitimacy, then what factors are these elements influenced by, and what constitutes their attainment?

The relationship between PJ and acceptance is illustrated by Wüstenhagen, Wolsink, & Bürer's 'triangle model' (2007) (Fig. 2). Community acceptance requires procedural justice, distributional justice and trust. However, the actual acceptability of GGR activities is poorly understood. It has been suggested that the abstract nature of removal activities could present a barrier to proper public understanding and awareness of GGR, which feeds into its acceptability (Gough et al., 2018a, 2018b). Following this logic, it could also be argued that purported support for GGR² implies an unrealistic level of acceptability, if a proper understanding of the opportunities and risks involved is absent (Batel et al., 2013). This is compounded by the fact that GGR activities, such as BECCS, are not operational at large scale anywhere globally (Gough et al., 2018a, 2018b). Ultimately, attitudes towards GGR and its overall acceptability are likely to be unclear.

According to Thompson and Boutilier (2011, p.1786), legitimacy is

² In a public attitudes survey published by BEIS (2019, p.7, p.25), support for CCS and biomass energy generation amongst respondents who were aware of both processes was found to be 63% and 68% respectively.

achieved through a combination of 'community engagement, raising awareness of the company, acknowledging community concerns and abiding by community norms, customs and practices'. By enhancing the legitimacy of a project within the local community, developers may seek to gain informal permission to pursue their activities – also known as the 'social licence to operate' (SLO) (Morrison, 2014; Thompson and Boutilier, 2011, in Dowd & James, 2014). An SLO can reduce the risk of the proposed activity being contested and rejected. This aligns with the argument of Batel et al. (2013), that the active and participatory engagement of social actors is key to the sustainability of technologies long term. This contrasts to the passive reception of these infrastructures, as inferred by acceptability alone. The SLO recognises the 'complexities of a relationship between communities and technologies' (Gough et al., 2018a, 2018b).

Noting the role played by these various factors, it becomes clear that prior informed consent combined with inclusive, deliberative processes must inform decision-making when seeking to uphold PJ for activities that intentionally affect Earth systems, whilst also placing pressure on local resources and altering local conditions (Frumhoff and Stephens, 2018). It is arguably only through understanding stakeholder perceptions that the risks involved in GGR deployment can be fully captured. By contrast, presumption of consent for GGR development – based on superficial support rather than genuine social licence – could ultimately constitute a barrier to decarbonisation, by creating community resistance or limiting buy-in (Gardiner, 2013). It is evident that PJ is a prerequisite for developing acceptability and legitimacy of a technology (Mikunda and Feenstra, 2009), and in turn for successful deployment.

2.3. The role of PJ and social legitimacy in GGR

Why are we concerned with decision-making processes and the acceptability and legitimacy of their outcomes in relation to GGR? The recent shift in focus towards justice and PJ in the design of climate policies is evident from the Paris Agreement (UNFCCC, 2015) and the more recent Talanoa Dialogue (UNFCCC, 2018). Simultaneously, the achievement of an SLO for mitigation activities has become the focus of many social science studies.³ Yet the novelty of GGR in an overarching sense, both in terms of its technological immaturity and its establishment in public and expert discourses, has arguably inhibited the PJ

³ Moffat et al. (2015) find that in the case of forestry, achieving an SLO results in the community being more willing to adopt sustainable practices and undertake voluntary certification processes. By contrast, Hall et al. (2015) argue that CCS has no history of an SLO to build on, meaning progress could be hindered by lack of public awareness.

discourse surrounding negative emissions from evolving in the same way.

Learning from historical infrastructure developments, green or otherwise, is valuable in this context. In the Netherlands, Germany and Japan, the failure of CCS projects has been attributed to issues of public acceptance and local opposition, as well as environmental concerns (Ashworth et al., 2015). Meanwhile, public resistance to fracking in the UK originated from safety concerns (Whitton et al., 2017; Whitton, J., & Charnley-Parry, 2020), but over time focus has shifted towards PJ and governance issues, particularly regarding inclusion of the local community in the decision-making process (Gough et al., 2018a, 2018b). This is also reflected in research into community attitudes to CCS in the United States – community benefit and procedural justice have been cited as elements required for CCS projects to progress, alongside technical requirements (Ashworth et al., 2015; Bradbury et al., 2009).

It is not only the failure to deliver PJ and achieve social legitimacy in past projects that provides cause for concern, but also attitudes towards PJ among developers, who have demonstrated a tendency to ‘design out’ justice elements of the development process. For example, UK shale gas developers interpreted the EIA process in a way which did not deem public protest or consultation a prerequisite prior to issuing exploratory permits (Aczel et al., 2018). Although laws in democratic societies are typically correlated with societal norms and values (Dowling and Pfeffer, 1975), the UK’s experience with fracking emphasises that legal and social paradigms can misalign, framing the public out of decision-making, despite legitimate social and environmental concerns (Aczel et al., 2018; Aczel and Makuch, 2019).

The importance of public buy-in for achieving climate targets, of which GGR deployment is now a part, must not be understated. In the Net Zero report it is noted that “it will not be possible to get close to meeting a net-zero target without engaging with people or by pursuing an approach that focuses only on supply-side changes” (CCC, 2019). According to the Report, somewhere between 9 and 62 % of mitigation activities will involve some change in societal and consumer behaviours (CCC, 2019, p.155). And while behaviour change may not directly contribute to GGR deployment, the public’s acceptance of new mitigation activities, predicated on the knowledge that PJ is upheld in their delivery, could in turn support acceptance of the wider net-zero transformation.

3. Method

Justice can be described as the fairness of institutions and their associated processes (Rawls, 2005). However, the lived experience of justice has been suggested as a more realistic indicator of whether justice is provided (Sen, 2010). It is therefore important to assess both the quality of the PJ procedures that are in place, as well as the extent to which their intended impact has been achieved, to truly characterise whether justice has been realised. This research comprises two elements to reflect this:

- 1 An analysis of relevant procedural justice provisions in UK legislation, to understand how PJ is being, and ought to be, delivered in relation to GGR,
- 2 A series of scenario-based interviews examining stakeholder attitudes towards BECCS, to understand whether social legitimacy is likely to develop for GGR and to illuminate weaknesses in the current PJ framework.

Each of these methodological elements will be detailed in this section.

3.1. Legislative analysis

Legal research within the GGR landscape has been conducted previously, though predominantly with a focus on geoengineering or CCS.

Talberg et al. (2018) have explored the architecture and actors associated with geoengineering governance, while Armeni and Redgwll (2015) examine the norms of the UK’s institutional landscape and how this could be used to govern geoengineering. The Global CCS Institute (2018) Legal and Regulatory Indicator assesses the readiness of global legal frameworks relating to CCS deployment (Havercroft, 2018). Such methodologies informed the present research.

3.1.1. Data collection

Four GGR activities were selected as the focus of this research: bioenergy with CCS (BECCS), afforestation, peatland restoration and direct air capture and storage (DACS). These are the technologies that the CCC proposes scaling up significantly to reach net-zero (CCC, 2019). Combining these terms with the identified PJ criteria and their synonyms created the search terms shown in Table 1, which were then entered into the UK Government’s legislation database, legislation.gov.uk, using the advanced search function. To constrain the search, results were limited to UK Primary Acts and UK Statutory Instruments introduced between 1980 and 2019, and also to reserved matters and devolved matters implemented in England.

This research approach enabled the identification of both remedial mechanisms as well as procedures through which people’s rights may come under threat, and how these threats are represented in legislation. In the case of GGR, judicial review procedures in planning legislation and procedures relating to compulsory acquisition rights were identified. However, due to the limitations of this research, liability procedures were not examined.

A content analysis of the legislation was conducted. Table S1 details the instruments examined, the identifying criteria, and the procedure that is in place to deliver PJ.

3.2. Selby case study

3.2.1. Background

The town of Selby, situated in the Yorkshire and Humber region of North East England, was selected as the subject of this case study. A number of factors made Selby an appropriate location for this study. The Humberside area, just east of Selby, has been identified in the Government’s CCUS Action Plan as an area with the potential for CCUS (carbon capture utilisation and storage) development (BEIS, 2018, p.16). The area already hosts an existing industrial centre, built on refining, steelmaking and biomass-fired power generation (BEIS, 2018). In fact, the Yorkshire and Humber region hosts the highest density of biomass-fired generation plants in the UK (biofuelwatch, 2019). The area contributes significantly to national emissions – in fact, emissions stemming from harder-to-abate industrial sectors, which could be the target of GGR activities (BEIS, 2018; ETC, 2018). In addition, the region is home to one of the UK’s most viable geological storage sites for CO₂: a Triassic saline aquifer lies beneath Humberside, extending into the southern North Sea (Senior, 2010; Vandeweyer et al., 2009).

Table 1
Search terms used for the legislative analysis.

	PJ concept	Technologies
Access to information	“Public information”	GGR
	“Register” & “public”	CDR NET
	“Notice” & “public”	Climate geoengineering
	“Data” & “public”	BECCS
Public participation	“Consultation”	Bioenergy
	“Engagement”	CCS
	“Local communities”	Afforestation
	“Opinion”	Forestry
Access to justice	“Appeal”	Peatlands
	“Hearing”	Wetlands
	“Compensation”	DACS
	“Compulsory acquisition”	

In October 2018, Drax power station, situated in Selby, launched Europe's first BECCS pilot project, currently capturing up to one tonne of CO₂ per day (Drax et al., 2019). In May 2019, Drax, in partnership with Equinor and National Grid Ventures, announced a new zero-carbon partnership, with the aim of delivering the UK's first zero-carbon industrial cluster in the Humber region during the mid-2020s (Hill, 2019). In 2019, the UK Government also lent its support by awarding Drax £500,000 to investigate new carbon capture technologies (BBC, 2019).

It is clear that both political legitimacy and commercial opportunity lend themselves to the development of BECCS within the Yorkshire and Humber region. This potential development can therefore be used to explore the UK's tentative, early stage interactions with GGR more broadly. As such, it is important to develop a better understanding of stakeholder interactions with GGR activities in order to characterise how acceptability and social legitimacy manifest and to assess whether PJ is achieved.

3.2.2. Recruitment

It is widely agreed in the SLO literature that communities local to an operation have the greatest claim in terms of defining a SLO – though non-local interest groups and other citizens may also play an indirect role (Moffat et al., 2012). Potential participants were therefore identified as:

- 1 Individuals in the community of Selby,
- 2 Local interest groups (i.e. local NGOs, local branches of trade associations, local branches of political groups),
- 3 External interest groups.

The self-identification of interest groups encouraged by social media allows communities to have unmediated discussion about issues important to them (Gehman et al., 2017). Social media therefore provided a gateway to access a broad audience of community members and local interest groups (from business networking groups to environmental organisations) who might be interested in the local development of BECCS. Meanwhile, literature review was the primary method used to identify external interest groups, based on their previous involvement with Drax, bioenergy or CCS.

The list of individuals who responded to the call for participants are detailed in Table 2.

3.2.3. Case study design

Currently, only a memorandum of understanding has been signed between Drax, Equinor and the National Grid for the development of the first industrial decarbonisation cluster (Hill, 2019). The intricacies of the development are therefore still speculative and liable to change. As such, an approach that combined deliberative methods and scenarios was considered the most effective for identifying attitudes to BECCS in

Selby. A scenario-based approach would give stakeholders a chance to consider the implications of different situations, in a way which would not confine them to specific issues, solutions and perspectives, as typically happens with expert elicitation (Bellamy et al., 2016; Mabon et al., 2015). Moreover, by using scenarios, this study sought to identify the drivers and values behind attitudes, which imagined futures are useful for revealing (McLaren et al., 2016).

Two central themes were used to design the scenarios and guide question design:

- 1 Distributional dimensions of local BECCS development, to ground the scenarios and support the identification of risks and opportunities envisaged by participants.
- 2 Procedural dimensions of siting new developments, to understand community-industry relations, and to characterise aspects such as awareness, fairness, inclusion in decision-making and compliance with social values and norms.

The scenarios and a list of basic interview questions can be found in tables S2 and S3.

3.2.4. Data collection and analysis

Questions regarding (i) awareness of BECCS and Drax, and (ii) attitudes to climate action assessed participant's baseline knowledge of the topic area. Semi-structured interviews centred on the developed scenarios were then conducted. Where possible, interviews were conducted face-to-face, within 15 miles of Selby town, though some Skype and telephone interviews were also conducted. The conversations were recorded (with consent) and transcribed to support accurate analysis.

Since the scenarios are intended to simulate a specific (BECCS) project, an analysis of strengths, weaknesses, opportunities and threats (SWOT) was considered appropriate. SWOT is a commonly-used form of situational analysis that can help identify the key planning elements required for functional community-industry relations before a project begins (Nelsen and Scoble, 2007). The SWOT framework also mirrors the themes outlined in section 3.2.3 – distributional dimensions of legitimacy for BECCS mirror the external opportunities and threats, while the procedural dimensions of legitimacy mirror the strengths and weaknesses of a company's internal capabilities. According to Nelson and Scoble (2006) an opportunity might be the availability of a local skilled work, whilst a threat might be poor company image based on risks associated with past activities. An example of a strength might be past experiences with similar projects, whilst a weakness might include poor engagement with local communities (Nelsen and Scoble, 2006).

Inferring whether social legitimacy is likely to develop, based upon the influence of SWOT factors, turns the classic weaknesses of SWOT analysis – the subjective views of those defining the SWOT factors (Phadermrod et al., 2019) – into a strength. This is because participant views will reflect the nuanced SWOTs that they envisage in relation to

Table 2

List of interview participants included in the study. The term 'representative' has been used to provide anonymity.

Participant	Stakeholder type	Detail	Role
1A	Community individual	Local to Selby	Business Administrator
1B	Community individual	Local to Selby	Apprentice
1C	Community individual	Local to Selby	Veterinary Assistant
1D	Community individual	Local to Selby	Bar Staff
1E	Community individual	Local to Selby	Engineer
2A	Local interest group	Friends of the Earth Selby	Lobbyist
2B	Local interest group	Selby Town Council	Representative
2C	Local interest group	Women's Institute	Representative
2D	Local interest group	Green Party	Representative
2E	Local interest group	Green Party	Representative
2F	Local interest group	National Farmers Union	Representative
3A	External interest group	Legal NGO	Representative
3B	External interest group	Biofuelwatch	US-based Representative

BECCS, thus helping to uncover personal values and beliefs.

Following the categorisation of responses into the SWOT framework, interview transcriptions were coded by hand⁴ into recurrent themes based on similarity of opinion (table S4). The themes were used to deduce the factors influencing legitimacy and whether legitimacy was likely to evolve for BECCS in Selby.

4. Results

4.1. Procedural justice: legislative analysis

4.1.1. Access to information

There are no specific provisions in place guaranteeing access to information in relation to GGR activities. Instruments such as the [Freedom of Information Act, 2001](#), the Environmental Information Regulation and the Pollutant Release and Transfer Register 2004 (PRTR) are general and passive provisions regarding public access to information. However, the establishment of public registers is a more common requirement across the legislation. The Energy Act 2008, under section 29, requires the Secretary of State to 'maintain a register containing prescribed information relating to licences'. Although this is one of the only specific measures identifiable in relation to GGR activities, it is consistent with a general requirement to maintain a public register under the Environmental Permitting Regulation (England and Wales) 2010 under Schedule 24. This covers all activities that would require an environmental permit, and therefore would cover the GGR projects proposed by the CCC. However, no provisions identified in this search serve to actively inform the public of national climate strategy or the activities required for such strategy, and why these are needed.

4.1.2. Public participation

There are specific provisions regarding public participation that are applicable to GGR activities, mainly within planning legislation such as the [Planning Act \(2008\)](#) and the [Town and County Planning \(1990\)](#)—namely relating to environmental impact assessment (EIA), strategic impact assessment (SEA)⁵, Nationally Significant Infrastructure Projects (NSIP) and National Policy Statements (NPS).⁶ However, these are primarily adapted, vague and flexible provisions. It is not clear who is represented, and the recognition given to participant's voice in the process is unclear. Current public participation provisions appear to fall short of providing public participation, with procedures for discussion absent from the process.

Analysis indicates that if deployed to the scale proposed by in the Net Zero report, all four GGR activities would require an EIA.⁷ In general, the applicability of SEA is more difficult to determine, given the precedent of narrow interpretation of the definition ([Sheate, 2017](#))—however, its relevance for GGR may require particular consideration. This is particularly true for CCS, which is a combination of different technologies and is also set to be implemented in clusters. It should therefore fall within the scope of SEA, as the development of a capture

⁴ Partly this was because the number of interviews were manageable for the researcher to analyse by hand. However, the colloquial language and often jumbled conversational syntax used meant that coding through a software was likely to miss or misinterpret some sections of the transcripts.

⁵ EIA and SEA requirements provided through Directive 2001/42/EC (SEA) and Directive 2014/52/EU (EIA) respectively. These are legislated under the Environmental Assessment of Plans and Programmes Act 2004 and the Town and Country Planning Act 1992 in England and Wales.

⁶ The [Planning Act, 2008](#) was created to streamline the decision-making processes for major infrastructure projects and it established the NPS and NSIP as mechanisms to do this. The NPS comprises a statement of the government's objectives for the development of NSIP. They are often viewed as mechanisms to fast track large planning developments ([Sheate, 2017](#)).

⁷ The thresholds for applicability are shown in tables S5 a-c in the Supplementary Information.

facility would in turn require the development of transport and storage infrastructure to complete the CCS chain. Meanwhile, CCS (and hence DACCS and BECCS) would be covered under NSIP legislation ([Planning Act, 2008](#), Part 3, Section 14; 1).

Who?

Overall, there is very little specificity regarding *who* should participate. EIA legislation advises disseminating information about the application by advertising in a local newspaper; posting a notice on the land, and directly notifying relevant individuals who are unlikely to see either of these (EIA, Section 20.2; EIA, Section 19.2).⁸ Meanwhile, SEA requires the project be brought to the attention of impacted individuals (SEA, Section 13.2.b). Within NSIP legislation, there is a stronger mandate for who to consult as it notes in *the vicinity of the land* which may bring wider interpretation of consultees (Planning Act, 2008, Section 47). The NPS simply requires the Secretary of State to arrange for publicity as they see fit ([Planning Act, 2008](#), Section 7.2).

Valid interpretations of these non-descriptive requirements could result in very low levels of stakeholder engagement. Yet standing against this is the possibility that the rollout of GGR at scale would have a particularly expansive set of stakeholders—while the local public will invariably be concerned with local risks and benefits, the national public may be concerned with climate change mitigation—and thus require wider engagement. Although SEA requires the consultation of those who are likely to be impacted, the precedent set by historical planning developments indicates that the interpretation of 'impacted' would be narrow, meaning wider implications might not be considered.

How?

Section 20.2 of the Town and County Planning Act 1992 mandates the use of local newspapers to inform and engage with the public about the proposed activity. More recently it also includes that the Planning Authority should publish the statement on their website. This is consistent with the EIA (Agricultural) Regulation 2017, covering BECCS and Peatlands, and the updated EIA (Forestry Regulation) 2017, which also introduces mandatory online information (Section 13.1). Meanwhile, the Environmental Assessment of Plans and Programmes Act 2004 for CCS does not mandate any specific form of engagement. The [Planning Act, 2008](#) mandates NSIP applicants to use local newspapers to inform and engage with the public regarding the activity—however, for NPS there are no specific procedures mandated in regard to participation.

Recognition

Across both EIA and SEA procedures there are no details given as to how the public's responses to the application should inform the application or the decision ([Town and County Planning, 1990](#), Section 26. 1; Environmental Assessment of Plans and Programmes Act, Section 13). The [Planning Act, 2008](#) mandates the applicant to 'have regard' to any relevant responses from the consultation processes in relation to NPS applications and NSIP legislation (Section, 7.6, Section 49.2).

4.1.3. Access to justice

Both judicial review procedures and acquisition of land procedures were identified within the legislative analysis as providing access to justice under GGR developments. Although there are judicial review procedures in place that are applicable GGR development, there is considerable uncertainty as to their accessibility and affordability, bringing into question whether access to justice is upheld in reality. Judicial reviews for EIA and SEA would also be possible due to the application of the AC. Within the [Planning Act \(2008\)](#), Part 2.13, Part 9.118), judicial review procedures allow the challenging of development consent for NPS and NSIP.

The scale of land acquisition and land-use change that GGR

⁸ In the case of the EIA, these notices should show when and where the development proposals can be viewed and how the public can make representations regarding the application.

deployment would entail are likely to have implications for PJ – particularly under Article 1 of the Human Rights Act 1998. The [Planning Act, 2008](#); [Compulsory Purchase Act, 1965](#) and [Acquisition of Land Act \(1981\)](#) state that breaching Article 1 is permissible if the acquisition is in public interest. However, due to the vague and non-prescriptive consultation requirements of the NPS, the way public interest is determined (under Section 7.2) is in itself superficial and does not facilitate PJ.

Others mechanisms facilitating access to justice include the requirement for compulsory acquisition hearings within the [Planning Act, 2008](#) (Section 92). The Energy Act 2010 (Section 12a) establishes a procedure for the acquisition of land rights for the development of pipelines conveying CO₂. However, the procedure does not include a mechanism for the landowner to be consulted or to be notified of this order prior to acquisition.

4.2. Social legitimacy: scenario-based interviews conducted in Selby

4.2.1. Strengths

Individuals in the community largely “don’t care” about what Drax does (**1B, 1C, 1D**). This community disinterest is recognised by local interest groups. One participant commented that “power generation is not something that gets people out of bed in the morning” (**2E**). It was also suggested that the construction of a transport pipeline for the CO₂ would largely go unnoticed, as it is primarily agricultural land that occupies areas from the east of Selby, towards the North Sea (**2B**). Simultaneously, a positive framing of Drax’s community relations was evident in the discussion – a result of “positive stories” in the newspaper, “Drax open days and activity days”, as well as their community fundraising activities (**1A**). One participant suggested that Drax’s image in the local community might improve if the link between its operations (BECCS) and preventing climate change were made clearer (**1D**).

A desire for more action on climate change, particularly among local interest groups, was a commonly held social value and emergent theme. For participant 2E, this meant that “we need to change our lifestyles and we need technologies such as BECCS, both in extreme quantities”. For individuals in the local community, either they wanted more action on climate change, but did not know what this might entail, or reflected on their own efforts to protect the environment. These efforts frequently returned to the issues of plastic waste and recycling (**1A, 1B, 1D**), as well as a sentiment that businesses are most responsible for tackling the effects of climate change 1C and 1D. This is based on the assumption that big companies are the ones “causing the most harm” (**1C**).

The above information suggests that the community benefit that Drax provides and the value placed on business-led climate action may support the development of legitimacy for BECCS in Selby.

4.2.2. Weaknesses

Despite the general disinterest in Drax’s operations, some participants felt that inclusion of individuals in decision-making about the development of BECCS would be necessary. According to one participant, although Drax provides many direct and indirect job opportunities and therefore benefits the local economy, “it would be important for Drax to go out and get people’s opinions before they went ahead with that (BECCS)” (**1E**). This was based on the proximity of the town to Drax, as well as historical concerns regarding air pollution from the power station, which participant 2A also mentioned. Though the need for consultation is not in itself a weakness, the 2026 deployment deadline chosen in the scenarios suggests that “consultation would have to begin as soon as possible to mitigate the risks identified, or not proceed if BECCS is not a sustainable option” (**3A**). There is a need to allocate sufficient time for the consultation process in the development timeline for outcomes to be considered legitimate. According to participant 3A, consultation should include all those whom transect the BECCS supply chain, “with the fully informed consent of all parties as a prerequisite” for progression of the project (**3A**).

In this context, one barrier to proper engagement is lack of awareness about BECCS. Just under half of participants suggested that a lack of information about BECCS would preclude them from being involved in discussions on the topic. Even reporting in the local newspaper regarding the ‘New Zero-Carbon UK Partnership’, which centred on BECCS and Drax, failed to inform perceptions about BECCS, as two thirds of participants had still never heard the term. Where consultation is needed, one participant commented that “there would have to be a lot of information explaining what it actually is, so that people feel they were educated on it” (**1C**). A failure to raise awareness would therefore limit the community’s ability to be engaged or to form an opinion on the topic (**1C, 1D**). Participant 1C also suggested that for individuals to understand and trust information disseminated in the preparation for consultation, it would have to be non-technical and reported by “somebody impartial...rather than somebody from Drax” (**1C**).

Local and external interest groups also echoed the scepticism felt by some community individuals about how BECCS might be framed by Drax. It emerged in discussion that participant 2A’s views on Drax were tainted by earlier engagement involving Drax’s ‘Re-power’ project.⁹ Based on previous attendance, the participant argued that while some people do attend consultative meetings (requested by the Planning Inspectorate for large projects), but there is often a “specialist surveyor who will throw technical gobbledeygook at the resident of Selby to offset their worries or woes” (**2A**). For this participant, an existing suspicion of Drax’s activities influenced the perception of future BECCS development, due to a negative experience engaging in the planning process, as well as the assumption that CCS would justify the additional gas-fired power units requested under the ‘Re-power’ project. Consequently, both participant 2A and 3A suggested that the shift to develop BECCS by Drax was potentially a distraction used to retain their social licence. This is especially the case if the potential for climate “mitigation is small” (**3A**), or there are “greener” alternatives available for power generation (**2A**).

Lasting impressions of the ‘Re-power’ project also led participants 1E and 2C to suggest a “parallel” between Drax’s activities and fracking (**2C**). Participant 1E elaborated that many people in the local area were “uneasy” about Drax’s plans to begin burning natural gas, because it could “promote fracking in the area, which is a sensitive issue” (**1E**). The link to BECCS is that the CCS could be used to offset emissions from burning shale gas. It is worth noting that the participant who raised this point was the only one with a technical background – nonetheless, the comments are illustrative of the complex ways in which awareness could influence legitimacy.

4.2.3. Opportunities

Aligning with participant conflation of climate action and recycling, participant 1A and 2C suggested that it would be “extremely desirable” to “reuse” some of the CO₂ captured and utilised in the BECCS process (**2C**), as opposed to “it just being wasted” (**1A**). However, the primary opportunity envisaged by nearly two thirds of participants in relation to BECCS was the localisation of the supply chain. The feeling that “people from the town would prefer all of these local options [for the growth of feedstocks, transport of and storage of CO₂ needed for BECCS], even though it could cause more disruption, because it will bring more work” (**1C**). Similarly, participants 1D and 2F suggested that locally grown bioenergy feedstocks could provide farmers with an “alternative” income stream, especially after Brexit (**1D, 2F**). Although some participants had reservations about the availability of land for local bioenergy feedstock growth, it was suggested that job creation would likely outweigh environmental concerns for the majority of residents in Selby

⁹ Re-power is a project proposing to modify two coal-fired generating units at Drax Power Station, Selby, to become up to four new combined cycle gas turbines. It was granted developmental consent in October 2019 ([Planning Inspectorate, 2019](#)).

(2B). This is a result of a lack of local opportunity, particularly following the decommissioning of local power stations Eggborough and Ferrybridge in 2018 and 2016 respectively. For participant 2B, this means “people would put jobs first” (2B).

4.2.4. Threats

Ethical and environmental risks involved in both the international procurement of bioenergy feedstocks and the storage of CO₂ were envisaged by most participants. For the few aware of Drax's operations, the current sourcing of feedstocks from the USA was “not a reassurance” (2E), given the rollback of environmental protections by the Trump administration. Meanwhile, over half of participants voiced concern about the possibility of CO₂ leakage. Participant 1B argued that “it doesn't seem like a complete solution...you can't just stick it underground and forget about it” (1B). Participant 2A echoed this point, suggesting that CO₂ storage could recreate difficulties faced in the storage of nuclear waste and would be willing to oppose CCS on these grounds.

5. Discussion

There is currently an adapted and unplanned PJ framework in place for GGR, characterised by Talberg et al. (2018) and Gupta (2018) as an unplanned landscape of mixed agreements. In the legislation, the primary mandate for public participation has been adapted from other instruments, namely from the planning framework (Town and County Planning, 1990; Planning Act, 2008). Meanwhile, access to information provisions for GGR are generic and passive (Environmental Information Regulation; PRTR; Freedom of Information Act). At present, legal frameworks cannot adequately deliver PJ in relation to GGR deployment, and this is evident in attitudes towards BECCS in Selby. There is a risk that PJ might fail to be delivered, which could in turn undermine the achievement of social legitimacy, and in turn jeopardise the deployment of GGR to meet climate targets.

5.1. Engagement of ‘interested people’

One of the primary difficulties for PJ revealed by this study is the way in which participation is understood and defined, and hence conducted. The vagueness of theoretical definitions of public participation¹⁰ is mirrored in the legislation – vague requirements lead to reductive interpretations of the ‘who’ and ‘how’ aspects of participation, and in turn to poor-quality engagements (which themselves are unlikely to be adequately recognised by the developer). Requirements appear to be designed with the verifiability, rather than quality, of engagement in mind – taking measurable steps towards engagement (such as advertising in a paper with a quantifiable readership) is emphasised over creating a satisfactory experience for participants. Public participation is therefore understood by all parties as a box-ticking exercise, rather than a process through which developers might seek to learn, and indeed to build legitimacy and enhance the quality of their project.

This top-down analysis is echoed in the lived experience in Selby, where community members' limited knowledge of or interest in Drax's activities evidence the ineffectiveness of the company's current engagement strategy. While it is the case that the legal requirements for participation are too limited to engage the full range of interested people, it is also evident that

¹⁰ Rowe and Frewer (2005) argue that Arnstein's (1969) model of public participation is inadequate, suggesting that it is more of a model of public engagement. The two are differentiated based on the flow of information: passive engagement is a form of communication where information is only received on one end - in contrast, active engagement, is participatory, conversational and dialogic, which facilitates the transformation of opinion (Rowe and Frewer, 2005). Current procedures within the UK are not sufficiently dialogic to be considered public participation.

local stakeholders are not adequately equipped to participate meaningfully – due to a limited availability of accessible, non-technical information, and perhaps also to a distrust of the information that is available. It could also be suggested that the information flows from Drax to the Selby community are highly one-directional and thus perhaps susceptible to manipulation – this is reflected in some individuals' very positive perception of the company via the local newspaper. Overall, it seems that Drax have pursued an informative approach to engagement and information transfer, with a view to maintaining acceptance, rather than a participatory approach, in order to build social licence.

The possibility ought to be acknowledged that development of BECCS in Selby may go unnoticed, meaning that any future efforts to develop social legitimacy for BECCS are unlikely to require significant further effort by Drax. Nonetheless, it is arguably only through conducting more inclusive, accessible, non-partisan engagements that the value of legitimacy and social licence may be revealed. Moreover, as climate change rises up the national political agenda, the relationship between Drax and the community might evolve accordingly. Doing so could reveal what both sides stand to gain.

5.2. GGR perceptions versus GGR realities

Forbes et al. (2011) state that to achieve effective engagement, all stakeholders must anticipate and address community concerns throughout the process. However, this becomes more difficult in the context of GGR, for which a range of peripheral issues feed into perceptions. Research in Selby illustrates the disconnect that could exist between the realities of future BECCS deployment and the expectations and priorities of stakeholders.

Interview responses indicate that feelings of patriotism towards British-grown feedstocks, alongside the envisaged boost to the local economy (primarily) through the farming of bioenergy crops, would enhance the legitimacy of BECCS among the local community considerably. In reality, the opportunity for future employment may be limited. Under current projections, the UK might only be able to sustainably source 36 % of target feedstocks under a 50 MtCO₂e/year removal scenario (Albanito et al., 2019). Moreover, of the community members and local interest groups who envisaged additional job opportunities, few could comprehend the scale of land use change required to sustain a scaled bioenergy market in the UK.

A similar discord between stakeholder priorities and feasibility exists in conceptions of wider climate change mitigation. The value that most participants placed on climate action was considerable, transcending all participant groups, which invariably contributes to the legitimacy of BECCS, led by Drax. However, a deeper understanding of the transformations needed to combat climate change was absent among many interviewees. Indeed, this lack of understanding could undermine the success of net-zero initiatives more broadly. Barriers to awareness and understanding are also reflected in concerns about the security of CO₂ storage, which were prevalent amongst more than half of all participants. Although research overwhelmingly suggests a low probability of leakage (IPCC et al., 2005, p.12; Alcalde et al., 2018), it is worth noting that this is a matter for which community concerns could translate into active opposition, given the perceived safety risk.

Negative perceptions of BECCS were influenced to a surprising extent by local experience of the Re-power project. Of particular interest was the memory among stakeholders of the alleged sabotage of public consultation during the planning process for Re-power. This provides important lessons for future procedural justice mechanisms, highlighting that positive community-industry relationships require long-term investment, and indeed perhaps the fragility of community trust.

The evident lack of awareness surrounding BECCS highlights the disagreement between local stakeholder perceptions and national level priorities in the context of climate change mitigation. Such dissonance undermines the realisation of PJ for all types of GGR, as it points to nominal public engagement efforts and limited access to information.

Box 1**The importance of strategic environmental assessment (SEA) for GGR.**

SEA legislation provides for plans or programmes that 'set the framework for future development consent of projects' (Annex 1/Annex 2, EIA directive). Recognising that the scale of GGR deployment proposed by the CCC require large amounts of land across a variety of landscapes, and also noting the multi-stage nature of technologies such as BECCS, it is likely that GGR falls under this definition, and hence would require overarching planning – rather than planning on an individual site or activity basis. It has been suggested that planning GGR developments at a strategic level would allow for further understanding and engagement with the risks and uncertainties involved (Buck, 2016). SEA could serve as an important tool to ensure PJ is upheld in GGR developments. To comply with the Aarhus Convention (Article 6.4), SEA should be used to facilitate participation when 'options are still open'. However, the narrow interpretation of its applicability has resulted in 'salami slicing', with some significant plans and programmes not being considered as such. This has been the experience for previous CCS projects (neither the White Rose project nor the Yorkshire and Humber CCS pipeline were subject to SEA) – a particular concern given that capture facilities require extensive associated infrastructure, namely pipelines for transport and sites for storage of CO₂. Moreover, CCS facilities are set to be implemented in industrial clusters. The development each capture facility therefore sets the framework for extensive other projects, and, in turn, extensive social and environmental impacts, and hence should be subject to SEA.

Maintaining this precedent could significantly undermine the role of PJ in achieving the net-zero target. Ensuring sufficient consideration of alternatives and a wider discussion at strategic level can help ensure PJ is embedded in decision-making and therefore enhance its legitimacy (Eales and Sheate, 2011).

5.3. Scale

The effective application of legal instruments is frustrated by a precedent of narrow interpretation of the legislation, with large-scale developments being 'salami-sliced' in order to circumvent the more restrictive requirements of SEA, which include different processes for PJ. This is particularly problematic for GGR, as explored in [Box 1](#).

Going hand in hand with this contest between EIA and SEA, is the corresponding scale at which the public should be engaged. Rolling out GGR at scales in line with CCC recommendations would invariably have a broad impact: occupying large amounts of space, consuming resources in significant quantities, and ultimately affecting a large population. This could necessitate an expanded definition of 'interested people', in turn increasing the risk that people and interests will fail to be represented. It should also be recognised that, in its attempt to mitigate climate change, GGR arguably becomes a part of the public interest itself, meaning the risks associated with not deploying GGR also ought to be evaluated. Yet the provisions surrounding PJ in GGR-relevant legislation are incompatible with this level of complexity. Not only is there a lack of recognition in the legislation that different scales of activities, and the context in which they are being developed, would require different levels of participation and engagement, there is likely to be a fundamental clash between the needs and interests of the public at these different scales.

Across the legislation, no procedures are available for gauging broader public opinion or stimulating cross-cutting societal conversation about GGR and the trade-offs it would entail. Relevant tools, namely SEA and NPS, could be used to facilitate a national conversation about the role of GGR and other technologies in climate policies 'when options are still open' (AC, Article 6.4; Sheate, 2017), and in turn to incorporate feedback into high-level decision-making. Such a procedure could serve to enhance social legitimacy among the wider *national* public – a concept that has been overlooked in the literature, but which could be considered particularly relevant for GGR. However, current consultation requirements and the precedent for usage of these tools make this unlikely.

There is a clear need for locally-focused provisions to uphold PJ in relation to GGR, as well as high-level strategy and planning to oversee deployment at country level, and mechanisms to bridge these two levels of governance. Citizens' assemblies have been suggested as a forum for

public-led discussions about climate issues that can be impartial and transparent (OPSI, 2016). And while an assembly has been established, it remains uncertain how its outcomes will be fed into decision-making for national policy-making and local planning. A GGR stakeholder group, in a similar style to the CCUS Council, could provide another forum for interested parties, expert and layman, to engage on national- and local-level developments.

6. Implications for achieving net-zero emissions in the UK

It is worthwhile to contextualise these findings in terms of the UK's ambition to achieve net-zero emissions by 2050, as legislated in 2019. Primarily, there is a need to recognize that GGR activities are not detached from the broader social environment in which they take place (Szolucha, 2018; Heyward, 2019; Whitton and Charnley-Parry, 2020). Any changes to climate governance are set against a dynamic socio-political landscape, and it is therefore no surprise that people's expectations of such governance change correspondingly (Whitmarsh et al., 2013), as evidenced by research in Selby. There is an evident desire for change and more participatory governance structures among the public (Whitmarsh et al., 2013) – this can be seen in recent environmental movements, like the Youth Strike for Climate and Extinction Rebellion (Bowman, 2019; Krieger, 2020) Denying such calls for change, and denying public involvement, could jeopardise public support and public legitimisation for these policies, and undermine progress towards net-zero.

Leveraging existing governance structures will invariably be unhelpful for delivering PJ if the object of governance is not recognised as novel. PJ provisions have not evolved to meet the unique needs of GGR – the need to engage a broader range of stakeholders, or to help participants navigate conceptual complexities by providing non-technical information, for example. But even more fundamentally, PJ fails to be delivered even before the complexities of GGR are introduced. There is an opportunity to remedy this, and build on learning from past developments as the country tries to reach net-zero, by moving towards an 'anticipatory' form of governance (Bellamy, 2018; Talberg et al., 2018) – failing to do so would be incompatible with a just transition. The urgent need to mitigate climate change must not be used to expedite or otherwise compromise PJ procedures. Procedures must be designed have regard for people, their land and their values – particularly given that developments will be supported using public revenue.

7. Conclusions

This study illustrates the inadequacy of current PJ mechanisms for GGR, through a legislative analysis and a series of interviews conducted in Selby. The research presented reveals that the current PJ framework for GGR is adapted, unplanned and not suitable for the complexities that governing GGR at scale requires. Primarily, there is a lack of understanding as to how society should be engaged in GGR planning and deployment, demonstrated through top-down and bottom-up research. Provisions specifying who should participate, how they should participate, and how participation should feed into decision-making are vague and lead to narrow interpretations by developers. PJ provisions become mere 'tick-the-box' measures, and potential benefits to developers and stakeholders are overlooked. This manifests in the Selby community as a disillusionment with participatory processes among some members, or as detachment and disinterest in GGR activities among others – making it difficult to understand whether social legitimacy could evolve for GGR.

Placing these findings in the context of the UK's transition towards net-zero also highlights that GGR is in the interest of the national as well as the local public, as a climate change mitigation activity. This raises the relatively new question of whether, and if so how, the broader national public should be engaged as stakeholders in GGR development, and how their legitimisation could influence deployment.

The deficiencies of the existing PJ framework are also highlighted when considered in the context of GGR – if current provisions are arguably too limited to engage the full range of interested stakeholders, or to provide adequate information flows (with respect to both quantity and accessibility), how will they fare with the scale and complexity of GGR? It seems critical that GGR activities are understood collectively, rather than individually, by policy-makers, so that relevant SEA requirements apply. This could go hand in hand with a concerted effort to inform the public about GGR and its role in mitigating climate change, perhaps through a form such as a citizens' assembly or a dedicated council, so that citizens understand the benefits and trade-offs they will experience in the short- and long-term.

The urgency of meeting national climate targets is undeniable – as is the role of GGR in such action. But as demonstrated by this research, there is need to ensure that GGR deployment is tied to a comprehensive procedural justice architecture that recognises the unique features of GGR activities and the corresponding needs of the stakeholders implicated in GGR deployment. By deepening the understanding of the role social legitimacy and social licence play in technological deployment, and the benefits this could bring for developers, policy-makers, stakeholders at all levels and, ultimately, for climate change mitigation efforts, there is an opportunity to ensure that a truly just transition can be delivered.

CRediT authorship contribution statement

Patricia O'Beirne: Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Francesca Battersby:** Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Amy Mallett:** Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Supervision. **Miriam Aczel:** Conceptualization, Validation, Formal analysis, Resources, Writing - original draft, Writing - review & editing, Project administration. **Karen Makuch:** Conceptualization, Validation, Formal analysis, Resources, Writing - original draft, Writing - review & editing, Supervision. **Mark Workman:** Conceptualization, Formal analysis, Resources, Supervision, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition. **Richard Heap:** Methodology, Validation, Investigation.

Declaration of Competing Interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.envsci.2020.06.013>.

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