Bioenergy with Carbon Capture and Storage and Shale Gas: A comparative discourse analysis of two energy technologies in the context of the UK's net zero transition

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Thesis Abstract

Contributing to the fields of energy and environmental policy studies, using Maarten Hajer's (1995) framework of discourse analysis as its main analytical and methodological approach, this thesis focuses on two energy technologies, bioenergy with carbon capture and storage (BECCS) and hydraulic fracturing. This thesis expands on the existing knowledge and body of research in this area, by providing a comparative discourse analysis of the two energy technologies in the unique context of the UK's net zero transition.

Approaching energy technologies as inherently socio-technical systems, the choice of comparing shale gas and BECCS is justified in several ways. Both past and present energy policies described shale gas and BECCS as being able to contribute to decarbonisation to various degrees, being described as a lower carbon and a net zero carbon energy technology respectively. Although utilising different processes, one of storage and the other of extraction, the energy technologies share the use of underground space. Their low-carbon credentials are also points of contestation. Neither of the technologies is being deployed at a commercial scale in the UK, with shale gas having only been in exploratory stages and BECCS being trialled. Additionally, they share a tension between the substantial roles that the two energy technologies were envisioned to play in the UK's energy mix at different points in time and the current lack of realisation of these roles.

In 2019, the UK Government announced a legally binding target to bring all greenhouse gas emissions to net zero by 2050. Using purposive and snowball sampling, I have conducted 31 semi-structured interviews with key actors, between 2020 and 2021, during a time when the net zero transition was well underway. Working with the assumption that language is not a neutral transmitter and that the world is shaped by the language we use to describe it, this thesis used discourse analysis to answer how key actors make sense of BECCS and shale gas in the context of the net zero transition. More specifically, the thesis focused on how the participants' understanding of shale gas and BECCS reflected in the language that they used to describe the

energy technologies and the energy transition itself. I have analysed this using the discourse analytical concepts of ‘storyline’ and ‘discourse coalition’ and have then subsequently categorised the different visions of the net zero transition as presented in these discourse coalitions.

By doing this I demonstrated that there is not a clear shared understanding of the role and potential of BECCS among key actors and that there is a wide range of views on the functionality, scalability, and sustainability of the technology. In contrast to previous findings, this research also showed that in the context of net zero transition, the shale gas discourse is less polarised. Instead of the expected two discourse coalitions, pro- and anti- shale gas, this discourse is divided into three, neither of which is distinctly pro-shale gas. Rather, the shale gas discourse coalitions differ in the way they make sense of the absence or failure of shale gas development in the UK. The thesis also demonstrated that it seems to be very difficult for key actors to make sense of and conceptualise future visions of both BECCS and shale gas without referencing the net zero transition and that there are three types of visions of the net zero transition among key actors. These visions vary widely in the way they understand the potential and role of the net zero transition, and most importantly in the way they view the relationship between shale gas, BECCS and the transition. These insights highlight the contentious nature of the energy debate and the discursive struggles within the net zero transition, which could ultimately shape the way in which the net zero transition develops and are therefore important to study and to pay attention to at this point.

List of Abbreviations

BEIS	Department for Business, Energy and Industrial Strategy
BECCS	Bioenergy with Carbon Capture and Storage
BECCUS	Bioenergy with Carbon Capture Usage and Storage
BGS	British Geological Survey
CCC	Climate Change Committee
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
DESNZ	Department for Energy Security and Net Zero
DECC	Department for Energy and Climate Change
EIA	Environmental Impact Assessment
EOR	Enhanced Oil Recovery
EU	European Union
EV	Enhanced Weathering
GGR	Greenhouse Gas Removal
GHG	Greenhouse Gas
IAM	Integrated Assessment Model
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquified Natural Gas
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
NCP	National Contact Point
OECD	Organisation for Economic Cooperation and Development
SLO	Social License to Operate
STS	Science and Technology Studies
UHD	Unconventional Hydrocarbon Development
UK	United Kingdom of Great Britain and Northern Ireland
UKOOG	The United Kingdom Onshore Oil and Gas
US	The United States of America

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1 Introduction

The ongoing climate emergency requires wide-ranging changes across all sectors of society, especially the energy sector. This is because the energy sector is responsible for more than three quarters of global greenhouse gas emissions (International Energy Agency, 2021) the limiting of which is crucial to mitigate the global climate emergency. Therefore, focusing research efforts on energy technologies is of particular importance at this point. This thesis then focuses from a social science perspective on two energy technologies, bioenergy with carbon capture and storage (BECCS) and fracking. In this first and introductory chapter of the thesis, I will focus on the contemporary issue of decarbonisation, energy technologies and energy transitions as well as introduce the three important elements of this thesis: shale gas, BECCS and the net zero transition.

Selecting fracking and BECCS as two important energy technologies within the UK, in this research I sought to answer the questions about how they are viewed and discussed in the context of the UK's landmark net zero by 2050 decarbonisation policy (Department for Business, Energy & Industrial Strategy, 2021), which was the first of its kind in the world and the details of which I describe later in this chapter. Furthermore, I was interested in the comparison of the discourses of these two technologies which emerged during the time of the net zero transition and assessing in what way they are different and in what ways they are similar, with the rationale, that this provides an important insight into the UK's energy context and the discursive struggles within the net zero transition.

Whilst BECCS and shale gas have had very different developmental pathways, and very different impacts on the UK energy landscape, and are technologically very different, they share the use of underground space (Tang et al., 2023) and they both have been at some point considered within the UK context as being able to play a part in decarbonisation of the energy sector (Change, 2016; Daggash et al., 2019; Williams and Sovacool, 2020). Both energy technologies have also been plagued by controversies (Henderson and Duggan-Haas, 2014; Stephenson, 2015; Haikola et al., 2019b; Waller et al., 2023) and had their usefulness and sustainability credentials questioned by

key actors (Low and Schäfer, 2020), policy makers (Cotton et al., 2014) as well as the public (Bomberg, 2015; Shackley et al., 2009a). Additionally, and more importantly, neither of the two technologies has (yet) been operating at a commercial scale in the UK, despite various actors, policy makers and industry representatives (Daggash et al., 2019; García-Freites et al., 2021; Hammond and O'Grady, 2017; Smith et al., 2010; Tagliaferri et al., 2017) laying claims to the scale of the potential either of the technologies has to impact the UK's energy landscape.

This thesis then primarily contributes to the scholarly work on environmental and energy policy studies. It also draws on some concepts and principles from science and technology studies (STS), the main focus of which is to examine technology and science from a social perspective. It does so by approaching energy technologies as socio-technical systems, a concept which I elaborate further on in section 2.1 of the Literature Review. However, as this thesis focuses on how actors relate two energy technologies to a specific decarbonisation policy, as opposed to focusing on the interplay between the social and the technical aspects of the technologies themselves, it mostly draws from and contributes to environmental and energy policy literature as opposed to science and technology studies literature.

Policy studies can broadly be defined as a study of the process of policymaking and policy content (Meehan, 1985) and energy policies then cover the 'set of guidelines, regulations, and objectives that a government, organization, or individual sets to manage the production, distribution, and consumption of energy.'(Doty,2024, p.12). Environmental policies broadly cover environmental issues, such as pollution and the impacts of climate change (Kraft, 2021). Discourse analytical approaches, such as the one adopted in this thesis, have played a key role in the study of policy since the 1980s (Hajer, 2002). This is because discourse analysis combines the analysis of the production of the discourse with the analysis of the socio-political context within which the key policy actors operate and from which the key policies emerge. So, using discourse analysis in the context of environmental and energy policy studies can also help make sense of how different policy problems get defined and

what consequences these particular definitions have on the policy approaches taken.

The reason for the suitability of discourse analytical approaches to environmental and energy policy studies is that, as Nelson (1996) writes, the role of policy studies at large is to try to understand the world and try to change it at the same time. In other words, policy studies aim to develop knowledge which can be used to change policy and help resolve current social and policy issues (Lasswell, 1951). The analysis of language can serve to uncover what Hajer (2020) refers to as the 'mobilisation of bias' within the policy context, in particular, how and in what ways the linguistic power shifts and then also how we define what the 'problems' at hand are and what is the 'right' way to solve them. Furthermore, Feindt and Oels (2005) describe that discourse analytical work matters to the study of environmental and energy policy, in three ways. First, environmental problems are not self-explanatory, because they are complex and involve interdependencies and are not described using what they refer to as 'common sense' language, but rather are described using expert language and concepts, which contributes to the 'social construction' of their problems. Viewing environmental problems as socially constructed as a result of them being described and defined in specific language also means that there is not one 'correct' interpretation of this problem, rather the definition and interpretation of environmental problems is negotiated in discursive arenas. This negotiation is what discourse analysis can help uncover. Secondly, the articulation of a policy problem then shapes how it is approached. Instead, there are 'discursive formations' which are crucial to the way a particular environmental problem is understood, as the environmental discourse is not homogenous. The discursive formations this thesis is interested in are storylines and discourse coalitions. Finally, the environmental discourse is also intertwined with institutions, practices and technologies – it is the latter which this thesis focuses on. Using the discursive perspective and applying it to environmental and energy policy, allows one to understand how 'the environment' or 'the socio-technical energy systems' are continuously produced and reproduced through the process of environmental and energy policymaking.

In the next few sections, I start outlining the net zero transition, which provides an important policy context to this study. Then, I move onto introducing the two energy technologies that this thesis is focusing on, bioenergy with carbon capture and storage (BECCS) and shale gas exploration, or fracking. I then lay out the policy background and discuss the historical developments of these two energy technologies within the UK. This is followed up by a section outlining the importance of discourse analytical approaches to the study of energy technologies. Finally, I also lay out the aims and objectives of this thesis and introduce the three research questions before signposting to the contents of the remaining chapters.

1.1 Net Zero Background

This section will focus on explaining the origins of the UK Government's landmark announcement made in June 2019 of an amendment to the *'2008 Climate Change Act'* (Great Britain. Climate Change Act, 2008). The *'2050 Target Amendment'* to the *'Climate Change Act'* became a key factor shaping the trajectory of this research. In the simplest terms, net zero greenhouse gas emissions refer to the scenario in which total emissions are equal to or lesser than the emissions which are being removed through various methods, also referred to as greenhouse gas removal (GGR). These methods can include technological processes (such as BECCS or other processes including carbon capture) but do not have to. Greenhouse gas removal can also include using non-technological methods, such as planting trees which absorb CO_2 throughout their growth (Teskey et al., 2008) or maintaining peatlands which are a known carbon sink.

The base starting point for the development of this net zero policy approach is the premise that climate change is the direct result of the concentration of carbon dioxide in the atmosphere being too high. Therefore, the objective is to both reduce the rate at which it is being emitted and remove a portion of it. GHG removal is an important part of climate change mitigation. Even with serious efforts to reduce GHG emissions, GHG removal is necessary to curtail the effects of the already high CO_2 concentration in the atmosphere and also because of sectors, such as steel, which are hard to decarbonise.

In 2008 the UK Government passed the Climate Change Act, which called for an 80% reduction of the UK's greenhouse gas emissions (GHG) compared to pre-industrial levels (Great Britain. Climate Change Act, 2008). This new amendment from June 2019 calls for the reduction of GHG emissions to net zero by 2050 (Great Britain, Climate Change Act 2008, 2050 Target Amendment). The UK was the first major economy to adopt such a net zero greenhouse gas (GHG) emissions target by 2050.

In 2015, at the 21st United Nations Conference on Climate Change in Paris, the international community agreed to limit global warming to well below 2 degrees Celsius, as compared to pre-industrial levels, preferably even to 1.5 degrees (Delbeke et al., 2019). This then became known as the Paris Agreement (2015). The Agreement also aims for global net zero greenhouse gas emissions by the second half of the 21st century. Including the UK, 181 countries have ratified this Agreement, but notably, in 2017, under President Trump, the US withdrew its participation from this commitment. Under President Biden, the US then rejoined in 2021. In 2016, the Climate Change Committee, which is an independent, statutory body established under the Climate Change Act 2008, published a report titled '*UK climate action following the Paris Agreement'* (Bell et al., 2016), in which the Committee advised the UK Government that it was yet too early to firmly establish a net zero target for the UK, but that this should be considered in the future. In 2017 the UK Government published *'Clean Growth Strategy*' (HM Government, 2017), in which the UK Government confirmed its commitment to work on reducing greenhouse gas emissions to net zero globally in the first half of the 21st century and that this will be reflected in future legislation efforts. At the time, more than 141 MPs from both the governing as well as opposition parties signed a letter calling for a legislative commitment to a net zero target set before 2050 (The Climate Coalition, 2019). The following year, in 2018 the Labour Party stated at their conference that they would be in support of a 2050 net zero target (House of Commons Library, 2018), similar statements were also made by the Liberal Democratic Party (House of Commons Library, 2018). Within the Green Party, there have been calls for a net zero by 2030 target (House of Commons Library, 2018). In the spring of 2018, new climate change

legislation was introduced in Scotland, the Climate Change Bill, which called for a 90% reduction of Scotland's greenhouse gas emissions by 2050. Reflecting the more challenging target, at the time the Scottish National Party, called for evidence to support setting an earlier target than 2050. These events show the multilayered development leading up to the eventual 2019 announcement of the 2050 net zero target, and the development of a discourse across the political spectrum.

Whilst the events described above provide important contextual references to the origins of the net zero discourse, one of the crucial turning points in the climate change policy discourse was the publication of a report titled *'The Special Report on Global Warming of 1.5°C'* by the Intergovernmental Panel on Climate Change (Allen et al., 2018). This report, published in October 2018, garnered significant attention. It found that in order to limit global warming to 1.5 degrees Celsius as compared to pre-industrial levels, significant and rapid changes will need to be made across all aspects of society. The report also mentions that this includes reaching the target of net zero greenhouse gas emissions by mid-century (around 2050). The IPCC emissions pathways, which are compatible with the aforementioned Paris Agreement, as produced by the Integrated Assessment Models (IAMs) frequently depend on a large scale of carbon dioxide removing technologies and mitigation strategies (Butnar et al., 2020; Gambhir et al., 2019; Haikola et al., 2019b; Low and Schäfer, 2020; Rickels et al., 2019; Vaughan and Gough, 2016), ranging from nature-based solutions such as afforestation to on-site carbon capture (CCS) or carbon capture from ambient air (DACCS). IAMs are computer-based models, which analyse a broad spectrum of data, including physical, economic, and social data to produce information to inform decisions. The IPCC models specifically, aim to connect various features of our society and economy with the biosphere and atmosphere in one framework (Dowlatabadi, 1995). The models are developed to predict greenhouse gas emissions and their impacts and so help decide on the best climate change mitigation pathway.

Finally, in 2019, the UK Government was the first government to legislate to meet its net zero greenhouse gas emissions to net zero by 2050. It was the

first country to legally do so. This created an unprecedented and unique policy context for the future development of energy technologies. This announcement was preceded by a report published by the Climate Change Committee in 2019 titled*: 'Net Zero the UK's contribution to stopping global warming*', which called for this specific net zero target. The plan to introduce this target was featured in the *'Net Zero Strategy: Build back Greener*' (HM Government, 2021) which was finalised and published in October 2019, and is comprised of both policies and proposals for all sectors across the UK economy and outlined how to meet the net zero target by 2050. Shale gas is not mentioned in this strategy directly, however, the opening statement by the then Prime Minister Boris Johnson refers to divesting from *'dirty fossil fuels'* (UK Government, 2021). On the other hand, the report mentions that by 2030, the UK Government envisages significant deployment of mature technologies (p.189).

In the same year, UK Fires (Allwood et al., 2019), which is a UKRI (UK Research and Innovation) funded collaborative research programme, published the 'Absolute Zero Report', providing an alternative perspective to the net zero discourse. Absolute zero, as opposed to net zero, refers to an absolute reduction of greenhouse gas emissions. In the scenarios presented in the report, there are no negative emission options which are seen as acceptable, and neither are carbon offsets. The emphasis is to make the energy sector emissions-free by using low-emissions technologies that are already available as opposed to using as-yet un-scaled negative emissions technologies (Allwood et al., 2019). In contrast, when the UK Government announced the net zero target, on June 27th, 2019, they referred to *'planting trees or using technology like carbon capture and storage'* as a means to offset emitted greenhouse gases to create a net zero balance.

1.2 Bioenergy with Carbon Capture and Storage

BECCS falls under the category of so-called negative emissions technologies. We can also think of this energy technology as consisting of three elements, bioenergy, carbon capture, and carbon storage. Sometimes, a similar acronym is used, BECCUS, which stands for bioenergy with carbon capture, usage, and storage, this is however used less frequently in the UK context especially, as there are not many avenues available to utilise carbon capture from biomass

combustion. Because of this, and the Drax power stations focus on CCS and not utilisation of carbon, this thesis only focuses on analysing the discourses related to bioenergy with carbon capture and storage as opposed to bioenergy with carbon capture utilisation and storage, as arguably this would have produced a different case study as the addition of the utilisation element changes the characteristic of the energy technology.

Bioenergy is energy gained from organic material, called biomass. Biomass can take many different forms and come from a wide variety of sources. These can include but are not limited to biomass gained from crops which are deliberately grown as energy crops, such as willow or miscanthus (Balat and Ayar, 2005). Municipal solid wastes (MSW) from households or the restaurant industry can also be used as biomass. Additionally, biomass can also include different forms of residues, such as wood residues from forests, residue materials like pulp which are created by the paper industry, or similarly sawdust from the wood processing industry or waste oil from the food industry. These different materials are then processed to produce a kind of fuel, which can be biofuel, wood chips, pellets, briquettes or even biogas (Prasad et al., 2012). Each of these could potentially be used as a bioenergy feedstock.

BECCS is referred to as a negative emissions technology because CO_2 is absorbed as the biomass (re-)grows. The regenerated biomass absorbs CO_2 from the atmosphere and so if the CO_2 created during the production of energy through the combustion of biomass can be captured and stored indefinitely, this achieves the removal of CO_2 from the atmosphere and results in net-negative emissions. Carbon negativity requires the amount of CO_2 that is removed to be higher than the amount of CO_2 that is being emitted. This is different to carbon neutrality which means that the CO_2 that is being emitted into the atmosphere is then removed at the same rate.

Carbon capture and storage technologies can be used in combination with bioenergy systems in different ways, depending on when the emissions are captured. The emissions can be captured at different life cycle steps within the bioenergy system. Emissions can be captured directly at the plants where the bioenergy feedstocks are converted to various fuels, but also at the end of the

bioenergy life cycle where the fuels are converted to energy (through combustion). The emitted CO_2 is then captured, compressed, and transported to suitable underground storage sites, which in the UK is most likely to be offshore, however, other countries also have onshore carbon capture storage sites (Selosse and Ricci, 2017). Sometimes, this process of capturing CO_2, and in a compressed form injecting it into old oil and gas wells for storage is also used in combination with a process called enhanced oil recovery (EOR). Whereby, the injecting of CO_2 is used to recover any possible left oil and gas for further extraction. There are carbon capture and storage sites which use CO_2 in this way (Melzer, 2012). EOR is not a process that is planned to be used when storing carbon derived from burning biomass, as extracting, and then burning more fossil fuels would defeat the purpose of BECCS being a negative emissions technology.

BECCS went through different waves being considered an important option in the UK's energy portfolio. In 2007 and then in 2012, government initiatives were launched to support the development of the UK's first carbon capture and storage site. Both initiates have however been cancelled, in 2012 with a very short notice (Allen et al., 2018) (House of Commons Library, 2020) which resulted in uncertainty about the progress of CCS. In 2013 the government then published a report titled *'Government's guidance on UK carbon capture, usage and storage'* in which it set out its future approach, which included scaling up the technology so that it could be deployed in the 2030s. Notoriously in 2015, ringfenced funding for a carbon capture and storage competition was removed by the government at short notice again (Carrington, 2015). This significantly halted the development of that technology and created distrust among investors and developers. BECCS then became more relevant again after it was featured in the IPCC 2018 Special Report on Global Warming of 1.5 ° (Allen et al., 2018) which mentioned BECCS as a key feature of the climate change mitigation strategy. When examining the Intergovernmental Panel on Climate Change (IPCC) scenarios of limiting temperature rise to 1.5 degrees, BECCS is expected to deliver approximately 12 billion tonnes of CO_2 removal each year. Depending on the scale-up of BECCS, the pathways differ in the mitigation strategies required (Muri, 2018). Fewer BECCS-dependent

pathways rely on more extreme reductions in greenhouse gas emissions, equally pathways that heavily rely on BECCS, call for less immediate mitigation strategies (Bui et al., 2021).

Some (Köberle, 2019) link the reliance on BECCS in IPCC scenarios to the use of IAMs. They argue that, as it became increasingly more complicated for the models to find the pathway, which was compatible with the Paris Agreement, given the incremental levels of change in both decarbonisation and energy technologies development, solutions like CCS became more frequently used. CCS was initially viewed as a technology that could remove carbon dioxide from coal-fired power stations and then store carbon in deep underground storage for unlimited amounts of time. By the 2009 IPCC convention in Copenhagen, no CCS facilities existed, which means that no technology was available to curb the emissions of coal fire plants. The most stated explanation for the lack of technological development in this area was cost (Fridahl and Lehtveer, 2018). This circumstance then provided the need for a technology that can go beyond slowing down the rate of CO_2 emissions and reverse the effects of the previously high emitting years. The integrated assessment models already included solutions such as plant-based sinks (biomass) and geological carbon storage and so this then resulted in a solution which combines the two, bioenergy with carbon capture and storage, being a suitable solution within the models.

Many policymakers then credit this report as to why it became part of the UK's energy discussion again (Hansson et al., 2021). In 2017, a CCUS Cost Challenge Taskforce was launched, which concluded that to make the energy technology cost-effective, CCS would need to be launched at scale and preferably in different regional clusters. The '*CCUS Deployment Pathway'* published in 2018 (Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy, 2018) led from this and laid out a plan for the UK to develop the first functioning CCUS facility in the mid-2020s. Despite, these efforts to progress the technology, the UK Government has also faced some criticism, specifically on the lack of progress and the ambiguous nature of the targets set thus far (Climate Change Committee, 2023).

Drax Power Station, which is a large biomass power station based in North Yorkshire, and the largest power station in the UK plays a key role in the development of BECCS. Firstly, it converted its three previously coal-fired generating units to run on biomass. In 2019 Drax started capturing CO_2 with the 100% biomass feedstock, which was the first instance of this in the world. Currently, the aim for Drax is to have BECCS technology installed on at least one biomass-generating unit by 2027 (Drax, 2019). This thesis mentions specifically Drax, as opposed to other CCS projects, which capture CO_2 from other non-biomass, fossil fuel feedstocks which have different environmental and economic implications and because the key focus of this thesis is specifically on bioenergy with carbon capture and storage as opposed to other uses of CCS.

Drax has also been subject to some controversy and criticism, specifically pertaining to the sustainability of its biomass supply chain. In October of 2021, a complaint was filed against Drax to the UK National Contact Point (NCP) for the Organisation for Economic Cooperation and Development (OECD) Guidelines for Multinational Enterprises (the Guidelines). One of the organisations which filed the complaint was Biofuelwatch. Biofuelwatch, a UK and US-based non-governmental organisation (NGO) campaigns to point out the various impacts on the environment, the climate and society as a whole of large-scale use of biomass for energy. They opposed BECCS and criticised Drax for its use of biomass and even more so for using only imported biomass. They further alleged that Drax published misleading statements about their carbon emissions and the environmental impacts of their operations and were so in breach of the OECD Guidelines. Drax has also been subject to the inquiry from investigative journalists, and the subject of a BBC Panorama episode, which aired on October 8th, 2022 specifically focusing on its biomass sourcing from Canadian and US-based virgin forest further questioning Drax's claim to a sustainable supply chain. If the supply of biomass is not sustainable, and there are emissions which are not accounted for, this then undermines the claims of BECCS being a negative emissions technology as the biomass supply results in releasing more emissions than the capture technology can capture and store. Drax also receives large government subsidies, and so

there is also the concern about whether public funding is being used to 'burn trees for biomass', as opposed to developing a genuine negative emission technology. This level of scrutiny is however not new to Drax, as the UK's largest power station, and historically one of its biggest emitters.

1.3 Fracking and Shale Gas

Fracking is a shortened word for hydraulic fracturing, which is a technique of extracting gas or oil from subterranean rock. Whilst this process can take place onshore and offshore, when talking about shale gas exploration this thesis is exclusively referring to onshore shale gas exploration. Hydraulic fracturing includes injecting fracturing fluid, which usually consists of water, sand, and additional chemicals, horizontally into boreholes to release trapped gas or oil. Whilst it is not a new extraction technique per se, in that it has been used for example in the United States for many years, fracking specifically for shale gas has not gone past exploratory stages in the UK.

An innovative technique developed in the 1990s in the US of horizontal hydraulic fracturing, as Cotton (2017) points out led to a steep drop in costs of fossil fuel extraction and was an economic success, which piqued the interest of fossil fuel industries in other countries. In the *'Bowland Shale Gas Study'* report (Andrews, 2013), published in 2013 by the British Geological Survey, an independent geological survey, estimated that if it were possible to recover 10% of available shale gas in the UK, this could potentially meet the UK's energy demand for several decades. Also, in 2013, the Department for Energy and Climate Change (DECC), published a report in which they stated that shale gas has similar emissions to conventional gas, however lower than coal and liquified natural gas (LNG), which led to the then Secretary of State at DECC to describe shale gas a bridging technology to a lower-carbon future. Later, a study by Whitelaw et al. (2019) pointed out that the estimates from 2013 were based on a desktop study, largely relying on data from the US, and did not take into account the differences in the composition between UK and US shale rock structures. The Whitelaw et al. (2019) study then concluded that the scale of the resource in the UK is much lower than projected and could cover up to 10 years of supply of current energy demand, as opposed to earlier projected 40 to 50 years.

The first licenses for onshore shale gas exploration in the UK were awarded in 2008. However, from the start, the development of the shale gas industry was treated with scepticism from many different angles. One of the earlier triggering points for the pushback against fracking was the 2009 council application submitted by Cuadrilla Resources, a privately owned British exploration and production company. By reducing the exploratory area to just below 1 hectare (0.99 ha), and labelling the drilling activities as exploratory, the application was exempt from an independent Environmental Impact Assessment (EIA) required as part of the Town and Country Planning Regulations of 1999 (Cotton et al., 2014). Additionally, in 2011, fracking in Preese Hall near Blackpool, Lancashire, led to felt seismicity, which then led to the suspension of fracking operations and prompted studies into induced seismicity and risks. This too resulted in significant public backlash. As far as political backlash, the Labour Party, the Liberal Democrats, and The Green Party of England and Wales opposed the technology (Hayhurst, 2017). The resistance also came from non-governmental organisations such as Friends of the Earth (Lewiński, 2016), but also smaller community-led groups (Sherval, 2023), which manifested in frequent protests and direct actions of blocking operations taken at the industrial sites.

In November 2019 the moratorium on fracking was announced by the UK Government, a few months prior the net zero target was announced. However, before the moratorium, the UK Government was in support of the development of shale gas. Specifically, the Conservative Party's 2017 Manifesto laid out its support for shale gas, arguing that it would provide greater energy security, growth, and jobs. Even though the moratorium still stands and was announced before the data collection which took place between April and August of 2020, shale gas is still relevant to the overall energy discourse, particularly in instances where it was referenced as an example of technological risk.

In 2021 the CCC published a letter titled: '*Advice to the UK Government on the compatibility of onshore petroleum with UK carbon budgets'* (Climate Change Committee, 2021). At this time, the moratorium is still in effect, and it is acknowledged that this is mainly because of the risk of earthquakes caused by the drilling and extraction activities. The letter then states that shale gas is

acceptable only if it were to be compatible with the commitment to reduce direct emissions from fossil fuels, and that is regardless of where the emissions occur, that is to say, whether they are from imported or domestic fossil fuels. The letter then responds to the hypothetical scenario, if the issue with seismicity and earthquakes were to be overcome, and says that the ban should not be lifted without *'an in-depth review of the evidence on the climate impact'* and that the *'implications of fracking for public acceptance of the energy transition on the path to net zero, and the risk of lock-in fossil fuel infrastructure'* should be considered, therefore suggesting that it is not only seismicity issues which are preventing the development of shale gas in the UK.

On September 22nd, 2022, the UK Government formally announced that the moratorium on shale gas had been lifted, however, the ban was reinstated only a few weeks later, on the 26th of October 2022. The official reasoning for the moratorium given in the first instance, and which remains unchanged, is that *'it is not possible with current technology to accurately predict the probability of tremors associated with fracking'* (Department for Business, Energy & Industrial Strategy, Oil and Gas Authority, 2019). This is important to note, as the official reason for the moratorium was independent of the announcement of the net zero decarbonisation target announcement and the efforts to decarbonise the UK's energy supply.

In September of 2022, well into the transition to net zero, the UK Government requested that the British Geological Survey (BGS) address recent scientific research on the hazard and risk from induced seismicity during the hydraulic fracturing of shale rocks. The six questions, issued in a letter by the then Secretary of State Kwasi Kwarteng focused on any new developments in science regarding fracking, with a special emphasis on new ways to reduce the risk and magnitude of seismic events, which halted the progress of shale gas developments previously. The letter then also asked to draw comparisons between the seismic activities of fracking and other forms of underground energy production, such as geothermal and coal mining activities. Interestingly, question number 5 asked: '*Are there other sites, outside of Lancashire, which might be at a substantially lower risk of seismic activity, and what level of confidence would we have in our assessment of seismic activity in these*

areas?' (Baptie et al., 2022). This reinforced the point that despite what the letter refers to as a *'pause in seismic activity since 2019'*, there is still discursive development regarding shale and possibilities for the restart of shale gas operations. The justification given for the questions in the letter was: '*While it remains the case that shale gas extraction is not the solution to near-term price issues, it is right as a government - given the unprovoked invasion of Ukraine by Putin's regime - that we keep all possible energy generation and production methods on the table*.' (Department for Business, Energy & Industrial Strategy, 2022). In other words, there is a potential for an energy and or national security argument to override the efforts to decarbonise within the net zero transition which many, including the CCC, argue, call for shale gas or the development of any new fossil fuel sites to be *'off the table'*.

1.4 Discourse Analytical Approach to Energy Technologies

The above sections focused on laying the ground and outlining the technical and policy aspects of the net zero transition and energy technologies. In this section, I will discuss the importance of approaching energy technologies and energy transitions from not just a social science perspective but specifically from a discourse analytical perspective to help further justify the focus of this research and its contribution to environmental and energy policy studies scholarship. The specificities and details of the exact discourse analytical approach followed in this research are then described in Chapter 3 Methodology.

Discourse and frame analysis are the dominant methods within the field of public policy and environmental social science (Scrase and Ockwell, 2010), whereby discourse is not to be understood as a synonym for *'discussion'* or *'deliberation'*, rather it is to be viewed as detectible linguistic regularity which can be traced in different discussions or deliberations. Discourse analysis is then making sense of *'language-in-use'*. The three main strengths of this approach are its capacity to uncover the role that specific language plays in policy-making processes, the degree to which specific language is embedded within these processes and illuminate how this came to be. And so, the role of discourse analysts is to identify new sites of argumentation and politics within policy-making processes (Hajer and Versteeg, 2005).

The discursive study of energy systems, energy policies and energy transitions from a social science perspective has increased in recent years. Loorbach et al., (2017) and Sovacool and Hess (2017) attribute this interest to the shared understanding among researchers that energy transitions, which are socio-technical in their nature, are complex and involve a high degree of uncertainty. Furthermore, climate change adaptation and energy policies are not derived from an objective and linear process (Isoaho and Karhunmaa, 2019). Instead, this is a process of prioritizing one solution over the other which then leads to both policy and discursive struggles over the strategic and technological choices that need to be made in the context of the transition. These contextual factors then make the field of energy transition highly suitable for the application of discourse analytical approaches. Scrase and Ockwell, (2010) even pitch the discourse perspective as the opposite of the linear understanding of the policy process. In other words, the discourse perspective helps us analyse the '*messy*' part of environmental and energy policymaking.

And so, in the context of energy technologies and energy transitions, discursive approaches are most frequently used to make sense of institutional change as well as analyse the choices made about energy technologies and transitions at the policy level. Furthermore, discursive approaches enhance our understanding of the interactions between social norms, and politics related to technologies. They allow us to view BECCS and shale gas as more than just *'instrumental objects'* (Sovacool and Hess, 2017). Rather, discursive approaches produce information about the different phases of the technological lifecycle relevant for policy, by uncovering hidden drivers and barriers to technology adaptation. So, the discursive focus on BECCS is of particular interest as the technology is still in the technological development stages.

Sovacool and Hess (2017) argue that the narratives of energy technologies can be very contradictory and so are continually negotiated and reproduced by the people who create them. These contradictions and negotiations are then particularly noticeable in the public discussions of technologies, which are deemed *'controversial'* like shale gas, the contestation of which I have outlined in the previous section. It is therefore perhaps not surprising that Isoaho and

Karhunmaa (2019) found that the most in-depth discourse analytical approach to the study of energy technologies has been dedicated to nuclear power, which is frequently discussed in the public sphere as a controversial technology. Ultimately, Isoaho and Karhunmaa (2019) argue that discursive methodologies enable us to grasp these controversies and contribute to the energy policy discussion by understanding transitions as *'complex and dynamic processes of change'*.

Scrase and Ockwell, (2010) raise the question of why in light of the rapid developments of climate change energy policy is relatively resistant to much-needed change. They argue that whilst there is a myriad of reasons, one of them is the role that linguistic framing of policy problems and solutions plays in creating and sustaining the dominance of existing policy positions. And so, they argue that discourse analytical approaches to net zero transitions are key because whilst we need to know how to best shape and design new sustainable energy policies, we also have to influence the way in which they are framed linguistically in order for them to be successful.

Isoaha and Karhunmaa (2019) then argue that discursive approaches are of particular importance as they do not just shed light and provide new knowledge of the transition, but also influence it by making certain policy issues visible and not others. The value of the discourse analytical approach then is to move away from a traditional linear understanding of policy and transitions development but rather conduct research in a way which reflects the interplay of *'values, beliefs, entrenched interests and institutional structures that serve to facilitate or constrain the policy traction of certain framings of energy policy problems or solutions'* (Scrase and Ockwell, 2010). This makes the discursive study of energy technologies an integral part of how we make sense of them, particularly in the policy context of an inherently social process like the net zero transition.

1.5 Research Aims & Objectives

As an approach and a method, discourse analysis at its core aims to examine the argumentative structures in texts, spoken media as well as practices. The basic assumption of this approach is that the world is shaped by the language we use to describe it. By focusing on language, discourse analysis can help

investigate how a political problem is defined and how it relates to a particular narrative in which the problem is discussed. As Feindt and Oels (2005) write '*The articulation of a particular problem shapes if and how the problem is dealt with'* (Feindt and Oels, 2005, p. 162). And so, if the problem, or challenge rather, is decarbonisation of the energy sector, being dealt with by employing the net zero transition policy, how this transition is envisioned, described, and discussed shapes how it materialises. Similarly, Hajer and Versteeg (2005) write that language has the *'capacity to make politics, to create signs and symbols that can shift power-balances and that can impact on institutions and policymaking'*. The discourse analysis of BECCS and shale gas in the context of the net zero transition then combines the analysis of how the meaning of these two energy technologies was produced, with the analysis of the practice from which these meanings emerged.

Hajer gives examples of the types of questions which can be answered with discourse analysis. The first example he provides relates to the rebuilding of Ground Zero, the area where the Twin Towers used to stand and were left in rubble after the 9/11 terrorist attack. When assessing the different options that were being considered as to what to do and how to rebuild Ground Zero, Hajer raises this question which could be answered with a discourse analytical approach *'(rebuilding Ground Zero) was more about than who gets what and when and why – but then, what was it about exactly?'*. (Hajer, 2005a, p. 447). Relating to his most influential study of the acid rain controversy, Hajer provides an example relating to dead trees, which were understood by some as a result of acid rain or acid precipitation. Hajer (1997) then explains that the argument around the social construction of these phenomena is not that dead trees are a social construct in themselves, but how one makes sense of the dead trees is what is important, and so the questions one can ask and also answer with discourse analysis are *'How could the meaning (of dead trees) be tracked or traced?'.*

In this study, discourse analysis is used to gain an insight into how key actors understand and make sense of BECCS and shale gas energy technologies and secondly, how this then relates to the way key actors make sense of and understand the net zero transition. I argue, based on the aforementioned

assumption that language is not a neutral transmitter, that these are important questions to ask, as the answer to those questions provides a key insight into the discursive tensions and also the possible future developments of the net zero transition.

The thesis has three aims:

- to analyse the shale gas discourse in the context of the net zero transition.
- to analyse the BECCS discourse in the context of the net zero transition.
- to provide a comparison of the two discourses with a focus on the different emerging discourse coalitions and storylines, paying attention to how the relationship between the energy technologies and the net zero transition is conceptualised by key actors.

These aims have been operationalised into three distinct research questions, each of which is answered in a dedicated data chapter:

1. ***What BECCS discourse coalitions exist? And which visions/narratives do they promote in the context of the UK's net zero policy?***
2. ***What shale gas discourse coalitions exist? And which visions/narratives do they promote in the context of the UK's net zero policy?***
3. ***How do the visions of net zero promoted within the different BECCS and shale gas discourse coalitions compare?***

The first and second research questions were deliberately phrased in the same way, so that I can accurately compare and discuss both shale gas and BECCS discourses, and specifically delve into the understanding of net zero transition across both shale gas and BECCS discourses as per the third research question. To answer these questions, I used qualitative methods, specifically semi-structured interviews conducted with key actors, which included policymakers, industry representatives, academics, and representatives of non-governmental (NGO) and environmental organisations. The participants were sampled using a combination of purposive sampling, followed by snowball sampling to ensure access was gained to relevant key actors.

In the analysis of the data, I mainly worked with the concepts introduced by Maarten Hajer in his work on discourse analysis (Hajer, 1997a), storyline and discourse coalition. When identifying these within the data, I used an inductive and interpretative approach. This means that I looked for the storylines and discourse coalitions as they emerged from the data in distinct linguistic patterns or turns of speech. The comparative analysis of the BECCS and shale gas discourses is a key element of this thesis. Firstly, I focused on comparing the discourse coalitions and storylines that emerged to qualitatively assess how the shale gas and BECCS discourse differed from each other and in what ways they were similar. Then, I moved on to comparing specifically how the net zero transition is conceptualised across these discourse coalitions and categorised these different ways of understanding the transition and the role that the technologies can play within the transition into *'visions of net zero'*.

1.6 Conclusion and Thesis Structure

This introductory chapter focused on *'setting the scene'*, by outlining the net zero policy and introducing the two energy technologies, BECCS and shale gas. In the first section, I provided a background of the net zero policy, starting with the 2008 Climate Change Act and its implications. I then moved on to discussing various important reports published by the Climate Change Committee and the Intergovernmental Panel on Climate Change and explained the various greenhouse gas emission reduction goals that were set historically, which culminated in the net zero by 2050 goal in the UK. I then moved on to introduce BECCS and briefly explained the technical aspects of the technology, specifically outlining what makes it a *'negative emissions'* technology and explaining the difference between carbon negativity and carbon neutrality. I then outlined how BECCS is utilised in IPCC mitigation scenarios and specifically the origins of BECCS being considered within integrated assessment models. The sustainability claims of BECCS are contested, which is also illustrated well by the example of the Drax power station and the criticism its operations have amassed from environmental NGOs which are described in this chapter. The following section focused on shale gas and fracking, and similarly to the above, I started with discussing the technical aspects of the technology, pointing out the use of underground space, and then moved on to discussing the policy background and in

particular the role the concerns over seismicity have influenced the trajectory of shale gas in the UK. The sections dedicated to energy technologies were then followed by section 1.4 *'Discourse Analytical Approach to Energy Technologies'*, in which I discuss the importance of approaching energy systems and transitions from a discourse analytical perspective and the value of this scholarly contribution.

Despite it being anticipated that BECCS will play a substantially bigger role than shale gas in meeting the net zero target the justification of the comparison of the two within this thesis is based on both energy technologies being considered during various periods and for various reasons to play a part in decarbonisation policies, albeit not specifically in the UK's net zero policy. However, shale gas was also in the past framed as a lower-carbon technology (Department for Business, Energy & Industrial Strategy, 2013) or a bridging fuel (Department of Energy & Climate Change, 2016) by the UK Government. And although, as mentioned, there is currently a moratorium on onshore shale gas extraction in the UK, this was justified largely by geological reasons, and seismological unpredictability, as opposed to incompatibility with the net zero policy. Leading on from this context, I then finally introduced the aims and objectives and the three research questions which I will answer within the remaining chapters of this thesis.

The thesis is structured into eight chapters. The next chapter is titled '*Literature Review'* and is divided into two sections, as I mostly treated BECCS and shale gas social science literature as two distinct corpora. Within these two larger sections I point out some of the common themes discussed within the literature such as social acceptance or risk. The chapter concludes by identifying gaps in the literature, which justify the focus of this thesis, such as the novelty of comparing BECCS and shale gas and reaffirming its original contribution to the field of energy and environmental policy studies.

In the third chapter, titled *'Methodology'* I first delve into all aspects of discourse analysis, and then specifically Maarten Hajer's approach, which has strongly informed the methodological and analytical choices made in this thesis. I then go on to describe the research protocol, including the sampling process, data

collection and data analysis. This is then followed by looking back on collecting data amidst the global COVID-19 pandemic and reflecting on the unique ethical challenges this presented and how I overcame those.

The fourth chapter is the first of three data chapters, in it I answer the first research question: *What BECCS discourse coalitions exist? And which visions/narratives do they promote in the context of the UK's net zero policy?* by analysing 16 semi-structured qualitative interviews. It is structured so that each large section corresponds to a discourse coalition and each subsection to a storyline. The analysis revealed that there are various competing understandings of BECCS, which differ in the way the scalability and functionality of the technology are viewed.

The fifth chapter focuses on presenting shale gas-related data findings from 15 interviews, and answers the second research question: *What shale gas discourses exist? And which visions/narratives do they promote in the context of the UK's net zero policy?* In the same way as the previous chapter, this chapter is also structured so that each main section is a discourse coalition, which contains several storylines. The chapter found that there are three distinct shale gas discourse coalitions, which differ in many aspects. One of these aspects is how the lack of development of shale gas in the UK is explained and understood.

Chapter Six answers the third research question: *How do the visions of net zero promoted within the different BECCS and shale gas discourse coalitions compare?* and focuses on the comparison of the BECCS and shale gas discourses. Whilst the previous two data chapters focus on how the two energy technologies are perceived in the context of the net zero transition, the third data chapter then focuses on the different visions of net zero transition itself as described in the various discourse coalitions, and thus cutting across them, so to speak. The chapter shows that the relationships between the net zero transition and the two energy technologies can be distilled into distinct visions of the net zero transition. I have then categorised these visions into three different types.

Chapter seven, the *'Discussion'* is dedicated to discussing the key data results in the context of the literature outlined in Chapter Two. In this chapter, I highlight key findings, such as the difference between the shale gas discourse coalitions in this research, and those found in previous studies conducted before the net zero transition. Furthermore, the chapter also points out that it seemed to be very difficult for participants to discuss and conceptualise the future of either of the two energy technologies, without a reference to the net zero transition, which was particularly surprising in the case of shale gas. Additionally, the findings also showed that whilst the same number of discourse coalitions was found across both energy technologies, the points of contention between them differ substantially, which is apparent in the fact that whilst there is a clear pro-BECCS discourse coalition *('BECCS as a Legitimate Solution'*) there is not an equivalent of an equally supportive discourse coalition within the shale gas discourse.

Chapter eight is the last and concluding chapter of this thesis, in which I provide a summary of the key findings and contributions of this thesis, as well as reflect on the research process as a whole. Furthermore, I discuss the limitations of this study, focusing on the methodology and the selection of shale gas and BECCS as the two energy technologies to research. Finally, I offer some final remarks and recommendations for future study, pointing to other energy technologies or other aspects of the net zero transition which could be studied.

2 Literature Review

2.1 Introduction

This chapter's purpose is to review the social science literature on bioenergy with carbon capture and storage and shale gas. The aim of this is to demonstrate in what ways the existing knowledge and literature feed into and support the premise of this research and its findings. I have conducted this literature review by using a combination of the University of Nottingham's library system NUSearch, and the Web of Science peer review text search engine and database. I then narrowed the search by means of using the keywords 'CCS', 'BECCS', 'carbon capture and storage', 'bioenergy with carbon capture and storage', 'shale gas' and 'fracking' and focused on searching for social science papers. I kept the literature in two distinct energy categories, BECCS and shale gas. These were subsequently sorted into different subcategories, which correspond to the subsection in this chapter. At first glance, it is evident, that whilst there are some subsections which are the same across both energy technologies, there are also some differences. This is because there are topics which are covered by both sets of literatures, but some are focused on more by one and not at all by the other.

Energy technologies are inherently socio-technical systems (Rohracher, 2001). In other words, even though highly technologically complex, they are inherently connected not only to material realities, but also to social practices, governance mechanisms, policies, and other social elements. Socio-technical systems comprise institutions, regulations, cultural values, social practices, expectations, and relationships with the stakeholders involved within these systems (Rosenbloom et al., 2018). Some literature (Rosenbloom et al., 2018; Stirling, 2014) argues, that these stakeholders and actors then employ strategies to influence the way in which these socio-technical systems develop, in line with the actors' interests. Thus, studies which deploy different forms of discourse analysis can show how the different actors struggle over the framing and legitimacy of particular technologies (Chen et al., 2015; Duan, 2010; Guo et al., 2022; Liang et al., 2011; Reiner and Liang, 2009; Weng et al., 2021; Yang et al., 2016).

Rosenbloom (2019) even goes as far as arguing that understanding actors' interests and how they influence specific institutional and material structures is crucial to gaining a full understanding of energy systems.

Energy technologies are generally examined academically by two types of works of literature, technical, focused on engineering, environmental and geological aspects, and social scientific literature, which generally examines the social and economic aspects of energy technologies with a focus on public perception of energy policy, and risk perception. Further, as energy technologies often foster public and policy debates, because of their complicated and embedded nature within national energy-security systems, the literature also focuses on issues of democracy and landownership as well as issues of discussing extractive practices and their links to our ways of governing.

There are differing views as to what the role of social science is in energy studies. Stern (2014) points to social science focusing on how energy systems are understood and the effect that this particular type of understanding has. He elaborates, that part of energy social science is to gain an understanding of *'the ways the causes and effects of energy phenomena are mediated by the ways people at all scales of action think about and perceive the energy system and its impacts and the ways their understandings affect their actions.'* (Stern, 2014 p.42). Fri and Savitz, (2014) argue, that the role of social science in energy and innovation is to stimulate change in two ways, to help influence consumer choices to use more energy-efficient technologies and to guarantee that during the various energy system changes which are triggered by climate change and other factors, we have a durable framework which drives innovation. As Evensen (2018) pointed out in his review of social scientific literature in the UK, it broadly covers three categories, which are public perception, discourse and rhetoric and planning and regulation. Sovacool (2014) in a comment published in Nature *'Diversity: Energy studies need social science'* argues that social science is a necessary component of energy studies, yet at the same time Sovacool (2014) points out that the vast majority of research written about energy and energy transitions do not engage with social scientific approaches. In other words, the majority of energy papers

focus on the technological aspects as mentioned above, as opposed to social scientific and there is little explicit overlap between the two. This means that the expertise and knowledge related to energy technologies spans many different disciplines, however, examining the technical, engineering-based works of literature covering these two energy technologies is beyond the scope of this thesis. Therefore, this review aims to focus on and add to the social scientific perspective on energy technologies, specifically BECCS and shale gas. The findings of the thesis then also contribute primarily to the social scientific understanding of BECCS and shale gas. The structure of the chapter is as follows. Firstly, the chapter focuses on BECCS literature, which has been divided into 6 subsections: '*Discourse, Framing and the Media', 'CCS, Stakeholders, and Social License to Operate', 'Public Perception', 'Social Acceptance', 'Risk' and 'Knowledge and Expertise'*. The second part of the chapter focuses on the shale gas literature and is divided into 7 sections: *'Discourse, Frames, and Framing', 'Social License and Acceptance', 'Policy Focus', 'Risk, Uncertainty, and Seismicity', 'Public Resistance and Public Support', 'Shale Gas in the Media', 'Knowledge and Expertise'*. The section categorisation is very similar for both energy technologies, with some differences, which are reflective of the volume of literature dedicated to each energy technology, as well as the attention that was given to different subjects within the different energy literature corpora. I then move to a section in which I discuss the role of space and place across both energy technologies explain the geographical contexts as well as reflect on shale gas being a Devolved government issue. Finally, the chapter finishes with a conclusion, which provides a summary point to the gaps identified in the literature and makes the connection between this literature review and the research presented in this thesis.

2.2 Bioenergy with Carbon Capture and Storage

The social science literature on BECCS has a strong overlap with literature on carbon capture and storage, the latter being much more expansive. There is an overarching assumption within the literature corpus, which this thesis has also adopted, and that is that the results from studies translate from one technology to the other and vice versa. Although there are some studies which

focus on the comparison of carbon capture and storage and carbon capture utilization, the comparison of BECCS and CCS is lacking, which is perhaps a further indication that within the social science literature, there is little difference made between the two as far as research focus goes. This can be explained by the fact, which was pointed out in the Introduction chapter, that BECCS is by far the most considered carbon dioxide removal (CDR) technology in the IPCC Assessment reports (Bui et al., 2021). It is discussed more than other applications of CCS, such as direct air carbon capture and storage (DACCS). This level of focus is then also reflected in the social science research focused on this topic.

There are nevertheless some exceptions and papers which focus on a comparison of BECCS and CCS. Whitmarsh et al. (2019) found that BECCS is more likely to be widely accepted as a new technology than CCS linked with fossil fuels. The instances where CCS could be linked with fossil fuels are for example using the technology for enhanced oil recovery, or to capture emissions which result from burning fossil fuels as opposed to from sustainable sources such as biomass, as was discussed in the Introduction. Dowd et al. (2015) also argue that the lessons learned from public perception of CCS can impact BECCS, in that if there are prior concerns about CO_2 leakage that the public might have about CCS, it is likely that the same concerns would translate into the public's view of BECCS.

The vast majority of the literature on BECCS/CCS is dedicated to discussing public perception and public acceptance. At the same time, whilst public perception is a focal point in the literature, globally the public's awareness of CCS is low (L'Orange Seigo et al., 2014). The authors explain this focus on acceptance and perception by pointing to the various carbon capture projects which have been cancelled in different countries because of public resistance to the technology. However, as previous reviews of CCS literature (Nielsen et al., 2022) found, the way social acceptance and resistance are conceptualised, and the way communities are represented varies across the research. Additionally, with regard to public resistance, the research in this area does not differentiate between the conclusions being drawn from studies focusing on public resistance to CCS and public resistance to BECCS. This overall focus

on public resistance and public acceptance is also reflected in this literature review.

2.2.1 Discourse, Framing and the Media

The way BECCS or CCS is talked about and is represented in various arenas, from policy to the media is a key point of interest to researchers in this area. There is an underlying assumption that permeates this literature, namely that the way carbon capture is framed matters to whether it is accepted or not and what kind of support it garners from both the public and political parties. Carbon capture and storage is perhaps a uniquely placed technology in this sense, as on one hand it is being used in combination with bioenergy, creating a carbon net-negative energy technology the goal of which is to help reduce carbon emissions. On the other hand, CCS has a much longer history of being used in combination with fossil fuels like coal and being utilized for enhanced oil recovery. The key difference here is that from a carbon emissions perspective using carbon capture for enhanced oil recovery is creating more emissions from fossil fuels whilst the use of bioenergy in BECCS is to displace and avoid the use of more fossil fuels. This means, that the way CCS is perceived is not settled, with the different varying points of view on the technology across the literature. On one hand, CCS is being viewed as a fossil fuel lock-in technology (Hansson and Bryngelsson, 2009) which provides an opportunity for developing countries to use carbon-intensive technologies the way developed nations have done and continue to do, but to do so without the consequences of carbon emission (Liu and Liang, 2011). There is also the view, that CCS is a technology that enables developed nations *to 'sustain the modern lifestyle'* which depends on fossil fuel use (Hansson and Bryngelsson, 2009).

When reviewing the literature on greenhouse gas removal with a social and political focus, Waller et al. (2023) found that the majority of this literature is generally framed in three ways, two of which take the development of greenhouse gas removal (specifically BECCS and afforestation) for granted. GGR is then framed either in techno-economic ways and contends itself with the question of whether scaling up of BECCS is within technical and economic grasp. The second frame looks at social and political acceptability and examines whether public perception barriers can be overcome. The third frame

labelled *'responsible development*' asks the question of whether GGR is feasible and what it means for other decarbonisation pathways that do not rely on GGR if it is not feasible.

When analysing the way fossil fuel companies and trade bodies frame CCS, Gunderson et al. (2020) found that in that context, carbon capture is primarily being framed in three ways, as *'faith in innovation'* which is the equivalent of the *'technological fix'* framing mention in other studies and contexts. Secondly, it is *'value instrumentalization'* whereby economic values are cited as one of the examples as to why the technology is justified. Thirdly, as '*status quo maintenance'*, it justifies carbon capture as enabling the continued way of life with current levels of carbon consumption. The first and third frames are mentioned in other studies, except not always are these frames perceived as positive. Sometimes, the 'status quo maintenance' is understood as *a 'fossil-fuel lock-in'* (Hansson and Bryngelsson, 2009) meaning that carbon capture is a hindrance to decarbonisation. Research however shows that the support for CCS increases when it is seen as having climate change mitigation credentials (Ferguson and Ashworth, 2021) and in turn decreases when it is associated with fossil fuel operations (Whitmarsh et al., 2019). At the same time framing carbon capture too positively without presenting the risks when it comes to the readiness for deployment of BECCS, and the potential consequences of delaying climate action can have also adverse effects on public perception (de Vries and Ferrarini, 2017).

How CCS is framed in the media also has an impact on its perception (Røyrvik et al., 2012). However, what is considered a positive frame in one context, can be considered the opposite in another. As an example, Asayama and Ishii (2017) found that the discourse on CCS in the Japanese media is largely positive, with one of the factors emphasised being the compatibility of CCS with the fossil energy regime. This feature of CCS is then understood differently in the Dutch media context, where the narrative is referred to as a *'carbon lock-in'* (Janipour et al., 2021) and does not have a positive connotation. In the US media context, this connection between CCS and fossil fuels is present with the metaphor of *'clean coal'* (Fitzgerald, 2012). This narrative characterises CCS as a technology, which allows for the continuation

of fossil fuel, particularly coal use, and makes coal seem like a *'clean technology'* because of the capturing of the emitted carbon.

The frames in the media also are not static, and in fact, ter Mors et al. (2023) argue that in the Dutch media, it is possible to track the developing relationship with and perception of the technology. CCS was first perceived as necessary to reduce carbon emissions and the technology risks were discussed in earlier coverage, whereas later coverage focused on the availability of decarbonisation alternatives to CCS and less so on risk. Although, this shows the differences in framings across different regions. At the same time, it is important to bear in mind that because of the stagnated nature of CCS developments, meaning that there is a limited rollout of this technology which is plagued by projects often being cancelled (Otto et al., 2022), the discourses exist largely as a technological imaginary (Asayama and Ishii, 2017). This term is used by Asayama and Ishii to reference that the discourse around carbon capture and storage is shaped more by narratives than by physical realities, because of the aforementioned lack of development.

2.2.2 CCS, Stakeholders and Social License to Operate

There is a subset of literature which seeks to conceptualise the relationship between the energy industry and the relevant community. These efforts to gain public acceptance are characterised as an effort to gain a *'social license to operate'* (SLO) (Mulyasari et al., 2021; Gough and Mander, 2022; Gough et al., 2018; Dowd and James, 2014; Gallois et al., 2017). Within the literature which engages with SLO, the relationship between the industry and the community is understood in the terms that the community has values beliefs and perceptions, which the industry is trying to influence, with the goal being the approval of the community for the industrial operations in that area. In other words, it is understood as a type of informal permission from the community which is needed to avoid public resistance stalling progress.

Examining the industrial clusters in the UK, Gough and Mander (2022) argue that a social license to operate is necessary for a successful CCS deployment. However, the understanding of SLO is not universally shared amongst the industry or community (Dowd and James, 2014). In an example, Gough et al.

(2018) explained how the Teesside region in the UK was much more positively minded towards CCS, because of a long history of energy and industrial project pioneering in that area, and so the confidence in the industry and stakeholders is high. In comparison, in Lancashire, because of previous bad experiences with the fracking industry, there was high mistrust towards other industrial developments in the area, which would also translate into if and how the social license to operate could be obtained.

There is also a need to mention, that because the public lacks understanding of this technology, they might not even be able to provide the social license to operate, as Dowd and James (2014) point to in an example of implementing CCS in Australia. A most recent study into BECCS and social legitimacy (Donnison et al., 2023), pointed out different BECCS storylines in the media, including BECCS being framed as a *'necessity'*. The findings have also shown that the media and public debate on BECCS in the UK is not yet settled. Which in turn can impact the capacity to which the public(s) can provide SLO. The perceptions and media coverage also translate into how stakeholders perceive CCS. This is important, as stakeholders are key in helping to facilitate public trust in CCS (Terwel et al., 2011). The most important stakeholders in this aspect are policymakers, regulators, and the local community (Chrysostomidis et al., 2013). These examples show in different ways, that the discourse around BECCS is not settled, which can be observed in its media coverage, which affects the way the public and stakeholders perceive the technology.

Stephens et al. (2011) argue the CCS community is different from other networks associated with more traditional industries and technologies, because of the complexity of its many components and thus the dependence on experts from a wide range of disciplines, from electrical engineers to pipe-line experts, chemist, and geologist to mining experts for CCS to work. Stephens et al. (2011) also make the point, that this is a wider range of disciplines than the deployment of many other emerging technologies necessitates, which also presents the challenge of BECCS having a wider range of stakeholders compared to other technologies. Previous research by de Coninck et al. (2009) showed that this wide net of experts and stakeholders translates into the international communication and coordination among CCS

demonstration projects being difficult and often insufficient. Although generally, stakeholders tend to also have a more positive attitude towards CCS than the public (Sun et al., 2020), this support decreases when carbon capture and storage is associated with enhanced oil recovery (simplified, the captured carbon is injected into depleted oil and gas well to be stored and also to extract remaining oil to be burned as fossil fuel). Stakeholders also tend to focus on economic and political uncertainties as most significant in determining the success of CCS implementation (Kainiemi et al., 2013).

2.2.3 Public Perception

One of the bigger subsets of the BECCS and CCS literature explores public perceptions of the technology, with L'Orange Seigo et al. (2014) providing a review of the literature, where they found that the lay public's reaction and perception have been analysed the most. Most of the attention regarding perception is directed to carbon storage, with carbon transportation being a blind spot and the most commonly cited barriers to CCS implementation being a lack of knowledge and poor communication strategies (Tcvetkov et al., 2019).

Often public perception is explored comparatively, with the comparison being focused on different countries as opposed to for example different geographical locations within the same country. This international comparison, as opposed to the comparison of sites within countries, can be explained by the relative rarity of CCS and BECCS projects and thus it being rare for there to be more than one site in one country (there is only one BECCS site in the UK). According to the International Energy Agency (2023), an autonomous intergovernmental organisation, there are around 40 commercial capture facilities in operation globally, with the majority being in the US and China. This is also reflected in the focus of the literature, which has a heavy focus on China (Chen et al., 2015; Duan, 2010; Liang et al., 2011; Reiner and Liang, 2009; Wang et al., 2022; Yang et al., 2016) although other countries were examined as well; US (Van Alphen et al., 2010), Canada (Boyd et al., 2017; Moutenet et al., 2012), Germany (Arning et al., 2019; Jones et al., 2017; Kraeusel and Möst, 2012), Netherlands (Broecks et al., 2021; van Os et al., 2014), Norway (Buhr and Hansson, 2011; Roettereng, 2016; Tjernshaugen and Langhelle, 2009), Poland (Brunsting et al., 2011; Kaiser et al., 2014; Riesch et al., 2013;

Uliasz-Misiak and Przybycin, 2016) and Japan (Ishii and Langhelle, 2011; Itaoka et al., 2013; Saito et al., 2019).

In some ways, there are differences in public perception in different countries, for example, van der Zwaan et al. (2022) found that both the public in the UK and the Netherlands are generally supportive, in the Netherlands there is a bigger concern regarding CO_2 transportation, whereas the UK the cost of the technology is a key concern. Also because of concerns regarding transportation and security of storage, Germany perceives carbon capture and utilisation more positively than carbon capture and storage (Arning et al., 2019). The concerns regarding the security of storage are however not present across all greenhouse removal measures, such as afforestation, which is often argued is a less secure way of storing carbon. There is a danger of carbon being released during wildfires, and trees do not capture the same amount of carbon consistently across their lifespan. Nevertheless, in Germany, large-scale afforestation is more favoured when compared to carbon capture (Braun et al., 2018). This discrepancy regarding the perceptions regarding the security of carbon storage can be explained by the '*perceived naturalness'* of the natural cycle of capturing during biomass regrowth, as opposed to capturing it '*artificially'* with CCS, which Thomas et al. (2018) found, was a frequent view when comparing CCS with BECCS. Schumann et al. (2014) also found that despite the concerns regarding storage and numerous CCS projects being cancelled because of public resistance, there is a neutral view towards CO_2 pipelines in Germany. This indicates that maybe the resistance to CCS as a whole, amounts to more than the sum of the resistance towards storage and transport. For example, attitudes towards storage shift significantly towards negative, when the carbon stored is transported from another country (Merk et al., 2022), as it is viewed as dealing with another country's problem without incurring the risk of storage.

The literature indicates that there is widespread low awareness of CCS across various countries such as Japan (Kubota and Shimota, 2017), Brazil (Lima et al., 2021) Netherlands (Brunsting et al., 2011), Canada (Moutenet et al., 2012), UK and Germany (Jones et al., 2017) and the Russian Federation (Vasile et al., 2015) to list a few. Many of these studies which indicate low awareness of

carbon capture, recommend scientific communication and educating the public on the technology, implicitly assuming that increased awareness will lead to acceptance. However, some findings show that generally positive attitudes toward CCS are not sufficient for the successful implanting of CCS projects. Kaiser et al. (2014) argue solely by communicating risk, acceptance cannot be guaranteed. However, risk communication can increase the likelihood of the project being successfully implemented. In other words, the way in which different aspects of CCS are framed, matters for the way in which CCS is perceived.

The research also identified tensions along numerous axes when it comes to public perception. Firstly, there is a generational tension, where older generations in the UK are much more likely to make the connection between disposing of CO_2 and disposing of nuclear waste, whereas younger generations are less so (Lock et al., 2014). Secondly, there is a temporal tension in perceptions of carbon dioxide removal, where there are calls for urgent action and also for providing a long-term solution. BECCS straddles both perceptions, as it is both a promise of long-term storage as well as a potential risk of delaying carbon emissions reduction because of it (Cox et al., 2020). Thirdly, there are also geographical tensions, whereby there are disputes around the safety of onshore storage, and the actual benefits to the coastal communities from the energy infrastructure and living near offshore storage (Mabon et al., 2014). In this regard, CCS is different from other energy infrastructures, like for example a wind farm, where the local community can have the co-benefits of co-ownership and provide electricity supply directly to the region. This model of community co-ownership and associated benefits does not translate to CCS projects.

2.2.4 Social Acceptance

According to the literature, the two biggest barriers to carbon capture with storage are cost and social acceptance (Jouvet and Renner, 2015; Linzenich et al., 2019). There are different factors which influence public attitudes towards carbon capture ranging from perceived cost and benefits, personal values (Howel et al., 2014) to the perception of stakeholders and risk (Moon et al., 2020) to beliefs about the local economic benefits (Krause et al., 2020).

Some (Shackley et al., 2009b) suggest that when it comes to public acceptance, CCS is disadvantaged right from the start because of its early association with fossil fuels, and enhanced oil recovery. This holds even in more recent studies, that show that CCS is not necessarily winning the battle for acceptance, also because of the perception that is diverting money from renewable energy developments (Vögele et al., 2018). Public perception being a barrier to CCS is shown in different geographic contexts, as in additionally to Vögele et al.'s (2018) study from Germany, a study by Broecks et al., (2021) shows that in the UK the public is concerned about the safety of CO_2 transport comparatively to the Netherlands, where cost-control is a bigger worry for the public. This was also echoed in a paper in an earlier paper by Upham and Roberts (2011), which focused on a comparison of the UK, Belgium, the Netherlands, Germany, Spain and Poland, and found that across the board there was a strong preference for renewables over CCS and that there were high levels of concern about safety, specifically tied to CO_2 leaks. Whilst the reasons for public concern are nuanced, the studies from different geographical contexts, spanning over a decade, show that public perception is a barrier to CCS, particularly hinging on the way the safety of CCS is viewed.

Although sociological research consistently points and the literature in this review supports this, to the importance of social acceptance, this concern is sometimes not translated into specific projects. Pointing out a project in Northern Netherlands van Os et al. (2014) show how because the stakeholders did not think social acceptance was a big concern, they agreed on the *'lowest'* form of public participation which was informing the local population at the end of the development about the project which led to a lack of a clear and shared understanding of the need and necessity of CCS among the developers and the public. This ultimately led to the failure of the project, which was unsuccessful in garnering enough public acceptance to continue (van Os et al., 2014).

The lack of public acceptance around the CO_2 storage project is then approached within a small subset of the literature (Brunsting et al., 2013; van Os et al., 2014; (Krause et al., 2014) with the concept NIMBY (not in my backyard). This implies, that the physical proximity to the site is a key area of

consideration for acceptance, where the resistance is not necessarily based on principled disagreement with the technology, but with the proverbial presence in one own's backyard. The acronym has been adjusted to Not Under Our Back Yards (van Os et al., 2014; Krause et al., 2014); and to fit the discourse around carbon storage.

There are also different mechanisms which are commonly employed to overcome resistance at a local scale and win communities over. These mechanisms include but are not limited to establishing community funds where the developers provide a lump sum to the benefit of residents, and benefits in kind where developers pay directly for local facilities such as schools, churches etc. Thirdly another method used is local ownership shares, whereby members of the community own a part of the development (for example one wind turbine out of the wind farm) or the energy development provides local contracts which lead to local employment during the contract period. According to the literature, community compensation or community funds are one of the more effective ways to win communities over, but only if the parameters of the compensation are aligned with local needs (Boomsma et al., 2020). For example, a Dutch study found that there was a preference for community compensation in the form of a fund to account for the damages caused by the nearby CCS site (Terwel and Ter Mors, 2015). Some also suggest that the communities which are affected need the resources to develop the ability to be well informed about CCS to then be able to negotiate better what the different benefits for the community should be (Coyle, 2016), circling back to the studies which identified low awareness of CCS making the case for increasing education in this area. It should be also noted that these different forms of compensation schemes are sometimes criticised from an ethical perspective. This is for a number of reasons. Firstly, the ethical question arises to what extent is it justifiable to compensate one community for the local impact of an energy technology the use of which has an impact that stretches far beyond its site location. Secondly, as industrial sites are usually located in rural areas, these areas might be in particular need of financial assistance and therefore their ability to decline any financial incentive or compensation from an industrial energy developer might be limited. Furthermore, the affected community do

not have the same resources as far as access to legal consultation as the developers and so are not on equal footing from the start of the negotiations for appropriate community compensation. And lastly, the impact of a particular energy site might not always be clear upfront when the compensation is being negotiated, therefore it is also questionable whether it is possible to consent and accept compensation for these sites, or whether the compensation for the community and their consent is something that should be continuously renegotiated.

2.2.5 Risk

Risk is a frequently examined concept in science and technology literature and is conceptualised in different ways. In the literature around energy, it is referred to in technical terms, for example, the risk of spill, risk of pollution, and risk of the technology malfunctioning. Risk is also understood in a less technologically specific way, but in terms of future hazard, meaning as a way of jeopardizing sustainable futures and sustainable developments. Risk is also discussed as a barrier to public acceptance within this literature. Hajer and Wagenaar, (2003) refer in their work to the work of Ulrich Beck and the concept of *'risk society'* which Beck defines as a "systematic way of dealing with hazards and insecurities induced and introduced by modernisation itself" (Beck, 1992 p. 21). Hajer and Wagenaar (2003) make a reference to Beck's point about technology and risk, in particular the understanding that technologies are always tested out under particular controlled, laboratory-like conditions, which makes their *'real life'* application risky and unpredictable. Hajer then points to the environment being the '*real life laboratory'* (Hajer and Wagenaar, 2003 p. 186).

Risk perception seemed to have played a role in more than one cancelled CCS project, as Lofstedt (2015) identified that risk communication has been poor across these cancelled projects. In the Netherlands, a Shell CCS project in Barendrecht was cancelled due to public opposition, and one of the risk factors which the public was concerned with was the decrease in property values in the areas of the CO_2 pipeline infrastructure. This shows that not all perceived risk is connected to health, safety, or the environment.

The question has also been raised, regarding who is taking the risk and who is liable. Chalmers et al. (2013) made the point that if we look at risk management in policies regarding the disposal of nuclear waste in the UK, it is very complex and if similar complexity and level of liability were to be applied to CCS, this could have adverse effects on the development of CCS in the UK. In this instance, risk is conceptualised within an engineering and management discourse, where the assessment and management of risk are central concepts.

There are also regional differences. Karimi and Komendantova (2017) compared risk perception across three countries, Germany, Norway, and Finland. The research showed that opposition is strongest in Germany, where the perception of risk is based on a lack of trust in the justifications of the need for the project. Whereas in Norway and Finland, the risk perceptions were more connected to the risk of investment into CCS. Interestingly they also found, that across different countries the CCS risk perception differs the most among NGOs and scientists, whereas private sector stakeholders' CCS risk perceptions do not differ from each other across different regions. Across these studies that discuss risk and public perception, there are strong links between risk and safety or lack thereof, and generally, the risk is discussed in the context of the specific sites and local region. What is absent from the discussion of risk is a broader perspective.

And finally, the definition of risk is also not to be taken for granted. Research (Signleton et al., 2009) found that the public generally has a social constructivist risk perspective, and experts generally use a realist perspective. Singleton et al. (2009) explain that experts view risk as something tangible, which can be measured with sufficient data and quantified, such as the percentual chance of technological failure. The public’s perception of risk then, they argue, is not as singular true objective risk, but rather as multidimensional and subjective, which means that their risk perception cannot be overcome by the refining of risk assessment models, as the study concludes.

2.2.6 Knowledge and Expertise

There are a number of studies which focused on CCS experts' perceptions. Overall, they were found to have a positive view of the technology (Hansson and Bryngelsson, 2009) and viewed public engagement as important (Whitmarsh et al., 2019). They also identified cost, long-term policy framework, international regulatory framework, safety, and suitability of storage sites as possible barriers to CCS scale-up (Gough, 2008; Sala and Oltra, 2011). Communication and sharing knowledge on CCS amongst various publics has also been studied in the literature. Some of the assumptions around knowledge and acceptance of CCS are, that because CCS is relatively unknown it does not bode well when it comes to public acceptance (Ashworth et al., 2010). However, what became clear is that it is not necessarily the increase in CCS knowledge that leads to a better chance of acceptance, but it matters what kind of knowledge is shared, through what medium and via what stakeholders.

Depending on which part of the BECCS process is emphasised, this can alter the public acceptance and perception of the technology. When the carbon capture process is linked to *'natural'* processes, such as biomass growth (Oltra et al., 2012) it is perceived more positively. This results in BECCS having an edge in public perception over other applications of carbon capture technology, which do not involve biomass. The theme of *'nature'* and *'natural processes'* is also present in other studies, that found that carbon storage is particularly contested because *'tampering with subsurface'* is seen as *'tampering with nature'* (Thomas et al., 2018; Wallquist et al., 2012; Wolske et al., 2019). These associations are not likely to be overcome by explaining the process of subsurface storage in greater detail to relevant audiences, as it might be counterproductive and reinforce the *'tampering'* perception.

It also matters who communicates the knowledge. The knowledge and information supplied by NGOs on CCS is trusted more than the one supplied by industrial organisations (Pigeon et al., 2012). This is because the motivations of the speaker are considered when processing what is being said. Secondly, when multiple stakeholders from different backgrounds provide shared communication on CCS, this is seen as more effective (Ter Mors et al.,

2009). When looking at information on CCS shared online, Feldpausch-Parker and Peterson (2015) found that knowledge of CCS on government websites is often written with technical jargon and appears to be geared more towards the industry as opposed to the lay public. Sharing CCS knowledge on social media also does not reach the lay public, as it is viewed and shared only by niche audiences who already have pre-existing connections with the technology (Mander et al., 2017). Thus, the lessons learned from this literature subset are that public awareness of CCS is low, and interest tends to spike mostly in connection with controversies (Ashworth et al., 2015). A recently (2023) released BBC Panorama documentary *'The Green Energy Scandal Exposed'* zeroed in on the use of biomass by the Drax power station in the UK, created an interest in BECCS. Secondly, it cannot be assumed that lay publics are blank slates, as they might have already existing knowledge or associations of carbon capture with other technologies (Bradbury et al., 2009; de Best-Waldhober et al., 2011). In fact, assuming an ignorant public can be counterproductive, as diluting CCS information with hopes that is better understandable for the public, can make it seem less trustworthy (de Vries et al., 2014). And finally, even if knowledge leads to positive views of technology, research has found that sometimes even that is not enough. Kaiser et al., (2014) found in their example of Polish CCS, that what was decisive in local acceptance was key local stakeholders being directly involved in planning processes which built trust, which turned out to be more of a decisive factor than initial positive attitudes.

2.3.7 BECCS Conclusion

I have structured the BECCS literature review section based on the topics which were most frequently discussed within the BECCS social science literature. Firstly, the focus was on framing and discourse and how BECCS media representation is understood within the social science literature. The second section then discussed the concept of social license to operate, the reviewed the literature which focused on stakeholder engagement with CCS and BECCS. SLO is an important concept within BECCS literature, as it is frequently how local public support is conceptualised. Although SLO does not have any legal standing, it is nevertheless viewed as desirable and necessary. Furthermore, a subset of the literature focused specifically on public

perception, with the underlying thread throughout the literature being the understanding that BECCS either already is or could turn into a controversial technology. The following section then focuses on public perception of BECCS, which was followed up by a section on social acceptance. A section on risk discussed the different ways in which risk is conceptualised in the context of BECCS, as either a technological risk or as a future hazard. Finally, the last section discussed the literature which focused on different types of knowledge and expertise.

This review of BECCS literature revealed a strong focus on public perception and acceptance of the technology. This is not a surprising finding in the literature but is rather reflective of the concerns around different CCS or BECCS projects facing public resistance or being cancelled altogether because of lack of acceptance. The BECCS literature also revealed a strong tendency to overlap the findings of CCS and BECCS, particularly when it comes to discussions around social acceptance. Furthermore, whilst overall the peer-review literature corpus on BECCS and CCS is dominated by mostly engineering literature, this review showed that there is a growing body of social science literature focused on this technology in particular, providing a good contextual basis for the research presented in this thesis.

2.3 Shale Gas

In the last ten years, according to Evensen (2018) over 1000 peer-reviewed journal articles, chapters and monographs have been published that focus on social scientific aspects of shale gas. When looking at the publication rates today, according to the academic search engine *'Web of Science'*, there are similar levels of research on the social science aspect of shale gas as the study by Evensen (2018) found five years prior. *A 'Web of Science'* search also showed that there are approximately similar numbers of articles published on the social science aspects of BECCS and CCS.

This level of attention on shale gas by social scientists is explained by the contentious nature of shale gas, which results in a lot of public attention, media attention and government attention, all of which then contribute to fuelling the discourse around the technology. The richness of the discourse makes shale

gas then particularly interesting and suitable for different types of social science research, be it focusing on the relationship between space and place, advocacy coalition frameworks, the study of social movements, issues of energy justice and energy democracy, governance, and social license to operate, discourse analyses and more. Cotton et al. (2014) write that the combination of the *'rhetoric and growing grassroots' activism'* makes shale gas a matter of *'public discourse debate'*, and the different views of NGOs, different political parties and other interested parties make the argumentative struggle around shale gas visible.

Shale gas also produces different discursive questions compared to other fossil fuels (Neville et al., 2017), because of a number of reasons. Firstly, the drilling density required poses unique social, environmental, and geological challenges. Secondly, the low-carbon narratives surrounding shale, for example, coal in combination with CCS is referred to as '*clean coal'* (Rosenbloom et al., 2018), do not have an equivalent when it comes to conventional fossil fuels. The most frequently asked research questions within this literature are related to public support or opposition to shale gas and enquiring what the reasons are for one or the other (Evensen, 2018).

2.3.1 Discourse, Frames, and Framing

Shale gas frames and the framing of related issues have received a noticeable level of attention in the shale gas social science literature. Framing has been applied to every aspect of shale gas and particularly what has been explored is the way a certain framing impacts the perception of shale gas. Williams and Sovacool (2019) examined how the policy debate on shale gas in the UK has been framed by UK institutional actors and found that the safety and feasibility of the technology were seen as the main policy indicators. Evensen et al. (2022) examined how the framing of the seismic activity caused by fracking impacted the perception of shale gas. It was found that whether the seismic event was framed as an earthquake made little to no difference in how the technology was perceived. What was key, however, was the cause of the event, which was fracking, which led to a negative reaction to it. McNally et al. (2018) examined whether the framing of the name for onshore shale gas extraction matters. The results showed that it does matter how shale gas

extraction is referred to. *'Fracking'* was found to garner much less support than '*using hydraulic pressure to extract natural gas from the ground'*. This was explained as fracking having specific connotations of risk. Not just the technology itself, but also those resisting and protesting it have been framed in different ways, from respectable figures to *'violent unemployed nomads'* (Muncie, 2020, p. 417). The protesters have then been also framed as either what Muncie (2020) calls *'rent-a-mob'* if travelling from outside of the area, or as NIMBYs if they were local to the site. The framing of protests and protesters is not static, but rather shifting as new identities emerged within the protest groups, such as those of citizen journalists who were providing '*credible accounts'* compared to the mainstream media.

Nyberg et al. (2020) say that shale gas frames have solidified over time via the process of creating simplicity, and familiarity. In other words, our adherence to fossil fuels and the want to pursue shale gas is supported by fossil fuels being framed about economic growth, jobs, standards of living and energy security, all of which are necessary to be able to live in the developed world.

A key paper on the discursive struggle connected to shale gas is 'Shale we drill? Discourse dynamic in the UK fracking debates by Bomberg (2017). This study engaged with Maarten Hajer's discourse analysis and applied it to fracking in the UK. The study found that there are two coalitions, the anti-shale gas and pro-shale gas coalitions. The anti-shale gas coalition gained a slight edge at the time, by having credible actors presenting the key storyline of shale gas as a threat. Hajer points to three criteria, which we can apply to storylines, and that is plausibility, acceptability, and trustworthiness. And whilst the pro-shale storylines were plausible, they were not trustworthy. At the same time, the anti-shale coalition fell short of gaining discursive dominance (then), because although their framing was trustworthy, they somewhat lacked plausibility.

Williams and Sovacool (2019) analysing the UK parliamentary debate on shale also utilised similar analytical tools and determined that the '*dirty fossil fuel'* frame had more resonance than for example the shale gas as '*bridging fuel'* frame, which failed to gain support beyond the members of the Conservative

party. They also found, like Bomberg (2017) that the anti-shale coalition was slightly more successful, in that it positively influenced the institutionalisation of the decarbonisation agenda and shifted the focus more on community interests within the shale gas debate.

Although the clear division of anti-shale and pro-shale coalitions seems to be the case in a different context, the framing of the storylines they rest their arguments on seem to be location specific, so much so that meanings of shale gas storylines differ between countries but sometimes also within them (Janzwood and Millar, 2022). Chen et al. (2020) found that in Canada, the pro liquified natural gas coalition relied on the '*progressive extractives'* storyline, which presented LNG as an opportunity for export which was compared to the '*less ethical*' Chinese imports of LNG. This is different from the pro-shale gas arguments in the UK, where the ethical component was present on the anti-shale gas side. In the Netherlands, uniquely, the opponents of shale gas introduced elements of degrowth framing to the debate (Metze, 2018). In Scotland, Stephan (2017) distinguished between not two but three discourse coalitions, the pro-shale gas, anti-shale gas and the Scottish government as a third, which is unusual across the different argumentative discourse analyses of shale gas. Stephan (2017) argues that the Scottish government constitutes a third discourse coalition, as he identified that the Scottish government has initially employed a *'dual discursive strategy'* straddling the line between the public's scepticism of the technology about also possible economic opportunities that shale gas could present. In the end, the Scottish government has adopted an evidence-based approach which differentiates it from the other two discourse coalitions. He also found that the anti and pro-fracking groups wanted to expand the shale gas conflict to include discussion about costs and risks, whereas the government wanted to contain the conflict and focus solely on the technology and its implications. In the end, Stephan (2017) argues, that the Scottish government achieved discursive dominance within the Scottish context. This is because it managed to influence and structure the debate around shale gas and institutionalise its position with the moratorium policy. Scotland is also touted as one of the places which have achieved discursive dominance, as the Government has imposed a moratorium based on the

evidence-based approach, which was identified as the prominent storyline. This was also impacted by the anti-Westminster storyline before the Scottish Referendum in 2014 (Stephen, 2017).

In New York, Dodge (2017) talks about a case of *'crowded advocacy'.* She finds that the relevant discourse coalitions influence the discourse by presenting divergent ideas of firstly what constitutes credible shale gas knowledge, who is a credible speaker with authority, and thirdly how should risk be managed institutionally. Because of these divergent notions on these three points, advocates of different positions had to first defend the credibility of their knowledge and their authority to speak on the issue rather than presenting their argument. This then led to what Dodge (2017) describes as a crowded field. She then expands, that this does not necessarily mean that there are many advocates for or against shale gas, but rather that the advocates present very many perspectives to gain attention.

Also utilising discourse analytical tools, but focusing on metaphors, as opposed to storylines, Cotton et al. (2019) examined Australian, UK and US broadsheet newspapers and found that across the two dominant framings and the three countries, unconventional hydrocarbon is understood as temporally situated, fundamentally risky and being decided on by unreliable policy and decision-makers. There were also some nuances found in the different use of metaphors across the regions, with the UK newspapers using terms like a *revolution* to describe the possible impacts of unconventional hydrocarbon development (UHD) extraction, whereas US-based coverage referred to a *boom*. Overall, the discourse emphasises the uncertain nature of UHD, its short-term nature and its unreliability. This is an important finding as it shows the contrast between shale gas being perceived as fundamentally risky and temporally situated by the UK and US press, and the arguments that shale gas is a source of reliable, long-term energy supply.

2.3.2 Social License and Acceptance

Just like the BECCS literature, shale gas literature also engaged with SLO. There are specific factors which SLO depends on, including distributional fairness, local knowledge of the industry, governance of the industry and more.

Perceived impacts on the local community were identified as the key factor in determining SLO for shale gas. Walton and McCrea (2020) suggest that to have a chance at establishing SLO and create knowledge among the community by targeting residents with less established views on shale and sharing specific information about the sharing of benefits, the mitigation of potential negative impacts, and procedural fairness as opposed to sharing general information about the shale gas industry.

Fracking, more so than the case of BECCS, exposed the fact, that although social acceptance is key, social license to operate does not have any legal standing. As an example, even though shale gas was heavily opposed in the Lancashire area, operations were still able to proceed (Bradshaw and Waite, 2017). Even the current shale gas moratorium in the UK is based on the unpredictability of earth tremors, as opposed to incompatibility with the local communities near sites of operation. Sovacool et al. (2020) provided a retrospective account of lived experiences in Lancashire, where the participants detailed their personal negative experiences with the planning processes and the way the community was divided, which by their account caused a lot of pain. Short and Szolucha (2019) also speak of the collective trauma experienced by the Lancashire residents as a result of the fracking operations in the area.

Another case of impact on the community was described by Soyer et al. (2020), looking at Dalton, Texas. In this instance, the pro-fracking groups leaned into arguments connected to love for the city and environmental and bodily health, whilst the pro-fracking groups leaned into faith and *'love for Texas'* arguments. This then led to a splitting of the community, as opposing or being in support of the technology then shifted to being in support of the town and the whole state.

When comparing fracking across the US and the UK, Beebeejaun (2017) found that the UK's Government rhetoric implied that fracking is a simple task of technological innovation. Whereas what the examples above have shown is that energy is not just something to be extracted but requires and relies on different technological and institutional structures to materialise. In particular,

the case of Delton has shown that shale gas is not just a question of innovation, but the issue extends to wider implications for institutions, regulatory bodies, and social and political dynamics within the affected communities.

2.3.3 Policy Focus

Shale gas policy has also been a focus of enquiry. Metze and Dodge (2016) approached shale gas as an interpretive policy problem. Within interpretive policy analysis, importance is given to human intersubjectivity and historical context when trying to understand individuals' views of particular policies (Moore and Wiley, 2015). Metze and Dodge (2016) then found that across different countries, there are tensions along two strands within fracking policies. Firstly, they found there is a struggle between framing fracking as an economic opportunity versus environmental harm. Secondly, there is a discursive struggle between moving towards a more carbon-free energy future or further locking in the fossil fuel system. Dodge and Metze (2016) found that depending on how shale gas was framed had governance consequences. So, if shale gas was seen as a threat, this resulted in risk-based governance, which would focus on mitigating seismic activity as an example. If it was seen as a barrier to a low-carbon energy transition, this resulted in the decision to ban fracking in that region. These policy tensions, or contradictions were also picked up by Cotton (2017) who argued that there is inherent conflict within the policies. As an example, he uses the initial shale gas policy in the UK which served to protect local residents and mitigate seismic risk. This was replaced by a policy which favoured the industry thus shifting the power from the local context to the central government and industry. Despite this move from the local focus to the national, Hilson (2015) found that there were blind spots in these policies, one of which was the consideration of the '*final fuel use'*, the emissions created and their impact on a wider scale. At the same time, research suggests, that it was not the UK's specific policy landscape that led to this outcome. (Cairney et al., 2016) compared the policies across the UK and Switzerland and found that despite the different governance systems and policy procedures the conclusions were similar, namely the national governments not supporting the development of commercial fracking, local governments restricting fracking, and local communities resisting fracking.

Providing a retrospective view, Bradshaw et al. (2022) assessed what they ultimately described as a policy failure, with no shale gas in operation today in the UK. They assess that there were three key factors which led to what they describe as a *'discursive energy policy failure'.* This label is based on the fact, that the UK had relatively little shale gas infrastructure, and never produced onshore shale gas using fracking commercially, and so the policy debate has really been about visions, imaginaries, frames, and what role shale gas should play, as opposed to what role it has played. They categorised the reasons into three factors, the first of which is the framing of the shale gas *'issue'* in parliament. The second factor they identified is the shift in public attitudes towards shale gas and the third one is the lived experiences of local communities affected by shale gas. They also characterised this as a procedural justice issue, specifically pointing to the example where the national government in England overruled planning proposals on a local level and ignored local concerns. In the case of South Yorkshire, which this example is connected to, there was evidence found not just of procedural injustice, but also of distributive and recognition injustice which included concerns about unequal distributions of risks, specifically affecting vulnerable residents as well as unequal access to relevant data and information by local residents (Devine-Wright et al., 2021)

The issue of shale gas and social justice is not just limited to the UK. Research (Whitton et al., 2017) showed, that in both examples of the UK and the US, the public's influence on policy is minimal and that generally there are very few opportunities for citizens to influence the policy, which feeds into the issues of justice, procedural fairness as well as ultimately (failing to gain) a social license to operate. To achieve *'true justice'* in these policy procedures, Sherval, (2023) argues that all stakeholders, including the local residents and the public, must be considered legitimate actors and their opinions as valid. Furthermore, stakeholders with power, such as the government and industry should consider distributional inequalities and particularly risks associated with the shale gas industry in terms of environmental and human health. It should be noted that particularly environmental health in connection with unconventional oil and gas has been under-researched in the literature (Cotton and Charnley-Parry, 2018)

The impacts on environmental and human health were no secret to the public. In the cases of the US and UK, before shale gas operations, shale gas extraction was viewed as a perilous development, which could pose substantial risks to human and environmental health. The scale of that risk spans from broad threats to human health through air and groundwater pollution, all the way to risks to our way of life on Earth (Harthorn et al., 2019). There are also some studies which point directly to links between human health and unconventional oil and gas development. Namely, Gaughan et al. (2023) published a paper which found that in Ohio, there are higher odds of limb reduction defects in infants and other serious medical issues, if they were born near oil and gas developments. It is therefore perhaps not surprising, that O'Neill and Schneider (2021) found that in the US public attitudes towards fracking were found to be based especially on perceived risks to public health and the environment.

2.3.4 Risk, Uncertainty, and Seismicity

Throughout the literature, fracking is discussed in terms of the risk it poses, what kind of risk and how that risk is perceived by the public, stakeholders, and local communities. Some of the fracking hazards identified were so-called *'operational hazards'* ie. hazards associated with operating a shale gas site. This includes leaks and seismic activity, risks to water resources like groundwater contamination, risks to air quality, risks to the climate, and ecological risks which include but are not limited to causing stress to water streams from water extraction, impacts on local habitats and finally public health risk (Small et al., 2014). These different hazards result in what Harthorn et al. (2019) refer to as compound risk.

Discussing risk perception is important, especially as the public has a greater awareness of it than of potential shale gas benefits (Whitmarsh et al., 2015) and the risk perceptions related to shale gas are unique to shale gas and do not necessarily translate to other technologies which use underground space (Haemmerli and Stauffacher, 2020) except in some cases, like geothermal energy where the risk associated with fracking have been found to *'spill over'* (Westlake et al., 2023). This *'spillover'* also works in a reverse way, in that

participants with levels of trust in the oil and gas industry felt similarly about shale gas, which they then also perceived as low risk (Bradshaw et al., 2022).

Risk perceptions are not static and are in fact dependable on contextual factors. One of these is the stage of shale gas development in which the risk is being assessed (Tan et al., 2022). Another factor is the scalar nature of risk perception (Pollard and Rose, 2019), meaning that the way risk is perceived can be influenced by international, national, regional, and local factors. For example, the movie Gasland, which is a US-based documentary on the environmental impacts of fracking, including an example of water contamination, influences the risk perception of fracking in New Zealand. The documentary thus became an *'international risk event'*. What the literature shows is that risk perception involves considerations of different concerns and is based on different values which go beyond concerns for safety, or seismic events (Thomas et al., 2018).

Overall, when it comes to risk, it is clear that the debate as to what constitutes an acceptable level of risk and what kind of risk (e.g., social, environmental, health) is not settled. Public views as to whether the perceived benefits of shale gas outweigh the risks are mixed (Thomas et al., 2018). One of the questions that arise, is why, when there is widespread awareness of the environmental harms of fossil fuels, we keep pursuing them, and even seek out 'new' forms, like onshore shale gas. One of the ways this is explained is because of the way risk and temporality interact in the framing of shale gas. Nyberg et al. (2020) explained how the ways shale gas benefits are framed to things such as job creation, and economic growth bring an idea of a desired future to the present to allow for a positive view of fracking. They refer to this as a frame becoming '*temporally portable'*. They however also point out that if we continue to use fossil fuels, the future presented in these positive framings does not materialise and is heavily impacted by adverse effects caused by climate change. Some see fracking as fundamentally incompatible with a desired energy future, because of the risks associated with deepening the fossil fuel lock-in (Thomas et al., 2017).

2.3.5 Public resistance and public support

Shale gas, particularly in the UK is associated with high levels of public opposition and is generally viewed as being a divisive energy technology. Shale gas development in the UK has led to a number of protests, notably the Balcombe drilling protest, which occurred in 2012 in West Sussex or anti-fracking protests in Lancashire which took place largely between 2014-2016. There are different ways in which this resistance has been explained and characterised. Based on research by McLaughlin and Cutts (2018), it would be a mistake to characterise shale gas protests as NIMBY (not in my backyard) (Dear, 1992; Devine-Wright, 2005; Hermansson, 2007) protests, or protests that stem from the public's territorial concerns about their immediate surroundings.

They found that there is a deeper discourse within the anti-fracking movement which some oppose shale gas based on the principle of protecting the planet as opposed to protecting their immediate surroundings (McLaughlin and Cutts, 2018). At the same time, a survey by Howell (2018) showed that the British public is more united in negative than positive beliefs on fracking and that the support for fracking drastically declines if it were to happen *'within 10 miles of home'* Another survey (Andersson-Hudson et al., 2016) identified that what also lessens the likelihood of support for shale gas is an early association with environmental impacts like water contamination or earthquakes.

Evensen et al. (2017) compared a sample of the UK and US public, they found that in the US shale gas is more likely to be associated with positive impacts like providing cheaper energy and advancing national security. Whereas in the UK, shale gas was more likely to be associated with negative impacts such as the aforementioned water contamination. Still, in the UK, those who saw an association between shale gas and national security were much more likely to support shale gas than those with the same association in the US. Research also pointed out that shale gas support is associated with sustainability whereas the opposition to shale gas is more associated with resilience (Evensen et al., 2017). It is clear that the attitudes towards shale gas are highly heterogeneous (Whitmarsh et al., 2015) and influenced by pre-existing values. For example, someone with pre-existing environmental values is unlikely to

support shale gas based on economic and national security and resilience arguments. Instead, they are more likely to be susceptible to framings like when it comes to combustion emissions, shale gas being slightly better than coal. As Williams et al. (2017) put it, fracking is not a problem just about the existence of objective risks and the public's ability to understand them. They argue that resistance to fracking cannot be reduced to a lack of understanding via the knowledge deficit model, also assuming that greater awareness and understanding would lead to acceptance. Instead, they argue, the problem hinges on the ways in which, if at all, institutions are able to accommodate the heterogeneity of public views and show that the perceived benefits are subject to as much scrutiny as the risks to avoid the impression of shale gas '*hype*', which participants did not react well to.

Not only do the attitudes towards shale gas differ across regions, but also the motivations of anti-shale gas campaigners (Garland et al., 2023) and the way they are characterized (Steger and Drehobl, 2017). In Ireland, the mobilization against shale was what Steger and Drehobl (201) referred to as a '*frame war'* on the credit of the activists. The activists were either referred to, based on their approach, as violent or as peaceful, based on their ability to reason as either reasonable citizens or as hippies and based on their connection to the locality as genuine or as professional protesters.

Different ways of participation in the shale gas discourse in the UK were possible in planning, environmental permitting, public consultations, and dialogue workshops. However, these were found by the public as very restrictive formal, and performative with no real interest in a genuine public consultation (Williams and Sovacool, 2020). This approach of formal public participation opportunities in England ultimately backfired, as it did not help deliver a shale gas industry. Instead, what came to the forefront were questions about democracy within the decision-making processes. This is warranted, as the influence of the public on shale gas decisions was found to be minimal (Whitton et al., 2017).

This section showed there is a strong focus within the literature on studying public acceptance of shale gas. This is not surprising given the level of

controversy and public outcry that is associated with the technology. The literature suggests that public acceptance depends on a number of factors, including geographical proximity but also how shale gas is framed and whether it is associated with other aspects such as domestic energy security, or with cheaper energy supply. Overall, the literature suggests that public acceptance of and public resistance to shale gas cannot be explained by using the knowledge deficit model, as the reasons for acceptance/resistance are complex and multifaceted.

2.3.6 Knowledge and expertise

It seems that the interest in public resistance to shale gas is somewhat based on the assumption (Cantoni et al., 2018) that if the public or local communities were better informed about the risks and benefits, they would not oppose it. Firstly, there are counterarguments to this knowledge deficit model and examples where providing more knowledge about shale gas made no difference to the outcome of support of the technology (Evensen et al., 2017). Arguably, the more likely influence on the perception of shale gas is the public's values as opposed to their knowledge or lack thereof. However, the knowledge deficit model also works in the reverse way. In the UK Rattle et al. (2020) found that anti-shale gas activists' leaders who were sharing information online found this disempowering because they felt that it ultimately failed to garner enough influence to have an impact on policy. Hawkins (2020) also found that in the UK shale gas context, there is a misunderstanding by the public about what the role of experts and their knowledge should be. There was a desire for expert-led decision-making, which challenged the assumption in previous literature that expert-led decision-making is undesirable because it endangers the legitimacy of the process. Within the UK shale gas context, Hawkins (2020) argues that experts were viewed by the public as a body of people who could and should make decisions. Although both expert and lay forms of knowledge are important, the research found that the latter in the shale gas context can be deceiving. Hildebrand and Liang (2020) investigated anecdotal knowledge of groundwater contamination connected to shale gas in the Marcellus Shale region in the US, and found, after sampling the water, that there was little factual support for those knowledge claims.

2.3.7 Shale Gas Conclusion

The second half of this chapter focused on shale gas and was broadly structured in the same way as the first part of this chapter. The first subsection discusses the application of discourse and framing methodological approaches. The second section looks at the concept of social license to operate and acceptance, looking at the attempts to resolve tensions between industry and local communities. This is followed up by a section which discusses policy-related literature, also providing a retrospective perspective on, what was ultimately deemed as a shale gas policy failure. The section on risk discusses how risk relating to shale gas was conceptualised within the literature, and then particularly risk connected to earth tremors. The next two sections, public resistance and public support discussed different approaches to attitudes and the NIMBY (not in my backyard) concept, which is utilised in shale gas research that focuses on explaining local resistance. The last section then describes the different types of knowledge discussed and the unique way in which the role of experts was envisioned by the UK public in the context of the shale gas dispute.

2.4 The Role of Space and Place

In the Introduction chapter I laid out how BECCS and shale gas are similar and why it makes sense to compare them, however, they both differ significantly from geographical and spatial perspectives. Energy technologies by their nature of being socio-technical systems are embedded and situated in a particular space and place. Whilst this thesis pays more attention to the role of both energy technologies within the net zero transition and the net zero policy, as opposed to their local impact or the specific implications of their geographical locations, it is nevertheless important to discuss their relation to space and place. Bridge et al (2016) even argue that we should examine energy transitions as geographical processes.

Firstly, BECCS as a technology is being trialled only at one site in the UK, Drax Power station. This is located in the Northeast of England, in North Yorkshire, between the cities of York, Leeds and Hull. Drax also has an international biomass supply, which reaches the US and Canada. As the carbon storage is also planned to be in the North Sea, the technology's spatial impact stretches

out beyond North Yorkshire. Shale gas is different in that there is no active onshore shale gas site in the UK at present, and when shale gas was explored this was done at multiple sites located throughout England. The site that garnered the most attention was Preston New Road, in Westby-with-Plumptons, in Lancashire, which was run by the company Cuadrilla and was also the country's biggest shale exploration site. Additional shale gas exploration sites were located in Yorkshire and the Midlands as well as Sussex. Whilst the locations of the energy technologies are different, they share the use of the subterranean, which is an important geographical factor. Huber et al (2017) present the case that under current industrial energy regimes, there is an intensive over-reliance upon harnessing subterranean stocks of energy, they even referred to this as the 'subterranean energy regime'. Because of BECCS' reliance on the use of the carbon storage sites in the North Sea, this energy does not present a move away from this 'subterranean energy regime', something Huber et al (2017) argue is necessary for a successful low-carbon transition.

When sampling participants I did not differentiate between actors based in England, Scotland or Wales. Whilst shale gas is a devolved administration issue, because the licensing of onshore oil and gas has been devolved to both the Scottish and Welsh governments, in this thesis I did not make this distinction. Shale gas was effectively banned in Scotland via a moratorium, which is why there were no shale gas exploration sites in Scotland. In 2018, the Welsh government also announced that shale gas will not be supported in Wales. At the time of this thesis, except for a very brief period in September 2022 when Liz Truss became Prime Minister, there was a moratorium on shale gas in England also, and thus the shale gas policies were de-facto aligned across the devolved nations which resulted in my decision to not differentiate between them and allow the sampling of actors across the UK. It should also be noted that the participants themselves did not make this distinction and discussed shale gas as a de facto UK-wide issue as opposed to zeroing in on the regional differences between the shale gas sites or policies. Below I present an illustrative map of the location of Drax, Preston New Road and

Bowland Shale Gas Area, where the majority of shale gas drilling sites were located.

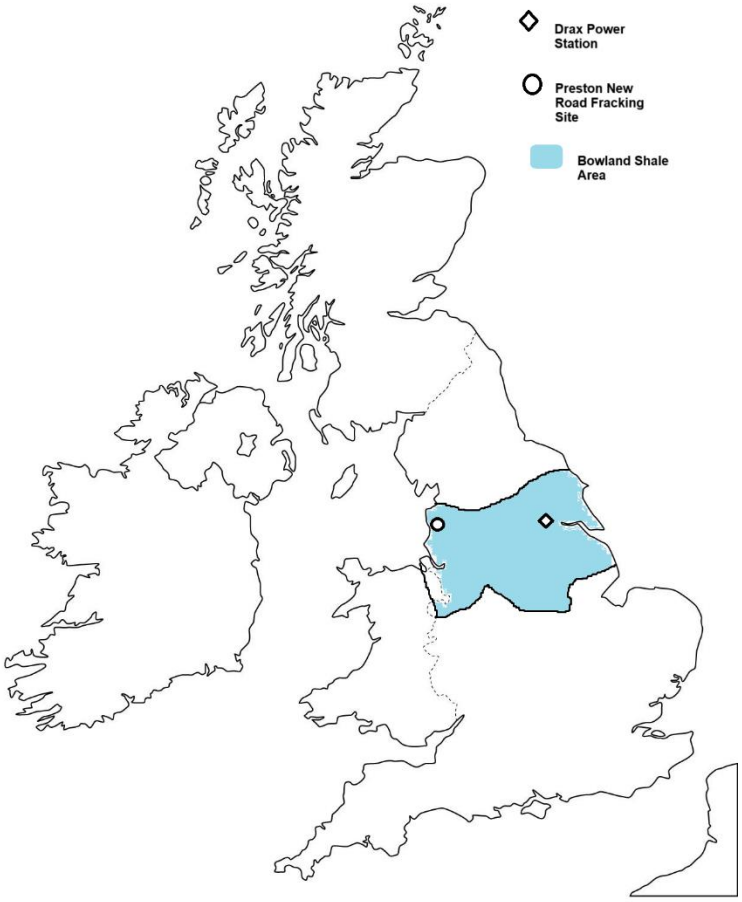

Fig. 1 ***Illustrative Map of Bowland Shale Area, Preston New Road Fracking Site and Drax Power Station***

2.5 Chapter Conclusion and Gaps in the Literature

The purpose of this chapter was to provide a comprehensive overview of BECCS and shale gas social scientific literature, with the aim to identify gaps in the literature and make it clear how the research proposed in this thesis fits in with the already existing knowledge. One of the gaps identified was the clear preference for focusing on CCS as opposed to BECCS, with notably fewer studies focusing on the latter. Although there were a few exceptions, the majority of literature, particularly published earlier in the 2010s focused on the CCS and the link to fossil fuels, and enhanced oil recovery. By focusing on BECCS in the UK context, this research will contribute to a small subset of carbon capture literature and bring to the forefront an application of CCS which

is not always emphasised. Secondly, in the case of shale gas, there is a focus on the period between 2010 and the moratorium in 2019. The research in this thesis will provide a different perspective by having interviewed key shale gas actors in the UK after the moratorium was announced and also after the UK Government's net zero policy announcement. The net zero policy aspect, understandably because it is a recent development, is absent from the literature. And so, by situating this research against the backdrop of this policy, it significantly differentiates itself from the rest of the literature. The methodological approach in this thesis will contribute to existing literature which has frequently used Hajer's discourse analytical approach to examine the discourse and debate surrounding both energy technologies. Particularly, in discourse analyses of shale gas (Bomberg, 2015; Cotton et al., 2014; Williams and Sovacool, 2019), Hajer's approach is used frequently.

Although regarding either of the energy technologies, comparative analyses are not uncommon, these largely focus on comparisons between different geographical locations as opposed to two energy technologies. The studies which did mention both BECCS/CCS and shale gas did so largely in the context of drawing lessons from the latter to inform the successful implementation of the former in Germany (Themann and Brunnengräber, 2021, Wolff and Herzog, 2014), and the Netherlands (Vergragt, 2009,) or in the context of drawing comparisons between CCS and nuclear energy (Lock et al., 2014; Poumadère et al., 2011). In summary, this thesis will fit in with the already existing substantial literature corpus on discourse analyses of both energy technologies but will also stand out because of the unusual and underexplored comparison element and the backdrop of the UK's net zero policy.

The different subheadings reveal that risk, social license to operate (SLO) and knowledge and expertise were topics which were present in both literature subsets. There were however also some differences, and some topics were present in one subset but not the other. Notably, within the shale gas literature, there is more focus on the media representation than in the BECCS and CCS literature. This might be the result of the more publicly visible controversies surrounding shale gas, such as seismic activities, for which there is not a

comparable public instance of such controversy with BECCS. This association with seismicity permeated also other categories of the literature. For example, although risk was covered by both shale gas and BECCS literature, there was a distinct focus on seismicity within the shale gas subset. Furthermore, in connection to seismicity, there is also a bigger focus on public resistance within shale gas literature and less so within the BECCS subset. Notably, both subsets of literature focus on discourse and framing. This is unsurprising as discourse analytical approaches are frequently applied to phenomena with controversy (Schirrmeister, 2014; Shortell, 2011), which to different extents both shale gas and BECCS are, to help uncover and understand the different sites of argumentation and reveal the positionality of the various actors involved. This is ultimately the body of literature that this research also contributes to both empirically and methodologically. It does so by being methodologically innovative by applying discourse analysis to compare two energy technologies. Secondly, the timing of the net zero transition as well as the shale gas moratorium provides a unique energy policy background which provides new data and points of view and differentiates this research from previous studies.

3 Methodology

3.1 Introduction

In the previous chapters, I have focused on setting the scene, outlining the policy context, and the literature background and introducing the three research questions. This chapter will then outline the methodological and empirical approach that is taken to answer them. I will also present how the approaches and ideas, identified in the literature, were operationalised in the research design. I will detail Hajer's (1995) argumentative discourse analysis, as it is both the key methodological and theoretical concept this research relies on. I will also discuss the ways in which this particular type of discourse analysis differs from others, and what its specifics are. The three key concepts metaphor, storyline and discourse coalition are explained in detail.

The second part of this chapter explains the research procedure. Firstly, I outline participant sampling and establishing first contact with participants. I then move on to discussing the interviews themselves and the process of

transcription and data analysis. Finally, I also offer a reflection on the boundary-blurring which occurred because of having to conduct interviews online from my home during the COVID-19 pandemic.

3.2 Theoretical Concepts, Assumptions and Limitations

This section will outline the key underpinning concepts and frameworks used in this research, starting with Maarten Hajer's argumentative discourse analysis, which informs both the theoretical frameworks of this research as well as the methodological choices made. It will then move on to outlining Hajer's 10 steps of discourse analysis (Hajer, 1995). Finally, I touch on social constructivism, which is the theoretical wheelhouse in which argumentative discourse analysis sits. It informs the assumptions made during this research, such as that language is not a neutral transmitter of information and that the meaning of language can be taken for granted. All these components substantially influenced the choice of methods and the format of sampling as well as data collection.

3.2.1 Discourse Analysis

Discourse analysis sits within the social constructivist approaches to meaning, which acknowledges that actors engage in the construction of meaning and the construction of knowledge. It is also based on the assumption that language is seen as not being able to influence communication and interests and preferences within itself (Hajer,1995). More specifically, language enables and limits the range of practices and interactions in which actors can engage.

Hajer sees language as having the power to *'make politics, to create signs and symbols that can shift balances and that can impact institutions and policymaking'* (Hajer & Versteeg, 2005 p.176). In the used definition discourse is not synonymous with discussion and discourse analysis is therefore not confined just to the analysis of what is being said (Hajer and Versteeg, 2005). Hajer points out that discourse analysis can be understood as the study of '*language in use'*, as it does not simply '*move freely'* through society but is related to the specific practices in which it is employed (Fischer and Forester, 1993). This is an important distinction that Hajer mentions, as it distinguishes his argumentative discourse analysis from other types of discourse analysis.

The origins of Hajer's argumentative discourse analysis lie in Foucault's work. In Hajer's book The Politics of Environmental Discourse: Ecological Modernization and Policy Process (Hajer, 1997), Hajer refers to Foucault's later work, specifically on Discipline and Punish. Foucault, as Hajer points out, broke down the discourses on discipline and punishment to point out their multiplicity. One of the key arguments within Foucault's work is the focus on the smaller, less obvious practices and mechanisms, which he referred to as '*the disciplines'*. He argued that these disciplines determined how institutions worked. Hajer also identifies as one of the contributions of discourse analysis the application of Foucault's concept of governmentality. In Foucault's work, governmentality is a concept which he uses to make sense of the deployment power of the policy sphere. Hajer argues that this concept is particularly useful when analysing '*eco-speak'*, as it is not a neutral way to communicate, but rather an attempt to discipline society.

Discourse is then defined as '*an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices'* (Hajer, 1995 p.67) The particular emphasis on meaning giving and meaning reproduction through identifiable practices lends itself well to be used when exploring discourses that are controversial and under investigation as is arguably the case with current energy technologies such as BECCS. Equally, it is well suited to analysing what are perceived as *'controversial'* environmental and energy policies and technologies, such as shale gas.

Hajer argues that the study of discursive constructions such as narratives, storylines or metaphors is particularly commanding in the context of the study of the social-historical circumstances in which the statements were created and established. This is because the discourse is intrinsically related to and entangled with the social practice within which it came to be. This also strengthens the argument for using this method to analyse shale gas and BECCS discourse, because of the fast-changing energy policy landscape, especially in the context of decarbonisation efforts.

Discourse analysis makes it possible to methodologically combine the analysis of socio-technical practices with the analysis of the discursive production of meaning. Applying this method, analytically I try to make sense of the regularities and variations in what is being said and try to understand the social backgrounds and the social effects of specific modes of talking. As Cotton et al. (2014) put it, the focus is on the '*linguistic strategies'* that are utilised by actors. As Hajer argues, the political power of a text does not stem from its consistency but comes from its multi-interpretability (Hajer and Versteeg, 2005). This is useful when applying to a comparative analysis, but at the same time, the methodological challenge is for the tools to stay consistent across the different data sets.

The key concepts that Hajer works with are metaphor, storyline, and discourse coalitions. Metaphors and storylines bring together and are the tools of discourse coalitions. For Hajer these coalitions are heterogeneous and united more by language than by interests or identity (Hajer, 1995). They compete for discursive hegemony. This attempt to secure support for their definition of reality is determined by the relative power or resonance of a coalition's storylines and frames (Hajer, 1995). For Hajer, discursive power is influenced by three factors: credibility, acceptability, and trust (Hajer, 1995). In Bomberg's adapted version, credibility or plausibility is about how compelling the various kinds of claims (e.g., epistemic, moral, emotional) associated with a frame are and can be increased by storylines that refer to other cases. Acceptability or relevance becomes a matter of whether claims associated with a frame apply to the audience's experiences and everyday lives and can be improved by storylines that make connections with more familiar things. Trustworthiness concerns the confidence that an audience has in the actors, institutions and practices associated with a frame (Bomberg, 2015). Hajer is fundamentally interested in the creation of common understandings of environmental problems around which discourse coalitions form, and which may be institutionalised if they possess sufficient discursive power (Hajer, 1995). At the same time, environmental problems and the landscape of environmental policy and energy policy is a fast-paced moving environment so the power of the different discourses can change, even if they were institutionalised.

Hajer finds it remarkable that interdiscursive communication is possible. In other words, diverse sets of actors each with their own mode of talking – for instance, environmentalists, climate change experts, engineers, public representatives, ecologists etc. – are seemingly able to understand one another when an environmental issue brings them together. Storylines play a key role in this improbable achievement, which Hajer terms '*the communicative miracle'* (Hajer, 1995).He explains it as a phenomenon that, despite the great variety of modes of speech used by various actors, they somehow seem to understand one another. In other words, specific framings of environmental problems gain importance or prominence because of a dynamic negotiation of many social actors who construct those problems within that negotiation. The creation of different environmental problems is recognised by social constructivists as a process that involves different types of actors, which can include environmental NGOs, policy makers, think tanks, environmental consultancies and more. They view the way environmental problems are conceptualised as the product of the interactions between these actors in public and private contexts, where each actor tries to negotiate their definition of the problem at hand (Hannigan, 1995). It is then the constant back and forth of the redefinition of environmental issues and solutions that social constructivist sees as an important source of political socioeconomic transformations, that in turn, may help in the advancement of a successful environmental policy (Fischer, 1998).

At the same time, he also argues that environmental issues and politics should not, however, be understood as a fixed play with actors acting out a given role, for example, an environmental activist, an industry lobbyist, or a scientist. Hajer argues that environmental politics becomes an argumentative challenge in which actors aim to have others see the problems according to the way they see them, and they also readjust their position according to other actors they interact with. It is not as though actors are not aware of the discursive struggle, but they constantly practice it. Established forms of discourse, therefore, show the continuous power relationship that is effective because it evades conflict.

Since complex environmental issues implicate several distinct discourses and are difficult to understand in their entirety by any single actor, group or

organisation, storylines enable discursive closure by allowing diverse sets of actors to come to a seemingly common understanding based on a metaphor. Although Hajer does talk of common understanding, he is also clear that coalition members may have different understandings of the meaning of the storylines that bind them (Hajer,1995). This is then explored in the semi-structured interviews, in which the understanding of a storyline by an actor can be delved into with more depth so that the meaning of the metaphors and storylines used is not taken for granted. To be able to grasp inter-discursive communication, such as that used in environmental and energy policy development, Hajer's argumentative approach uses three key concepts: storyline, metaphors, and discourse coalitions, which will be explained below. By inter-discursive communication, I refer to communication within a specific discourse.

3.2.1.1 Metaphors

In everyday use, a metaphor is a figure of speech in which one thing is described by referencing another thing, for rhetorical effect (Steen et al., 2010). For example, describing someone's kindness as having a '*heart of gold*' is a metaphor in a linguistic sense. In Hajer's usage, a metaphor can be understood as a bridge that connects the common grounds of various discourses. It enables actors to produce their understanding of the (environmental) issue at hand, and through the metaphors re-interpret diverse elements of knowledge outside of their realm of competence or areas of expertise. Metaphors can also fill in the holes and ambivalences that were in the original text. Filling these holes and gaps Hajer refers to as "discursive closure," whereby a complex network of discourse gets reduced to a catchy one line ("Silver bullet" regarding BECCS for example or '*Frack Off*' with fracking). However, at the same time, the reduction to a metaphor is also simultaneous to a loss of meaning. Just as the gaps get glanced over so are the different nuances of that discourse. Hajer even argues that the relationship between different actors relies on this loss of meaning and the ability to interpret a storyline or a discourse in a multitude of ways.

3.2.1.2 Storyline

Whilst storylines and narratives might be terms understood to have identical meanings and be used interchangeably in everyday life, there is a distinction between them in the context of discourse analysis. Firstly, in a paper co-authored by Hajer (Yuana et al., 2023), narratives are referred to as something that storylines consist of. In Hajer's paper on Techniques of Futuring (Hajer and Pelzer, 2018), Hajer writes that storylines can be analysed '*in terms of their narrative structure'*. Furthermore, Hajer (1997) refers to storylines, as *'a condensed sort of narrative'* (p. 64). Hajer also provides a distinction between narrative and discourse analysis (Moran et al., 2006). He argues that the former approaches the ordering of linguistic systems in a much broader sense, allowing for a more in-depth understanding of how these systems are ordered. Secondly, within discourse analysis, as Hajer points out, discourse is not synonymous with '*discussion'* as it would be within narrative analysis (Moran et al., 2006). In contrast to discussions, discourse in this context refers to '*something the analyst infers from a situation'* and are 'patterns in social life, which guide discussion' (Moran et al., 2006 p.261)

Storylines fulfil a vital role in the collecting of understanding, the positioning of actors, and eventually in the creation of coalitions amongst the actors of a particular context. The storyline is the key term that unites several established concerns in research. The discursive practice of metaphors comes under the definition of a storyline (Hajer and Versteeg 2005). These narrow and ambiguous discursive practices are a vital discursive binding agent that creates a communicative network among actors with different perceptions and understandings. Storylines, in other words, not only aid the construction of a problem but also play a significant role in the creation of social and moral order in each domain. Hajer (1995) describes this as a narrative that enables actors to use diverse discursive categories to make sense of specific physical and social phenomena. The key aim of a storyline is to help form unity amongst the complex intertwining of various discourses. One of the underlying assumptions is thus, that actors do not always draw upon and use comprehensive discursive systems but rather evoke this system through a simplified storyline. Storylines narrate social reality combine many distinct aspects of various domains and provide actors with a set of symbolic references that give the impression of a

collective understanding. Storylines are political devices that enable the overcoming of gaps and aid towards achieving discursive closure (Hajer et al. 2006). In some way storylines relate to metaphors, in that uttering a specific storyline evokes the greater discourse, just as the use of metaphor does not just evoke the metaphor itself but a greater storyline behind it. Furthermore, the more storylines get used and more commonly accepted, the more certainty perpetuity they give to the debate. Hajer points out that the main purpose and use of the storyline are for the various actors, be it a scientist, an environmentalist, or a politician to be able to show where their works fit into the complex discursive network. The power and the strength of storylines are based on the notion that “it sounds right.” Whether a storyline sounds right or not is not necessarily based on the logic of the argument, but also relies on the trust in the creator and the narrator of the storyline as well as the context within which it is used.

3.2.1.3 Discourse Coalition

A key concept introduced by Hajer is discourse coalition. In the fight for discursive hegemony, coalitions emerge among actors who are drawn to the same storylines. Discourse coalitions are first to be understood as a collection of the storyline, the actors who narrate these storylines and the practice around which the discourse is based. Hajer talks about metaphors as the cement which holds the storyline together, and in the same fashion storylines are the cement which keeps discourse coalitions together. Just as discourse differs from the discussion, discourse coalitions differ from the more commonly understood and used traditional political coalitions and alliances. The emphasis is on the linguistic bases of the coalition, and the storylines, as opposed to shared interests. Discourse coalitions also enable the various actors to expand the scope of where they are located. Both language and context help to establish the beliefs of the actors, who are not seen as holding one stable set of values but as having a rough, clashing, and unstable set of value positions. New discourse can change the existing cognitive commitments and so influence the values and beliefs of the actors. One of the differences between discourse coalitions and advocacy coalitions (Sabatier and Weible, 2019) is that the latter understand a coalition as a set of conspiring actors with shared beliefs which remain stable over time, while the former

understands coalitions as based on the shared usage of storylines, as thus actors in the same coalition can have different beliefs which may change over time (Hajer, 2002 p.70)

3.2.2 Discourse Analysis and Social Constructivism

Discourse analysis as an approach sits within the social constructivist approaches to meaning. The social constructivist approach acknowledges that actors actively engage in the construction of knowledge and the meaning of that knowledge. There are various distinctions within the social constructivist approaches that scholars take, notably the distinction between so called 'thin' and 'thick' constructivism (Hay 2002; Marsh 2010). Thin or sometimes also called moderate constructivism still accepts some materialist and individualist perspectives, whilst thick constructivism, developed by Checkel (1998), does not and argues that power is created by everyday actions and rejects materialist approaches, and also does not view the difference between the self and the other as established, but rather as produced and reproduced. This is more radical approach to social constructivism than the position taken in this thesis and Hajer.

This is relevant to this research and subject area, as Hajer states, that the development in environmental politics relies on the social construction of environmental problems (Hajer, 1996). He drafted the notion of discourse coalitions, which was explained earlier, to be able to analyse the social dynamics and formations that shape up around a certain environmental problem.

In the introductory chapter to his most influential text '*The Politics of Environmental Discourse Ecological Modernization and the Policy Process'* (Hajer, 1995) he argues that social constructivism is not just about opening '*black boxes'.* Instead, they can also aid the development of new institutional measures and can help evaluate to what extent these institutional measures are capable of bridging fundamental contradictions at the bottom of many ecological dilemmas. These dilemmas, he also argues, are somewhat unique to the ecological policy, and I would argue also therefore extended to energy policy. The main argument is then that social constructivism and discourse

analysis add essential insights to our understanding of contemporary environmental politics.

The social constructivist approach accepts the notion that environmental policy and the solving of environmental problems depends on the relationship between agency and structure, in so far as the actors and complex structures participate in the policy process, directly or indirectly, to try to influence its output. Environmental policy, and by extension energy policy can then be seen as a way of legitimizing which environmental problems should be paid attention to, and a legitimate process through which we channel the constant construction and redefinition of social phenomena. It can also define what an environmental problem is. This leads to environmental policymaking being understood as the channel through which we can try to define and solve different types of environmental problems (Hajer, 1995).

Applying this perspective, this research is then interested in the comparison of how BECCS and shale gas are being made sense of how the different understandings of both energy technologies are described within the various storylines and what discourse coalitions emerge based on these shared understandings. To do so, the thesis conducted interviews about both energy technologies, with almost symmetrical interview topic guides, only adjusted for the specificities of the energy technologies (such as the use of biomass) and applying the same analytical tools from Hajer's discourse analysis to both data sets as to see how many and what kind of discourse coalitions and storylines emerged, and overall, how the discourse was structured. From then it was possible to analyse and compare the way in which the net zero transition was being discussed within the discourse coalitions and structure this into competing visions.

3.2.3 Adapting Hajer's 10 Steps to Discourse Analysis

As outlined in the previous literature review chapter, there are a number of studies which have used discourse analysis to study shale gas (Cotton et al., 2014, Metze and Dodge, 2016, Sovacool and Williams, 2020) and BECCS (Whitmarsh et al., 2019, Dowd et al. 2015). The studies, to different extents, use the three key concepts and apply to different degrees varying aspects of Hajer's 10 steps of discourse. The steps, outlined in the table, provide a

template for the order of the research process. This structured plan provided by Hajer is convenient for the use of this method in a comparative way, as it is robust and clear enough so that it is applicable across two different contexts and is also able to capture potentially very different narratives and debates.

Below is the Table of Hajer's (adapted from Hajer, 2006 p. 73) proposed way to conduct discourse analysis. The ten steps outline an approach the duration of which would stretch beyond the parameters of this PhD. Therefore, the steps were chosen selectively based on what the PhD timeline was able to accommodate and based on what made the most sense for answering the research question.

This research has adjusted the 10-point scale which focused on steps 4 to 9. Steps 1-3 were adapted for this research. The desk research included specifically a focus on newspaper articles as well as government policy documents. Step 2 '*Helicopter Interviews'* was not included in this research, as the timeline available for data collection was not suitable for conducting both helicopter interviews and interviews with key players. Finally, step 3 consisted of analysing the newspaper coverage of both shale gas and BECCS and the relevant policy document so that they could inform the decision as to who the key stakeholders are, as well as inform what the key topics and sites of argumentation are so that they could be included in the interview topic guide.

Firstly, the research included conducting semi-structured interviews with key actors. Steps 5 to 9 were used to inform the approach to data analysis, particularly looking at different sites of argumentation among the various discourse coalitions that formed. Most time, out conducting the interviews, was then spent on step 9 '*interpretation'.* This is the step of analysing '*what is being said'* and identifying the different structures and patterns that emerge and in what way they relate to each other. Because of the subjective nature of this process, Hajer then suggests going back to conduct second interviews with the same actors, who should be able to recognise the patterns and structure of language which was identified during the analysis. This was however not practically possible within the parameters of the PhD.

1. Desk Research	First reading of events and establishing a chronological order – newspaper analysis, analysis of relevant journals
2. Helicopter Interviews	Gaining an overview by interviewing actors well-versed in the field – well-informed journalists or policymaker
3. Document Analysis	Identifying storylines and metaphors and establishing the opposing sites in the discursive struggle
4. Interviews with Key Players	Conducting semi-structured qualitative interviews to gather more information to gain a better sense of the meaning of specific events or specific messages for the interviewee
5. Sites of Argumentation	Looking for data to show an argumentative exchange –for example, parliamentary debates, minutes of inquiries etc.
6. Analysing for Position Effect	To show how people and institutions get caught up in an interplay
7. Identifying Key Incidents	Looking for key incidents and events that aid the understanding of the discursive dynamics
8. Analysis of Practices in Particular Cases of Argumentation	Revisiting the data to understand if the sense of what is said can be connected to the practices in which it was said
9. Interpretation	Coming up with an interpretation of the discursive structures within a given discussion as well as making sense of and accounting for the related practices.
10. Second Visit to Key Actors	Revisiting key actors with the aim of monitoring if the analysis of the discursive space is correct – interviewees should recognise and be able to make sense of some of the veiled structures of language.

Table 1 ***Hajer's 10 Steps to Discourse Analysis***

3.3 Research Procedure

In this section, I will focus on outlining the practicalities of the research methods and design. Firstly, I will discuss how the research design came to be and why I have used qualitative semi-structured interviews as the main method of data collection. I will then move on to discussing sampling, contacting participants and the interviews themselves. I reflect on the impact of moving interviews online and conducting them from my home. Lastly, I discuss the approach to analysis of both BECCS and shale gas data sets.

3.3.1 Qualitative Research Methods

This research project utilises a qualitative research method, namely, semi-structured interviewing. Before diving into data collection and sampling, this section will address the methodological implications of using qualitative research methods as opposed to other approaches.

The primary objective of qualitative data is not to quantify, but rather to provide in-depth insides into specific areas. Unlike quantitative research, qualitative research does not rely on numerical data or counting and its main goal is not reporting a high N number. And although, as alluded to in the earlier section, describing the analytical approach to discourse analysis as looking for '*often repeated phrases'* this was done so to identify similar storylines and identify key actors to contact for interviews, not to specifically quantify the mentions of a certain word or phrase.

Qualitative and quantitative research are both anchored in different epistemological and ontological underpinnings (Bryman et al., 1988). Quantitative research is sometimes seen as being able to observe the one objective truth, which exists independently from its observers (Hammersley, 1992). In terms of the underpinning positivist epistemology of this method, this focus is on the discovery of observable and measurable facts (Alharahsheh and Pius, 2020). Whereas in the interpretive epistemological paradigm, the research considers different factors in participants' experiences, as the focus is on individual meanings and experiences intending to gain deep qualitative insight into specific contexts (Alharahsheh and Pius, 2020). Thus, qualitative research is based on the notion that there is no one objective reality, but that reality has many different meanings and is experienced differently by different actors. This is then further emphasised in this research by social constructivist theory, arguing that language is not a neutral transmitter of objective reality. Another key feature of qualitative research is the engagement with and the commitment to the event perspectives of those being researched, and the goal to get a holistic understanding of that perspective and the corresponding context (Bryman, 1988).

So, in that light, the question then arises what question can this research answer and what is the nature of the claims it will make? To what extent would

the findings be valid in a different context, and would they be generalisable at all? This research aims to explore the discourse within the UK-specific context and thus not seek to generalise its findings. Although Bryman et al. (1988) write that interview sampling must be carried out with the aim of findings being generalisable, as this study is interested in a comparison, the argument can be made that the same rules do not apply. The aim with sampling is not to get a representative sample of the views from the respective energy fields but rather to interview key actors and get a grasp of the various storylines across both energy fields and then to be able to see to what extent they are similar and how do they compare. The mix of shale gas, BECCS and the commitment to get to net zero by 2050 are all unique to the UK context, which is another argument as to why generalisability is not a priority of the research design and data collection. Furthermore, the specifics of the UK political culture, which was described by Almond and Verba (1963) as being impacted by class and regionalism, is also unique, furthering the point about generalisability not being a priority for this research.

This research is also interested in analysing the discourses of the two energy technologies at a specific point in time and that is the UK's transition to net zero. As the environmental policies progressed and the UK's net zero target was announced, it became clear that there were distinct elements and signifiers unique to the UK's energy landscape. As the UK framed its energy goals around the 2050 net zero carbon targets, both BECCS, as well as shale gas, were seen by the UK Government as having the potential to play in decarbonisation. In November 2019 the UK Government issued a ban on fracking but still cited the then Business and Energy Secretary Andrea Leadsom on fracking having a '*huge potential of UK shale gas to provide a bridge to a zero-carbon future*' (Department for Business, Energy & Industrial Strategy, Oil and Gas Authority, 2019). This was unique to the UK's energy strategy. For these reasons, and because ultimately the research is interested in understanding the *meaning* of the various metaphors, storylines, and discourse coalitions (Hajer, 1995), I decided to use qualitative research methods as opposed to quantitative.

3.3.2 Data Sampling, Collection and Analysis

This section will outline and describe the sampling strategy of interview participants, the semi-structured interview format, the interview process itself, as well as debriefing and post-interview note-taking. I will also touch on the shift from face-to-face interviews to online interviews, and the implication of elite interviewing.

As this research loosely follows Hajer's 10 steps of discourse analysis, it focuses on interviewing key participants. This meant conducting elite interviews, as most *'key actors*' fall roughly in the categories of established researchers, policymakers and public representatives or NGO representatives although these categories are not exclusive and are visible, in so far as they are mentioned in the national newspapers (purposive sampling) or known in the field (snowball sampling). The advantage of interviewing visible actors is that they are relatively easily contactable, as visible actors often have an online profile.

3.3.3 Semi-structured Interviews

This research uses semi-structured interviews as its main data collection method. Opting for the semi-structured format gives the researcher the freedom not to be restricted by rigid, predetermined questions (Taylor, 2005). Using a more flexible interview guide allows for the interviews to be co-constructed partly by the interviewer and the interviewee. Semi-structured interviews are the most suitable method to meet the aim and objectives of this research, in that they allow the interviewer to touch on key topics such as the net zero transition without restricting the participant and allowing for new storylines to emerge from the interviews. They involve a set list of questions with leeway to follow lines of investigation in the dialogue with the interviewee as the researcher sees fit.

3.3.4 Participant Sampling

This research employed two different types of sampling, purposive and snowball sampling. Establishing a sampling frame is a particularly crucial part of this research, due to its comparative nature. The sampling frame is understood as a criterion that dictates how the sample from the wider

population is chosen, often with the ability to generalise in mind (Bryman, 2001), however generalizing is not the purpose of this research or the sample.

To establish who the key actors are, this research focused on those actors who have issued public statements in the printed news media regarding shale gas or BECCS as a starting point for sampling. This was done with the assumption that those key actors were already openly sharing their views on the relevant energy technology so they would be more forthcoming in being interviewed about them.

The snowball sampling was used to ensure an appropriate number of participants would be sampled for the scope of a PhD thesis, but also to allow the participants themselves to identify who they perceive the key actors in the field to be, actors that may not have been cited or referenced in the media, but who are important in shaping the direction of the discussion around either of the energy technologies. Thirdly, by also using snowball sampling, access can be granted to those participants who would otherwise not be easily contactable. Despite there not being official gatekeepers, snowball sampling is also a useful method to bridge access issues, which from previously researched discourses around fracking was identified as an important consideration of this research.

I decided that I had sampled enough participants and to end data collection at the point at which actors were suggesting other participants to interview which I had already interviewed. Therefore, I established that new data would not have contributed to the answering of the research question and would not have added more insight. Whilst this sampling strategy worked well in that it enabled me to gain access to key actors who I had no previous connections with and enabled me to gather enough data for analysis, it was difficult to ascertain whether actors recommending potential participants for me to speak to that have already been approached was an indication of data saturation, or a kind of bias, that has potentially resulted in the exclusion of other actors who are not known to the participants and who were not identified in the initial mapping. As I maintained anonymity, I could not confirm to the actors who I have already spoken to prevent a potential ‘closed loop’ of participants. The possibility of

creating this closed loop, could have been limited, if I had only utilised purposive sampling of visible stakeholders as per the original mapping and determined the number of participants based on this alone and not relied on the participant's knowledge of the field, as well as their recommendations for further interviews which may have introduced their inherent bias into the sampling strategy. It was also difficult to ascertain whether there were certain participants that the actors did not want me to contact.

3.3.4.1 Purposive Sampling

Purposive sampling, in the literature, also referred to as judgement sampling (Hennink, 2010), is based on the researcher selecting participants deliberately based on predefined features and qualities. It is commonly used in qualitative research that does not rely on and does not need their participants to have a specific predefined demographic characteristic, such as age, gender, class etc. (Hennink, 2010). An important distinction between purposive and random sampling is that purposive sampling does not depend on meeting a specific number of participants. Instead, it enables recruitment of participants with a variety of views and from a wide range of backgrounds. One of the drawbacks of purposive sampling is the reliance on the initial in-depth document analysis to identify suitable participants. This was accommodated by intensive background reading on both shale gas and BECCS through which visible key voices became evident.

3.3.4.2 Snowball Sampling

Snowball sampling is built on the participant's willingness to use their social network to contact or recommend potential participants with suitable characteristics (Taylor, 2011). This is a sampling method commonly used in researching closely guarded communities which are difficult for the researchers to reach and contact. As this research aims to do elite interviews, snowball sampling is also used to increase the legitimacy of the researcher and thus increase the likelihood of elite participants agreeing to be interviewed. The participants, who were recruited by the researcher, to begin with, will be enabled to gain access to other actors or potential participants, and so creating a chain referral mechanism (Paltsev et al., 2021). The advantage of snowball sampling lies in its ability to help gain access to otherwise for the researcher

inaccessible participants. However, the drawback of using this form of sampling is the danger of recruitment bias (Magnani et al., 2005). This is not unique to snowball sampling, but rather a trait found in all non-probability sampling methods. There is a potential risk of types of participants being overrepresented, this is due to potential participants identified through the chain referral mechanism not only sharing a connection but also a characteristic. Also, Sadler et al. (2010) point out the risk of any added information being gained through this sampling method, as the participants gained through the initial group might also share the same views. However, this risk will be mitigated in this research by not solely relying on the snowball sampling method but using it alongside purposive sampling. Furthermore, during the research participant sampling process, the researcher will become more familiar with the field which will aid in the identification of suitable participants to approach.

3.3.5 Before the Interview: Establishing Contact

Once a list of potential participants was compiled, a first email, inviting them to take part in this research was sent. In the email, I introduced myself and outlined the core interests of the topic and my purpose in contacting them. Following literature guidance on conducting elite interviews, or '*interviewing up',* it became clear that building trust and rapport would be crucial, particularly around the issues of anonymity and confidentiality. As Lancaster (2017) argues, the key to building trust within elite interviewing is absolute transparency. This was ensured by introducing all the core details, such as who is funding the research in the initial email and being open to questions from the participants.

Once rapport with participants was established by contacting them via email and an interview day was set, the participants were sent the participant information sheet, the consent form and the privacy information sheet and an invitation for a virtual call via Teams, which was the only system that the Ethics Committee allowed for these purposes.

3.3.6 During the Interview

At the outset of the interview, the information in the participant information sheet was discussed briefly again to gain verbal consent for the interview to

be recorded. The participants were also reminded that the interview was being recorded and that they could end the interview by hanging up without explaining. After the interview ended, the participants were sent a debriefing email, reminding them of their right to withdraw. I then asked the participants to introduce themselves and briefly outline the connection that they have with the given energy technology.

To start the discussion on the topic I asked the participants to describe what they thought of either shale gas or BECCS and what role they thought this energy technology could or should play in the UK's energy mix. The expansiveness of the answers varied from participant to participant, but I have made a conscious effort during the interviews not the fill the gaps in conversation, but rather let the participants do that.

3.3.6.1 Doing interviews online

Due to the COVID-19 pandemic, all the interviews had to take place via Teams as opposed to in person. In this section, I will briefly touch on the implications of online interviews and in what way they are comparable to face-to-face interviews.

Firstly, using online interviews allowed me to minimise time and place limitations for me as a researcher and it could also be argued that online interviews happen during more convenient conditions for the participant (Deakin & Wakefield, 2013). Also worth noting, is that all the interviews so far had to be conducted from within my home, which does not have a designated workspace that would be appropriate to be used as an interview background. However, Microsoft Teams (the technology used) offers the possibility of a virtual background, thus hiding the real background and providing more privacy to me as a researcher. Secondly, by utilising both the audio as well as the video function of the platform Teams the interaction is comparable to the in-person presence of nonverbal and social cues (Stewart & Williams, 2005; Sullivan, 2012). However, at the same time, as most web cameras only capture a '*headshot'*, this creates difficulties in observing the participant's body language.

Establishing eye contact with the participants was quite challenging for a few reasons. Firstly, although all the participants had their cameras turned on, not all of them had them positioned so that their faces were visible or had them positioned to the side so that I saw them mostly from the side. Secondly, it was difficult to make sense of long pauses in the interviews, particularly in instances where there was a lag in audio or where the internet connection was not working properly. I tried to note down instances where it was evident that the gap in conversation was a result of technological factors as opposed to a genuine pause.

Whilst during an in-person interview the participant might take note of or feel discomfort because of the audio recorder present on the table, the online software used (Teams) displays a banner at the top of the screen, which notes that the video is being recorded, which is present for the entire time of the recording. This constantly reminds both the researcher and the participant that they are being recorded, not allowing either party to establish a seemingly more organic form of conversation. The interface of Teams also changed slightly during the course of the data collection. During the last few interviews Teams also issued a reminder at the top of the screen when the scheduled meeting had less than five minutes left, which sometimes interrupted the flow of the conversation and made it seem like the interview had a hard cut-off time, which was not the case.

Finally, moving the interviews online allowed me to accommodate the participants' schedules more effectively, as I was able to conduct more than one interview in a day. This would have not been possible had I had to travel to each interview if it were face-to-face, which was the original plan for most interviews, depending on the proximity of the participant.

3.3.7 After the Interview

After the interview had taken place, the recording was stored in the university's OneDrive. The decision has been made to make use of the newly developed transcription service provided by the university. Because I was granted early access to the service, it was not as developed as during the later transcribed interviews, which meant that a substantial percentage of the transcription was not accurate to the recording. This issue became lesser, as the transcription

software improved, so much so that the last few interviews needed barely any corrections.

Additionally, notes made during the interview focusing on the themes and content of the interviews rather than the minutiae (pauses, sighs, laughs, emphasis on particular words or sounds, etc.) were attached to the audio file to later make sense and aid the nuanced interpretation of the interview tone. During the interview, participants were asked about who they thought would be willing and suitable for me to contact next for snowball sampling. The purpose of the interviews is also to uncover any storylines that were not present in the press, such as the scale of the use of BECCS for example, the interview topic guide was revisited to include a question about the storyline in the next interview.

3.3.8 Participant Characteristics

Overall, 31 participant interviews were conducted, and anonymity and confidentiality were granted to all participants. The quotes in the data chapters are labelled with the pseudonym I assigned to the participants as opposed to their real names to ensure they could not be identified. To further ensure anonymity, I did not specify the participants' place of work but rather grouped their occupations into broader categories, which I have laid out in the table below. I further refer to these categories in Tables 3 and 4 in the data chapters. I decided to use only male pseudonyms because the number of women who work on these two energy technologies and who could be considered key actors is very limited, and therefore they could potentially be identified by their occupation (Academic, Industry representative etc.). I did not collect any other demographic information from my participants as I deemed it not necessary to the research, so I cannot with confidence comment on their nationality or ethnicity, but as a category they could all be described as approximately middle-aged working professionals.

Type of Participant	**Number of Participants**	**BECCS Participants**	**Shale Gas Participants**
Energy Industry Representatives and Energy Consultants	7	3	4

Regulatory organisations/civil service representatives	5	3	2
Academia	16	8	8
International energy/sustainability/environmental organisation representatives	1	1	0
Environmental non-governmental organisation representatives	2	1	1
Total	**31**	**16**	**15**

Table 2 ***Participant Overview***

3.4 Data Analysis and Comparison

When approaching the comparison of shale gas and BECCS analytically, firstly the shale gas and BECCS interviews were initially treated as separate data sets. I then analysed the interviews for storylines, by highlighting re-occurring phrases or phrases of similar character Hajer storylines as having a '*ritual character'*, so they will repeat with the same or similar words. This was not done using any software, but rather manually, using a bottom-up approach. I took a similar approach to Williams and Sovacool (2019) who also used argumentative discourse analysis whereby a storyline can reflect particular words and metaphors used to convey meaning (Donnison et al., 2023). I have looked for often repeated phrases or meanings, which I colour-coded in the text and then established the storyline. So, for example, whenever shale gas was referred to as a *'bridging technology'*, a stepping stone to a decarbonised future, or a technology which is '*necessary until other technologies become available'* this would all belong to the *'bridge'* storyline.

Once the storylines had been established, these were then categorised into discourse coalitions based on the view of the technology that was shared among different storylines, so for example, if a number of storylines presented the view of BECCS not being a viable technology, they would be categorised as the same discourse coalition. It was only after this point that both the shale gas and BECCS storylines and discourse coalitions were compared to each other. The focal point of the comparison, as is highlighted in the three research questions, were the different types of visions of the energy technologies that

these discourse coalitions argued for, but also the different ways in which the UK Government's net zero target was understood.

The rationale behind a comparative research design was to be able to provide a more nuanced understanding of the prominent discourses in the UK's energy landscape. It was clear from the beginning that for this comparison to be meaningful it was important to develop a methodologically defensible, practically viable, research strategy for identifying discourses and storylines. Argumentative discourse analysis seems to be the most suitable method for these purposes. This is because it can both capture the various nuances of the debates surrounding the two controversial technologies, whilst at the same time providing a clear framework which can be used consistently across both cases.

The key purpose of the comparative discourse analysis is to comprehend why a particular understanding of both energy technologies was at some point more legitimate than others and to tell a story about the UK's energy sector in the new transition towards net zero, for which exploring both fracking and BECCS is key. Hajer also points out that environmental (and by extension energy) policies are in particular inter-discursive, as they bring together a wide range of actors that have a shared concern but have different modes of talking when expressing those concerns and might be drawing on a wide range of arguments when expressing those concerns. Many of the phenomena which the environmental issues and politics revolve around cannot be explained through the lens of a singular discourse, as their impact is often complex, and so by expanding the analysis to a comparative one, this PhD research aims to capture that complexity.

In evaluating the research strategy for this study, the lessons learned can be divided into the practical and the methodological. It is acknowledged, that for the comparison to be successful, the same approach must be applied to researching both energy technologies. However, during the initial scoping out of literature and background, the discourses and storylines are not equally developed, in terms of public visibility. Secondly, there were initial concerns with symmetry and interviewing the same type and the same number of actors

across both fields, for example, the same number of researchers or the same number of industry representatives. However, the distribution of actors is not similar and the types of actors across both fields are not the same. BECCS, as a yet-to-be-realised energy technology, has mainly researchers and industry representatives, with two notable environmental NGOs. The actors visible around fracking are generally public servants, NGO representatives or industry representatives (although these categories are not exclusive). It then became clear that the point is not to force symmetry in terms of the types of actors across both fields, as that would not be representative of that energy technology, but to ensure an equal number of participants to be interviewed across both categories and to follow the participant sampling procedures. The different mix of experts revealed that there is more of a current research interest in BECCS as a developing technology, which was evident from the number of actors currently working on researching different aspects of BECCS. Whereas with shale gas, there was a lesser representation of current academic researchers, whereas there were more actors from the fossil fuel industry.

3.5 Blurring Boundaries

As mentioned, the data collection to place during the unprecedented times of a global pandemic. This meant that all the interviews had to take place from my home bedroom using my personal computer, which was not the intended plan at the onset of this research. The pandemic presented unprecedented challenges for how to navigate what under normal circumstances would have been an interaction in an office environment. In practice, this meant a complete blurring of my personal and research space, not having an appropriate interview room or office, which meant I had to conduct the interviews from my bedroom. Furthermore, this also meant relying on my internet connection, as opposed to the university's Wi-Fi when doing the online interviews. Furthermore, because of the need to use headphones, the interviews were only recorded using Teams locally on the computer, as opposed to with another audio recorder for backup. This increased the risk of losing the interview recording during a computer malfunction, which thankfully did not happen. Relying on an unreliable Wi-Fi connection, alongside the risk of the hidden background feature on Teams malfunctioning and thus revealing my bedroom

to the participants, put me in a heightened state of anxiety before and during the interviews. It is difficult to say whether these feelings of anxiety would have been different in a different setting, however, it is reasonable to assume that an office setting and access to different recording equipment, apart from my personal computer, would have enabled better ways to mitigate technological malfunctions.

In many ways the boundaries between personal and workspace were blurred for the participants as well, which manifested itself in diverse ways. One participant, being interviewed from her home, apologised when her young child interrupted our interview and then sat on her lap for the remainder of it, presenting a distraction for both me and the participant at that moment. It was a reminder of the unusual nature of the situation as well as the lack of available childcare during the pandemic, which the participant was forced to provide at that moment. This resulted in my feeling a deep sense of empathy for the female participant because of the overlap of her caring duties with her work. I was also conflicted about whether I should talk to the small child and thus acknowledge the awkwardness of the situation. I have decided at the moment to not interact with the child at all, to try to maintain a sense of professionalism, which I felt would have been compromised had I diverted from the topic of the interview to talk about the participant's child. This type of interruption is unlikely to have happened in different circumstances out with the global pandemic. Although I might have interviewed some participants online under normal circumstances as well, it is unlikely that I would have met one of their children during the interview.

However, there were also other types of boundary blurring and interruptions that would have also occurred if the interviews had taken place at a different time. On more than one occasion participants, usually those where it seemed like they had two computer monitors open would be notified that they had received an email, which they would then check during the interview. This would be evident from them breaking eye contact, looking at a different screen or starting to simultaneously type as they answered my questions. Only on one occasion did a participant start answering the email for which they apologised during the interview. This posed a dilemma for me as a researcher, whether to

ask them to focus on the interview rather than on other aspects of their work. However, I have decided not to call any attention to this during the interviews to not make the participants uncomfortable or hostile towards me for the remainder of the interview.

A final blurring of boundaries happened in the form of some participants commenting on my personal characteristics, where they either commented on my accent or asked what my nationality is, because of their curiosity regarding my unusually spelled last name. In most cases, I had given a brief answer to the questions and then tried to move on to the topic of conversation. There was however one instance, where upon saying that my name is of Czech origin, the participant replied that their family have a Czech au pair. This changed the dynamics of the interview as my initial reaction gave away that the comment startled me and made me uncomfortable as it was a way for the male participant to assert his position over me. This was a particularly troubling feeling as the interviews with key actors already had an inherent power imbalance in terms of the experience and knowledge of the actors compared to me. This comment made me feel the skewed power dynamic even more. The participant noticed my brief change of facial expression and body language upon hearing this comment, and after this, the participant became less talkative and reserved, which was evident from his change of facial expressions and body language and the brief answers he provided from that point forward.

It could be argued that some of the boundary blurrings would have happened regardless of the circumstances of the COVID-19 pandemic, but the main difference was that it occurred with me being present in my personal space, with no possibility of an alternative arrangement against the backdrop of local lockdowns, restricting my movement outside of the blurred work and home space.

Finally, my having to conduct the research interviews from the bedroom, often balancing my laptop on an ironing board, as opposed to a proper desk, made me acutely aware in various interviews of the difference between me and the participants' socio-economic status, particularly in situations where the

participants did not blur their virtual background and I could see that they were working from their home office, a designated home work space which I did not have available to me at that time.

3.6 Ethical issues

Ethical approval was granted for this research by the Ethics Committee in the School of Sociology and Social Policy (REIC approval reference number: Ethics approval number 1920-074-PGR). However, the application itself had to be resubmitted, as by the time it had first been considered the Covid-19 pandemic had started (March 2020), which made it clear that face-to-face interviews as originally planned were not going to be possible. Secondly, because of the restrictions in place at the time, the interviews had to be conducted on my home computer, from my home which I shared with my partner, who at the time also worked from home. This then required adjustments in data management plans, in so far as I had to make sure the interview data was stored on my university system, as opposed to my personal hard drive.

Secondly, the participants were granted anonymity and confidentiality. It is self-evident when conducting interviews in person that the participant is talking only to the interviewer and that there is no one else present to overhear. However, when an interview is conducted online this is not always clear. Because of the limited working space, I conducted the interviews from my bedroom and had to utilise the online virtual backgrounds providing a different view from where I was sitting. It was therefore not self-evident to the participants whether there was someone else in the room who could either see the screen or overhear the conversation. I have therefore decided to vocalise to the participants at the onset of the interview, that I am in the room alone, and that I am also using headphones for absolute privacy.

Not all participants sent the participant information sheet and participant consent form signed back via email before the interview. If that was the case, I addressed it straight away before the interview started but was often met with the response that whether it'd be okay, they send it signed afterwards. I then insisted that for procedural and ethical reasons it is important to read and sign both before the interview starts, which on some occasions was met with

disapproving remarks or body language (sighing) from the participants. They then, in what seemed like a hurry, signed the consent form and the participant information sheet. I questioned whether they were able to read the form and the sheet, to which the participants mostly gave a short answer that they were happy to agree to everything and they were happy to proceed with the interview, which I then did. However, some participants were so fast in sending the form after I had prompted them during the interviews that I had doubts whether they were able to read through all of the important information, however, I decided to trust their word when they said that they had understood and read everything.

Lastly, during most of the shale gas interviews, the participants asked, '*Who else have you spoken to?'*. I answered that I could not share that information as that would breach the anonymity that I had granted my participants. From the context of the conversation, it was clear that the participants were asking this as a way to establish trust and familiarity with me and the research itself. There was one notable example of a participant whom I had asked, like all other participants, at the end of the interview, who else he would recommend I interview (as per purposive sampling). He then asked who else had already been interviewed, and when I declined to answer he said, *'In that case, I can't help you.'* It was not clear to me at the moment, whether this was a genuine response, and the participant genuinely felt like he couldn't be of help with recruiting new participants, or whether this was a pressing comment, trying to gain information on who had already been interviewed.

These situations highlight that research ethics are also negotiated within the interviews themselves when unexpected situations or questions arise. For example, during in-person interviews, the situation of the '*doorframe'* confession might arise, where participants feel comfortable sharing certain responses only after the interview has formally ended or the recording has been switched off. This is different in online interviews, where the interview effectively ended with the call itself ending. A possible equivalent of the *'doorframe'* confession could have happened, if I had turned the recording off before I had turned off the video call itself, thus providing space for unrecorded

conversation. However, as the goal was to record as much as possible, I chose not to end the recording function prematurely.

3.7 Conclusion

This chapter has introduced the methodological approach of argumentative discourse analysis as described by Maarten Hajer (1995) and described the research procedure as well as challenges encountered during fieldwork.

Firstly, I have laid out the basics of discourse coalition and its limitations. I have also introduced the three main concepts of discourse analysis: metaphor, storyline, and discourse coalition. Following on from this, I presented the ten steps of discourse analysis that Hajer proposes (Hajer, 2006 p.73) and described the way they have been utilised in this research. Although they provide a useful guideline to complete them in their entirety would require more time than was available and so the focus was largely on step 4, interviews with key actors.

The second half of the chapter then focused on the practicalities of the research procedure. It started by defending the choice of using a qualitative research method as well as justifying semi-structured interviews as the main data collection method. I then moved on to discussing the two types of sampling, purposive and snowball sampling. In the following sections, I described the interviews themselves, in terms of the preparation and what happened during their duration. In the final sections, I discuss some of the ethical pitfalls and boundary blurring that happened as a result of the interviews having to be conducted online from my home. Although moving the interviews to an online format presented some unexpected challenges, it also allowed me to conduct the interviews more economically, with me being able to schedule more than one interview in a day.

4 BECCS Discourse Coalitions and Storylines

4.1 Introduction

In this data chapter, the first of three, I will focus on one of the two energy technologies this thesis is concerned with, bioenergy with carbon capture and storage (BECCS). The chapter will present and discuss the results of sixteen qualitative interviews with key actors, which were conducted between May 2020 and April 2021 to answer the first research question:

What BECCS discourse coalitions exist? And which visions/narratives do they promote in the context of the UK's net zero policy?

To answer this research question, I have utilised both the analytical concepts of discourse coalitions and storylines, which were discussed in more depth in the previous Methodology chapter, alongside the explanation of how the interview participants/key actors were selected. This chapter is structured so that each main section is a discourse coalition, and corresponding subsections are storylines that make up that discourse coalition. Each main section has an introduction which discusses the underlying assumptions of that given discourse.

The first discourse coalition, '*BECCS as a Legitimate Solution'*, views BECCS in the most positive light and displays the most trust in the energy's scalability. It is comprised of three storylines, '*Pumping Back CO_2', 'Necessity'*, and '*Knowing the Storage'*. The second discourse coalition, '*BECCS as a 'Good Fit'*, views BECCS as a technology that is convenient to the existing socio-economic and governmental systems. It is comprised of two storylines*, 'Good Fit'* and *'Lack of Ingenuity'*. The third discourse coalition, '*BECCS as a 'Non-Starter'*, is in opposition to the first discourse coalition. They have very different assumptions about the workability of the technology. The third discourse coalition assumes that BECCS is not scalable for technological as well as economic reasons. It is comprised of three storylines, *'Absolute Zero', 'Moral Hazard'*, and *'Smoke and Mirrors'*.

The chapter then concludes with an overview table of the discourse coalitions and storylines and reflects on the differences between the discourse coalitions, particularly in terms of the contradicting assumptions about BECCS and points out the incompatibility of the presented visions as well as addresses the

differences in power between the various discourse coalitions as to debunk the assumption that they are equal in their presence in the public and private sphere. As mentioned, in the 3.6. Ethical Boundaries section in the Methodology chapter, participants were granted anonymity, and so the quotes from the participants are labelled with a pseudonym and their occupation.

4.2 BECCS as a Legitimate Solution

This section will discuss the first of the three discourse coalitions '*BECCS as a Legitimate Solution'.* The underlying assumption of this coalition is that BECCS is workable and scalable, and a genuine carbon-negative energy technology which is rightfully considered as a key part in decarbonisation and climate change mitigating strategies and efforts. It is understood to be a reliable, investment and trustworthy technology.

This view is then reflective of various projects, financial investments, and policies related to BECCS which operate on the assumption of workability of the technology. The UK Government's Ten Point Plan for the Green Industrial Revolution, from November 2020 talks about investing in '*clean energy'* and lists carbon capture as one of them. The Government's Biomass Policy Statement from 2021 (National Audit Office, 2024) mentions that BECCS '*has significant potential to reduce industrial GHG emissions while also delivering vital negative emissions.'* In October of 2022, the Government started a consultation into a business model to incentivise the deployment of BECCS, which states that BECCS is *'expected to play an important role in helping the UK to achieve net zero through delivering negative emissions'* (Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy, 2022), listing the market barriers as a factor holding back the roll-out of this technology. In other words, if there are any barriers identified to the wide-scale implementation of BECCS within this discourse coalition, they are identified as market barriers, as opposed to engineering design barriers as is the case in one of the other discourse coalitions.

The UK Government has also recently introduced a programme to identify several industrial clusters in the UK, suitable for the rollout of CCS. In August of 2022, the government launched a consultation on how to support the development of biomass energy generation, particularly when associated with

carbon capture over the next decade. It cites that BECCS has the '*potential to produce home-grown energy with 'negative emissions'* (García-Freites et al., 2021) and that the role of the consultation is to '*help boost Britain's energy security, while also supporting new job opportunities across the country including industrial clusters developing carbon capture networks.*' (Department for Business, Energy and Industrial Strategy, 2022). This is to say, that the assumptions of BECCS being a feasible viable technology are widespread across both industry as well as the public sector**.** Furthermore, within this discourse coalition, pursuing net zero greenhouse gas emissions is viewed as a positive step forward towards decarbonisation and the proposed timelines are seen as acceptable and sufficiently challenging. The actors, whose quotes and statements contributed to the creation of the storylines presented in this chapter, were from academia, the energy industry, scientific and regulatory organisations, and the civil service.

4.2.1 Pumping Back CO_2

The premise of this storyline is best represented by a statement which was issued by the CEO of Drax, Will Gardiner on the Six O'Clock News on the BBC on the 6th of June 2020 (BBC Six O'Clock News, 2020) when he was describing how BECCS works and what Drax as a power station does now that it has moved away from coal to burning biomass and capturing and sequestering carbon. The statement was as follows: *"We'll stick [the carbon dioxide* CO_2*] into a pipeline. It will take it out to the North Sea and stick it under the sea and we will bury it under the ground … absolutely, we will stick the CO2 back underground where it belongs".*

With Drax being the biggest power plant in the UK, and the only site in the UK trialling BECCS, the description of its activities by its CEO is key to understanding the overall discourse. Using Hajer's concept of metaphor, which is a shorthand to evoke a storyline, the description of *'pumping back'* is important, albeit not scientifically accurate. This is like the aforementioned '*acid rain'* example, which is more accurately described as 'acid deposition'. Although carbon sequestration is part of carbon capture and storage, the CO_2 is not per se pumped '*bac*k.' The plan in the UK is to deposit the CO_2 in depleted oil and gas wells in the North Sea. And although the oil and gas,

which were previously extracted from those locations were then most likely burned as fossil fuel thus creating CO_2 emissions, however, the CO_2 that is *'pumped back'* is from the emissions created by burning biomass at Drax, not fossil fuels, which exposes the technical inaccuracy of this statement.

The '*pumping back'* metaphor, is then used as 'shorthand,' as Hajer describes it, for this storyline. This is best visible in the way in which some actors mirrored the language used by Gardiner during the interviews as demonstrated by a quote from a participant below:

'We have a lot of the storage capacity available, and we can pump that (CO_2*) back into the ground in the same way as we get oil, so we've got most of the infrastructure.'*

Peter, Energy Industry Representative and Energy Consultant

The above quote also uses the language of '*pumping back'* or in other words, returning to its origins or even re-depositing. However, that narrative cannot be blanketly applied to all CCS projects, because sometimes (albeit not in combination specifically with BECCS), carbon storage is also used for enhanced oil recovery (EOR). EOR is the process of injecting CO_2 into partially depleted oilfields. This is done to pressure out additional volumes of oil with the injected CO_2 which then stays trapped in the well instead of the oil. In that instance, although CO_2 is *'pumped back'* it is done so to release more oil and gas. The oil and gas are then likely going to be burned as fossil fuels and so the storyline would not apply, or in the least would not be telling the entire *story.* Notably, to date, there has been no supply of CO_2 to support industrial-scale CO_2-EOR in the North Sea.

This storyline opens up the question then if the CO2 is '*pumped back'*, where does it belong in the first place? When analysing the above quotes, the answer would be, that it seemingly belongs deep underground. However, CO_2 or carbon specifically is present in many everyday uses and industrial applications, so to imply that CO_2 is inherently something that should be sequestered underground, and thus returned to its supposed place of belonging is not representative of the embedded nature of carbon in everyday

materials. Corresponding to the question about the 'belonging' of CO_2 a participant raised a question:

'Yeah, pumping it back where it belongs (pause)…. where it belongs…. I mean, I guess you could say 'Well if that's (underground) where it (CO_2) belongs, why do we take it away in the first place?'

John, Energy Industry Representative and Energy Consultant

In some respects, this exposes some of the inner contradictions of the storyline, in that we do not take away CO_2 from the underground. We do not source or extract CO2 but rather create it through various forms of combustion processes and add to already existing CO_2 (and other greenhouse gases) concentrations in the atmosphere. This storyline does not question the feasibility of the sequestration process, rather the technical capability of storing carbon in such a way is taken for granted, fitting in with the overall understanding of BECCS as technologically achievable within this discourse coalition. The storyline also does not capture the difference between CO_2 emissions from different feedstocks, such as biomass or fossil fuel, i.e., the source of the CO_2 which then needs to be '*pumped back'*. Rather it simplifies the various complexities of carbon emissions into a simple process of extracting and then returning to the same place of extraction, or as is characterised within this storyline, to carbon dioxide's rightful '*place of belonging'*. This particular phrasing also implies, that there is a place where CO_2 does not belong, the atmosphere. And so, this creates a dichotomy between dichotomy, between the atmosphere where seemingly CO_2 is out of place, and the underground where it should be returned to.

4.2.2 Necessity

This storyline is centred on the argument that BECCS is a positive development because it is necessary. It is viewed as necessary to mitigate climate change and necessary to meet the UK's net zero by 2050 target. Within this discourse coalition, the goal of mitigating climate change impact and striving to achieve net zero carbon emissions are seen as largely overlapping. This is not the case for all three discourse coalitions, some actors view the efforts to achieve net zero greenhouse gas emissions by 2050 as contradictory

to serious efforts to mitigate climate change. The understanding of the relationship between BECCS and the net zero transition is best illustrated in the quote from a participant below:

'*So … I cannot see how the UK can sort of get to net zero without at least some BECCS'.*

Peter, Energy Industry Representative and Energy Consultant

What this quote illustrates, is that it is difficult to imagine, or see, a pathway to net zero emissions without BECCS, as they are framed by each other, and their imagined futures are interlinked. A negative emissions technology is required when carbon emission overshoots are anticipated as is the case with the net zero transition. This would be different if the UK pursued an absolute reduction in carbon emissions instead, which would not necessitate the use of carbon capture. There was a palpable uncertainty in the participant's voice, as they were making this statement, which was corresponding to the words '*sort of'*. There is also a vagueness around *how much* BECCS is, described by the *word 'some'* before BECCS at the end of the quote. This vagueness around the scale of BECCS required to reach the net zero target the UK Government is notable, not least because in line with the CCC assessments, the UK has set the specific ambition of deploying at least 5 Mt/yr. of GGR by 2030, potentially rising to 23 $MtCO_2$/yr. by 2035. Yet these ambitions are not reflected in the participant's statement, which calls for *'at least some'* development of the technology.

Working under the assumptions that net zero emissions can only be reached with negative emission technologies, such as BECCS the quote below also points out the inability to '*see' t*he UK reaching the net zero by 2050 target without NETs:

'You could see there may be other routes for decarbonizing aviation, but I am not convinced they will be as cheap. I think you can see some behavioural change in diet, but it is just not going to be enough, you know. And industry even if you do decarbonize, you are going to need CCS for it, and CCS is only ever about 90% efficient. So, whatever you do, you are going to have at least

sort of those 10% emissions. So, I cannot see how the UK can sort of get to net zero without some BECCS'.

Michael, Academic

Using the same language of *'some BECCS'* as the previous quote, this statement also reflects the need for BECCS and whilst there is still some vagueness around the scale of the development, there is a specific mention of the percentage of residual emissions that BECCS would be needed for. There are a number of reasons the participant lists as a justification for the impossibility of successfully achieving the implementation of net zero without BECCS, ranging from the decarbonisation of aviation to arguments about behavioural change to the challenge of hard-to-decarbonise industries.

Firstly, BECCS is framed as necessary a is seen as the more economically viable option when decarbonising aviation. According to the CCC, the aviation sector accounted for 8% of the UK's overall GHG emissions in 2018 (Climate Change Committee, 2018), and the same progress report provides three options for reducing emissions from aviation. These are reducing demand, secondly, make more efficient aircraft fleets, and using sustainable aviation fuels instead of fossil fuels. The last option has several production routes, one of which is bioenergy subsequently capturing the carbon through CCS. Another option is using DACCS (direct air carbon capture and storage), which is not operationalised in that way yet, and its cost-effectiveness, like with BECCS is dependent on wide-scale use. Both the quote from the participant as well as the routes to reduction as proposed by the CCC do not propose an absolute reduction in aviation emissions through banning all domestic flights for example, as is favoured by environmental NGOs.

The second justification for the necessity of BECCS is the lack of effectiveness, or the insufficiency of the impact of behavioural change, and in particular dietary changes Although not explicitly stated, these likely refer to a reduction in meat and dairy consumption, as the research shows that the meat and dairy industry are responsible a substantial per cent of GHG emissions. Koneswaran and Nierenberg cite the farm animal sector in their 2008 paper as the single largest anthropogenic user of land, contributing to many environmental

problems, including global warming and climate change. Similarly, Stehfest et al. (2009) cite in their 2009 paper that dietary changes, particularly a transition to less meat, or even a complete switch to plant-based protein food, would have dramatic beneficial effects on land use as it would free up cropland, which would enable a large carbon uptake from regrowing vegetation. It is therefore worthy of notice, that one of the more effective changes which could have a radical impact on climate change mitigation, is framed as insufficient, particularly when compared to BECCS, which so far does not share a similar scientific endorsement of climate change mitigation benefits.

The third justification provided in the quote is about *'industry'*. The industry sectors which are widely acknowledged as hard to decarbonise and so used as justification for CCS, are steel and cement. Although as both the quote and the literature acknowledge, the efficiency of CCS used in those instances is variable (Paltsev et al., 2021). There is also an unsaid assumption that a BECCS site, compared to a steal or cement site, is inherently more efficient. A 2019 Grantham Institute Briefing Paper (Fajardy and Köberle, 2019) discussed the efficiency of BECCS finding that accounting for the biomass life-cycle energy use in BECCS energy balance, can decrease the potential net energy production of a BECCS power plant and decreasing its efficiency.

The quote then finishes with an example of the way BECCS is viewed as relational to net zero, which within this storyline and this discourse coalition as a whole is not challenged as a concept. The necessity of neither BECCS nor the net zero target is questioned but rather emphasised. The act of not questioning the net zero target is also pointed to in the quote from a participant below:

'It is great that the UK Government just put it (net zero) into a legal requirement. Is it achievable? It Is. I would say that should not be the question. It should not be a question because it must be achieved quickly. It is going to be hard to achieve. But the penalties for not doing it are going to be far worse for future generations.'

Matthew, Environmental non-governmental organisation representative

The achievability of the UK's Net zero by 2050 target is not questioned, and a point is even made of why it should not be questioned. The target is seen as challenging or difficult, but worthwhile pursuing because the repercussions of not doing so are greater than the challenges in reaching the target. This storyline then views BECCS as relational in an instrumental sense, in that BECCS is viewed as a necessary means to achieve the end which is net zero.

4.2.3 Knowing the Storage

This storyline frames BECCS as a positive and feasible energy technology largely because of the availability of the carbon storage space and the already available infrastructure, which was previously utilised for oil and gas extraction. The existing knowledge of the sequestration areas is seen as an advantage to the technology. It is also used to provide reassurance regarding the security of the storage and dispute any claims of potential carbon leaks. In other words, *'knowing the storage'* is equated to the storage being secure because of prior experience with and the understanding of the processes, the infrastructure, and the locations. This is best illustrated in the quote below:

'So, in my mind, storage of carbon dioxide in geological locations is essentially easy to do and could be done right now… there are active places around the world that are doing it both purely for storage but also enhanced oil recovery. We know how we do it, we know what to do. These areas are mapped and understood with about as high of confidence as they can be.'

Lukas, Regulatory organisations/civil service representative

The assumption with BECCS in the UK is that the captured carbon will be stored offshore in geological storage sites, most likely utilising the already existing infrastructure of depleted oil and gas wells (Gough et al., 2018). There are speculations as to what the most feasible way is for the carbon to be transferred from the site where it is being captured to the storage site. The security of the storage is thus linked not solely to the technology itself but is also space-dependent and relies on the operators' (Drax) and regulators' (The North Sea Transition Authority - NSTA) knowledge of these storage sites. The UK is also the first country in the world to provide detailed information about

its geological storage via an online database – CO_2 Stored hosted and developed by the British Geological Survey (BGS) and The Crown Estate.

As BECCS is not a widely rolled out technology and is being trialled, there is no long-term precedent to show what some of the challenges of the technology as a whole are, but rather there are discussions as to what they might be in the future expressed with different degrees of confidence. And so, to make the case for BECCS, actors draw on knowledge from existing CCS sites, to instil confidence in those questioning the technological feasibility of BECCS. Not only is carbon storage framed as doable, but doable with *ease* because of existing knowledge. The argument of existing knowledge being key is also reflected in a quote from a participant below highlights this focus on the UK specific features as a positive argument for BECCS:

'Having said this, I think an advantage is we have in places like the North Sea, a really good geological understanding of these subsurface reservoirs. We know that some of these reservoirs have held oil and gas methane in place for millions of years. And we know the processes of CO_2 *are being stored in the subsurface in the pore space of the rocks. We understand these processes quite well.'*

Simon, Academic

Similarly to the first quote, the existing knowledge and lessons from previous CCS operations are being used as an argument in support of BECCS. Whilst the previous quote uses the existing knowledge to make the case that carbon storage from BECCS would be simple, the second quote uses it to make the case that the storage would be safe, because the reservoirs have held other gaseous substances previously.

The argument around security is both spatial as well as temporal, where the participant drew attention to both knowing the locality, as well as having the knowledge of for how long the reservoirs in question have previously sequestered gas, implicitly suggesting that CO_2 could be stored there for similar lengths of time too. The argument as to why BECCS is an appealing technology is being made based on existing knowledge about CCS, specifically the existing knowledge about the North Sea and the familiarity with

the territory and the technology. What is notable in these comparative arguments between future deployment of BECCS and already existing CCS projects, is the cost associated with carbon storage. Whilst literature points to the fact, that the cost of storing carbon can vary widely, one of the factors which it is dependent on is the amount of carbon stored and the source of the carbon emissions (Budinis et al., 2018). When Herzog (2017) analysed the lessons learned from CCS projects over the last twenty years, he found that there is a strong link between successful CCS demonstration projects and the oil and gas industries, particularly as EOR was a significant financial incentive. Given that BECCS projects would not rely on EOR to make them financially viable, this begs the question of to what extent it is useful to draw comparisons between CCS and BECCS, especially to make a convincing case about the viability of BECCS.

4.2.4 Conclusion

The above-discussed storylines share the view of BECCS as a genuine part of climate change solutions and a legitimate technology with sustainability credentials, which would be safe and easy to execute because of lessons learned from previous carbon capture projects. The *taking for grantedness* of BECCS having the aforementioned attributes is then what binds this discourse coalition, the storyline and actors who utter them, together. However, all of these assumptions are contested elsewhere for various reasons, ranging from biomass availability, cost, the readiness of technology etc.

BECCS is sensible because carbon capture is easy and safe which we can infer from previous CCS projects and additionally, it returns to CO_2 to its supposed place of origin and belonging. This is to say that the understanding of BECCS within this discourse coalition is very positive. The positive attitude towards the technology then rests on three pillars. The first is the promising prospect of BECCS not just reducing carbon emissions but doing so in a way where the carbon is stored in what is presented as the most natural place for such purpose – the place of its supposed origin, the underground. The second pillar which is used to prop up the positive view of BECCS, is the difficulty of reducing emissions by other means. The participant's view of the net zero transition necessitates the use of BECCS. The third way in which BECCS is

presented in a positive light is by referencing previous use of CCS and the knowledge gained from previous extraction activities in the North Sea. There is an underlying assumption of an interchangeable relationship between extraction and storage; fossil fuels were extracted from an oil or gas reservoir, which were burned to produce GHG emissions, this then makes it both technologically possible, sensible, and also logical to store CO_2 in the same place, thus painting a picture of a closed loop of emissions which are returning to where they were extracted from.

Furthermore, the idea of biomass as a '*clean fuel'* is taken for granted and not questioned. This however not correspond to scientific literature, where the sustainability of biomass is contested (Welfle, A., & Roeder, M. 2022). The sustainability of biomass or its suitability as feedstock in a power plant such as Drax is dependent on the scale, the type of biomass (woody biomass, miscanthus, straw etc.) and for what it is burned. However, it is to be noted that currently biomass is used as feedstock at Drax, which had previously used domestic coal as opposed to domestic or imported oil and gas. Secondly, Drax currently imports all its woody biomass feedstock from the US and Canada, so the life-cycle emissions, particularly including transport need to be taken into consideration. When assessing the sustainability of biomass, high biomass life cycle CO_2 emissions in the carbon balance of BECCS could potentially outweigh the amount of CO_2 captured by BECCS (Fajardy and Köberle, 2019)

Secondly, the storylines which make up this discourse coalition also do not challenge the timeline of the UK's net zero target, nor do they challenge the concept of net zero emissions (overshoot with the possibility of capturing carbon emissions post-combustion). *The Net Zero -The UK's contribution to stopping global warming 2019* report published by the Committee on Climate Change recommended this target, with the comment that it will 'deliver on the commitment that the UK made by signing the Paris Agreement', that is to limit global warming temperatures to 2 degrees Celsius above pre-industrial levels. It then also states that reaching this target is achievable with 'known technologies.'

4.3 BECCS as a 'Good Fit'

The second of the three discourse coalitions, '*BECCS as a 'Good Fit'* is comprised of storylines and actors, which view BECCS as primarily fitting existing energy systems. Its role in policies and climate change mitigation strategies is made sense of as a convenient technology which suits current energy consumption patterns. Compared to the first discourse coalition, BECCS is still viewed as feasible and functioning, but it is not viewed as necessary or as a positive, promising development. Rather it is viewed as a symptom of the way climate solutions are proposed and assessed via Integrated Assessment Models (IAMs), the embedded nature of current energy systems and patterns and the lack of pursuit of mitigation strategies outside of those systems and patterns. Within this discourse coalition, the ideal implementation of BECCS is seen as small in scale but is not used as an excuse to avoid bigger systemic change. One of the ways this is imagined is to account for carbon dioxide targets separately from emissions reduction targets. This is so that any carbon dioxide removal via BECCS or other NETs is treated as additional removal to emissions reduction. And so, the relationship between BECCS and net zero, or overall emission reduction targets, is not seen as mutually dependent as is the case in the first discourse coalition.

This discourse coalition is then comprised of two storylines, '*Good Fit'* focusing on the perceived connection between the integrated assessment models and BECCS, and '*Lack of Ingenuity'* describing the view of BECCS as old fashioned and not inventive, only being considered because it fits existing infrastructure.

4.3.1 Good Fit

This storyline is centred around the argument that BECCS is considered a serious energy technology in climate change mitigation strategies not because it is the best available technology, but rather because it fits in well within both existing socio-technical systems, as well as within the modelling systems of the Integrated Assessment Models which are used by the International Panel on Climate Change (IPCC) (both aspects although here seen as a positive attribute are seen as a point to criticise within the third discourse coalition).

The quote below illustrates well the perception of BECCS and the model within this storyline:

'That is why (BECCS) is attractive. I think, particularly in scenarios. Another thing that may be a prospect at the forefront of people's minds is that it can be simulated in integrated assessment models. And if you do not describe any of the other negative emission technologies like enhanced weathering, carbon sequestration through afforestation, peat restoration… if they're not in the models, the model can't pick them up as a potential option… we desperately need to improve the models.'

Paul, Academic

The explanation here for the *'attractiveness'* of BECCS is not because of its well-engineered design, or because of its carbon-capturing potential, but rather because the choice of technologies for the Integrated Assessment Models is limited and other options such as enhanced weathering are understood to be underrepresented and underexplored. The participant suggests also that if other options were *described* in the models, BECCS perhaps wouldn't feature so prominently in the various scenarios. As an alternative, the participant also suggests enhanced weathering (EW). EW can describe a number of procedures, one of which can be spreading silicate rock as a soil amendment on agricultural soils. The other two options, the participant mentions were afforestation and peat restoration, which are also sometimes described as *'nature-based solutions'* (Osaka et al., 2021), which the participant views as more favourable. Whilst the term nature-based solution is also highly contested (Bellamy and Osaka, 2020), it is commonly used to refer to non-technological methods of carbon storage, such as afforestation.

The quote then finishes with a plea to *improve the models* by making more solutions available. This suggests that using this type of modelling itself is not problematic if improved to allow more options. Furthermore, the participant didn't suggest that BECCS should not be one of the options but that it might not be seen in a favourable light if the models are adjusted to include other options. Differing from the first discourse coalition, this also hints at a distrust in the workability and effectiveness of BECCS and suggests other

technologies are better options but are not being considered because they cannot be as easily simulated in these models as BECCS can. This storyline, as illustrated in this quote, then describes a particular relationship between the IAMs and BECCS and attributes the way BECCS is perceived and used within IPCC reports to those models, as opposed to the merit of the technology. This relationship then contrasts with the way BECCS is described in the *'Necessity'* storyline in the previous discourse coalition. That storyline perceives BECCS as a must-have to be able to meet the net zero target and the positive view of the technology is not attributed to models or other external factors.

The quote below, in a distinctly more cynical tone, also describes the relationship between the IPCC models and BECCS:

'*I think some of the folks at IPCC, they kind of had their backs to the wall trying to come up with pathways to achieve reasonable degrees of warming, and they just sort of threw these things into the models and, it is unfortunate that they did that because it would be good to face reality without having all these models showing 'Ohh yeah, we can do this. We just need to use negative emissions and BECCS is probably the way to do it.'*

Matthew, Environmental non-governmental organisation representative

Firstly, the different emotional tone from this quote is apparent. The participant does not refer to IPCC modelers or authors, but rather just as *'folks'*, who *'threw these things into the models',* giving the impression of a haphazard and trivial process by way of which BECCS ended up being a preferred technology in IPCC scenarios. Additionally, the quote gives the impression that the decision to include BECCS in IPCC modelling scenarios was out of desperation (*'backs against the wall'*) rather than based on a process of genuine scientific deliberation. The participant then laments this decision as unfortunate and wishes for a confrontation with *'reality'*. The quote then finishes with the participant describing, condescendingly, the way in which NETs and then BECCS specifically are approached, with not a thorough consideration of their workability, but rather an overly optimistic '*Ohh yeah, we can do this'* attitude.

Both quotes echo a mistrust in the IAMs, as well as how BECCS came to feature in various pathways, agreeing that it is not because of BECCS' merit as a legitimate climate change mitigating technology, making the contrast between these storylines and the ones from the previous discourse coalition more apparent.

4.3.2 Lack of Ingenuity

This storyline understands BECCS as a functioning technology, but not as an advanced or exciting development as compared to the first discourse coalition. Here BECCS is understood as technological development that is not challenging and only being focused on as it fits within existing infrastructures. In other words, its key positive feature is that it *fits* within existing socio-technical infrastructures. This is different to the previous storylines which addressed the view of BECCS *fitting* into IAMs specifically. One of the ways in which this storyline is different from the first discourse coalition's view of the technology is that in the first discourse coalition and then notably in the '*Knowing the Storage'* storyline, the re-use of existing pipelines and infrastructures is seen as a positive, whereas here it is seen as negative and as non-inventive.

In the quote below, a participant described in an angry and frustrated tone the view that BECCS as a design is not reflective of the skills engineers have. Rather, BECCS is painted as archaic, in complete contrast to being seen as innovative in the storylines of the first discourse coalition:

'As an engineer, it is an embarrassment, you know. There is 2020, you know, this is a long time after James Watt and the Industrial Revolution. The best that we can produce is that we are going to burn plants and bury the CO_2*?! That is what we are going to do. I mean, surely engineers can do more. Engineers and technology can do much more wonderful things with much greater harmony and similar and symmetrical with the world than burning huge quantities of plants and burying the* CO_2*. That is a blunt approach that would be fine in 1870 but not appropriate in 2020 and it is an embarrassment that our engineers are considering that as an option.'*

David, Academic

The quote refers to 1870 as a point to highlight the engineering inadequacies of BECCS. To put it into context, in 1870 the cable car railway and the lantern projector were invented. So, the participant is comparing BECCS to designs that we would from today's perspective view as trivial, or even as technologically regressive. It is thus seen as not complicated complex technology but as not challenging enough, and not the *'best we can produce.'* The point of criticism is that the design is not considerate of '*harmony and symmetry with the world*.' This is a vastly different understanding of the technology and the process of carbon capture and carbon storage than what is described in the '*Pumping Back CO_2'* storyline. In that storyline where the process of storing carbon in reservoirs is seen as in *'symmetry with the world*' whereby CO_2 is *returned* to its supposed place of belonging, thus restoring harmony. Contrastingly, in this instance BECCS is viewed as fitting in with other blunt approaches but not fitting in with *the world* as the participants describe, citing the burning of copious quantities of plants (biomass) and the *burying of the* CO_2 (storage), which are seen as disharmonious processes. Finally, the quote finishes by singling out engineers as a key group, which should not consider BECCS as an engineering design worthy of their capabilities and which could address the contemporary climate and energy needs. The participant assures us that there are other options which '*our engineers are capable of.'* Although the participant does not elaborate further as to what those options are, the quote suggests that they are hopeful there are other more suitable technological solutions. Whilst the participant is critical of BECCS there is also a distinct hope for a better engineering solution, and so the argument is still based on a '*technological fix'* (Johnston, 2018). This means that there is an understanding that a change in technology in this case finding a more inventive energy technology, with more complex engineering, would '*solve*' the problem or the challenge of reducing CO_2 emissions.

The lack of imagination or lack of ingenuity is mentioned several times. In this instance, investment in carbon storage is seen as uninspired, because it prevents more value from being extracted from CO2, which instead is buried underground. The issue of lack of imagination in storing CO_2 underground and

the argument for the better valorization of carbon is expressed in the quote below:

'So, we need to look much more imaginatively at a range of CO_2 *uses that will sequester carbon atoms on the planet for a long period of time but are not necessarily geological storage. If you think of geological storage and what you are doing, you are paying for an infrastructure to keep stuff being stuck in the ground where there is a risk of releasing constantly… and instead, you can turn that around and say, well, forget that. Let us extract value.'*

Andrew, Regulatory organisation/civil service representative

Here the premise of long-term geological storage is seen as wasteful, as it requires financial resources and investments in monitoring the storage sites. It is important to note, that when CO_2 is stored in particular saline aquifers it interacts with its surroundings and over time solidifies, so the notion that there is a constant risk of carbon release is not supported by scientific literature (Michael et al., 2010). A 2012 report on CO_2 storage liabilities published by the Department of Energy and Climate Change (DECC) described the risk of CO_2 leakage specifically in the context of using the reservoirs in the North Sea as '*negligible*' (DECC, 2012).

This quote also uses contrasting language from storing, in that it calls for '*extracting value'* and so improving the economic viability of BECCS. In other words, what is seen elsewhere as a strength of BECCS – safe, permanent underground storage of CO_2 is here seen as a second-best option to sequestering carbon in more *'imaginative'* ways. The biggest difference here is the shift to seeing CO_2 as a resource in itself which should be used, as opposed to a waste product of biomass combustion which should be disposed of or stored away underground.

Whilst safe and permanent storage in other storylines is described as a *'returning'* to or a *'pumping back'* there is a shift in the tone by describing carbon storage as the carbon being *'stuck'*. Being *'stuck'* implies that the carbon is in the wrong place from which it cannot be removed. This is the opposite viewpoint to the one presented in the '*Pump Back* CO_2*'* storyline, where the appeal of carbon storage is described as the carbon being in the

'*right place'*. Additionally, the permanence of the storage here is questioned and also framed as posing a *'constant'* risk which needs to be monitored at a costly expense. As an alternative, carbon utilisation is presented as the safer option. Whilst there are a range of applications of carbon utilisation, whereby the CO_2 can be used in various products, the primary uses of CO_2 are as fertilises and for enhanced oil recovery. There are other potential uses for CO_2 in the synthetic fuels or chemicals industry, however, they are not as well established, particularly as the CO_2 captured from burning biomass is not of high enough grade to be used in the drinks industry as an example (Bui et al., 2018) to create carbonated beverages.

4.3.3 Conclusion

This discourse coalition is different from the first one, in that BECCS is not seen as taking a leading role in climate change mitigation efforts. Its feasibility and scalability are not questioned, however, BECCS is viewed largely as a symptom of current socio-economic systems, as opposed to a genuine climate change solution. The ideal implementation of BECCS within this discourse coalition is on a small scale and as supplementary to other climate change mitigation efforts which require bigger systemic changes. Both storylines contest the idea of BECCS being the best available solution, either because other solutions are under-explored in the IAMs or other assessment systems, or as per the second storyline, because of a lack of imagination, indicating a lack of willingness or the inability to look beyond existing systems. Particularly when assessing the aspect of carbon storage, the geographical location of the UK in proximity to available carbon storage is often highlighted as a positive aspect of the technology and the understanding of the area is used to advocate for its safety. However, within this discourse coalition storing carbon underground is not framed as '*safe*' but as unimaginative or wasteful. There is a suggestion, that a safer or more appropriate way to deal with the emitted CO_2 is with carbon utilisation as opposed to carbon storage. However, one of the more frequent ways captured CO_2 is being utilised is for enhanced oil recovery (Harrison and Falcone, 2014). Utilising CO_2 in this way, would not be in line with the overall understanding of BECCS in this discourse coalition. Extracting more oil would be counterproductive to reducing GHG emissions and achieving net zero, which is the desired outcome within this discourse

coalition. The relationship between BECCS and net zero transition, or overall emission reduction targets, is not seen as mutually dependent as is the case in the first discourse coalition but rather as a relationship developed out of convenience.

4.4 BECCS as a 'Non-Starter'

This is the third, and final discourse coalition. The vision of BECCS is drastically different from the other two discourse coalitions. Within this discourse coalition, BECCS is not viewed as a serious legitimate energy technology and so the materialisation of BECCS as a successful climate change mitigating strategy is seen as highly doubtful. In the first discourse coalition, BECCS and the UK's net zero target by 2050 are seen as compatible and also dependent on each other. The storylines are connected through the shared understanding of the urgency of climate change mitigation and the viewed mitigation pathways, which include BECCS. A similarly strong connection between the technology and the net zero target is also found in this discourse coalition. However, both BECCS and the concept of net zero emissions, as well as the UK-specific 2050 target, are not seen aiding climate change mitigation. Rather, they are described as problematic and counterproductive to serious and legitimate climate change mitigation efforts. This is because firstly, biomass as a feedstock is seen resoundingly as non-sustainable and framed negatively as *'burning down trees'*. Using biomass as fuel is then pitched against a preferred mitigation strategy, afforestation, which fits in with the understanding of BECCS and net zero in this discourse coalition. Secondly, the carbon capture element of BECCS is seen as untrustworthy, and as a means to keep producing CO_2 emissions, as opposed to ways of trying to reduce them. And finally, carbon storage is seen as difficult to manage and be accounted for in the long timelines that carbon storage is proposed for. Alternatives to the dominant discourse of net zero are preferred, in particular, the concept of absolute zero, i.e., an absolute, or close to an absolute reduction in carbon emissions with no anticipated overshoot is preferred.

The storyline presented in this section is '*Absolute Zero'*, which focuses on the contestation of BECCS because it is seen as a product of policies which focus on net emissions as opposed to preferred absolute zero emissions. It then

moves on to discuss the view of BECCS as a '*Moral Hazard'*, i.e., an unreliable technology that no emission mitigation strategies should rely upon. Finally, the storyline '*Smoke and Mirrors*', which out of all the storylines presents BECCS in the worst light and views it as a technology of almost fictional character, which is not grounded scientifically and cannot be made functional at any reasonable scale.

4.4.1 Absolute Zero

The essence of this storyline is best represented by the '*Absolute Zero'* report, which was published by Allwood et al. in 2019. A synopsis of this report published by UKFIRES (UK Future Industrial Strategy) argues that waiting for BECCS and other *'breakthrough technologies'* is misguided and counterproductive. The synopsis is particularly critical of technologies, such as BECCS, which have not been used at a commercial scale. Instead, the '*Absolute Zero'* report proposes sole reliance on electricity from non-emitting technologies, such as wind or solar. It then continues to question the validity of claims on bioenergy being carbon negative, citing storing burning carbon as *'implausible'* and pointing out a shortage of biomass, raising the concern of the resource being insufficient for BECCS being used at scale. There is also strong support for so-called '*natural solutions'*, as the report argues that carbon capture and storage can be done without the use of any new technological advances, instead, this could be accommodated by afforestation and storing carbon in trees, citing the abundance of tree-seeds, and the simplicity of planting a tree, calling it *'the most important technology (…)'* which doesn't require any further technological innovation.

Below is a quote from a participant whose views align with this storyline and reflect the *'absolute zero'* approach described above:

'Well, I think it's a mythology that you can have net zero. You can only have net zero if you accept the mathematics of people who do things like BECCS and pretend that if it's carbon neutral you know you can make it carbon negative and then you know it defies the laws. The basic laws of physics in the universe, right? You don't get you don't get energy for free, and so it's just pretty absurd, I think you know having targets in general for climate is a little

bit useful, but it's been, you know, overblown and net zero targets are just (overblown) to the point of absurdity.'

James, Academic

Firstly, the quote presents a clear contrast to the previous views of net zero. Net zero is described in a much more negative way as mythical or imaginary and made-up as opposed to genuine climate change mitigation strategy and goal. What is similar however is the conditional relationship described between BECCS and net zero, where the participant describes that net zero is only acceptable to those for whom BECCS is also an acceptable technology. The acceptance of net zero is viewed as conditional on the acceptance of BECCS. This is similar to the ways in which net zero and BECCS are seen as intertwined and mutually dependent even in previous discourse coalitions. In this case, however, both net zero and BECCS are viewed as absurd. There is a distinct condescending tone with which the participants described *'people who do things like BECCS'* and implied that they pretend that the technology is carbon negative and do so by using illegitimate mathematics, which defy *'the basic laws of physics'.* Additionally, there is a rhetorical shift in the statement whereby the participant characterises carbon-negative energy technologies, as getting *'energy for free'*. This reframing of negative emissions as '*energy for free'* is significant. This is the only instance in which negative emissions or BECCS has been described in the data, however, it demonstrates well the overall dismissal of net zero and negative emissions within this storyline. Whilst the quote finishes with an acknowledgement of the importance of targets, it then notes that the concept of net zero or reliance thereupon is viewed as exaggerated.

4.4.2 Moral Hazard

The second storyline of this discourse coalition strongly opposes BECCS because it is morally and ethically difficult to justify deliberately emitting CO_2 in hopes of then being able to capture and store the carbon later. The main argument underpinning this storyline is that BECCS has not been shown to work at scale. And so, the burning of biomass without a solid guarantee of being able to capture the carbon via CCS is high risk and so caution should be exercised when relying on BECCS in climate change mitigation scenarios. For

that reason, it is described as '*morally hazardous'.* Moral hazard as a concept has its origins in economics and insurance, when '*insured agents no longer bear the full consequences of risk-taking, and consequentially increase their risk exposure'* (Tsipiras 2022 p.33). In the context of CDR, it encompasses a patchwork of the mechanism of action, hazardous behaviours, and undesirable outcomes (Tsipiras, 2022). It has also been used by Anderson and Peters in their 2016 paper in Science in which they describe proceeding with the assumption that CDR will work at scale as a *'moral hazard par excellence'*. This idea of moral hazard also stretches to net zero. In this sense, this storyline is similar to the first discourse coalition, which views the net zero transition and BECCS as inseparable.

'Net zero is incredibly dangerous as a concept. And of course, it is new, most people do not even know what the 'Net' bit is. It came into the language, and it is just used now without people stopping to think: 'What do you mean by net zero?' What we mean by it is 'not zero,' so that is what we mean by it. So, we will pass on to next-generation requirement that they find some way to suck the CO_2 *out of the air.'*

Aamos, Academic

The quote above hints at several arguments as to why both BECCS and net zero are hard to justify from a moral point of view. Firstly, it mentions the generational burden of *'sucking* CO_2 *out of the air'*, and although that is not the precise functionality of BECCS, the message still applies. Even if BECCS is successful, meaning it is truly carbon-negative and removes CO_2 and stores it, the responsibility of stewarding that storage will fall on future generations. The quote also discusses that perhaps when assessing the net zero transition, there is a focus on the *'zero'* as opposed to the '*net'* prefix. The '*net'* means an acknowledgement of continuous emissions as opposed to an absolute reduction in emissions as discussed in the storyline before.

4.4.3 Smoke and Mirrors

This third storyline and the final in this chapter, has a countering view to the first discourse coalition. It not only contradicts the claims of legitimacy of BECCS but also argues that there is an intentional level of deception

concerning these claims of legitimacy. This is best demonstrated by the quote below:

'I mean, BECCS is smoke and mirrors, you know at a very fundamental level I would say two things. One is that I think that the promotion of BECCS came about because there were no cost-effective and feasible technologies available for moving CO_2 *from the atmosphere and so people just sort of came up with this out of their hats when there was no real-world demonstration of its feasibility and lots of reasons to be very sceptical given the impacts of large-scale bioenergy that we were already seeing even before this idea of BECCS came about.'*

James, Academic

Firstly, the quote opens by contesting the legitimacy of BECCS at a '*fundamental level*', i.e., questioning its workability and scalability. It then continues describing the way in which BECCS gained its status as a legitimate climate change mitigating technology as coming up *'with this out of (their) hats'*. In other words, describing the origins of BECCS so to speak as fictional and not based in reality. This is different from the storylines of the second discourse coalition, which suggests that BECCS gained its legitimacy as technology that can still play a role in mitigation scenarios because other options are either underexplored within IAMs or are not seen to be able to fit existing socio-technical systems as well as BECCS. The distrust in BECCS in this storyline is then described not just as distrust in how it gained its legitimacy but also whether it as technology can function. This is then further reinforced by referencing that there is no *'real-world demonstration'*. This refers to BECCS largely, not just to CCS of which there are a few demonstration plants.

Lastly, the quote finished with discussing the concerns around the sustainability of biomass irrespective of its use for BECCS or the readiness of CCS, which implies that regardless of the readiness of CCS as a technology or the scale of its deployment, biomass is viewed as unsustainable.

4.4.4 Conclusion

This discourse coalition '*BECCS as a Non-Starter'* viewed BECCS as technologically not scalable and is focused on opposing it based on its

sustainability credentials. Because of the fundamental distrust in the technology's workability, the argument is made that therefore it should not be part of any climate change mitigating efforts. In the first discourse coalition BECCS is viewed as a necessary facilitator of the net zero target, in the second discourse coalition it is viewed as a symptom of pursuing the target, and in this discourse coalition both the target itself and the technology are viewed as unrealistic or even absurd.

The first of the three storylines discussed, '*Absolute Zero'* is precisely focused on this connection of BECCS, which is framed as *energy for free* as opposed to as a negative energy technology. The second storyline discussed is '*Moral Hazard'* which presents the view that the idea of negative emissions itself is very risky, as it is not guaranteed that the last part of BECCS – the capture and storage is scalable or reliable and so the first part – burning biomass for fuel is too dangerous as it passes on the responsibility to deal with these emissions to future generations. Finally, the last storyline '*Smoke and Mirrors'* focuses on the absolute distrust in the processes by which BECCS became a technology that is being taken seriously by policymakers and various advisory bodies, like the CCC or IPCC.

Within this discourse coalition, so-called '*natural solutions'* (such as afforestation) for example are seen as preferable to NETs like BECCS. Natural solutions are often seen in opposition to BECCS (Bellamy and Osaka, 2020), as afforestation is not seen as compatible with the supply of particularly woody biomass, which is the type used in the Drax power station (Abt et al., 2022) but is also criticised within the wider BECCS discourse. But as Bellamy and Osaka (2019) argue, framing some climate change solutions as '*natural'* is a strong determining factor in the acceptance of the solution, but they also importantly add, that the label '*natural'* is assigned selectively, and not self-evidently. They then expand, that natural solutions are often suggested to be more economical, and have additional benefits to ecosystems, as also mentioned in the Absolute Zero report. They also found that the risk perception is different between '*natural*' solutions and '*technological'* solutions in that natural solutions are seen as less risky. Specifically, related to BECCS, although BECCS and biochar burial both consist of enhancing already existing natural

processes (biomass) and *'articles manufactured from nature (pyrolysis plants and power stations combined with carbon capture and storage, respectively)'*, they are not classed in the same way. Biochar is seen as *'natural' whereas BECCS is a solution of modern technology'* (Bellamy and Osaka, 2020 p.98).

4.5 Conclusion

This chapter aimed to answer the essay question: ***What BECCS discourse coalitions exist? And which visions/narratives do they promote in the context of the UK's net zero policy?*** by analysing the results of sixteen qualitative interviews.

The chapter identified three distinct different visions of bioenergy and carbon capture and storage which were categorised into discourse coalitions and subsequently into storylines. The first discourse coalition '*BECCS as a Legitimate Solution'* is built on the notion that BECCS is functioning and scalable and a legitimate part of climate change mitigating efforts. *'Pumping back CO_2'* is a storyline centred on the idea that CCS is essentially a process of returning CO_2 and implies that underground storage is the true place of belonging for CO_2. The storyline '*Necessity'* frames BECCS as something that is a key '*means-to-end'* technology, and an enabler to reach net zero carbon emissions by 2050. Finally, the first section finishes with the '*Knowing the Storage'* storyline, which emphasises the seeming advantage of BECCS being deployed in the UK, because of prior and substantial experience with and knowledge of the depleted oil and gas wells which are to be used as carbon storage.

The chapter then moved on to the second discourse coalition '*BECCS as a Good Fit'*, which presented the argument that although BECCS is seen as feasible and scalable, it is only considered '*legitimate*' because of its fit within existing systems. It does so by allowing for current energy consumption habits to be continued, with the assumption that emitted carbon can be stored indefinitely. The first storyline '*Good Fit'* focuses on the interlinked nature of IPCC's IAMs and BECCS and makes the case that BECCS is seen as a more suitable technology as it aligns with the assumptions of the models. Secondly, the storyline '*Lack of Ingenuity'* presents BECCS as not cutting edge, but rather outdated and too simple of a technology. Here contrastingly, the existing

infrastructure is seen as an excuse to pursue an outdated engineering design, and sequestering CO_2 is not viewed as returning CO_2 underground, but rather as uncreative and the CO_2 being *'stuck'.*

The chapter then moved on to discussing the third discourse coalition, *'BECCS as a Non-Starter'*, which was also comprised of three storylines. The first one, *'Absolute Zero'* then unpicked the co-dependence of BECCS on net zero. Therefore, the preference for an absolute reduction of emissions also makes the need or desire for BECCS redundant. The section then moves onto the storyline '*Moral Hazard'* which focuses on ethical issues of burning biomass for fuel and creating more emissions with the lack of assurance that those emissions will then be able to be captured and the postponing of consequences to future generations if they are not. The discourse coalition then finished by discussing BECCS as '*Smoke and Mirrors'* which is a storyline that is centred around the notion that the visions of a BECCS scale-up and wide roll-out are of a fantastical, mythical nature and not practically possible. This is the most sceptical BECCS storyline of them all.

Although this chapter has dedicated equal space to discussing all three discourse coalitions, to make the best sense of them, it is important to note that they are not equal in power. As discussed in the Methodology chapter, Hajer argues that in a discourse analysis one ought to be able to link discourse coalitions to power via the devices of structuration and institutionalisation. And so, applying this approach, it becomes evident that the discourse coalitions are not equal in that aspect. The first discourse coalition and its assumptions of the workability of BECCS are manifested more clearly and frequently in the public sphere, in the private and public sectors. This can be observed in a number of ways, firstly by looking at the investments made by the UK Government into CCS and bioenergy and the rollout of plans for several CCS clusters (Department for Energy Security and Net Zero, 2023). Then we can also examine the official reports published by the CCC (Climate Change Committee, 2020) and the IPCC (IPCC, 2023), which in various scenarios feature BECCS at varying scales, but view it as a functional technology. This is thus at odds with the way in which the technology is viewed in the third discourse coalition.

Views that are sceptical about BECCS, or either of its components, are largely and most vocally represented by NGOs, notably Biofuelwatch, which focuses on biomass use specifically and also Greenpeace, which has submitted evidence to the Climate Assembly on Greenhouse Gas Removal technologies in November 2021, citing that BECCS '*is not a substitute for rapid deep emissions reductions'* and that is *'cannot even be assumed to be carbon negative'* because *'burning biomass is not carbon neutral, and some impact on the atmosphere will remain however efficient the capture of carbon emissions at the smokestack of a BECCS plant might be'*.

Additionally, the visions of BECCS provided by the first two discourse coalitions, are not necessarily mutually exclusive. It is possible to view BECCS as a legitimate climate change solution and agree that it fits within the existing infrastructures and models. The second discourse coalition is also not mutually exclusive with the third one, as far as one can view BECCS both as a *'non-starter'* and as present in current climate change solutions because it seemingly fits in with the existing carbon-intensive, net zero systems. But the first and the third discourse coalitions are mutually exclusive, in that they represent contrary views on the potential of BECCS, in the first instance BECCS is viewed as promising and feasible, whereas in the third instance, BECCS is viewed as inoperable.

Although I had intended to bring up net zero in my questions as per the interview topic guide, in all interviews this concept came up organically from the participants. This is perhaps indicative of the fact, that BECCS and net zero as concepts are difficult to assess separately, as the former is often seen in national and international policies and environmental assessments as a vehicle to get to the latter. This connection is not without criticism, as there is a body of scholarships (Anderson et al., 2020, 2014; Anderson and Peters, 2016; McLaren et al., 2019) alongside activists (Greta Thunberg being a notable example) who call for earlier net zero targets or different absolute-zero emissions approach altogether, but also for pathways there are not dependent on negative emission technologies, or not dependent on biomass.

In summary, then, the three distinct discourse coalitions promote three different versions of BECCS, and net zero. The first discourse coalition views BECCS as playing a substantial role in the net zero transition. The second discourse coalition then views the role of BECCS as more limited, nevertheless the technology is still viewed as functional. The last discourse coalition sees no role that BECCS could play in the net zero transition because the technology itself is framed as unworkable and unscalable. Below I present an overview table (Table 2) which summarises the three discourse coalitions, and the 8 storylines. It also presents the different visions of the net zero transition which I found across the three discourse coalitions. These are then categorised into three types and become the focal point of the third data chapter, where I compare them to the visions of the net zero transition found within the shale gas discourse coalitions.

Discourse Coalitions	**BECCS as a 'Legitimate Solution'**	**BECCS as a 'Good Fit**	**BECCS as a 'Non-Starter'**
Explanation	BECCS is viewed as a genuine part of climate change solutions and a legitimate technology with sustainability credentials. It is seen as a dependable, and long-term solution, which will help.	BECCS is viewed primarily as fitting existing systems, a convenient technology which suits existing energy consumption patterns.	BECCS is viewed as technologically not scalable, and serious doubts are cast about the materialisation of commercial-scale BECCS, as well as its sustainability credentials.
Storylines	**Pumping Back CO_2** referring to storing carbon in depleted oil and gas wells, and thus BECCS and CCS returning the CO_2 to its 'origin' **Necessity** referring to the necessity of using CCS for hard-to-decarbonise	**Good Fit** referring to BECCS fitting in with Integrated Assessment Models, which are more susceptible to favour technologies such as BECCS. **Lack of Ingenuity** referring to BECCS as a lazy engineering design, which underuses the potential of carbon which could be used	**Absolute Zero** referring to BECCS in relation to net zero, which is seen as insufficient, absolute zero emissions are preferred instead and BECCS plays no role in achieving that. **Moral Hazard**

	industries such as cement and steel and to capture overshoot emissions. **Knowing the Storage** referring to the prior knowledge and mapping of the North Sea depleted oil and gas wells, which is why it is worthwhile pursuing BECCS/CCS and why BECCS is seen as a preferred negative emissions technology and even seen as easily implementable.	elsewhere, for example, in the food and drinks industry; 'we could use the carbon instead of just storing it,' but does not see carbon storage problematic in other aspects.	referring to the concept of negative emissions technologies being seen as delay tactics and immoral in the context of the climate breakdown **Smoke and Mirrors** referring to BECCS being fictional in the sense, that the sum of its parts (bioenergy, carbon capture and carbon storage) cannot materialise and that BECCS is a fantasy technology used as a distraction from real, tangible solutions.
Visions of Net Zero	Net zero is seen as a positive move towards decarbonisation, it is seen as a challenging target that can be reached with wide-scale BECCS and other technologies – the timescale of net zero by 2050 is not challenged.	The current net zero timeline is seen as problematic, and insufficient, earlier targets are preferable. However, net zero is still viewed as feasible, and emission overshoots as acceptable.	Net zero is seen as problematic, alternatives such as Absolute Zero, or earlier net zero targets (2025 instead of 2050) are preferable.
Key Actors Profiles	• Energy Industry Representatives and Energy Consultants • Academia • Environmental non-governmental	• Academia • Academia • Environmental non-governmental organisation representatives • Regulatory organisations/civil	• Environmental non-governmental organisations • Academia

	organisation representatives • Regulatory organisations/civil service representatives	service representatives	
Visions of BECCS	BECCS is part of a wider portfolio of solutions but plays a substantial role in the decarbonisation of the energy sector. Ambitious targets, such as the net zero by 2050 target, rest on the functionality of BECCS.	BECCS plays a small part in the decarbonisation of the energy sector, but this is also substantiated by other efforts of systemic change. Carbon dioxide removal via BECCS or other NETs is treated as additional to emissions reduction.	BECCS is not a part of any climate change mitigating actions or solutions – instead, the focus is on renewables and 'natural' solutions (afforestation). The sustainability of biomass is questioned.

Table 3 ***BECCS Discourse Coalitions and Storylines***

5 Shale Gas Discourse Coalitions and Storylines

5.1 Introduction

This data chapter, the second of three, will content itself with shale gas. The chapter will present and discuss the results of fifteen qualitative interviews with key actors, which were conducted between May 2020 and April 2021. The participants were sampled in the same way as the BECCS participants. Both BECCS and shale gas interviews were taking place concurrently. This chapter answers the second research question:

What shale gas discourses exist? And which visions/narratives do they promote in the context of the UK's net zero policy?

As described in more detail in the Introduction chapter, at the time of the interviews the UK Government imposed a moratorium on shale gas developments, citing the unpredictability of the seismic activity and events as the main reason for doing so. At the same time, the Climate Change Act of 2008 was amended to pursue a 100% reduction in greenhouse gas emissions by 2050 compared to pre-1990 levels, as opposed to the previously pursued 80%. This then provided a novel context for the study of shale gas discourse as compared to previous research (Bomberg, 2015; Cotton et al., 2019;

Evensen, 2018a; Williams and Sovacool, 2019). The main document accompanying the UK Government's announcement to pursue to net zero 2050 target is the '*Net Zero Strategy (Build Back Greener*)' which built on the previously laid out '*Ten-Point Plan for a Green Industrial Revolution'* (Department for Business, Energy & Industrial Strategy and Department for Energy Security & Net Zero, 2020). Neither the Net Zero Strategy nor the Ten-point plan makes any direct reference to shale gas at all, nevertheless, as pointed out previously, focusing on shale gas within the context of the net zero transition provides a unique insight into the discursive struggle within the transition. Secondly, it provides an interesting and useful comparison to the BECCS discourse because of the previously discussed shared characteristics of both energy technologies, such as the use of underground space and the promise of a large scale-up within various energy policies.

The chapter is structured in the same fashion as the previous one, in so far as each main section is a discourse coalition and the subsection corresponds to storylines. There are three discourse coalitions in total, firstly '*Shale Gas: Spectre of the Past'*, '*Shale Gas: Wrong Place Wrong Time'* and *'Shale Gas: Doomed from the Start'*. The first discourse coalition is sectioned into two storylines '*Technology with No Future'* and *'Bridge to Nowhere'*. The second discourse coalition is divided into three storylines, '*Domestic Security', 'Bad Reputation'* and '*Bridging Fuel'* and lastly the third discourse coalition is divided into two storylines, *'Wrong Geology'* and '*Lack of Pay-Off'*. The chapter concludes with a table attached, providing an overview of the discourse coalitions, the storylines and the connections to the net zero transition.

5.2 First Discourse Coalition: Shale Gas: Spectre of the Past

This is the first of three discourse coalitions, which is based on the argument that pursuing shale gas is fundamentally incompatible with the pursuit of the net zero goal, as pursuing shale gas would surely result in burning it for energy which would add to more greenhouse gas emissions and thus undermining decarbonisation efforts. Within this discourse coalition, the net zero greenhouse gas emissions target is viewed as a serious target and as a move forward towards a desirable decarbonised future, whereas shale gas, along with other fossil fuels, is viewed as a relic of the past and not something worth

pursuing. In other words, there is no acceptable future vision described within this discourse coalition which involves shale gas.

On the surface, it appears as though the storylines within this discourse coalition are the ones most aligned with policies at the time of the interviews, because of the current moratorium. However, the recent pivot to briefly lifting the ban on fracking in September 2022 and then its reinstatement in October of 2022 as outlined in the Introduction chapter and the fact that the official justification for this was not because shale gas does not fit in with a decarbonised future, but rather because of concerns with predicting and preventing seismicity makes it clear, that the issue is more nuanced. The difference is that this discourse coalition opposes shale gas on the principle that it is a fossil fuel, as opposed to other reasons, such as scepticism in the availability of the resource, or financial payoff, as it is in the other discourse coalitions.

Therefore, within this discourse coalition shale gas is being looked at retrospectively, and with the understanding that it no longer fits in with the current ongoing net zero transition and as long as the transition is ongoing shale gas will not be exploited in the UK. There is an understanding, that reopening up the discussion or trying to pursue opening up new shale gas wells is undesirable and should be actively avoided as it conflicts with the net zero agenda and with genuinely pursuing decarbonisation. This discourse coalition also disputes the narrative that shale gas could have acted as a '*bridging fuel'* to a lower carbon future. Arguably, outside of this data set, this discourse coalition is represented for example by the Climate Change Committee. The Committee found in 2016 that the exploitation of shale gas on a significant scale is not compatible with UK the carbon budgets it set out in its carbon assessments (Climate Change Committee, 2016). It found that shale gas was not compatible with the 2050 commitment to reduce emissions by at least 80% unless other emissions were offset in favour of shale gas. Shale gas was not included in any recommendations to the UK Government from the CCC since then. As mentioned, in the 3.6. Ethical Boundaries section in the Methodology chapter, participants were granted anonymity, and so the quotes from the participants are labelled with a pseudonym and their occupation.

5.2.1 Technology with no future

This first storyline is based on the notion that shale gas is an energy technology of the past, it is, like coal, and is argued to be archaic and redundant. There are frequent comparisons made between the role of shale gas and the role of coal to make the case that they are both technologies associated with a carbon-intensive past but do not fit in with future efforts to decarbonise the energy sector. There is a level of confidence within this storyline, that shale gas in the UK will become a commercially available energy technology largely because of the net zero transition. Reaching the net zero 2050 goal is viewed and acknowledged as a highly desirable goal and outcome which would not be aided by new fossil fuel developments like shale gas. The essence of this storyline can be summarised in the quote from a participant below:

'Is it even (shale gas) worth bothering with? Especially if natural gas demand is going to start to decrease, as we decarbonise'.

Aaron, Regulatory organisation/civil service representative

Here a participant makes the case that shale gas is truly unnecessary, as we pursue decarbonisation targets instead. Decarbonisation should result in a decrease in gas demand, as energy demand is covered by less carbon-intensive energy technologies and renewable energy technologies. And so, the question is posed as to whether shale gas exploration and extraction is something even worth pursuing. This is a very contrasting view to shale gas being viewed as a technology which could potentially provide the UK with 50 years' worth of energy security, as some have argued in the past (Rogers, 2013). The decreasing demand for gas is then one of the arguments that is used to underpin the case for shale gas being obsolete.

Frequent connections were made between shale gas and coal within this storyline as both are sources of energy that should not be renewed in the view of the participants. At the time of the interviews, new discussions started about the now-approved new coal mine in Cumbria (Pidd, 2019). The plans to open the new coal mine had been subject to public criticism (Willis, 2024), and because both shale gas and coal are seen as fundamentally undesirable participants drew parallels between the cases, specifically pointing out that the

public resistance to the new coal mine is indicative of the kind of resistance that new shale gas developments would be met with if the moratorium had been lifted:

'Recently, you know with the planning application for the new coal mine in Cumbria… now then the strength of feeling there and you know, and that's a traditional industry, not a new industry. So that (shale gas) is not going to happen.'

Alex, Academic

Here the connection is made that if coal is not being accepted or being opposed then shale gas has an even lesser chance of succeeding because unlike coal it is not a *'traditional industry'*. Indeed, shale gas developments never progressed past exploratory stages in the UK which means that there is no history of substantial job creation or job loss associated with the technology the same way there is with the traditional coal mining industry (Aragón et al., 2018). However, the link between coal and shale is also viewed from a different angle, specifically, as a somewhat of a false or misguided comparison. By this I mean, that coal is used as the standard of carbon emissions for shale gas to be compared to. In this comparison, shale gas comes out as the less carbon-intensive and thus more favourable technology:

'I think that is kind of like a romantic idea…that gas is seen as modern and clean and therefore lower carbon, and the industry has been quite keen to nod and agree in yes and say lower than carbon coal, much than lower carbon coal, half the carbon of coal and that that's, therefore perceived as a very positive message.'

Martin, Environmental non-governmental organisation representative

This quote also dismissed the idea that shale gas is a modern energy technology, cynically referring to the justification of pursuing shale gas because it is less carbon intensive than coal as *'romantic'.* The cynical tone is then also evident from how the participant hints that the shale gas industry is happy to focus on this comparison to coal, as it bodes well for shale gas. This narrative of shale gas emissions being lower than those from other fossil fuel

sources can also be found in official government documents. In a fact sheet from 2016 '*Shale Gas and Climate Change'* published by the UK Government, there is an answer to the *question 'Why use shale gas when we have renewable energy sources?'* (BEIS, 2016). The answer is that gas is both a flexible and reliable source of energy and that it has the *'lowest carbon emissions of all the fossil fuels.'* Challenging this narrative as *'false'* or as no longer relevant because of the availability and cost-effectiveness of renewable energy technology another participant also points out that the choice between shale gas and coal is not reflective of the current and future energy landscape:

'What's the worst in priority order? Coal is the worst one. Coal is going to emit much more CO_2*, as well as nasty compounds and pollutants as well. So of course, if the option available to us at the time was, we have to have coal or we can have shale gas, the answer would have been shale gas would have been better if, but we weren't faced with that choice though there is no coal industry in the UK, so it was false.'*

Ben, Regulatory organisation/civil service representative

It is implied that emissions from coal are too low of a bar for such a comparison, any energy technology would compare well to *'worst in the priority order'*. And secondly, the point is made, that comparing coal and shale gas emissions is not of use, as the choice in the energy system is not between these two energy sources as at the time no new coalmines in the UK were being pursued. Therefore, using coal emissions as the standard for comparison was argued to be inappropriate, and also outdated further feeding into the narrative that shale gas is not an energy technology appropriate or suitable for this point in time.

As I discuss in more detail in the following storylines '*Bridge to Nowhere',* shale gas is sometimes thought of as a bridge fuel, but not in the sense of bridging the gap between coal and another source of energy. Rather, the argument of shale gas as a bridge fuel is used in a context to bridge the gap between when the energy demand becomes less gas-dependent and when renewable energy sources become more economically viable, which the above quotes argue is

the case. Therefore, making the case that in the context of the net zero transition, shale gas is not needed as a bridge to a lower carbon future.

'But I mean, that's irrelevant now, because we have completed the transition away from coal, and the proportion of coal in the national electricity network is tiny. For the grid, that would have been the only sense in which shale gas could have been considered as part of the net zero transition, but experience has shown that it was never needed.'

Henry, Academic

In this final example, the comparison to coal is used to highlight not only that shale gas is no longer needed, but that it was never needed in the first place as the transition away from coal to more sustainable energy sources was completed without shale gas being part of the energy mix. This storyline then used different examples to argue that shale gas as an energy technology is redundant and not part of any future scenarios.

5.2.2 Bridge to Nowhere

The '*bridge to nowhere'* is a play on words, referring to the frequently used bridge metaphor which is used as a description of shale gas as a facilitator to a lower carbon future. This storyline however is the opposite of that argument as it views shale gas as a bridge to an undesirable future, i.e., a future where greenhouse gas emissions haven't been substantially lowered, because of continued and new use of fossil fuels/shale gas. There is also a clear depiction of what a desirable future outcome is, which is reaching the net zero target.

'So, I would have some sympathy with the notion of a bridge if it was quantitatively characterised, so you have to know how long the bridge is to know whether or not it's compatible with a particular set of climate targets. If it was a bridge to a very much hotter world with high climate impacts, then yes, that's a bridge. It's a bridge to a place that is not, I think, the intention of the Paris Agreement. If you want to stay well below 2 degrees and pursue 1.5, then it's a very short bridge. If it's a bridge at all, and I don't think that it is…'

Nathan, Energy Industry Representatives and Energy Consultant

The quote above unpicks the bridge metaphor in several ways. In the first instance, it acknowledges that if shale gas is viewed as a so-called bridge fuel, then the future it is bridging towards is a highly undesirable and dangerous world, where temperatures have risen (*hotter world* reference) and are negatively impacting the climate. Secondly, there is a criticism of the unclear or undefined length of the bridge, i.e., a specifically defined period after which shale gas production would stop. In the public discourse, the only temporal aspect, which was discussed with fracking in the UK, is in the context of how long shale gas could provide energy security. The answer from the energy industry was 50 years ago (Cahill, 2022). In that sense, that would have been a *long* bridge, but also not a bridge at all, as by that point the net zero transition, which includes less dependence on gas and mass upscale of renewable energy and negative emission technologies should have happened. Because of this incompatibility with a decarbonised future, the participant then dismisses this thought exercise with fracking as a bridge completely. They assert that shale gas is not a bridge at all, because it does not align with the goals of the Paris Agreement, keeping global warming levels to 1.5 dg as compared to pre-industrial levels, the pursuit of which is of the highest importance. This is then an important difference between the *'Bridging Fuel'* storyline I discuss in the second discourse coalition.

The increasing economic viability of renewables is then also used as an argument to show how unnecessary new shale gas developments would be:

'You know we are now in a situation where renewables are a cheaper way to produce energy. So, I think we're moving in the right direction, and I think if shale gas would have scaled in the UK, it would have held us back. I don't, I don't agree that it would have been a bridge fuel. It would have just delayed progress on renewables.'

Marcus, Energy Industry Representative and Energy Consultant

The view is then presented, that shale gas is something that would have stalled the progress of renewable energy technologies and impacted their scale-up and so the cost of the energy produced by them. The bridge metaphor for shale is often used as an example of progress in the sense, that shale gas or any

other fossil fuels can bridge the gap between when renewables and other energy sources become more available, more financially viable or when decarbonisation has sufficiently progressed, and less energy is needed. From the point of view of the participant, which is also supported by current energy price trends (Osman et al., 2023), the gap was already *'bridged'* by renewable energy becoming cheaper than other energy sources and thus once again making the case that shale gas is redundant and not a bridging fuel. On the contrary, shale gas is viewed as an active stifling agent of the progress to move to more renewable energy and not at all viewed as a tool (*bridge*) which could enable the transition.

5.2.3 Conclusion

In this first discourse coalition, two storylines were discussed, *'Technology with No Future'* and '*Bridge to Nowhere'*. The common understanding of shale gas between them is that it is fundamentally undesirable to pursue fracking in the UK, as this would be counterproductive to the efforts of decarbonisation. In the first storyline, participants made frequent use of the comparison of shale gas and coal. They did so to illustrate the point of shale gas being an outdated fossil fuel energy technology, which is no longer needed, and which should remain in the past. The second storyline, '*Bridge to Nowhere'* is a counterargument to shale gas being a bridging fuel. It points out that the future that shale gas would lead us to is highly undesirable, because of the consequence of climate change, which the use of shale gas would exacerbate through more GHG emissions. The bridge metaphor is then also dismissed because energy from renewables has become significantly more cost-efficient (Osman et al., 2023) than when the debates around fracking first emerged, and so there is no gap to bridge. This discourse coalition then has a particular temporal lens of seeing shale gas as a technology of the past, whereby participants utilise different tools to demonstrate this point by either comparing shale gas to other energy technologies which they consider archaic or by contrasting it with energy technologies, that they see more suitable for this time, such as renewables.

5.3 Second Discourse Coalition: Shale Gas: Wrong Place Wrong Time

This is the second out of the three discourse coalitions. It views shale gas in the most favourable light out of all three discourse coalitions. The key difference in assumptions is, that shale gas is not seen as inherently undesirable or bad or completely out of the question in future scenarios. Therefore, the moratorium and the lack of progress in shale gas exploration in the UK have then been explained in different terms than that shale gas was simply undesirable or completely incompatible with moving towards a lower carbon future. This discourse coalition, in contrast to the other two, also does not argue that the shale gas moratorium is justifiable for environmental and sustainability reasons. Firstly, the argument of shale gas being potentially a bridging fuel to a lower carbon future is taken more seriously than in the previous discourse coalition. The stalling of shale gas operations in the UK is mostly interpreted through the lens of public resistance, which is explained away using the knowledge deficit model, i.e. if the public understood the need for gas better, shale gas would have been viewed more favourably. Fracking not progressing is then framed as a political decision as opposed to an energy, ecological or geological decision.

This discourse coalition is then comprised of three storylines, firstly '*Domestic Security'* which frames shale gas as being a sensible option in terms of limiting dependence on the imported source of gas, '*Bad Reputation'* which explains the stalling of the progress of shale gas in the UK in terms of the public misunderstanding the technology, and then thirdly *'Bridging Fuel'* which views shale gas as having the genuine potential to *bridge* the gap between now and when there is a lesser demand for natural gas. Compared to the second storyline in the first discourse coalition, which viewed the bridging metaphor as a bridge to an undesirable future, shale gas within this discourse coalition is understood as a *genuine* bridging fuel to a *desirable* future.

5.3.1 Domestic Security

'To be honest, I didn't understand (shale gas) as bridging fuel. I saw it as a fuel and when you view it against declining production in the North Sea, it presents itself as a secure source of energy. It can then contribute to affordable energy for people. It reduces or increases the security of supply. Now, there are many

positives to having indigenous gas as energy. Originally, I didn't think of it as a bridging fuel, I didn't see it as a solution to becoming lower carbon, but that message did come later.'

Glen, Academic

Here the argument for shale gas is presented with the lower carbon transition. The argument is that it is not a bridging fuel to a lower carbon future, but rather a secure source of energy compared to the depleting oil and gas wells in the North Sea. The argument is built around the advantages of indigenous fuel supply, and the security of that supply. In other words, this is a counterargument to the notion of shale gas being a temporary bridge to a lower carbon future, or until renewable energy becomes more financially accessible. Rather, its shale gas is viewed as a substitute for or a continuation of the ongoing domestic sources of oil and gas, which are understood as important and positive.

Security linked with shale gas is not only understood in the sense of providing energy but also in the sense of job and economic security:

'If we had shale gas, then we would have been more energy secure, so there is that. There is that one thing that it would have benefited. We would have had more, you know, UK-only energy security and then perhaps another benefit that I think was motivating us at the time was the development of a new industry and job creation in the UK. So, I think there were those two potential benefits of shale gas that were also motivating energy security and jobs.'

Thomas, Academic

There were two benefits which were identified by the participants in interviews as to why fracking was seen as worth pursuing by some, which were job creation and energy security. It is important to mention, that particularly on the second point, the level to which shale gas could have provided energy security through a long-term supply of a domestic fossil fuel resource is a frequently contested claim. For example, Whitelaw et al. (2019) found in their research which used laboratory pyrolysis to evaluate shale gas reserves, that the shale

gas reserves in the UK would provide shale gas for less than 10 years per current UK gas consumption rates and not decades more.

Jim Ratcliffe, the CEO of INEOS, which was one of the companies, alongside Cuadrilla, that pursued fracking operations in the UK, is perhaps the most visible public representation of this storyline. He is frequently quoted as saying that shale gas should be explored in the UK for two reasons, which are 50 years of energy security (Cahill, 2022) and providing job security (Davies, 2016). The notion of energy security, or even long-term security is then in contradiction with the storyline of fracking/shale gas providing a short-term bridging solution until other (less CO_2 intransitive/cheaper) alternatives become available.

Contrary to the argument as presented in the first discourse coalition that shale gas is or was redundant because of the scale-up and low cost of renewable energy, here the argument is presented that this perspective is a benefit of hindsight and that the reliance or cost-effectiveness of renewables was not guaranteed, and therefore shale could have been the more secure option.

'I think there's probably a degree of hindsight bias now where people might say it (shale gas) was a crazy idea to have even considered it. (…) And there were lots of people including very kind pro-climate people who were very unsure about the extent to which you could scale renewables. So, I think I think anyone who says that the choice was like completely certain about the role of gas in general, that's not entirely fair really, because they were tough, tough choices to be made at the time, and it all looks a bit easier now in retrospect.'

Nathan, Energy Industry Representatives and Energy Consultant

In other instances, participants used examples of international context as a further reason to oppose shale gas. They did so by arguing that the emissions from burning more fossil fuels, would lead to global warming, which disproportionately affects poorer countries. However, in the quote below the international context was used to support the argument for shale gas developments in the UK, citing the continued need for gas and the ability to more easily regulate the conditions under which shale gas is extracted:

'At the moment we import huge amounts of gas into the UK and the impact of those gas products is that the gas that we import is not as well-regulated as we were proposing to regulate, and we just kind of stick our heads in the sand.'

The participant then continued making the point that having domestic gas available is a more ethical way of sourcing gas, as the UK has higher standards for health and safety and pollution management than the countries of origin of the gas, and therefore onshore shale gas exploration in the UK is more desirable. For context, typically, the UK's leading supplier of natural gas is Norway (Godzimirski, 2022). In 2021 Norwegian imports accounted for about two-thirds of all of the UK's natural imports (77%) (Office for National Statistics, 2022). The rest of the imported gas came from Qatar, the United States and Russia. Interestingly, the quote then finishes by outlining that pursuing these higher regulatory targets would also increase the price of gas. This runs counter to the argument that a domestic supply of shale gas would lower gas prices:

'Well, it's fine as long as it's not in Scotland or the UK. We're importing your gas, but we won't worry about your health and safety or worry about your local pollution of your local environment. We don't worry about all these things that we would not allow to happen here, which would make our gas more expensive.'

Aaron, Regulatory organisation/civil service representative

This participant made the argument that domestically sourced shale gas is more ethical than importing gas from places where there is limited control and oversight over working conditions and pollution prevention measures. The understanding of domestic security then stretches beyond a steady supply of energy but also includes having the capacity to control the conditions of that supply chain. Notable is also the somewhat cynical tone of the comment made by a participant, which became even more apparent when taking into consideration the very animated body language, especially when the participant talked about the lack of concern, they think the UK public has about the working conditions and pollution associated with fossil fuel production outside of the UK.

The United Kingdom Onshore Oil and Gas (UKOOG) are a trading body representing the onshore oil and gas industry in a briefing note from 2021 made the argument that relying on imported oil and gas resources, as opposed to exploiting domestic sources such as shale, is the UK's way of offshoring its environmental responsibility and will lead to an increase in the UK's carbon footprint (United Kingdom Onshore Oil and Gas, 2021). UKOOG, similarly to the participant's quote above, makes the argument the more responsible approach in oil and gas exploration would be to exploit domestic sources as opposed to importing oil and gas from elsewhere. Thus, making the argument that when using imported oil and gas in the UK, because of the way the carbon footprint is calculated, the UK's emissions seem lower than they are.

5.3.2 Bad Reputation

This storyline is largely based on the argument that shale gas is not opposed by the public because it is inherently bad, or because it does not fit in with more desirable decarbonisation scenarios, but rather because it is misunderstood and because of the lack of knowledge around the ongoing need for gas supply among the public. In 2021 a letter '*Advice to the UK Government*' (Climate Change Committee, 2021), authored by the CCC on the compatibility of onshore petroleum with UK carbon budgets, acknowledged that public acceptance is important, and whilst shale gas struggled to get public support CCC raised concerns in the 2021 letter, that lifting the ban on fracking could jeopardise the public acceptance of the energy transition on the path to net zero. The issue of public acceptance of communication and knowledge is then taken up in the quote below:

'I think one of the communication issues at that time was that people might not have understood why we need bridging fuel to help the journey to lower carbon futures, also now we're probably talking about five or six years ago at least. And I think the perception of a zero carbon future or net zero future hadn't been discussed. We were probably around the time of the 2015 Paris Agreement, so relating the aims and objectives of the Paris Agreement with gas as a fuel. Or don't think that argument was particularly well explained.'

Nathan, Energy Industry Representative and Energy Consultant

Here, shale gas is seen as a bridge or a vehicle to lower carbon future, which in this particular vision still relies on gas. In other words, the vision is of a *'lower'* carbon emissions future, not an absolute greenhouse gas emissions-free future. There is a sense that shale gas did not succeed in the UK both because the public (general population) did not understand its importance or potential during the lower carbon transition and also because the messaging about the need for shale was not well explained. The public are positioned here in a specific way as '*people who do not understand'* and '*people who need to be better communicated to'.* The argument here follows the principles of the knowledge deficit model. The knowledge deficit model (Ahteensuu, 2011) understands the public to be ignorant, and lacking understanding of science. And so, any public resistance to what is scientifically deemed as a good solution or technology is explained by the public's ignorance. This leads to the assumption that to overcome the resistance more education is needed because better understanding and less ignorance will lead to an agreement on the need for a proposed technology or solution. In the quote above it is insinuated that if the need for shale was explained better the '*general population'* would have understood which would have led to public acceptance which in turn would ensure a successful commercial operationalisation of shale gas. In other words, the assumptions align with those in the discussed knowledge deficit model. Another point on the issue of public resistance is described below:

KT: Were you surprised by the announcement of the moratorium, or did you see it coming?

I mean, I think so. I mean, I think it was…It wasn't a surprise. I think there were, you know, there were lots of factors. Involved and it was highly political. And the public, the public opposition to it…. was great. And then, of course, that public opposition and the strength of feeling influence political behaviour.

Ben, Regulatory organisations/civil service representative

The quote explains the moratorium on fracking as not surprising. It also does not attribute the moratorium issues, such as the inconsistent ability to measure or mitigate seismicity, which was the official reason given for the suspension

of all fracking operations (Rankl and Sutherland, 2022). Their perception is that the multiple factors at play were of a political rather than geological nature. The participant also points to a link between the public pressure and the political decision-making which led to the moratorium, which was *'of course'* strongly influenced by the *'feelings'* of the public. This quote fits in with the storyline, as it explains how the public is seen to have a substantial role in the decision-making process, through exerting pressure. Overall, there is an assumption, that if the public had more of a favourable view, the moratorium might not have been adopted. Another example of viewing the public as ignorant is described below:

I think (CCS) is fairly well understood and it's, you know, on the news so people know what it is. So, quite a simple message. Not to get into the details of it but we take carbon dioxide out of the atmosphere or out of the industry and then store it. It is quite a simple message, whereas contrasting that with hydraulic fracturing where you have terms such as hydraulic fracturing, fracking, drilling… Trying to illustrate that as something that could be positive was… quite difficult.

Henry, Academic

Similarly, to the previous quote, the argument here is around messaging and the number of terms that can be used to describe the process of hydraulic fracturing. There is an insinuation, that fracking itself is not a bad technology, or that new oil and gas are undesirable, but rather the unsuccessful commercialisation of the technology happened because of the difficulty in messaging it as *'something positive'* and the difficulty of understanding it. This is contrasted with CCS, which in this quote has been over-simplified. The oversimplification of the process of carbon storage as compared to the process of hydraulic fracturing is then also done with the implicit assumption that if fracking were as '*easy'* to understand as carbon capture, then the public would have seen it in a more positive light. There is also a contrast between '*taking from'* the atmosphere or the industry (on-site carbon capture) with '*taking out'* of the ground, using drilling or the process of fracturing, shortened to fracking.

Carrying on with the same tone and explaining the lack of public support through the lens of public ignorance was then also presented below, where the participant insinuated, that if the public had a better grasp of energy generation and *'where the gas comes from'* the opposition would not have been so strong:

'And people are largely unaware of where the gas comes from, and I think we have lots, and they have no idea that we have that. If you take the across the UK with part of its UK gas network, we import 50% of that gas.'

Ben, Regulatory organisation/civil service representative

Similarly to the previous quotes, this one was also uttered in a distinctly patronising tone towards the public, who are understood to have little to no awareness about '*where gas comes from'* and therefore are opposed to shale gas. Once again suggesting, that if the public's awareness were to increase, their opposition to shale gas would decrease.

Within this storyline shale gas is largely painted as an energy technology which is misunderstood and has a bad reputation because it is either difficult to grasp as a concept, the public does not seem to grasp the need for domestic gas supply and thus if the reputation or the understanding of fracking were to improve, it could possibly be an energy technology considered in the future. Overall, the public are portrayed not in a favourable light, and indeed patronisingly as in need of gaining a better understanding of shale gas.

5.3.3 Bridging fuel

This next storyline focuses on the commonly used *'bridge'* metaphor when describing shale gas. It depicts the different ways in which has been utilised in the data and then specifically discusses the different characteristics of the shale gas '*bridge'* that the participants point to. An example of shale gas being viewed as a bridging fuel or a facilitator to a lower carbon future can be found in a statement by the then Secretary of State for Energy and Climate Change, Amber Rudd, from 2015, which she made in the Shale Gas and Oil Policy Statement, where she said that: '*Exploring and developing our shale gas and oil resources could potentially bring substantial benefits and help meet our objectives for secure energy supplies, economic growth and lower carbon emissions.'* (Department for Energy and Climate Change, 2015).

A similar argument is made by the United Kingdom Onshore Oil and Gas (UKOOG) which is a trading body representing the onshore oil and gas industry. In a briefing note from 2021, they argue that the environmental benefits of shale gas include a '*lower carbon footprint supply of natural gas for UK consumers.'* (United Kingdom Onshore Oil and Gas, 2021). The briefing note then continues trying to square shale gas with the net zero transition in arguing that innovation across all industries is needed to meet the challenge of net zero, however, *'the non-uniform regulatory environment for UK shale gas…has unjustly slowed the development of one of the greatest industrial opportunities the UK has had for decades.'* The briefing note then further argues that the moratorium should be lifted to *'realise the potential emissions savings and economic opportunities'* associated with high-volume hydraulic fracturing in England. This narrative of shale gas as a bridging fuel was then also found in the data:

KT: So, you mentioned this sort of narrative of shale gas as a bridge fuel, could you expand on what you meant there?

'Well, globally you can argue that shale gas was a bridge fuel or that development on the global scene helped contribute to gas being a bridge fuel in the UK for obvious reasons. Yes, you know, looking back a decade you could argue it was. The renewables industry wasn't as well established. It wasn't as cheap. There is also a differentiation between the domestic use of shale gas and the use of shale gas at a national level.'

Carl, Academic

The central difference here, in terms of understanding shale gas as a bridge fuel, is that it is out of date. If the understanding is that shale gas was meant to provide energy supply until renewables became more economically viable, i.e., cheaper, the participant here points out that by the point of the moratorium that was already the case, and so, there was not a gap for shale gas to bridge. A key point to understand with the frequently used *'bridge fuel'* metaphor, is that there is not a shared understanding firstly where the bridge starts. For example, is the metaphorical bridge starting at a point when we have depleted oil and gas reserves in the North Sea, or is it starting at a point where reliance

on imported fuels is not feasible etc? Secondly, what is the valley or river that this bridge is bridging? For example, is the gap the time until renewables (wind in particular) become cheaper (which the participants agreed has already happened) or is the metaphorical river representing domestic energy security? On that point, the '*length'* of the '*bridge*' is also negotiable. Firstly, there are visions such as the one described above that would have seen shale gas being important as *long* as renewables weren't the more available options. Equally, there are more abstract descriptions of the length in terms of it leading to a '*lower carbon future'* as described earlier. Finally, the other end of the bridge is also not agreed upon, in that the destination so to speak could be energy security for example. That was one of the central arguments made by the fracking industry, that shale could provide energy security for the next 50 years (UK Energy Research Centre, 2022). Equally, the bridge could lead to a future with a failure to reduce greenhouse gas emissions. The description of gas, but not necessarily shale gas a bridging fuel, is depicted in the quote below:

'Gas is a bridge fuel kind of makes sense, while the renewables industry is getting off the ground and that's you know that's what's happened in reality, and so because of the economic benefits potentially for UK industry, you could argue that those it made sense for the UK to do it even though it potentially made our carbon budgets a little bit more difficult to meet.'

Alistair, Academic

Here the conditions, or the bridge, under which onshore shale gas exploration is permissible are clearly laid out – until the renewable energy options (although not specified it is highly likely that what is being referred to as wind and solar energy) become more widely available. The participant then also argues, in this scenario, that fracking is a suitable and worthwhile technology, even at the expense of '*difficulty*' with meeting the carbon budget. And so, then the bridge is *'too long'* to meet the carbon budget, which is too tight and *'difficult to meet'.* The specific bridge parameters were then also discussed in the quote below:

'Firstly, a bridge has to go somewhere. You set up an enormous shale gas industry. You've got this incumbency that's going to be hard to overcome. So,

in my mind, there was always a condition. Well, okay, fine, but you've got to have some sort of policy to proactively generate a phase-out. Whether that would happen or not, in reality, is pretty questionable, so that makes it a risk from a climate perspective. And just the very rapid shift in renewables made, it made the bridge much shorter.'

Martin, Environmental non-governmental organisation representative

The participant offered a reluctant acceptance of a need for shale if there is a clear definition of the '*length*' of the bridge, i.e., the phase-out of shale, which was shortened by the availability of other less carbon-intensive energy technologies, and renewables. In other words, the length of the bridge differs based on the argument that it is linked to. For example, when shale gas is argued to be acceptable or worth pursuing because of (at the time) economically inaccessible renewable energy the bridge is shorter than if the argument is made in connection with energy security.

5.3.4 Conclusion

This second discourse coalition comprised three storylines which left room for reluctant acceptance of shale gas under different conditions. Firstly, either shale gas is needed as a secure source of domestic energy, if the reputation of shale gas improves, or it can be used as a bridging fuel in a transition to renewables. Although the environmentally damaging effects of burning fossil fuels or the importance of decarbonisation were not directly disputed other factors, for example, economic benefits through job creation or energy security and independence from international suppliers were used as potentially justifying pursuing shale gas. Whilst in the first discourse coalition the argument was made that fracking in the UK would be unethical, as it would actively hinder the pathway to a desirable net zero future, in this discourse coalition not pursuing fracking in the UK as a domestic source of energy is seen as the environmentally worse choice. The reasons given for this were that domestically we can control better environmental performance on site, which we cannot do with imported fossil fuels, and so the understanding of what is ethical differs from the first discourse coalition. Secondly, fracking is viewed as a misunderstood technology with a reputation which does not reflect its supposed usefulness. In comparison, the first discourse coalition views

shale gas as understood to be fundamentally undesirable because it would undermine the decarbonisation efforts of the net zero transition. There is a detectable reliance on the knowledge deficit model in the second storyline, '*Bad Reputation'*, where the public are described as unknowing and ill-informed. Thirdly, shale gas is assigned the genuine potential as a bridging fuel, i.e., as an energy technology that can provide a reliable source of energy until other such reliable and economically viable technologies become available or until the demand for gas is no longer there. Throughout the storylines of this discourse coalition shale gas is viewed as an energy technology that does potentially have a future as compared to the way it is perceived in the previous discourse coalition.

5.4 Third Discourse Coalition: Shale Gas: Doomed from the Start

The main argument of the third discourse coalition is that shale gas as such would have not succeeded commercially or at any scale in the UK regardless of the circumstances of the net zero transition. The difference compared to the second discourse coalition is that there is no change in circumstances in which shale gas would have succeeded in the UK. The difference between this discourse coalition and the first discourse coalition is that although both view fracking as something that should not be pursued, the first discourse coalition justifies this view based on the principle that shale gas is a fossil fuel the pursuit of which would be counterproductive to decarbonisation efforts. This third discourse coalition justifies the view based on geological factors and the lack of economic pay-off of shale gas operations. Additionally, the net zero policy or in fact decarbonisation is not viewed as a deciding factor or the reason for why the UK does not currently explore onshore shale gas. This discourse coalition is then comprised of two storylines, firstly '*Wrong Geology'* and secondly, the *'Lack of Pay-Off'*.

5.4.1 Geological Factors

This storyline is based on the idea that the lack of development of shale gas in the UK, and the lack of likelihood of any development in the future, is largely due to geographical and geographical factors. One of these physical factors considered is the density of the population around shale gas sites in the UK which makes managing the effects of earth tremors associated with shale gas

extraction more difficult (Hays et al., 2015) than in less densely populated countries where shale gas had been extracted before, like the US. This specific factor is then discussed in the quote below:

'I mean, I think the only other thing to really consider when you think about comparing shale gas industries in the UK with another country… is that the UK is very different to say the (United) States where the UK has a higher density of population. I mean these leaks and emissions events matter more here (UK) than they would in the US because we have people living a hundred metres away from these wells and that isn't the case in other countries.'

Marcus, Energy Industry Representative and Energy Consultant

The participant drawing a comparison between the US and the UK is not surprising. The US is sometimes used as an example of the relative success of the shale gas industry (Lozano Maya, 2013), as, unlike in the UK, hydraulic fracturing was a commercially used shale gas extraction method for several decades (Soeder, 2018). These comparisons are drawn to highlight the potential of shale gas. Focusing on the higher density of the population the participant outlines why the comparison between the UK shale developments and the US is not appropriate, suggesting that if the UK were less densely populated perhaps shale gas could have also progressed to that stage in the UK. They then continue to explain that the risks of pollution through leaks or the emissions associated with the fracking sites matter more in the UK for that reason. There is no effort to dispute that those are some of the risks associated with drilling for shale gas, but rather the argument is made that that risk is relative to the closeness of the public to the fracking site.

The comparison to the US was also utilised in another instance, not only to point out the differences in the location of shale gas sites and their proximities to densely populated areas but also to point out the differences in shale gas reserves. The quote below is another example of using geological factors, this time the volume of available shale gas to frack, to justify or explain why shale gas did have the success in the US that was initially imagined by some to translate to the UK:

‘The classic line was in 2013 when David Cameron said the UK has potentially got 50 years of shale gas supply, and that onshore shale gas could be the next North Sea. However, there is research that suggests that that was an overestimation by factor certainly in the region of 6 to 8. So, you are instead looking at less than 10 years in terms of recoverable resources. I mean at some point the bottom drops out of the shale gas market and in the USA many operators since the financial difficulty borrowed so much money to get going in the first place.’

Henry, Academic

Firstly, the attention is being brought to one of the quotes by the former Prime Minister David Cameron which he issued in a statement in 2014 ‘*That's why we're going all out for shale. It will mean more jobs and opportunities for people, and economic security for our country.’* (in Bradshaw et al., 2022) This quote then also disputes the argument of shale as being able to provide energy security by providing 50 years’ worth of supply of gas. Instead, the participant refers to research done by Whitelaw et al. (2019) pointed to previously, which conducted modelling that showed that according to their calculations, the premise of 50 years’ worth of shale gas was exaggerated by a substantial factor. The participant then comments on the *‘bottom dropping out’*, meaning a sudden failure or something stopping to work, in this instance, the participant hints at a financial liability of shale gas in the US and thus questions the profitability of shale gas extraction overall. However, there is also the sense that if there indeed was a 50 years’ worth of supply of shale gas available then perhaps fracking would have been at least economically justifiable.

What both of those examples illustrate within this storyline is that the lack of progress of shale gas in the UK, as compared to the US example, is explained away by pointing to physical barriers, like population density and volume of shale gas, as opposed to pointing to the environmental concerns associated with fracking. Notably, when drawing comparisons between the UK and the US, this is done to highlight what the potential of shale gas exploration in the UK could have been, had the conditions been different, as opposed to using

the US example to point out the pollution incidents associated with fracking operations (Harthorn et al., 2019) as limiting factors.

5.4.2 Lack of Pay-Off

This last storyline is based on the argument that pursuing shale gas currently is non-sensical because of the lack of payoff, both in terms of economic benefits and in terms of energy security. This is then counter-narrative to the '*Domestic Security'* storyline, which discusses the advantages of a secure long-term domestic gas supply. The quote below discusses this perception of shale gas as an energy technology not worth policy makers' time:

'In my opinion, I don't think it (the moratorium) was a surprise at all, and I think it's (shale gas) ever had a window to get off the ground. And as I said, this isn't an official base version, but in my personal opinion ministers were just delighted to get rid of it. So, it wasn't worth their time and the cost to be honest, given there were other alternatives that fit in better with the kind of cleaner, greener narrative. So why wouldn't you get rid of it?'

Aaron, Regulatory organisation/civil service representative

This quote discusses that it was not the difficulty in the prediction of tremors which was the principal reason for the moratorium being announced. The argument made in this instance is that shale gas could have been successful, i.e., being commercially operationalised, but that window of opportunity had passed by the time the ban was announced. This is followed by the explanation that shale gas did not fit within a *'cleaner, greener narrative'*. Important to note here, that the net zero transition is not being referred to specifically but is framed as a *'narrative'* to support the idea that the ban was a political decision rather than one based on geological or physical factors. In summary, this quote focuses on the contextualisation of fracking in comparison to *'greener'*, *'cleaner'* energy technologies, so the question then posed was not why to abandon a useful technology but why to bother pursuing it, if it is not well publicly supported.

The lack of financial incentives to pursue fracking is then the central point of several participants' perspectives as to why fracking is not and should not be pursued in the UK. Firstly:

I think looking again from a financial point of view if you're an investor. What would you seek? Why would you be prepared to invest? In a technology that's going to be very time-limited, it's not compatible with achieving net zero goals.

Martin, Environmental non-governmental organisation representative

Fracking is seen as a short-term energy technology, compared to the '*Domestic Security'* storyline which views it as a long-term energy supply opportunity. Secondly, compatibility with the net zero policy is used as a benchmark for measuring whether fracking is a worthwhile investment, and since shale gas does not feature in any of the UK Government's decarbonisation strategies, it is deemed a bad investment. In a different instance, another participant said:

'Well, we're not investing in shale gas anymore because that's not a good source of return over the medium to long term.'

The return on investment is used as the principal reason why shale gas is not worth the investment, as opposed to concerns about the environmental impacts of shale gas or the net zero transition. This economic lens is also applied to shale gas in the quote below:

'Why would investors want to put money into fracking? Shale gas extraction is a technology with a very time-limited future and that future is getting more time-limited every year as opposed to say investing in offshore wind'.

Ben, Regulatory organisation/civil service representative

Each of the quotes above illustrates the way in which the abandonment of shale gas is viewed through the lens of economic profitability and so the net zero policy was not viewed as the key deciding factor in not pursuing shale gas operations, rather what is given as the primary reason is the lack of economic pay-off. What is also omitted as a key factor is public resistance to shale gas, which on the other hand was viewed as decisive in the second discourse coalition. Inadvertently, this storyline points to the upscale of renewables and their economic viability as a deciding factor in why fracking is not worthwhile to pursue. There is not a complete and absolute dismissal of a future for

fracking, but this future is viewed as extremely limited, so much so that it makes the technology not worthwhile.

5.4.3 Conclusion

This third discourse coalition '*Shale gas: Doomed from the Start'* is based on the understanding that shale gas was not worth pursuing from the onset, because of limiting geological factors, such as the geographical location of the fracking sites or the insufficient supply of shale gas. It consisted of two storylines '*Geological Factors'* and '*Lack of Pay-Off'*. The first storyline is based on the argument that shale gas could never have worked at scale in the UK because of the different geological formations compared to countries where shale gas extraction was more successful. The storyline then also depicted the contentions around the claims of long-term shale gas supply, and how claims of shale gas providing energy security are disputed. The second storyline then focused on outlining the lack of financial pay-off of shale gas. It does so to make the point, that irrespective of other factors, shale gas is simply not worth pursuing. In contrast with the first two discourse coalitions, the storylines within these discourse coalitions do not take into consideration environmental factors and the consequences of more GHG emissions being caused by pursuing shale gas. Instead, the storylines portray shale gas as simply not '*worthwhile'* because the geological and economic conditions are not favourable, as opposed because of shale gas being unacceptable, unethical or incompatible with decarbonisation the way other storylines do.

5.5 Conclusion

This chapter aimed to answer the second out of the three research questions: **What shale gas discourses exist? And which visions/narratives do they promote in the context of the UK's net zero policy?** It did so, by presenting three different discourse coalitions which each presented different visions of shale gas in the UK and the relationship between shale gas and the UK's net zero policy. The first of the three discourse coalitions *'Shale Gas: Spectre of the Past'* presented shale gas as completely incompatible with the UK's net zero transition. The second discourse coalition '*Shale Gas: Wrong Place Wrong Time'*, focused on what could be described as circumstantial factors such as public resistance, comparable price of renewable energy and

domestic security to explain why shale gas is not being pursued. The third discourse coalition, '*Shale Gas: Doomed from the Start*' views fracking as not pursuable regardless of the net zero transition or other policy context because the failure of shale gas in the UK is explained for economic and geological reasons.

Because of the timing of the data collection, some of the interviews were retrospective looks at shale gas in the UK, especially if the participants felt that the net zero transition was the right path to be on, and new fossil fuels were highly undesirable. At the same time, participants who had a more lenient view towards fossil fuels and viewed the net zero target as more negotiable did not negate that, although highly improbable, there might be a future for shale gas in the UK. The timing of the interviews also enabled me to offer a unique perspective of visions for shale gas in the UK at a particularly interesting intersection of time and explore its connection to the net zero transition.

The most notable difference between the second discourse coalition '*Wrong Place Wrong Time'* and the other two discourse coalitions is that it leaves a little window for shale gas to re-emerge, or to become justifiable. In the case of the second discourse coalition, the underlying assertion is that if shale gas did not have as much public opposition, or if the need for gas increased then shale gas exploration in the UK could be justifiable even with the ongoing transition. However, the first discourse coalition presented shale gas as fundamentally incompatible with decarbonisation efforts and also dismantled the narrative of shale gas as a '*bridging fuel'* to a lower carbon future. Because shale gas is viewed as a technology of the past, frequent comparisons were drawn between shale gas and coal, to illustrate the point that there is no need to pursue new sources of fossil fuels. The third discourse coalition then, in contrast to the second one, does not leave a possibility open for a potential shale gas future, because the factors which the two storylines focus on are not as easily, or at all changeable. So, whilst the reputation of shale gas could in theory improve and thus make it a more desirable energy technology to pursue as per the '*Bad Reputation'* storyline, the geological make-up of the UK's shale gas reserves will not change or shift and so if that is understood to be the key limiting factor than shale gas cannot be pursued. Finally, across the different

discourse coalitions and storylines, there are competing temporal narratives of shale gas, which is both imagined as being a long-term solution to the security of the domestic supply of gas and at the same time viewed as not worthy of financial investment because its life span is seen as extremely limited.

Below I present a table summary of the shale gas discourse coalitions and storylines. This is an analogue table to the one presented in the previous data chapter on BECCS:

Discourse coalitions	**Shale Gas: Spectre of the Past**	**Shale Gas: Wrong Place Wrong Time**	**Shale Gas: Doomed from the Start**
Explanation	Shale gas and net zero are incompatible because they represent different paradigms. Net zero is seen as a step forward, whilst shale gas is from the past and plays no role in decarbonisation efforts. The bridge fuel narrative is completely disputed.	Shale gas is not inherently bad, however difficult to put into practice in the UK as politically unfavourable and better options are available. Narrative as bridging fuel not dismissed. Under different political conditions may be possible, but not necessary.	Shale gas was a bad idea from the start, regardless of net zero it would not have materialised because of geology, controversy, and unsure financial pay-off.
Storylines	**Technology with no future** shale gas/gas overall is viewed, like coal as a thing of the past, unfit to be part of the energy resource	**Domestic Security** fracking domestically is more ethical than importing gas from elsewhere.	**Geological factors** unsafe because of leaks, emissions, and seismicity **Lack of Pay-Off** pursuing shale gas in the UK is simply not worth it, from an economical, climate

	mix in the current climate. **Bridge to Nowhere** the narrative of shale as bridging fuel disputed the 'bridge' does not lead to a desirable future which is net zero.	**Bad Reputation** it is not inherently bad and is doable but had an unfortunate history of controversy so is difficult to operationalise in the UK. **Bridging fuel** fracking could have genuinely played a role as a bridging fuel to bridge the gap between other energy technologies becoming more economically viable and the demand for gas decreasing.	and geological point of view.
Visions of Net Zero	Positive views of net zero result in negative views of shale gas – net zero is viewed as a move in the right direction, whereas shale gas is a step back.	Net zero is viewed as positive, but also not as absolute. The need for gas is acknowledged and so is the possible need for fracking despite the net zero transition.	Net zero is viewed as positive but not a key turning point for onshore shale gas.
Key Actors' Profiles	Academia	Environmental non-	Academia

	Energy Industry Representatives and Energy Consultants	governmental organisation representatives	Regulatory organisations/civil service representatives
Visions of Shale	Net zero and shale gas exploration are mutually exclusive so as long as the net zero transition is ongoing onshore shale gas will not be explored.	Could be viable and possible under different conditions Not seen as inherently bad, but better options for energy generation might be available.	Shale gas exploration should not take place in the UK under any circumstances, shale gas reserves and geological predispositions are unfavourable.

Table 4 ***Shale Gas Discourse Coalitions and Storyline***

6 BECCS and Shale Gas: A Comparison of Visions

6.1 Introduction

The two previous data chapters have focused on bioenergy with carbon capture and storage and shale gas, respectively. Each section corresponded to a discourse coalition and each subsection to a storyline. This chapter is different in that its analysis combines and compares the two energy technologies and cuts across the discourse coalitions and storylines, to provide an insight into the different ways in which net zero transition is conceptualised within them. The previous two data chapters also each included an overview table of their respective discourse coalitions and the different storylines, where each column was dedicated to a discourse coalition. This third data chapter focuses on the two rows which cut across the respective discourse coalition, '*Visions of Net Zero'*, and '*Visions of Shale'* and '*Visions of BECCS'* respectively, which I have summarised in a table at the end of this introductory section (see Table 3).

When conducting the interviews, it became apparent that when discussing the current state and also the future of either BECCS or shale gas this was almost exclusively done with reference to the net zero transition. Whilst the net zero transition was a point on the interview topic guide (see Appendix), the participants started discussing the transition and its connection to energy

technologies mostly on their own and at great lengths which was perhaps reflective of the importance of the transition as a topic of discussion in the public sphere at the time of this research. In preparation for the interviews, I anticipated that the net zero transition might be a longer point of discussion in the interviews which focused on BECCS because of the link between the development of the energy technology, negative emissions, and the transition itself as I have outlined in the Introduction chapter. What then was surprising, is that the transition was a strong focus within the shale gas interviews as well, despite the ongoing moratorium at the time. This in itself stood out as an important observation, because it was indicative of a new way in which shale gas is being made sense of by the participants compared to previous research findings from before the net zero transition.

To reflect this overall focus on the net zero transition and the importance it seemed to have for the participants when discussing the future of either of the energy technologies, in the analysis I paid close attention to specifically how the participants framed and understood net zero, in what ways the descriptions of the visions that the participants had for the energy technologies' development differed from each other, what language was used and what discourse coalitions and the storylines within them described the future developments of the energy technologies in a similar way. More precisely, what emerged as an important distinguishing factor between the respective three discourse coalitions across both energy technologies is how the future developments of the energy technologies and the energy transition were described.

This chapter then aims to unpick how the actors perceive and envisage the transition to the net zero 2050 target and what role they perceive the respective energy technology to play in it as well as whether the net zero target according to their perception played any role in shaping the trajectory of either of those energy technologies in the UK and so answer the third and final research question:

How do the visions of net zero promoted within the different BECCS and shale gas discourse coalitions compare?

In the previous two chapters, I have discussed the various discourse coalitions of the two different energy technologies. I have then broken the discourse coalitions down into storylines and then discussed what these storylines share and why I ultimately categorised them into the respective discourse coalitions. One of the factors that tied the storylines together is how the net zero transition was made sense of within them, as well as how the future of shale gas and BECCS was conceptualised because there are different relationships described between the shale gas, BECCS and the net zero policy described in each discourse coalition.

The visions of net zero were described within the discourse coalitions similarly and also differed from each other in the way the relationship between the net zero transition and the energy technology was described. In some discourse coalitions, the type of relationship between the technologies and the net zero transition was described in a way where they can co-exist concurrently whilst in other instances the existence of one was seen as incompatible with the existence of the other. As an example, the *'BECCS as a Legitimate Solution'* largely understands BECCS as an important energy technology in the net zero transition, whilst the '*Shale Gas: Spectre of the Past'* views shale gas largely as fundamentally incompatible with the net zero transition or other decarbonisation efforts. In other discourse coalitions, the relationship between energy technology and the net zero targets is described in such a way that the existence of one is seen as contradictory to the development of the other or contrary is seen as dependent or closely connected. This can be because the net zero target is viewed as dependent on the deployment of BECCS or because both the net zero by 2050 target, BECCS and shale gas are not viewed as aiding decarbonisation and are viewed as counterproductive to that emissions reduction goal. Then there is also the relationship were meeting the 2050 net zero goals, and the development of energy technologies is not seen as related, or only tangentially so. That can be because either the trajectory or the success of one does not depend on the other. For example, BECCS can be seen as one of the options for net zero but does not have to be viewed as decisive for its success.

Because of the developing nature of the net zero policy and neither technology being operationalised at a commercial scale in the UK, when participants talked about the connection between the technologies and net zero, it was almost always done in a sense of future development and envisioning how the development of the energy technology might unfold in light of the (at the time of the interviews) very new energy transition. When assessing how the participants envision the future developments of the net zero transition, generally two factors differentiated the various visions from each other. The first factor was, whether, within the discourse coalition, the net zero policy and net zero as a concept are seen as genuine decarbonisation efforts. Secondly, what also differentiated these different visions of future development was the understanding of how the energy technologies will be impacted by the net zero transition and what the relationship between the energy technology and the net zero transition is.

Looking at these factors, I then analysed the different visions described across the six different discourse coalitions and found that there are three different distinct types of visions based on the two factors I mentioned above: the understanding of the net zero policy and the understanding of the energy technologies' relationship to the policy. Following the analysis of these different visions I have found three categories which describe the relationship between technologies and the policy, which I have used to structure this chapter. The first category I have identified is 'Dependent' the second I referred to as *'Independent'* and the third one is called '*Question of Fit*'. It is of note that the participants did not comment on each other's energy technologies, and so the three cross-cutting categories of visions are conceptual categorisations, as opposed to reflecting the participant's interest in the opposite energy technology. As in both of the previous data chapters, here too the participant quotes are labelled with a pseudonym and the participant's occupation.

6.2 Discourse Coalitions' Net Zero Visions

This next section will provide a summary overview of the different discourse coalitions I discussed in the previous chapters. Specifically, I summarise and focus on how net zero is understood within each of the discourse coalitions

and in what ways the energy technology is positioned vis-à-vis the net zero policy.

The ***'Shale Gas: Spectre of the Past'*** discourse coalition is based on the view of shale being a token representation of a carbon-intensive past and that decarbonisation should be the overarching goal of the energy policies moving forward. The net zero transition is then viewed as positive and as a propeller to a decarbonised future. Exploring more ways of fossil fuel extraction through onshore shale gas, or other means, is deeply undesirable, even if there were not any geological or seismological barriers and challenges.

Secondly, the **'*Shale Gas: Doomed from the* Start'** discourse coalition, does not view the net zero policy as a key turning point for the fate of shale gas in the UK. Their developmental trajectories are viewed as independent of each other, however, shale gas is still not viewed as a desirable energy technology due to geological factors. This is reflected in the way in which, the lack of progress in commercial onshore shale gas exploration is explained by the participants. The main reasons given are unfavourable geological formations and practical on-the-ground, operational and technical challenges, as opposed to challenges associated with the introduction of new decarbonisation policies like net zero.

The third shale gas discourse coalition ***'Shale Gas: Wrong Place Wrong Time'*** views the net zero policy as negotiable as far as not presenting the only feasible policy trajectory to decarbonisation, and the 2050 target is viewed as challenging. There is a lack of trust in energy supply alternatives to natural gas, and so the ongoing need for gas is seen as a given, or as a staple of the UK's energy mix. Therefore, developing shale gas is not seen as inherently bad. Shale gas is then envisioned possibly as playing a role in producing hydrogen with residual emissions being captured by CCS technologies. This then means that pursuing shale gas and net zero simultaneously is possible within this discourse coalition.

The discourse coalition '***BECCS as a Legitimate Solution'*** views the net zero target as important, legitimate, and achievable with the aid of technologies, one of which is BECCS. In that sense, the rollout of BECCS and the pursuit of

the 2050 net zero targets run concurrently, as the latter is seen as depending on the successful development of the former. The relationship between the energy technology and the policy is then seen as one of dependency, as the net zero target relies on working negative emission technologies, such as BECCS.

The second BECCS discourse coalition ***'BECCS as a 'Good Fit'*** views decarbonisation via pursuing the net zero target as important. At the same time, the net zero target is also seen as an insufficient decarbonisation effort. The preferred decarbonisation pathway is driven not only by technological solutions such as BECCS but also by substantial societal changes, such as changes in consumption habits and diet. BECCS is not seen as instrumental to decarbonisation overall as is the case in the previous discourse coalition, but rather as a technology which fits within the parameters of the net zero policy.

Lastly, the sixth and final discourse coalition ***'BECCS as a 'Non-Starter'*** portrays a different relationship between the technology and net zero. Unlike in the previous discourse coalitions, net zero is not viewed as a stepping stone to decarbonisation. It is viewed as a policy effort running counter to the ultimate decarbonisation goal, which is to reach absolute zero emissions, and not rely in any way on negative emission technologies. BECCS is not viewed as a part of any serious decarbonisation efforts, instead, it is viewed as a product of the net zero transition. Neither of them is seen as progress in terms of decarbonisation, but rather as a distraction or even a false solution, as is discussed within the various storylines related to this discourse coalition.

Below, I present a summary table of the sections above, depicting all the discourse coalitions, and the way in which net zero is discussed within them:

Name of Discourse Coalition	**BECCS as a 'Good Fit'**	**BECCS as a 'Non-Starter'**	**Shale Gas: Spectre of the Past**	**Shale Gas: Wrong Place Wrong Time**	**Shale gas: Doomed from the Start**

Explanation	The current net zero timelines are seen as problematic, and insufficient, earlier targets are preferable. However, net zero is still viewed as feasible, and emission overshoots as acceptable.	Net zero is seen as problematic, alternatives such as Absolute Zero, or earlier net zero targets (2025 instead of 2050) are preferable.	Positive views of net zero result in negative views of shale gas – net zero is viewed as a move in the right direction, whereas shale gas is a step back.	Net zero is viewed as positive, but also not as absolute. The need for gas is acknowledged and so is the possible need for fracking despite the net zero transition.	Net zero is viewed as positive but not a key turning point for onshore shale gas.

Visions of Net Zero	BECCS plays a small part in the decarbonisation of the energy sector, but this is also substantiated by other efforts of systemic change. Carbon dioxide targets are viewed separately from emission reduction targets so that any carbon dioxide removal via BECCS or other NETs is treated as additional to emissions reduction.	BECCS is not a part of any climate change mitigating actions or solutions – instead, the focus is on renewables and 'natural' solutions (afforestation). The sustainability of biomass is questioned.	Net zero and shale gas exploration are mutually exclusive so if the net zero transition is ongoing onshore shale gas will not be explored.	Could be viable and possible under different conditions and might be necessary for the future. Not inherently bad, made worse by a combination of factors but better/cheaper options for energy generation might be available.	Shale gas exploration should not take place in the UK under any circumstances, shale gas reserves and geological predispositions are unfavourable.

Table 5 ***Summary Table of discourse coalitions and net zero visions***

6.3 Different Types of Visions and Categorisations

6.3.1 1st type of vision: Dependent

The first type of vision, which I argue the discourse coalitions '*Shale gas: Spectre of the Past'* and '*BECCS: A Legitimate Solution'* belong to, is where the relationship between net zero and the energy technology, be it shale gas or BECCS, is one of dependence. By this I mean, that the net zero policy is either seen as possible because of a scale-up of BECCS or because of the absence of shale gas. Successfully meeting the net zero 2050 target is seen as dependent on the presence of one energy technology, and the absence of the other. How the participants envisioned and then also verbalised how they think that the net zero transition will unfold was with a certainty of BECCS development or with a certainty of no further developments of shale gas, and thus for them the successful meeting of the target is dependent on the functionality of BECCS and no further efforts in shale gas exploration.

Within these discourse coalitions, there was also little to no questioning of the legitimacy of the net zero target as a decarbonisation strategy. Rather, the net zero approach was widely accepted, and so was the legitimacy of BECCS as a negative emissions technology. In other words, the use of BECCS, the UK's net zero plan, and the efforts to genuinely decarbonise the energy sector are seen as aligned with each other. As laid out in the data chapters, this is not always the case, as in other cases the net zero transition is now viewed as a legitimate or even a sufficient decarbonisation strategy, particularly in instances where an absolute zero approach to reducing emissions is preferred. In those instances, BECCS, the net zero strategy and decarbonisation are viewed as either separate or contrary to each other. Within this understanding of the net zero transition, which I describe as '*dependent*', BECCS is then seen as the means, and the net zero target is the end and decarbonisation is the ultimate goal. The opposite is true for shale gas, which is understood as a hindrance to decarbonisation and as an energy technology which would out of the principle of being a fossil fuel jeopardise the transition to net zero greenhouse gas emissions. Particularly illustrative of this point is the quote below, where a participant describes how they cannot picture a net zero future with shale gas developments at the same time:

'I just don't see the point anymore. I could be completely wrong, but I don't think I am, and I think the same old issues, plus net zero made the likelihood of a revival feel very remote to me. I mean never say never, it's hard to predict anything.'

Isaac, Academic (Shale Gas interviews)

The interpretation of the relationship between the net zero policy and shale gas is that they are not compatible, or at the very least the presence of one makes the presence of the other significantly less likely. However, the participant then follows this up with an important distinction of '*never say never'*. This can be interpreted as uncertainty about how the net zero transition will develop over the next decades up until 2050. Whilst it is not a complete denial of a vision of where both shale gas and the net zero transition could co-exist, which is reflected in the unsure way the participant has voiced his view (*'I could be completely wrong'*), they point specifically to the net zero transition as a factor which made the '*revival'* of the technology seem like an unlikely. The net zero policy seems to be then presenting a different reality from which shale gas is very *'remote'*. While there is some nuance in the statement, pointing to *'the same old issues'* with shale gas, still the net zero transition is mentioned as a factor which shapes how the future of shale gas is envisioned by the participant. Contrastingly, below is an example of how BECCS is seen as essential for the net zero transition:

'I mean in my view BECCS or some form of GGR (greenhouse gas removal) is absolutely 100% necessary (to get to net zero) because we can't get to zero in every sector. That's never going to happen.'

Peter, Energy Industry Representative and Energy Consultant (BECCS Interviews)

Expressed with much more certainty than in the previous example, this quote also shows a specific kind of relationship between energy technology and the net zero transition. Where the previous quote described shale gas development being very remote *because* of the net zero transition, this quote alludes to net zero transition being possible only *because* of BECCS. Whilst the caveat is given that potentially other greenhouse gas removal technologies

could also serve the same function, BECCS is by far the most deployment ready (Fajardy et al., 2019) negative emission technology which uses some form of greenhouse gas removal. Additionally, the issue presented is that net zero is seen as an achievable goal compared to absolute zero, which is here discussed as completely out of reach (‘*never going to happen’*). Expressed with a high level of confidence, what is described is a future vision of the net zero transition which is dependent on the development and deployment of greenhouse gas removal technologies. Whilst then BECCS is seen as a necessity within this particular understanding of the net zero transition, shale gas is seen as a hindrance to successfully reaching the net zero goal. This relationship between the net zero transition and shale gas is then described in the quote below:

‘And now that shale gas isn't happening in the UK, you don't see alarm bells going off that we are going to suddenly suffer from gas shortages or energy shortages. You know the market has worked this out just fine and renewables are now scaling to meet that demand and improving themselves to be cost-efficient. So, no, I don't think shale gas would have helped us on the pathway to net zero at all, quite the opposite.’

Henry, Academic (Shale gas interviews)

Here the argument is twofold as to why shale gas does not play a role in net zero transition. Firstly, the argument is that the energy demand for gas supply is not there because it is being met by renewables, and so regardless of the transition shale gas is seen as redundant. At the same time, the quote finished the pointing out that not only would shale not have been helpful, but it would also have held the transition back and not aided it in any way (‘*quite the opposite’*). And so, any future developments of shale gas are ruled out and also identified as counter to decarbonisation efforts, as so again presenting the vision of net zero that depends on the absence of shale gas. Contrastingly to the statement that shale gas *‘isn’t happening in the UK’* when discussing the role of Drax and the investments made into BECCS, some participants expressed clear optimism about BECCS *‘happening’* so to speak and playing a substantial part in the meeting of the net zero targets. Whilst the challenge

associated with the development of BECCS and pursuing the net zero target is still acknowledged; it is seen as a positive challenge and as an opportunity as opposed to a hurdle or a hindrance as is the case with shale gas:

'Things can be done and I'm much more optimistic, actually that we will reach net zero than I was 5 years ago. Things are moving so quickly, there is such an appetite. And you know once people realise there's a business challenge and an academic challenge that can be innovative. So, I'm more optimistic than I was, that's for sure.'

Dominic, International energy/sustainability/environmental organisation representative (BECCS Interviews)

This vision of the net zero transition then described a very specific relationship between the energy technologies and the transition itself, which I have also illustrated in the figure below (Fig. 1) – the net zero transition, BECCS and decarbonisation are seen as moving in one direction and connected positively, whilst shale gas development is seen as a move away from the overall goal of decarbonisation.

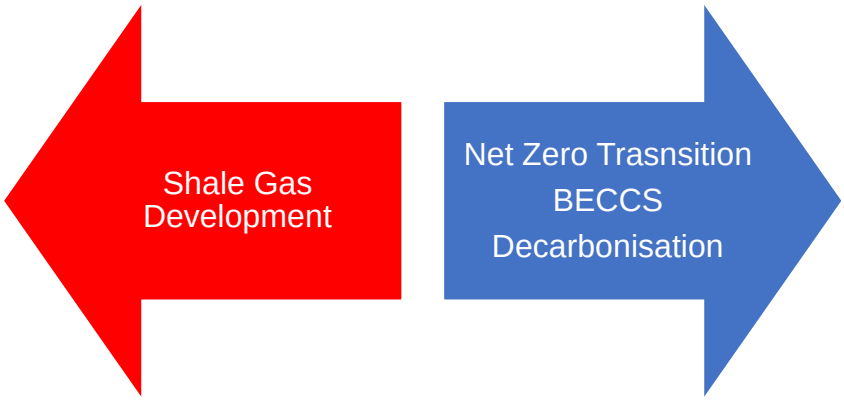

Fig. 2 1st type of vision: Dependent

6.3.2 2nd type of vision: Independent

The second type of vision, which I will describe in this section, is based on how the net zero transition was understood and made sense of in the following two discourse coalitions: *'Shale Gas 'Doomed from the Start'* and *'BECCS as a 'Non-Starter'*. In either of these two discourse coalitions the timeline and the development trajectory of the technologies and the net zero policy are viewed as independent of each other, with the latter not being framed as influencing

the understanding of the former. In the 'Shale Gas *'Doomed from the Start'* discourse coalition the abandonment of shale gas as an energy technology has been explained either through geological or economic factors, neither of which were connected to the introduction of the net zero policy. In other words, the view is that regardless of decarbonisation policy changes, the trajectory of shale gas development would have still been the same, as emission reduction targets will not change or affect the density of the population around shale gas sites. In the discourse coalition '*BECCS as a 'Non-Starter'*, the future development trajectory of BECCS is seen as potentially difficult because of technological complexities and limitations associated with carbon capture and storage and the sustainability and supply logistics of biomass feedstock.

The net zero policy or meeting the net zero 2050 target is then not primarily framed as dependent on either of the developments of shale gas or BECCS, the relationship is framed through a different lens than is the case in the previous vision of net zero I described in the section above. Whilst in the previous vision the net zero transition was largely seen as dependent on the development of BECCS which was then framed as a necessity for a decarbonised future, whereas shale gas was viewed as a spectre of a carbon-intensive past.

The quote below illustrates well how BECCS is not seen as a necessary tool to reach the net zero target. Instead, it is positioned as a convenient solution, a replacement for other decarbonisation measures based on behavioural change, such as flying less:

'In their (CCC) analysis BECCS is largely in just because we don't want to stop flying. It's the extent to which we need it, it is essentially around us. It's around the assumptions around behaviour, about the speed of decarbonization on the global scale.'

Matthew, Environmental non-governmental organisation representative (BECCS interviews)

Within this vision of the net zero transition, it does not depend on BECCS. Rather, BECCS is framed as necessary only to the extent to which behavioural change provides carbon reduction across other sectors, like aviation. The role

that individual decarbonisation plays in achieving meeting decarbonisation targets is questioned here, pointing to unwillingness to change. BECCS is then seen as largely compensatory to make up for the difference that limiting aviation would make. BECCS is then not a necessity for practical reasons, as lowering carbon emissions could be achieved through other means, but rather a preferential solution to avoid having to make that change (‘*We don’t want to stop flying’*). This notion that decarbonisation is not an issue of finding the right technology, or solely dependent on negative emission technologies, but rather an issue of societal change is also further explored in the quote below:

‘We don't need to develop more technology to achieve net zero. Yes, of course, technology will evolve between now and 2040, and 2050, which will make the journey easier. But it's this is fundamentally no longer a technological problem. This is a problem of shifting public attitudes choosing behaviours and getting the politics right. So, the right policies are put in place.’

Martin, Environmental non-governmental organisation representative (Shale gas interviews)

The net zero transition goal is seen as independent of any technological developments and needs, and whilst technological developments are seen to make the transition to net zero easier *(‘make the journey easier’),* they are not framed as the deciding factor in the success of reaching the net zero emission goal *(‘this is fundamentally no longer a technological problem’*). The net zero *‘problem’* is then reframed not as a *‘technological issue’* but as an issue of politics and public attitudes. In turn, the success of the target is seen as dependent on public attitudes and changes in behaviour as opposed to technological development. This contrasts with the first vision, where the net zero 2050 target is mainly interpreted as dependent on energy technological solutions the presence of negative emissions technologies and the absence of fossil fuels. At the same time, under-developed technologies such as BECCS are not completely dismissed either, as there is an acknowledgement of possible development during the transition, but it is made clear that although it would be welcome, it is not necessary. In other words, the relationship between net zero and developing technologies, such as BECCS, is not seen as

conditional, with the former relying on the latter, as a means to an end kind of relationship.

The perceived independence of the development of shale gas and the net zero policy is well presented in the quote below:

KT: Fracking, being able to play a role in that transition at all - Do you feel like that (announcement of the net zero targets) was sort of the end of fracking the UK?

'I don't think that (the net zero transition) was the end (of shale gas). I think the seismicity and the general election were the ends, so there's a technical reason for stopping fracking in that we couldn't predict the earthquakes.'

Thomas, Academic (Shale gas interviews)

Here's an example of how the relationship between the net zero transition and the trajectory of shale gas in the UK is seen as completely independent of each other. The introduction of the net zero transition is not seen as the main barrier or ending factor of shale gas developments in the UK, instead, the main barriers identified are geological and political. Although there is more emphasis on the '*technical'* reasons it also alluded to the unpopularity of shale gas and the potential implications for the then-upcoming general election results.

In the previous section, I have described how the net zero transition is viewed as dependent on the absence of shale gas or any other additional fossil fuel developments. Within this view of the net zero transition, the relationship between fossil fuels, such as shale gas, and the net zero transition is not seen as antagonistic. The net zero transition is not framed as dependent on the absence or presence of certain technologies as the existence of fossil fuels is not seen as contrary to reaching the net zero goal:

'There's no question we're going to be using gas. Even the most anti-oil and gas people can't produce any documentation which shows that we can get to net zero or at least close without oil and gas.'

Marcus, Energy Industry Representative and Energy Consultant

Whilst the previous understanding of the net zero transition viewed BECCS as a necessity, here the argument is presented that the net zero transition and its goals can be achieved (*'We can get to net zero'*) whilst still maintaining the use of fossil fuels, which is the energy technology that is framed as a necessity in this case, not BECCS. The mention of the *'producing documentation'* can be interpreted also as another way of saying that there is no way to support a vision which does not include natural gas. This view of the necessity of continuous use of gas or fossil fuels which do not impede the net zero transition was expressed frequently, particularly in interviews where the participants felt that shale gas developments were halted by physical, and geological factors as opposed to policy ones.

'I know all the evidence suggests that natural gas has a role to play in the energy transition because that's what it is. It's a process over the coming years to achieve net zero by 2050, and we're not going to stop consuming gas tomorrow.'

Nathan, Energy Industry Representative and Energy Consultant (Shale gas interviews)

The continuous use of gas throughout the transition presents a very different view of the transition from one where the net zero transition is perceived as swiftly moving from fossil fuels, whilst this view of the net zero transition leaves more scope for fossil fuels to be part of the transition. Another argument being made in envisioning shale gas playing a part in the net zero transition is the continued need for gas in the UK's energy mix. There is more room left to potentially use less or divest completely, as the participant acknowledges it is a *'transition'*.

Finally, the argument is made, that regardless of whether shale gas is viewed as a bridging fuel, or as lower carbon, it is an essential part of the energy system. This then does not change or is independent of the different decarbonisation policies, such as the net zero policy.

'I think we've seen less gas being positioned as low carbon or lower carbon in relation to net zero. What I see now is gas being positioned as a bridge fuel,

transition fuel or essential to have a backup to non-renewables. And so even if it's not low carbon or zero carbon, it's essential in the energy system.'

Ben, Regulatory organisation/civil service representative (Shale gas interviews)

Some of the storylines, specifically the ones contained within the *'Shale Gas: Spectre of the Past'* discourse coalition, are based on the argument that it was the net zero transition announcement which was the final and most important reason for shale gas not progressing in the UK because the transition is fundamentally not compatible with any new fossil fuel development. However, this particular vision of the net zero does not frame the transition as dependent on any particular technological developments and also does not see the transition itself as a key deciding factor in the trajectory of shale gas. And whilst BECCS is acknowledged as a welcome technological development which could aid the transition, it is centred as the key to success the way it is in the previous vision of net zero.

In the graphic below I have visually represented the relationship between the net zero transition, BECCS and shale gas. In comparison to the previous depiction of the relationship between the three, net zero is independent of the BECCS developments, but developing BECCS is seen as a helpful component in the net zero transition. Secondly, whilst any future development of shale gas is viewed as highly unlikely, fossil fuel use as such is not seen as directly opposed to the process of the net zero transition. Below I have illustratively depicted the relationship between the net zero transition and the energy technologies as described in this vision. The arrows point in the same direction as they are all able to progress regardless of each other, however, shale gas is positioned behind as the '*Shale Gas: Doomed from the Start'* which this vision is based on is seen as very unlikely to progress.

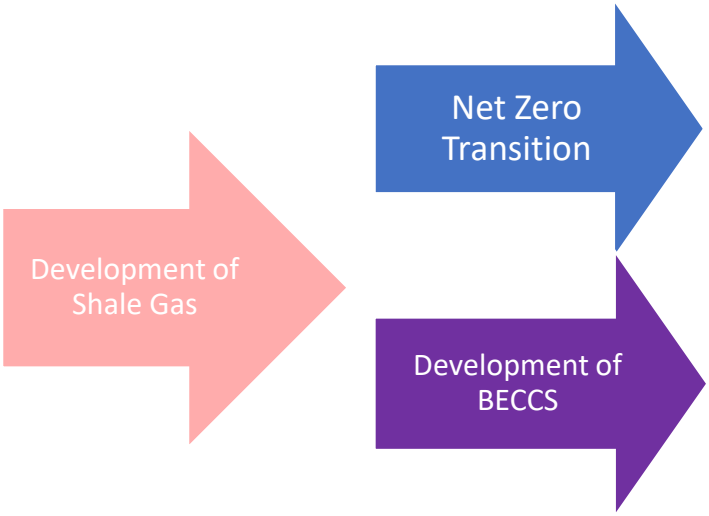

Fig. 1 2nd type of vision: Independent.

6.3.3 3rd type: Question of Fit

This is the third and final vision of the net zero transition. It is based on the way the transition was understood and made sense of in the discourse coalitions '*Shale Gas Wrong Place Wrong Time'* and '*BECCS as Good Fit'*. I have referred to this particular vision as the '*Question of Fit'* to accurately describe the type of relationship between shale gas, BECCS and the net zero transition that is described within these two discourse coalitions. The energy technologies are either seen to fit in with the net zero transition or not to fit in with it, that is predominantly the lens they are viewed through as opposed to through the lens of their environmental impacts or sustainability. This vision is different from the first type, where the relationship between the energy technologies and the net zero transition is described as dependent as the net zero goal is viewed as impossible to meet without BECCS and with shale gas. In the two discourse coalitions drawn from here, the participants viewed the relationship between shale gas, BECCS and the net zero transition as based on convenience and fit rather than dependence. Shale gas is then not viewed as inherently bad, however difficult to put into practice in the UK as it would be politically unfavourable and not *'fit'* in with the decarbonisation efforts of the net zero policy. Unlike in the first vision of net zero (Dependent), the narrative of shale gas as a bridging fuel to a decarbonised future is not dismissed, and it is suggested that under different political conditions, and perhaps with a different policy pursuing future shale gas developments might be possible, if

not necessary. It is not viewed as a technology of the past, but rather appropriate in different environmental and policy circumstances. BECCS is then seen as an energy technology that on the other hand does 'fit' the policy, or even is seen as a product of the policy but is not necessarily viewed as necessary for decarbonisation overall.

Within the '*BECCS as Good Fit'* discourse coalition, the net zero decarbonisation pathway is largely seen as problematic. The 2050 goal is viewed as insufficient with earlier targets than the 2050 target being preferable. However, reaching the 2050 net zero goal is viewed as feasible. And within the '*Shale gas Wrong Place Wrong Time'* the net zero transition is viewed largely positively, but also not as absolute, with possible future policy changes acknowledged. What the discourse coalitions then have in common, is that unlike in the other discourse coalitions, the net zero transition is seen as neither overwhelmingly positive as a correct decarbonisation policy nor as a completely unacceptable policy approach which should be substituted with an absolute zero emissions reduction approach instead *('BECCS as a 'Non-Starter'*). What this vision shares with the last one ('*Independent'*), is that it also does not see scaling as a necessary component for decarbonisation neither is there an emphasis on the absence of shale gas for the success of the net zero transition like in the first vision of net zero. An example which describes well the relationship between net zero and shale gas is laid out here, as it is presented that the net zero policy made shale gas '*less palatable'*, meaning less desirable, less fitting, and more difficult to pursue, resulting in pressures to reduce the production and consumption of fossil fuels.

'It just became very, very challenging. And of course, the backdrop was the fact that the net zero agenda started to emerge. And again, that meant there was further pressure on the reduction in hydrocarbons being shale gas or any other type of hydrocarbons. And of course, the desire - you know - it was becoming less palatable to support that kind of industry.'

Simon, Academic (Shale gas interviews)

What is not mentioned, however, is whether shale gas was feasible as an energy technology or whether there were any geological challenges. It is

important to note, that the moratorium on shale gas was announced after the net zero announcements and that the main reasons that were cited were related to the unpredictability of seismic events, as opposed to lowering carbon emissions by not pursuing new fossil fuels. It is also implied that the announcement of the net zero policy may have affected the public perception of shale gas. The relationship between the net zero policy and the moratorium on shale gas is then not seen as an entirely causal one.

Some participants viewed the analysis of the relationship between shale gas and net zero as something only possible to do because of the benefit of hindsight, in that before the net zero agenda was set, having a pathway dependent on negative emission technologies was up for debate. However, after it became clear that net zero is the approach to decarbonisation that is going to be taken, it then became easier to identify the technologies, that will not be a part of that decarbonisation effort. One participant pointed this out by referring to the '*benefit of hindsight'*:

'No, there's also sort of, and I guess that (view of shale gas) comes with the benefit of hindsight, but no sort of the UK being in the net zero 2050 transition.'

William, Academic (Shale gas interviews)

In this vision, both shale gas and BECCS can exist concurrently also, if the policy were to change, as neither of them is seen are seen as fundamentally undesirable. An example of this is the quote below:

'I think one of the communication issues at that time was that people in the general population might not have understood why we need bridging fuel too to help the journey to lower carbon futures. And I think the perception of 0 carbon future or net zero hadn't been discussed. '

John, Energy Industry Representative and Energy Consultant (Shale gas interviews)

The public resistance to shale is explained merely as an issue of communication. And specifically, the lack of communication of the message that shale gas is needed as a *'bridging fuel'* to a lower carbon future. There is a distinction here then between a lower carbon future and a future pathway

toward net zero. Implying if the policy were to change, that there is an alternative decarbonisation policy pathway which could include shale in some respects. The quote then shows an example of ongoing fossil fuel use alongside pursuing decarbonisation as being able to run concurrently. That is for several reasons, firstly, because shale gas is seen as a vehicle, or a bridge as is more closely described in the previous chapter, to pursue decarbonisation efforts. And secondly, here the end goal of those decarbonisation efforts is discussed as a *'lower carbon'* future, which is a different goal from pursuing a zero-carbon future, be it net or absolute zero. The bridge metaphor is then seen in some sense as expired in the context of the net zero policy. In other words, the bridge was seen as a bridge to a lower carbon future, not to a zero or net zero carbon future, it does not fit in the current net zero policy. Continuing to use the metaphor, the goalpost has moved, and the oil and gas bridge is too short so other *'bridges'* in the form of BECCS and other technologies must be pursued. This is because they are understood to have the power, understand length, to act as a bridge to the net zero future.

This third vision of the net zero transition then describes the relationship between the net zero transition, BECCS and shale gas as fitting in with each other, rather than their development being dependent or independent of each other. In the figure below I have visually depicted the relationship described in the energy technologies and the transition as described in this vision, whereby BECCS '*fits in'* with the net zero transition, but shale gas does not.

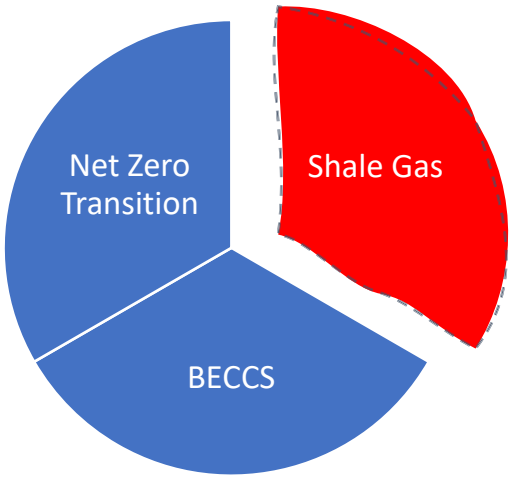

Figure 4 3rd type of vision: Question of Fit

6.4 Conclusion

To answer the third research question ***How do the visions of net zero promoted within the different BECCS and shale gas discourse coalitions compare?*** I analysed the six different discourse coalitions which I have established in the previous two chapters and narrowed in on the specific ways in which the net zero policy is viewed in each of them, what language is used to describe it and what the role of either BECCS or shale gas is imaged to play within it. I then identified three types of net zero visions across the six discourse coalitions. The first I refer to as *'Dependent'* because the net zero transition is seen as dependent on the development of BECCS and no new developments of fossil fuels. This type of description I have observed in the 'BECCS as a Legitimate Solution' discourse coalition, and the '*Shale Gas: Spectre of the Past'* discourse coalition.

The second type of vision, I refer to as *'Independent'*. The relationship between the energy technologies and the net zero transition is described in different terms, they are seen as being able to potentially co-exist but meeting the net zero target is not framed in relation to either of the two technologies. This understanding of the net zero transition presents itself for example when participants explain the lack of progress of shale gas solely in terms of geological barriers, as opposed to in relation to the decarbonisation policy. The

third type of vision of the relationship between the technology and the net zero I described as a *'Question of Fit'*. This is because shale gas was framed as not '*fitting in'* with the transition, and BECCS was described on the other hand as a technology that fits in well. This chapter's main aim was to compare the visions of the UK's net zero policy across the two energy technologies and the respective discourse coalitions related to those.

The conclusion is then that across the two energy technologies, and their respective discourse coalitions, they relate to the net zero target differently in the visions of net zero that are portrayed. Shale gas is only part of the visions of net zero in two cases, and that is if either the net zero target is viewed as an illegitimate decarbonisation strategy which excuses the use of fossil fuels, or it is seen as a decarbonisation strategy, but the target itself is seen as negotiable and the idea of shale gas as a bridging fuel is seen as permissible.

In the case of bioenergy with carbon capture and storage, in those storylines that view net zero as a legitimate decarbonisation strategy, BECCS and other negative emission technologies are seen as essential. The discourse coalitions which have a vision of net zero as not a legitimate decarbonisation strategy then view BECCS also not as a legitimate, climate change energy-solving technology, as the latter is seen as a symptom of the former. The argument is then that those discourse coalitions which had a positive vision of net zero as a legitimate decarbonisation strategy ('*Shale Gas: Spectre of the Past'*, *'BECCS as a 'Legitimate Solution'*) have a close and decisive relationship with the energy technologies. BECCS is seen as positive, legitimate, and important and as making progress towards net zero. Shale gas is seen as negative, and as an energy technology that decisively cannot play any part in reaching the 2050 target. And so then, BECCS is seen as a signifier of the future leading to the target of net zero carbon emissions by 2050, whereas shale gas is then viewed as a technology of the past. In conclusion, then, this chapter found that when comparing the different visions of net zero promoted by the discourse coalitions, both energy technologies have the same three types of visions. Net zero is understood as either dependent on, independent of, or being a good fit for the two energy technologies.

The net zero policy became a focal point in the interviews organically. Participants naturally made links between the points they were making and the policy, for example when explaining the prominence of BECCS or the demise of shale gas. The importance and gravitas of the policy were universally acknowledged across all the interviews, however, not all participants agreed to the point that it did have an impact on the particular trajectory of energy technology. Where the differences were found, is in the way the impact and its extent were interpreted. Secondly, the differences were also found in whether this is a sufficient policy as far as tackling climate change and thirdly, whether the policy and/or the goal of 2050 is at all negotiable. Below I present a table summarizing the different visions and the discourse coalitions they belong to:

Type of vision	**Discourse coalitions**	**Summary**
1st Type: Dependent	**Shale gas: Spectre of the Past** **BECCS: A Legitimate Solution**	The progress towards the net zero target, and so also to decarbonisation is seen as dependent on the presence of BECCS and the absence of shale gas in the UK's energy mix.
2nd Type: Independent	**Shale Gas: Doomed from the Start** **BECCS as a 'Non-Starter'**	The trajectory of BECCS and shale gas is seen as independent of the net zero policy, which neither propelled BECCS nor did it stop shale gas.
3rd Type: Question of Fit	**Shale Gas: Wrong Place Wrong Time** **BECCS as 'Good Fit'**	BECCS is seen as part of the energy mix simply because it fits in with the current policy. If the policy were to change, so would the preference for either shale gas or BECCS.

Table 6 ***Types of Net Zero Visions***

7 Discussion

7.1 Introduction

This thesis approached energy technologies as inherently socio-technical systems (Rohracher, 2001), which means that they cannot be understood only in technical terms, but as systems comprised of many elements including the technology itself, policies, energy providers, energy suppliers, energy consumers and other actors such as policymakers and activists. With the UK's net zero target, which poses technological, social, and economic challenges, this socio-technical understanding of energy technologies became even more important. The net zero transition itself depends on the deployment of carbon removal technologies and the scaling back of CO_2 emissions and burning fossil fuels (Committee on Climate Change, 2019). This transition has substantially shaped the UK's energy context, not least because the net zero 2050 target itself is legally binding. This provided an unprecedented and novel energy policy background. And so, the primary interest of this thesis was to research how then, in light of this new policy background the two energy technologies, BECCS and shale gas, were made sense of, how the net zero transition is understood, and how the future roles of the energy technologies within the net zero transition are envisioned and what kinds of discursive structures emerged in light of the net zero announcement. This focus was then reflected in the three data chapters, the first two which focused on the two energy technologies, and the third which focused on the visions of the net zero transition.

Shale gas and BECCS have been important features of the UK's energy map for various reasons for some time, which I have outlined in the Introduction chapter. Importantly, unlike, for example, conventional oil and gas, nuclear or renewable energy technology, neither of the energy technologies have reached the stage of commercial deployment. Instead, both exist in limited ways and are not (yet) moving past exploratory or trial stages. This, among other factors, differentiates them from more 'traditional' well-established energy technologies, which have a different precedent in terms of what they were able to contribute to the UK's energy landscape, the economy, carbon emissions, job creation etc. The biggest difference is that whilst there are various claims made concerning energy security, energy efficiency, and the

energy infrastructure, in the case of BECCS and shale gas these claims cannot be compared to reality or historical precedent in the way well-established energy technologies can. For example, we can compare the claims of North Sea oil and gas guaranteeing energy security to recent real-life examples of unstable international oil and gas supply or can comment on how challenging nuclear storage is from a regulatory perspective or reflect on the challenges of the availability of renewable energy technology in light of fluctuating energy prices caps because there are tangible experiences in this area to draw from. This lack of precedence and comparison leaves more room, than perhaps with the other mentioned energy technologies, for new BECCS and shale gas competing discourse coalitions to emerge. These differ in their assessment of the energy technologies' impacts, benefits, and drawbacks, which can be predicted and modelled, but are not comparable to examples of long-term use the way conventional, more established energy technologies can.

Assessing the impacts of energy technologies in the early stages of their development is notoriously difficult. This predicament was then also described by David Collingridge (1982) in what became known as the Collingridge dilemma: *'During its early stages, when it (technology) can be controlled, not enough can be known about its harmful social consequences to warrant controlling its development; but by the time these consequences are apparent, control has become costly and slow'* (Collingridge, 1982, p. 19). Therefore, the narratives that emerge around both shale gas and BECCS are arguably more important to pay attention to than the narratives around already established energy technologies, as there is more scope for the trajectory of the energy technologies to be changed and controlled. One such example of the dilemma between control and future impacts is the scale and availability of BECCS, which depends on the sustainability of the biomass supply and the future possibilities of providing domestic biomass as opposed to imported biomass. Therefore, the level to which BECCS is scaled up is crucial, as different scales could have varying environmental and emission outcomes (Donnison et al., 2020).

This thesis asked questions about how BECCS and shale gas are viewed and understood by key actors and deployed the methodological and analytical tools

of discourse analysis to try to answer them. The previous three data chapters demonstrated that there are several ways in which the role of two different energy technologies can be understood by different actors within the context of an energy transition. It also showed that there are varying ways in which the UK's net zero transition is viewed and how the role that different energy technologies play within it is conceptualised. Furthermore, the chapters found that whilst there is an equal number of discourse coalitions across both energy technologies, there is a distinct difference in the dividing factors between them. This is most evident in that whilst there is a clear pro-BECCS discourse coalition ('BECCS as a Legitimate Solution') such equivalent cannot be found among the three shale gas discourse coalitions, none of which are decisively pro-shale gas. Furthermore, the BECCS discourse coalitions are overall more future-minded, whereas the shale gas discourse coalitions largely reflect on the past of shale gas rather than its future. Additionally, within the BECCS discourse coalitions, there is one which is not just highly sceptical of BECCS but also of the concept of negative emissions and the net zero transition ('BECCS as a 'Non-Starter'). Equally net zero critical equivalents cannot be found among the shale gas discourse coalitions.

In this chapter, I will then discuss these results in detail and contextualise them by referring back to the literature discussed in Chapter 2. Firstly, in the 'Summary of results' section, I repeat the research questions and provide a summary overview of the discourse coalitions, and the storylines contained within them. I then specifically point out the difference between the shale gas discourse coalitions identified in this research and previous studies. In the following section 'Discursive Power and Resonance' I discuss the difficulty in identifying any one dominant discourse coalition and how the scaling up of BECCS could impact the make-up of the discourse coalition, and in particular change what is understood to be a plausible storyline. I then move on to discuss the net zero transition and what role it played in shaping the discourse coalitions and specifically how actors framed the futures of the energy technologies vis-à-vis the net zero transition. Subsequently, I then discuss the different ways risks were conceptualised within the different discourse coalitions, such as the risk of using a particular energy technology or the risk

of causing irreversible damage to the climate. Lastly, I discuss and explain why it is, that compared to the literature which is largely focused on the public acceptance of BECCS and shale gas, public acceptance did not seem to be a big topic in the research interviews.

7.2 Summary of Results

The core thread throughout this thesis is the focus on seemingly incomparable energy technologies in the unprecedented context of a newly established energy transition. The value of focusing on a comparative discourse analysis of two vastly different energy technologies in the context of the net zero transition is twofold. Firstly, it allowed me to gain an understanding of how the net zero transition itself and the unique and unprecedented policy context it provides has been made sense of by key actors. And secondly, how does this understanding of the net zero transition then reflect in the way energy technologies are perceived and how has this been linguistically conceptualised.

This thesis has then laid forward several arguments as to why focusing specifically on shale gas and BECCS as the two chosen energy technologies is useful. Firstly, BECCS and shale gas discourse can be compared based on both energy technologies being at some point in time considered to be able to play a role in a low-carbon transition. Secondly, the sustainability credentials of both energy technologies are not firmly established. Thirdly, they share the aspect of the use of the underground space. And lastly, at least in the UK, neither technology has scaled up (yet) to the scale imagined within various government or advisory bodies' visions. This differentiates them from other technologies and makes the comparison appropriate. And so, based on this premise I raised three different research questions:

What BECCS discourses exist? And which visions/narratives do they promote in the context of the UK's net zero policy?

What shale gas discourses exist? And which visions/narratives do they promote in the context of the UK's net zero policy?

How do the visions of net zero promoted within the different BECCS and shale gas discourse coalitions compare?

By interviewing thirty-one key actors, I identified that there are three different competing discourse coalitions connected to both energy technologies, which together consist of fifteen storylines. Each discourse coalition is distinct in the way that it understands the energy technologies and their role and potential, net zero transition, its role, and the future of energy technology. The storylines differ from each other based on the language, specifically, what different metaphors they employ when describing energy technologies and their futures.

Firstly, the analysis revealed that three distinct and competing BECCS discourse coalitions promote three distinct narratives of BECCS. The first of the three discourse coalitions 'BECCS as a Legitimate Solution' promotes the narrative that BECCS is a technology which is good and necessary and can play a genuine part in climate change mitigation and emissions reduction. The second discourse coalition 'BECCS as a 'Good Fit' promotes the narrative that BECCS is part of climate change mitigation as a result of policy and economic circumstances, as opposed based on its merit as a useful negative emissions technology. It *fits* in well with existing socio-technical systems. The view of BECCS is then not as positive and more critical than the first discourse coalition. Finally, in stark contrast to both the first and second discourse coalitions, the third discourse coalition 'BECCS as a 'Non-Starter' views BECCS as a non-viable energy technology. This view is based on the participants' belief that BECCS cannot be scaled up because it is technically too challenging to do so and not practically possible. The third discourse coalition is then a direct opposite of the first one, in that it views the net zero transition as not a genuine decarbonisation strategy but rather as a strategy of delay and BECCS as a practically in-operable technology which will not scale up to the demands required by decarbonisation. Therefore, alongside the dismissal of the sustainability credentials of BECCS, it cannot contribute to climate change mitigation in a meaningful way and poses a 'moral hazard' as the storylines in the third discourse coalition framed it. In other words, the difference between the first two discourse coalitions and the third one is the different views of BECCS feasibility, which the arguments about the practical difficulties of scaling up BECCS would fall under.

The shale gas discourse also consists of three discourse coalitions, which vary from each other, but in a different way than the BECCS discourse coalitions. The most glaring difference between the two sets of discourse coalitions is that the 'BECCS as a Legitimate Solution' discourse coalition, which views BECCS in a very positive light, does not have an equivalent among the shale gas discourse coalitions. Whilst the BECCS discourse coalitions offer a broad spectrum of understandings and opinions on the feasibility of the technology, the shale gas discourse coalitions differ from each other in the ways that they explain the absence of shale gas from the UK's energy mix and the way they view the net zero transition. And whilst the reasons for the UK no longer pursuing shale gas as an energy option varied across the discourse coalitions, there was no storyline or discourse coalition which offered a hopeful view of the return of shale gas or insisted on the importance of its presence in the UK's energy mix.

The first shale gas discourse coalition 'Shale Gas: Spectre of the Past' focuses on the incompatibility of shale gas and the net zero transition based on representing different eras of the UK's energy policy mix. Whilst the net zero transition is viewed as a step into the future, shale gas is viewed as a technology of the past. This perception of shale gas is then also emphasised by frequent comparisons between shale gas and coal, which is also presented as an outdated energy technology. This is done to argue that there is no reason for the return of shale gas and that it is not a necessary bridge to reach a lower carbon future, which is echoed in the 'Bridge to Nowhere' storyline. The second discourse coalition 'Shale Gas: Wrong Place Wrong Time' views shale gas as not inherently bad, but the policy environment in the UK as unfavourable for shale gas to be part of the energy mix in any capacity. In comparison to the previous discourse coalition, within this one shale gas is viewed as a potential bridging fuel to a lower carbon future, as reflected in the 'Bridging Fuel' storyline. Furthermore, the failure of shale gas in the UK is then interpreted as an issue of public unfavorability ('Bad Reputation' storyline) as opposed to an issue of technical implementation, as is the case in the third discourse coalition. In other words, the three storylines ('Bridging Fuel', 'Domestic Security', and 'Bad Reputation') contained in this discourse coalition, share the

view that shale gas is not being pursued for reasons we could describe as circumstantial or situational, such as the net zero transition and a lack of public support. The third discourse coalition ‘Shale Gas: Doomed from the Start’ dismisses shale gas as inoperable regardless of the circumstances of the net zero transition or overall favourable policy and public acceptance conditions. This is because physical factors such as population density, the effects of fracking-induced earth tremors and the volume of shale gas available (‘Geological Factors’ storyline) alongside economic concerns (‘Lack of Pay-Off storyline) are seen as the biggest barriers to the technology’s progress, compared to the second discourse coalition, where the net zero policy is seen as the decisive barrier. Based on this, the third discourse coalition also frames shale gas as not only unnecessary but generally as not a good idea, because of unsuitable geology, unfavourable public support, and unsure financial payoff, regardless of the current energy and decarbonisation policy approach. To illustrate this, comparisons are drawn with the perceived successes of shale gas in other regions, like the US, and pointing out that these do not translate into the UK context, because of the aforementioned barriers which were present even before the announcement of the net zero transition. Reflecting the ‘Geological Factors’ storyline of the third discourse coalition, in April of 2022, well into the net zero transition which was announced in 2019, the UK Government issued a call for a scientific review of shale gas. This was done to assess if it became any easier to predict earth tremors, which was seen as the deciding barrier to employing shale gas.

There are then in total 6 distinct and competing shale gas and BECCS discourse coalitions, each of which proposes a different vision of the net zero transition and the energy technology within it. Whilst the first two data chapters focused on analysing and describing the six different discourse coalitions and the storylines within them, the third data chapter focused on the visions of the net zero transition as described within the six discourse coalitions. This was so to reflect the overwhelming focus and interest the participants had in the net zero transition within the interviews, and the degree to which they used it as a point of reference when discussing the two energy technologies. Upon close analysis of the language the participants used to describe the net zero

transition, and more importantly the relationship of the net zero transition to the two energy technologies, I identified three different types of visions: ‘Dependent’, ‘Independent’ and ‘Question of Fit’.

The first vision, I referred to as ‘Dependent’, because it presents the view that the future of the net zero transition is as dependent on the development of BECCS and the absence of the development of shale gas. This is based on the ‘BECCS as a Legitimate Solution’ and ‘Shale Gas: Spectre of the Past’ discourse coalitions. The second vision of the net zero transition as described in the ‘Shale Gas: Doomed from the Start’ and ‘BECCS as a ‘Non-Starter’ discourse coalitions I described as ‘Independent’. This is because the trajectory of the net zero transition and the progress or lack thereof of the two energy technologies are seen as separate and independent of each other. This is because the barriers to the development of BECCS and shale gas are not described as policy-based but as technological and based on physical realities which a policy change would have little to no impact on. Thirdly, the last vision is based on the understanding of the net zero transition within the ‘Shale Gas: Wrong Place Wrong Time’ and ‘BECCS as a ‘Good Fit’ discourse coalitions I refer to as ‘Question of Fit’. This is because the relationship between shale gas and BECCS and the net zero transition is viewed as a question of good or bad fit which then also dictates the trajectory of the energy technologies. In other words, the pursuit of BECCS and not of shale gas is so, because BECCS fits in with the current decarbonisation policy framework and shale gas does not. If the framework were to change, so would the development of these technologies.

This broad spectrum of visions is firstly indicative of the socio-technical nature of the net zero transition and the many different aspects key actors take into consideration as they try to make sense of it and anticipate its future developments. Secondly, it is also indicative of the relative novelty of the net zero transition itself, which was only introduced in 2019. Whilst the net zero 2050 target is legally binding, the various pathways to get to net zero are negotiable from a policy perspective which is what leaves the room and scope for these diverging visions of the net zero transition to form within the various discourse coalitions.

What the six different discourse coalitions laid forth, is the degree to which both technologies are contested. Although coincidental, finding three discourse coalitions in both energy technologies showcased the wide spectrum of views on the potential of both shale gas and BECCS. Whilst previous papers (Bomberg, 2015; Williams et al., 2015), had identified strong pro- and anti-shale gas discourse coalitions, this research found that the context of the net zero transition changed the makeup of these discourse coalitions. Firstly, the most obvious change is the addition of a third discourse coalition, and secondly, it is evident that whilst the discourse coalitions differ in the arguments they lay forth, they are not as polarised as was the case in the findings from previous research. Previous research on shale gas (Metze, 2018) also showed that in the past both coalitions in support and in opposition to shale gas development have utilised the argument about a pessimistic future outlook, arguing that a future with or without fracking (depending on the case they are trying to make) is highly undesirable.

Previously, the competing shale gas discourse coalitions were centred around environmental impacts, ecological modernisation, energy security and environmental justice (Cotton et al., 2014). Furthermore, issues such as the industrialisation of the countryside and inadequate regulation were a diverse set of frames and different issues than the ones found in this research. Williams et al. (2015) found in their research two competing coalitions, consisting of clear pro-shale coalition frames and anti-shale coalition frames. One of the important points of difference between findings from previous years, such as the Williams et al. (2015) and Bomberg (2015) and the findings in this research is that the pro and anti-shale gas discourse coalitions are much more polarised and more obviously mutually exclusive, with a pro- and anti- shale divide. However, in this research, different concerns such as the compatibility of shale gas with future energy transitions or the reasons for the failure of shale gas development in the UK divide the discourse coalitions. Therefore, they cannot be labelled as simply pro- or anti-shale gas.

The other obvious difference in the discourse coalitions presented in this thesis compared to those in previous research is that they largely provide a retrospective view as the key actors interviewed had the benefit of hindsight of

the announcement of the moratorium on shale gas in 2019. Under the new circumstances of the net zero transition, the moratorium on shale gas and with the benefit of hindsight, being ‘pro-shale gas’ would mean being supportive of energy technology with a limited future potential. Whereas at the time in which the other research studies that found a distinctly pro-shale gas position within their findings took place, before the net zero transition announcement and the moratorium, there was more scope for future shale gas possibilities and opportunities which in turn made the pro-shale gas position perhaps more attractive to key actors.

Additionally, the findings correspond to those of Gunderson et al. (2020) who looked at how fossil fuels companies and trade bodies frame CCS, they found three ways in which it is framed, firstly as ‘faith in innovation’, which corresponds to the first discourse coalition ‘BECCS as a Legitimate Solution’ which views BECCS in a positive way as an essential part of the net zero transition. The second framing that Gunderson et al. (2020) found is value instrumentalization, whereby economic factors are cited to explain the technologies' prominence. This aligns with the second discourse coalition ‘BECCS as a ‘Good Fit’ which also explains BECCS as a part of the current policy and economic conditions, as opposed to a techno-fix (Johnston, 2018). And finally, Gunderson et al. (2020) identified a third frame, as ‘status-quo maintenance’ or ‘fossil fuel–lock-in’, which in this research best corresponds to the ‘Good Fit’ storyline, that argues that BECCS is the preferred carbon removal technology because it fits in with existing systems and thus enables the maintaining of the current socio-economic status-quo including the use of fossil fuels. Unsurprisingly, given that Gunderson et al. (2020) looked at how fossil fuel companies framed CCS, there is no overlap concerning the third discourse coalition, ‘BECCS as a ‘Non-Starter’ which questions the sustainability and environmental credentials of BECCS.

This comparison between the findings of Gunderson et al. (2020) and the research presented in this thesis shows that, firstly, there is an overlap between CCS and BECCS framings. Secondly, the addition of biomass to CCS, thus making it a net negative emissions technology does not make a substantial difference as far as the framing of the technology goes. Thirdly, it

raises the question of the influence of the fossil fuel industry on how negative emission technologies are framed and why there is a close overlap between the fossil fuel companies' framing of CCS and the framing of BECCS among key actors interviewed in this research.

Another difference between the discourse coalitions regarding shale gas and BECCS is the questions they raise and the type of claims that they make. There are claims made about both energy technologies that create a binary yes or no answer. One such claim is for example whether there is 50 years' worth of shale gas supply available or not. A second example of a binary question relates to BECCS, which either can be scaled up or not. Whilst it would be wrong to suggest that scaling up of the technology might resolve the discursive struggle around it, it might however force a shift in the discourse, the way the shale gas moratorium and the net zero transition shifted the discourse and changed the types of claims made and questions asked about shale gas.

As the net zero transition progresses there will be an increasing need and pressure for creating negative emissions, which BECCS is a key part of as the most deployment-ready negative emissions technology (Haszeldine et al., 2018). This pressure to make progress on BECCS will likely result in sizeable technological developments which might change the focus of the BECCS discourse altogether and push other aspects to more prominence. For example, what was absent from the discussions around BECCS in the interviews was the logistics of carbon transport from the carbon capture site to the carbon storage site. As this is not firmly established, with different suggestions for onshore carbon transport as well as offshore carbon transport (Freer et al., 2021; Singh et al., 2021), it can be anticipated that when this issue becomes more pressing and physical infrastructures start to develop, this will become a more important focal point in the discourse as there is a narrowing down or shifting away from the scalability question. In comparison, there are unlikely to be infrastructure developments of this scale in shale gas, and so the discourse coalitions might largely remain the same as in the future.

This research also exposed the unique nature of the BECCS discourse. BECCS is treated as a singular technology within the discourse, but it is comprised of many elements each of which is a point of contestation. One of the focal points of the discursive struggle is the sustainability of biomass, another is the security and the subsequent necessary multi-generational stewardship of long-term offshore carbon storage, and another one is the CO_2 transport. The difficulty with all these points of contestation is that their respective developmental trajectories do not necessarily overlap, e.g., if the sourcing of the biomass at Drax is discursively established as sustainable, that is not likely to have an impact on the concerns regarding the practicalities of storage. At the same time, the pro-BECCS arguments based on the established knowledge of the geology of the depleted oil and gas wells in the North Sea are unlike to shift the concerns regarding the sourcing of biomass wood pellets for Drax power station from the US and Canadian forest. The scaling up of BECCS requires large sums of investment, and commitment to building large-scale infrastructure, like CO_2 pipelines, managing CO_2 storage, negotiating between foreign and domestic biomass supply chains and much more. However, seeing scaling up of BECCS primarily as a socio-technical endeavour, it also depends in part on a favourable political environment and discourse. In other words, the scalability of BECCS is not independent of the BECCS discourse and so the question about scalability and the potential of BECCS cannot be resolved purely by technical means, which is why paying close attention to the developing discourse and storylines is important.

7.3 Discursive Power and Resonance

Maarten Hajer frames discursive power as succeeding at structuration and institutionalisation (Hajer, 2000). Discourse structuration happens when the discourse takes over and dominates how a particular social unit makes sense of the world. Discourse institutionalisation then happens when the discourse solidifies into institutional arrangements. If both structuration and institutionalisation occur, then we can say that the discourse is dominant. In simplified terms, if the discourse is commonly used among people to make sense of the world, then that is structuration. In the next step, if the discourse solidifies into an institution, then we speak of institutionalisation. The obvious example from this research to demonstrate both concepts is the net zero

transition and the concept of net zero itself. It is the dominant decarbonisation and energy policy discourse as opposed to other policy alternatives, such as absolute zero emission reduction. The dominance of the net zero discourse is demonstrated firstly by the fact that all the participants in this research linked the energy technology they were talking about to the net zero transition in some way or another, even if it was to make the point about how little role the transition played in the development trajectory of the energy technology. It has been brought up by most of the participants on their own accord, and so *'net zero'* meets the criteria for structuration. This is because the net zero transition is being used to make sense of the energy policy landscape by the participants, so much so, that it appears impossible to talk about energy technologies in an interview without a reference to the transition. There was a certain acceptance with regards to either the concept of net zero emission or the transition itself, with only a limited space in the discourse coalitions being given to opposing views, and even less to proposing alternatives, such as absolute zero, which only came up in the third BECCS discourse coalition '*BECCS as a 'Non-Starter'*. There was also a certain degree of confidence when the participants used the term '*net zero'*, it seemed very commonplace and not out of the ordinary.

As far as institutionalisation, the UK Government has replaced the previous Department for Business, Energy, and Industrial Strategy with the Department for Energy Security and Net Zero, thus creating an official institution for the net zero discourse. However, this Department was not established until February 2023, well after the data collection had been finished, and sometime after the net zero transition had been announced in 2019. Based on these two examples, it is therefore safe to say that both criteria that Hajer established for discursive dominance, institutionalisation, and structuration, are met, and because of that the net zero transition now has a substantial influence over how energy technologies are framed within the UK's energy context and is the dominant lens through which past, current and future energy technology developments are looked through and judged.

When assessing the discursive dominance of the different discourse coalitions across shale gas and BECCS, it would be difficult to speak of any of the

discourses as dominant, as there is not an obvious commonly shared understanding of BECCS as a sustainable energy technology nor is there a shared common understanding of why shale gas is not being pursued, which are the main dividing factors across the 6 different discourse coalitions. This difficulty in identifying a clear dominant discourse in either technology suggests that the discourse might continue in the future and settle then, for example, if BECCS is shown to be viable and sustainable. At the same time, particularly the shale example demonstrates this well, even if the discourse settles, the question around biomass sustainability settles and one coalition will become dominant, but this does not mean that other questions might not arise. The question at the heart of the shale gas discourse is no longer whether shale gas should be a technology that is pursued. Rather, the question which prompted the split into the three discourse coalitions detailed in this thesis, is why shale gas did not materialise into an energy technology viable at an industrial scale in the UK. This then shows, that although the argument can be made that the anti-shale gas coalition succeeded over the pro-shale gas coalition and institutionalised into a moratorium policy, that does not mean that new prompts for discourse around the energy technology will not arise and that overall, the discourse around shale gas is settled. Where previously the main question, which split the discourse, was whether fracking should happen in the UK and why it should not happen. This has changed now, as the question which splits the discourse on shale now is why it currently does not happen. In some ways, this net zero transition has shifted, from what could have been determined as a '*discursive lock-in'* of shale gas between established pro or anti-shale discourse coalitions into a different set of discourse coalitions altogether. Instead of the previously established pro- and anti-shale gas coalitions, I have found three which seem to be resigned to the fact that shale gas is difficult to pursue in the UK for a myriad of reasons.

With regards to BECCS, establishing a positive dominant discourse is important, because the assumption is that without a dominant discourse, it will be more difficult to establish BECCS as a widely rolled-out energy technology (Donnison et al., 2023) which is necessary not least because of the reliance on negative emissions technologies to meet the key net zero target (Climate

Change Committee,2019). Particularly, as Bradshaw et al. (2022) mentioned the net zero transition will need its own *'social license to decarbonise'* which they argue will not be achieved if a shared vision of the energy technology is not established.

What this research gave an insight into, is that there is a dominant BECCS discourse coalition and that the visions of BECCS presented by actors within different storylines vary. This lack of a shared vision of BECCS among the key actors could become a pitfall in the development of BECCS as key actors also become key communicators. And so, if a positive message about the technology is important for its development, it is not desirable that some key actors perceive the technology as un-feasible and technologically in-operable as is the case in the third discourse coalition *'BECCS as a 'Non-Starter'*. Some aspects of the discourse are more likely to shift over time than others. For example, BECCS can either be a scalable technology, as per the first two discourse coalitions, or not, as per the third one. The focal point on scalability might lessen if BECCS becomes a technology functioning at an industrial scale and moving beyond trial stages. Then a new question could arise, shifting from *whether* BECCS is scalable to the question of to *what extent and to what scale exactly,* which might become the focal point of the different discourse coalitions and the scalability of BECCS might be taken for granted by actors in the future. As Hajer (1997) writes, discursive struggles do not take play in a vacuum (p.60) and so the changing context is important. Not least, because, the power of storylines, as Hajer writes is based on the idea of what *'sounds right'*. And what *'sounds right'* might change with context, because as Hajer points out what sounds right is not only influenced by the trust in people who utter these statements but also by the plausibility of the argument that is being made. Bomberg (2015) also discusses the importance of storylines, which she assesses based on how they resonate how they are framed and how the resonance of these might change.

This shift happened in the shale gas discourse, where the low likelihood of shale gas materialising in the UK is taken for granted by the respondents, and so the discourse shifted to justifying, explaining, and understanding the cause of the low likelihood. If BECCS is not scaled up then it does not mean that

actors will accept this as proof of the fact that BECCS is not scalable, but they might rely on different arguments, different metaphors, and storylines to explain and justify why a potentially viable technology has not been scaled up. Thus, the scaling up of BECCS from being in the trial stages it is in now, could render some of the storylines as sounding implausible and so change the dynamics of the discourse coalitions.

Using Hajer's example of acid rain and dead trees (Hajer, 2005b), he argues that once the perception of dead trees shifted from seeing them as a *'natural'* phenomenon but rather as a result of acid rain, they then became a signifier of the structural problem of how we deal with pollution, and what its consequences are. If the *'BECCS as a 'Non-Starter'* discourse coalition were to become dominant, and key actors started framing the technology as unsustainable or even harmful because of the types of biomass sources (Drax has been accused of sourcing biomass from virgin Canadian forests (Snowdon, 2024), this could open a new set of question, such as '*What sort of decarbonisation policies rely on a harmful energy technology? How is burning trees for biomass justifiable when trees store carbon too? What sort of Government subsidises this kind of energy technology?'*.

The resonance of the discourse coalition and storylines is however difficult to ascertain in a fast-moving energy transition context, particularly if the discursive resonance is to be determined by what the current policies are. In September 2022 the UK Government under the leadership of Liz Truss, lifted the moratorium on shale gas for a brief period, only for it to be reinstated by new Prime Minister, Rishi Sunak, a month thereafter. Whilst the goal of the net zero policy is to reach net zero emissions by 2050, which requires a rapid reduction of CO_2 emissions and no new oil and gas licenses and developments (Committee on Climate Change, 2019) the goal of the shale gas policy was to create new opportunities for onshore shale gas development, which would have contributed to greenhouse gas emissions and thus undermined the commitment to reducing them. The government press release about the lifting of the moratorium on shale gas did not refer to the net zero policy but rather justified the decision as a necessity to secure the UK's energy independence in light of the geopolitical context of Russia's involvement in the war in Ukraine

impacting global oil and gas supply (Haouel, 2023). The moratorium was then reinstated a month and five days later on the 27th of October 2022, where the then Secretary of State for Business, Energy, and Industrial Strategy (BEIS) referred only to reinstating fracking *'if it can be done in a way that is sustainable'*, alluding to the issue of new emissions. Referring back to Hajer, concerning the acid rain example mentioned earlier, he writes that the role of discourse analysis is then to investigate the boundaries between *'the clean and the dirty'* and '*the moral and the efficient'* (1997, p.54) and how it comes to be that certain elements appear fixed, acceptable, and appropriate and others as problematic.

7.4 The Discursive Power of Net Zero

The UK's net zero transition became a prominent part of this research when the government's commitment to reach net zero emissions by 2050 was initially announced in 2019. The legally binding target set an unprecedented policy context for energy technologies in the UK, and so it became clear that this would impact the trajectory of this research because it substantially influenced the energy policy landscape and the discussions surrounding it. The degree to which this was indeed the case was reflected in the research interviews during which it became apparent how much attention participants paid to the net zero transition, how keen they were to talk about it and most importantly the degree to which they used the net zero transition as a point of reference within several shale gas and BECCS storylines. This itself is perhaps the most important finding of this research, which is that the imagining of the energy technologies seems not to be possible without referring to the net zero transition which demonstrates the discursive power of the net zero transition. Hajer (1997, p.261) writes, about ecological modernisation, that the discursive power of ecological modernisation manifests *'in the degree to which its implicit future scenarios permeate through society and actors reconceptualize their interests'* (p.261). The discursive power of the net zero transition manifested in the way it substantially shaped the focus of the interviews, and then specifically how actors conceptualised and re-conceptualised their perspectives on shale gas and BECCS vis-à-vis the net zero transition. That is not to say that the trajectory of the energy technologies themselves was always viewed as dependent on the transition, but even then, the participants

made sure to emphasise the independence of the energy technologies trajectory from the net zero transition.

Net zero becoming such a prominent part of the interview necessitates a reflection on to what extent the interviews just reflect the already existing net zero discourse in the public sphere and to what extent it was created by the actors. As I discuss in the Methodology chapter, Hajer (1995) writes that the construction of the discourse is particularly powerful in the context of the circumstances in which the statements analysed were created, precisely because the discourse is intrinsically related to and entangled with the social practice from which it came to be. As so, it would be difficult to separate the global discourse of net zero transitions from the discourse analysed within this thesis, because as Hajer (1995) points out discourse analysis allows us to combine the analysis of both the discursive production of meaning and the analysis of the socio-political practices from which the social constructs emerge. And so, whilst the interviews did take place when the UK's net zero transition was already underway and thus the actors paying attention to and mentioning the net zero transition in the interviews was to be expected, it is important to acknowledge the extent to which the net zero framing overwhelmed other frames and points of reference. More importantly, net zero was used as a point of reference even in instances where policy itself does not relate to the subject matter, so whilst there were many documents published by different Government departments on the role of BECCS in helping us achieve the net zero transition, such as the *'Ability of bioenergy with carbon capture and storage (BECCS) to generate negative emissions'* (Department for Energy Security and Net Zero, 2023) this was not the case for shale gas. And yet, even in the shale gas interviews participants frame the energy in relation to the transition.

There were three different relationships between the technologies themselves and the net zero transition that the participants described, which I then categorised into three different visions of the net zero transition. The vision, which I referred to as *'Dependent'* understands the net zero transition as being dependent on the presence of BECCS and the absence of shale gas. In other words, one technology is identified as being a necessary part of the net zero

transition whilst the other is a hindrance. This vision of the net zero transition is then also reflected in the 2019 report '*Net Zero the UK's Contribution to Stopping Global Warming'* by the Committee on Climate Change, which states that the net zero goal can only be met with at least 70 million tons of CO_2 ($MtCO_2$) being captured annually by that year and no new fossil fuels. The second type of vision of the net zero transition is based on the relationship described between shale gas, BECCS and the net zero transition I referred to as *'Independent'*. Within this understanding of the net zero transition, its success does not depend on negative emission technologies like BECCS, and neither is the net zero transition viewed as the determining factor or barrier in the scaling up of shale gas. Whilst it is acknowledged that negative emission technologies will help reach the decarbonisation goals of the transition, BECCS is not emphasised as the key to success in reaching decarbonisation targets as is the case in the first vision of the net zero transition. The third vision of the net zero transition I describe as the '*Question of Fit'*. This is because the relationship between BECCS, shale gas and the net zero transition is presented as one, where the energy technologies either fit in with the current net zero decarbonisation frameworks or do not. The attention paid to BECCS is then explained as a result of the net zero transition as opposed to the merit of BECCS as a genuinely important aspect of climate change mitigation. Shale gas is then framed not as an inherently bad energy technology, but rather one that currently does not fit in with decarbonisation strategies, but if those were to change so could the prospect of shale gas development.

Looking at the different visions of the net zero transition across the six discourse coalitions and paying close attention to how the transition is framed within them, it also became apparent that whilst there is a wide range of views on the net zero transition within the three BECCS discourse coalitions, that is not the same across the three shale gas discourse coalitions. Whereas across the three shale gas discourse coalitions, '*Shale Gas: Spectre of the Past', 'Shale Gas: Wrong Place Wrong Time' and 'Shale Gas: Doomed from the Start',* the net zero transition is largely viewed as a positive and as a genuine decarbonisation strategy. What differs across the coalitions is the perception and sense-making of the failure of shale gas and how this then relates to the

net zero transition, but the transition itself is not a central point of contestation. This is different from the way the net zero transition is contested and viewed within the three BECCS discourse coalitions, '*BECCS as a Legitimate Solution', 'BECCS as a 'Good Fit'* and *'BECCS as a 'Non-Starter'*. Whilst the first discourse coalition views both the net zero transition and BECCS in a very positive light, the other two discourse coalitions are increasingly more problematic. The '*BECCS as a 'Good Fit'* discourse coalition then views the current net zero timelines as problematic and insufficient however feasible, whilst the third discourse coalition views the net zero transition as highly problematic and actors within it argue for an absolute zero approach to emissions reduction instead. The discourse coalitions which are critical of BECCS, are also overly critical of net zero as a concept. Whilst it would be difficult to ascertain whether BECCS is viewed through a critical lens because of the perception of the net zero transition, this dynamic is not observed across the shale gas discourse coalitions which overall are not critical of the net zero transition.

7.5 Risk

A subset of the literature on both shale gas and BECCS focused on risk, and how it is conceptualised by the public (Cox et al., 2022, Linzenich et al., 2019) and within policies across both energy technologies. Lofstedt (2015) found the perception of risk particularly important, as they attributed poor risk communication as the reason for the failure of several CCS projects. Across the different discourse coalitions, there are different perceptions and perspectives on how risky either BECCS or shale gas are and what the specific dangers are in either implementing or abandoning either technology.

Within the first BECCS discourse coalition, the risk lies in not meeting the net zero target, for which BECCS is essential. The second BECCS discourse coalition contains the storyline *'Lack of Ingenuity'* which frames BECCS as a lazy engineering design and calls for more innovative options to use carbon rather than storing it. So, the risk then is framed in terms of not using the best available technological option as well as missing opportunities to use carbon as a resource. Whilst within the third discourse coalition the risk and danger are framed as the technology itself because its sustainability credentials are

challenged, and it is thus viewed as not aiding climate change mitigation. This is most evident in the *'Moral Hazard'* storyline, which frames BECCS as taking an unjustifiable gamble on unproven negative emissions technologies, the impact of which could be catastrophic. A warning in a similar vein was written in a 2019 BECCS briefing paper (Fajardy and Köberle, 2019), in which they cite that '*Policymakers should be sceptical about a future that is uniquely or heavily reliant on BECCS, and instead prepare for and implement alternative mitigation options as soon as possible.'*

Whilst aspects of BECCS might be perceived as dangerous or risky within one discourse coalition, that can be the opposite in another. This is demonstrable in the example of carbon storage. Within the third discourse coalition, '*BECCS as a 'Non-Starter',* carbon storage is viewed as a potential risk and is approached as a long-term liability which needs to be managed. At the same time, the first discourse coalition *'BECCS as a Legitimate Solution'*, based on the existing knowledge of the storage site, views it as the least risky component of BECCS, and a point of security, not risk. This question, at least within the data in this study, remains unresolved. Chalmers et al. (2013) argued that if the same policy framework that is applied to nuclear waste disposal in the UK were applied to carbon storage this would harm the development of the technology. And whilst there are examples from other countries where the comparison between CCS and nuclear to emphasise the risks associated with long-term storage is common (Otto et al., 2022) such a comparison was not made once by the actors interviewed for this research. It is important to note, that whilst both carbon and nuclear storage are long-term endeavours, they are different in the risk they pose. A study by Addassi et al. (2022) discussed how when carbon is stored underground, specifically in depleted oil and gas wells, the carbon interacts with its surroundings and so the storage becomes more secure over time. Still, this raises the same question that Chalmers et al. (2013) brought up about CCS, who is liable for the risks of long-term carbon storage?

Cox et al. (2022) found that fracking may have impacted the perceptions of non-fracking technologies, even in communities which are spatially and socially distant from any shale industry. So, it would have been reasonable to

expect some overlap in the references that the actors made when discussing either energy technology. Shale gas was mentioned in different contexts during the interviews which focused on BECCS. When discussing the technical intricacies of CO_2 storage, some actors drew comparisons to underground drilling and horizontal fracking. However, no connections were drawn between shale and BECCS during the interviews which focused on shale gas, even when the use of underground space was specifically brought up. This could be explained by the association between shale gas and seismic activity which could harm the perception of carbon storage and by extension BECCS as a whole. This is because the research (Dowd et al., 2015) also shows that the perceptions of CCS can impact the perceptions of BECCS as a whole.

Cox et al. (2022) further found that individuals with no direct experience of the fracking controversy used its negative connotations to draw similar negative conclusions about CO_2 removal technologies. It is important to acknowledge that whilst shale gas and BECCS share the use of underground space, they do so in very different ways which raises the question to what extent it is useful to make this comparison. In a sense, these two processes could not be more different from each other as shale gas uses the underground for extraction and carbon capture and storage for sequestration. There is also the contradiction regarding knowledge and the absence of knowledge regarding the underground. In the case of shale gas, there are discussions about the volume of the resource available, with a study by Whitelaw et al. (2019) disputing the claims that there is 50 years' worth of shale gas available. And so, the underground is perceived as an *'unknown'* entity. With BECCS however, there are claims made with regards to the knowledge of the underground storage because of the history of the UK extracting oil and gas from the North Sea for decades which provides detailed experience and knowledge of that area. In other words, the underground is then perceived as a known entity, something that is also emphasised within the *'Knowing the Storage'* storyline.

Cox et al. (2022) speak about the social amplification of risk (Renn et al., 1992) in other words, the ripple effects of one risk associated with a particular technology spill over to completely different technologies. Whilst previous research (Cox et al., 2022, Singleton et al., 2009) points to the possible

connections between shale gas and CCS this was not the case in this particular research, where this connection was not made. There might be several explanations for this. Firstly, the timing of the research. It could be the case that by 2019 and during the time of the net zero transition the participants became too aware of the controversial nature of shale gas and did not therefore want to make the association with it. The second explanation could be, that whilst Cox et al. (2021) found that negative perceptions of shale gas can impact the perceptions of CCS, their research focused on public perception whilst my research focused on key actors. Thirdly, as Asayama and Ishii (2017) pointed out the discursive narratives around carbon capture are based more so on a technological imagination rather than physical reality. And whilst neither energy technology reached a point of commercial development, they have had different physical realities (points of deployment), which are also reflected in the discourse. One such difference in physical realities is the proximity of shale gas sites in the UK to residential areas, which permeated the discussions of risk and feasibility as was raised as a point of concern in the '*Geological Factors'* storyline. BECCS is only limited to the Drax power station at the moment, so the discussions around feasibility were slightly different, in that they did not include comments on the technology itself being dangerous to residents as was the case with shale gas. And lastly, the difference between offshore storage of carbon and onshore extraction of shale gas could have contributed to this connection not being made.

One of the interesting findings was that the talk of carbon utilisation was completely absent from the interviews. Anning et al. (2019) found that in Germany carbon capture and utilisation is perceived more positively than carbon capture and storage, but there was no such comparison made in the interviews. This indicates that the default in the UK when using carbon capture is to store the captured carbon as opposed to using it differently as a resource. One of the reasons why carbon utilisation is perceived as better than carbon storage in Germany is because of the associations between carbon storage and storage of nuclear waste disposal (Otto et al., 2022), so the carbon that is utilised can be framed as a useful resource as opposed to as a waste to be disposed of. The carbon stored has not been referred to as a waste product

within the UK context. Rather, in the storylines where it is talked about explicitly, it is mentioned as something that is rightfully returned to its origins by being stored underground such as is the case in the 'Pumping Back CO_2' storyline, or as a potential resource as per the *'Lack of Ingenuity'* storyline, or as a long-term liability as per the *'Moral Hazard'* storyline. Whilst risk, or at least the perception of it, comes up as a topic across both energy technologies, it is conceptualised in different ways depending on the framing. For example, the risk of causing environmental harm, the risk of increasing carbon emissions, the risk of delaying genuine climate change mitigation measures, the risk of technology failure and unsafe carbon storage, the risk of earthquakes and so on.

7.6 Temporal Differences

One of the unexpected findings of this study was the way time was perceived within the different discourse coalitions and across both energy technologies. Firstly, the notable difference was that when talking about shale gas, most actors were talking about it in the past tense and a retrospective fashion, as opposed to in a forward-looking way. This was different from the way BECCS was talked about, in that the technology is thought of both as currently relevant and as a technology with prospects as opposed to as an energy technology to look at in retrospect. The data collection took place between 2020 and 2021, which arguably followed one of the worst years for shale gas policy. In 2019 it became clear that shale gas had failed to gain a social license to operate (Gehman et al., 2017), after the general election it no longer had political support in Westminster, and it faced regulatory barriers based on seismicity which was ultimately cited as the key issue when the moratorium was announced.

Perhaps, because of the timing of this research, there were three instead of the expected two discourse coalitions, that were found in previous studies (Bomberg, 2015; Williams et al., 2015) which differed not based on the support for shale gas, but based on the way the absence of industrial-scale shale gas extraction is being retrospectively justified. This a shift in the way shale gas is understood, not as a '*Why it should happen'* but rather circled the question *'Why it did not happen'*, firmly positioning the shale gas energy technology as

something to be looked at retrospectively, as opposed to BECCS, where two out of the three discourse coalitions are focused on the future of the net zero transition and the role that BECCS should or could play within it.

Cotton et al. (2014) point out that the discourse coalitions are *'neither definitive nor complete'*, and the context, which also includes the timing, is important. A retrospective view of shale gas development makes this clear, with the infamous statement from David Cameron in 2015 of going '*All out for shale'*, with the moratorium being enforced 4 years later. And in 2020, as Bradshaw et al. (2022) quoted, cabinet ministers issued statements such as *'for now fracking is over'* and in 2021 '*no more fracking'*. Then in 2022 the same Minister, (Bradshaw et al., 2022) commissioned a review of the science to see if the moratorium could be lifted. This was not prompted by any suggestion that the risk of seismicity changed, which was the principal reason for the imposing of the moratorium. As the paper writes, only with significant difficulty could one identify what worked well for those supporting shale gas the first time around.

This also supports the findings of Bradshaw et al. (2022) who framed shale gas in the UK as a '*discursive energy policy failure*', based on the limited shale gas infrastructure in the UK which never produced commercially available shale gas. The fact that the participants speak of shale gas also retrospectively and as if it were an issue of the past, indicates, that at least to some extent there is an acceptance of the fact that shale gas failed in the UK and so the discursive struggle is rather about how to explain this failure as opposed to arguing for re-instating the technology.

There is also a tension between the forward-moving net zero transition and the ongoing progress of BECCS, a technology which is also being invested in and shale gas, which, also from an investment perspective has been abandoned. With this abandonment certain storylines which were present in the past were no longer present in this research, notably shale gas being referred to as a '*lower carbon technology*' or a *'transition fuel to a lower carbon future'*, yet there seemed to be a shared understanding that there is either no or limited scope within this transition for shale gas, whilst there is a lot of scope for BECCS.

There are also temporal tensions within the discourses themselves. As Cox et al. (2020) pointed out, CCS straddles the temporal tension of providing long-term storage, and therefore a long-term solution to carbon emissions, whilst at the same time some argued that it is this promise of a long-term solution which delays more reduction in carbon emissions because it makes it seem like it is not necessary. So, whilst there is the promise of long-term secure storage of carbon if the carbon sequestration is used for enhanced oil recovery or to justify further burning fossil fuels, this will have an immediate impact on the rate at which climate change progresses and also the probability of reaching the net zero 2050 target.

There is a similar temporal tension in the shale gas discourse, where according to some storyline shale gas could provide a long-term fuel supply and thus boost energy security, yet at the same time extracting this resource could pose an immediate risk with regards to seismicity. Secondly, the current policy and energy landscape are seen as the wrong timing for shale within the second discourse coalition (*Shale Gas: 'Wrong Place Wrong Time'*), which makes the argument that in a different place and time shale gas could have been successful in the UK, but the timing is currently not right.

Then there are also different ways the past and the future present themselves in each of the three different net zero visions I have identified in the third data chapter. The first vision, which I labelled as *'Dependent'* frames the net zero transition as a transition that relies on the progress of BECCS and the absence of shale gas. In other words, it relies on there being a future with BECCS but not for shale gas, which should remain in the past. The second vision, which I labelled '*Independent',* understands the progress or lack thereof with shale gas or BECCS futures being independent of the net zero policy and so the developmental timelines. And lastly, the third vision which I labelled '*Question of Fit*' assumes that the net zero policy is just the right timing for BECCS and the wrong timing for shale gas.

7.7 Acceptance

Large parts of the literature focus on public acceptance of both energy technologies, as they can be perceived as controversial based on the public dissent towards shale gas drilling and carbon storage. Generally, the literature

agrees that social acceptance is important and contents itself with how to best establish this and tries to make sense of concepts such as '*social license to operate'* (Prno and Scott Slocombe, 2012) or NIMBY '*not in my backyard'* (Devine-Wright, 2005). Although there was a focus on seeking public acceptance in the literature, that was less the case in this research. One of the questions the participants were asked was about the development of either BECCS or shale gas. This was then followed up with more probing questions about what the participants attributed to the development or a lack of development to give them the space to discuss public acceptance and public resistance to BECCS or shale gas.

Considering the volume of shale gas and BECCS literature, which is dedicated to public acceptance, it is then surprising that this was not mirrored in the interests of the participants. Shackley et al. (2009) suggest that when it comes to public acceptance CCS is disadvantaged from the start because of the association it has with fossil fuels by being used for enhanced oil recovery and thus extending the life of some oil and gas extraction sites. Whilst there are no plans at the moment to use BECCS for EOR, there is the argument of *'moral hazard'* based on that BECCS is extending the status quo of current carbon production without the need for a large-scale systemic change.

Whilst Jouvet and Renner (2015), as well as Linzenich et al. (2019), identified cost and social acceptance as key barriers to carbon capture and storage, only the former was discussed by the actors in the interviews. The concerns of public acceptance were not raised, even by those who oppose BECCS. The concept of Not Under Our Back Yard (van Os et al., 2014, Krause et al., 2014) which was adapted from the Not in My Backyard (NIMBY) concept by van Os et al. (2014) when discussing resistance to carbon capture and storage in the Netherlands, does also not translate quite well into the UK context, because unlike in the Netherlands, which was the example used, there is no real physical proximity of the public to the offshore carbon storage sights. And so, the relative lack of concern for public acceptance among participants within the BECCS interviews could be explained by several reasons. Firstly, BECCS is a lesser-known technology than shale gas, and so there is lesser public awareness about the technology. Secondly, the points which could lead to

public dissent are not necessarily visible to the public eye. The woody biomass could raise public concerns if large sites of fallen trees were visible, which could lead to a lack of public acceptance. Whilst some media reports zeroed in on Drax's practice of sourcing biomass (Ravilious, 2020), all of Drax's biomass sourcing sites are in North America, and are not directly visible to the UK public, beyond what is depicted in media reports. Secondly, carbon storage is planned to be offshore rather than onshore, so there will not be large onshore sites with deep boreholes for carbon storage. Lastly, perhaps because there is no precedent of BECCS being used at a large scale elsewhere, there is no comparison as to what the challenge with regards to public acceptance and perception could be the way there is a comparison to how shale gas was perceived and the level of public discontent that the technology caused.

Firstly, as discussed before the participants largely talked about shale gas in the past tense, so perhaps did not think that seeking public acceptance for shale gas would be necessary again. Unlike BECCS, shale gas has caused what Short and Szolucha (2019) refer to as a collective trauma experienced by the Lancashire residents as a result of the fracking operations in the area, whereas there are not any such experiences of collective trauma linked to BECCS operations.

Finally, discursively, acceptance has different meanings in the BECCS and shale gas discourse coalitions. With regards to shale gas, the acceptance is focused on whether the technology should be used, based on the different suitable socio-economic, political, or geological conditions. However, in the case of BECCS, the question is raised whether it is accepted by key actors as a feasible working technology in the first place.

7.8 Conclusion

In this chapter, I have provided a summary and a reflection on the results presented in the previous three data chapters. Firstly, I summarised the results from the data chapters and discussed the differences between the 6 identified discourse coalitions and the storylines within them. I have pointed out that one of the key findings was the high importance of the net zero transition to the participants in the interviews and that then permeated into how they framed their understanding of the energy technologies and their future developments,

which were described in relation to the net zero transition. I also pointed out that the thesis found differences in the shale gas discourse and the division between the discourse coalitions as compared to previous research, with a pro-shale gas coalition visibly absent from the findings. I then also pointed to the omission of discussing carbon transport within the BECCS storylines well as the lack of focus on public acceptance compared to the focus on the issue in the literature. In the section *'Temporal Differences'* I pointed out that shale gas was within the data largely talked about retrospectively, as opposed to as future-oriented, which was the case with BECCS. This focus on the past then also translated to the make-up of the discourse coalitions, whereby the shale gas discourse coalitions differ in the way they explain away the failure of shale gas development in the UK, whereas the BECCS discourse coalitions differ in the way they view the potential of future uses of BECCS in the net zero transition and decarbonisation overall. At the same time, there were some commonalities across all six discourse coalitions, notably climate change and its effects were not disputed by any actor, nor were arguments being made that the use of fossil fuels does not contribute to exacerbating it, even within storylines that argued that shale gas could be used as a transitional fuel in some circumstances. In the *'Acceptance'* sub-section, I also discuss that whilst there seems to be a large focus within energy social science literature specifically on public acceptance and on gaining a social license to operate, this did not reflect in the interview data set of this research, where public acceptance did not seem to be a focal point for the participants.

As Hajer (1997 p.54) argues, discourse analysis can reveal where the boundaries lie between *'the clean'* and *'the dirty'* and in what ways certain elements of the discussion appear as fixed and appropriate, whilst others are framed as problematic. What this discourse analysis revealed then is that the understanding of the boundaries between *'the clean'* and *'the dirty'*, which in this case in relation to energy technologies can be taken quite literally, varies substantially across the six discourse coalitions. Actors utilise different linguistic tools, such as reframing the negative emissions energy technologies as '*energy for free'* or referring to storing carbon as *'pumping back'* to demarcate the boundary between shale gas or BECCS being considered a

good or useful energy technology. Hajer then also writes that these definitions between *'the clean'* and *'the dirty'* or the *'moral'* and '*the efficient'* can then either '*homogenize'* a problem or *'heterogenize'* it (p.54). In the case of shale gas, there was a homogenization of the discourse coalitions, in that there was not one decisively pro-shale gas, all three discourse coalitions discussed shale gas retrospectively.

8 Conclusion

8.1 Introduction

This is the last and concluding chapter of this thesis, in which I will provide both a summary and an overview of the thesis and its respective chapters, as well as draw attention to the key findings and contributions. I will also describe and discuss the limitations and reflect on the overall research and write up process. Finally, the chapter concludes with some final remarks and suggestions for future research developments.

This thesis set out to provide an original contribution to the field of environmental and energy policy studies and did so by conducting and social scientific energy research and completing a discourse analysis of two energy technologies in the context of the net zero transition. It approached the two energy technologies with the rational, that they can be used as touchstone to gain greater insight into the dynamic process of the net zero policy development. Understanding the policy process as a process of linguistic exchanges which shapes the way in which the policy develops, the focus on the language that is used to make sense of the two energy technologies in the context of the net zero transition was thought of as particularly insightful in this aspect. This thesis then showed, that because energy technologies are inherently socio-technical systems (Rohracher, 2001), the analysis of their social aspects can be used in energy and environmental policy studies, particularly when using discourse analytical approaches.

Hajer writes about the acid rain controversy that a single unified scientific discourse would not be able to explain the full story, because of the very many elements involved. That is also the case for the net zero transition, because of elements such as the social and economic repercussions of the net zero transition. A solely scientific discourse would not be able to pick up on the discussions of fairness, ethics and attribution of blame and responsibility within the transition and the development of energy technologies.

BECCS and shale gas were selected because neither of the technologies has been operationalised at scale in the UK, yet they both were imagined playing a part in the UK's decarbonisation efforts at different points in time (Bellani et al., 2021; Fridahl and Lehtveer, 2018). They also share the use of underground

space and have both been subject to controversy (Cotton et al., 2014; Haikola et al., 2019a). Focusing specifically on these two discourse coalitions enabled me to gain particular insight into the discursive dynamics of energy technologies in the context of the net zero transition. Furthermore, I was able to gain an understanding of how key actors make sense of the newly developed concept of the net zero transition and what terms they use to describe the future development they envision for it.

The first chapter of this thesis focused on '*setting the scene'* by outlining in detail the policy background of shale gas, BECCS and the net zero transition. In it, I discussed the policy origins of the net zero transition and outlined the UK's previous decarbonisation commitments. I then moved on to discussing carbon capture with storage and explained the technical aspects of the energy technology as well as what makes it a negative emissions technology and the connection between BECCS, the IPCC and the IAMs. In the following section on shale gas, I discussed the technical aspects of the energy technology and also laid out the history of shale gas in the UK, and various policy changes and moratoria which impacted its development. The chapter then closed out with me outlining the research aims and objectives and introducing the three research questions.

The second chapter, '*Literature Review'*, focused on presenting the past social science research on BECCS and shale gas; to illustrate in what ways this thesis was able to contribute to the existing scholarship. The chapter was divided into two large sections, BECCS and shale gas and then each subsection corresponded to the themes found in the literature. Whilst there were some overlaps, such as the focus on policy, social acceptance and risk, there were also differences. Notably, the BECCS literature often did not differentiate between the conclusions drawn from studies that focused solely on CCS and those that focused on BECCS. The chapter then concluded by outlining where the research gaps are, pointing out specifically that all social science literature focused on shale gas in the UK focused on the time before the announcement of the moratorium and the net zero transition in 2019. Secondly, whilst there were some comparative studies, these were usually comparing the same energy technology between different geographical

locations as opposed to comparing it to another. This then justified the focus on shale gas and BECCS in the context of the net zero transition as an original research contribution.

The third chapter, Methodology, focused on outlining in detail the analytical and methodological approach taken in this thesis, Maarten Hajer's discourse analysis. In this chapter, I explained all the key terms, such as storyline and discourse coalition and introduced the 10-point plan which this thesis loosely followed. As well as described the interview protocol and reflected on the unexpected ethical challenges that arose as a result of the interviews taking place online during a global pandemic.

The next three chapters were dedicated to data analysis. The first data chapter then was dedicated to the first research question and focused on BECCS. In it, I introduced and described the three BECCS discourse coalitions and the 8 storylines that they contained. The second data chapter was dedicated to shale gas and also described the three discourse coalitions I found with the shale gas data set and the 7 storylines they contained. The third data chapter was then different from the first two in that it cut across the six discourse coalitions and focused on what type of visions of the net zero transition are described within these discourse coalitions and what they have in common. I identified three types of visions based on how the relationship between energy technologies and the net zero transition was conceptualised. I also depicted these visually.

The following chapter, Discussion, contextualised the research findings from the previous three chapters. Firstly, the chapter provided a summary of the results, outlining again the three research questions the six discourse coalitions and 15 storylines. I then discussed the discursive power of the various coalitions and ascertained that it is difficult to refer to any one discourse coalition as dominant. Finally, I discussed how risk took on a different meaning across all six discourse coalitions and relayed the results back to the literature on risk discussed in the literature review. I then finished the chapter by pointing out the temporal differences across the shale gas and BECCS discourse coalitions, pointing out that shale gas was largely discussed retrospectively

and noted that whilst public acceptance was a focal point within the literature that was not the case in the research interviews.

8.2 Key Findings and Contributions

The previous chapter focused on discussing the findings from the three data chapters and contextualising them within wider literature. In this section, I will draw attention to and highlight the most prominent findings and contributions.

In the first instance, this thesis provided insight into the relationship between the net zero transition and energy technologies. It showed that it is difficult, if not impossible, for key actors to talk about energy technologies in a meaningful way, without drawing references to the net zero transition. This demonstrated the structuration of the net zero discourse that permeated every research interview and played an important part in how key actors made sense of the future and the past of shale gas and BECCS. This indicates that the transition is meaningful and significant both from a policy perspective and also signifies an important discursive landmark, which influenced how energy technologies, even those which are not part of the transition directly, like shale gas, are conceptualised and discussed.

Secondly, this thesis argues that there has been a shift in the shale gas discourse, as the findings in this research differ from those depicted in previous studies. Previously this discursive struggle was largely divided into two discourse coalitions, the pro- and anti-shale gas discourse coalitions. However, this research found three discourse coalitions, which rather than differentiating from each other based on support for shale gas, differ based on their understandings of why shale gas is not being pursued and whether there is any future for the energy technology. Whilst it would be difficult to ascertain whether it was the announcement of the net zero transition that prompted this discursive shift and changed the storylines around shale gas or whether it was the announcement of the shale gas moratorium, we can still say that in the context of the net zero transition the shale gas discourse coalitions seem to be less polarised than previously found. And secondly, the overall language in the discourse is retrospective and not forward-looking. Lastly, there is no one clear pro-shale gas discourse coalition, unlike in previous research findings, which indicates that there is an implicit agreement among the key actors, that any

future progress on shale gas is highly unlikely. Hajer (1995) speaks about how seemingly solidified discursive commitments can be dissolved and arguably, this has happened with the pro-shale gas which does not seem to be relevant anymore.

Another important finding of this thesis is how polarised the BECCS discourse is. A specific point of contention between the BECCS discourse coalitions is the scalability and sustainability of BECCS. Whilst one discourse coalition views it as necessary for BECCS to be scaled for the success of the net zero transition, the third discourse coalition argues that scaling up of BECCS is not possible and that it is not a well-functioning negative emission technology and that to rely on its development to aid decarbonisation of the energy sector is hazardous. None of the BECCS storylines directly relate to carbon transport but are rather focused on the biomass supply chain and the security of carbon storage, the process of capturing and transporting seems to be omitted from the discussion. This wide range of understanding of the potential of BECCS spells out the challenge that lies ahead in deploying BECCS in such a contentious discourse. Language can suggest that we should discuss BECCS in terms of operational solutions such as how to best source biomass, capture carbon, transport carbon and store it. Equally, language might also suggest that this is a lost cause and meaningless, as a genuine solution to decarbonising the energy sector would require substantial systemic institutional or cultural change and not BECCS.

The thesis also argues that when assessing the discursive dominance of the different discourse coalitions across shale gas and BECCS, it would be difficult to speak of any of the discourses as dominant, as there is not an obvious commonly shared understanding of BECCS as a sustainable energy technology nor is there a shared common understanding of why shale gas is not being pursued, which are the main dividing factors across the 6 different discourse coalitions.

Overall, as environmental and energy policy studies research, this thesis also made a good methodological case for using discourse analytical approaches to the study of policy and looking beyond the linguistic analysis of policy texts.

Rather, it showed, following Hajer's methodology, that strategically choosing two energy technologies as key policy touchstones and conducting qualitative research interviews with key actors of those two energy technologies can indeed provide an insight into the discursive contentions and the competing policy visions.

8.3 Reflecting on the Research Process and Its Limitations

Engaging in the practice of reflexivity is an important part of the research process (Haynes, 2012). Like all research projects, this research also has its limitations. These arose from the scope, the timeframe, funding limitations and from different deliberate methodological and analytical choices made during the research process. Whilst the choices made opened up possibilities for the research in one way, they also limited it in others. Because this thesis conducted a comparative discourse analysis of two energy technologies, this required interviews of participants linked to either technology in equal numbers. Because of the time frame of the PhD, this meant that I was able to interview 15 participants for one energy technology and 16 for the other. Had the thesis focused on only one energy technology or had the time frame been different, I may have been able to conduct more interviews per energy technology and thus gain a greater depth of qualitative data on the subject. Whilst I was able to interview 31 key actors, I was not able to follow Hajer's 10-step plan of discourse analysis (Hajer, 1997) and conduct a second round of interviews, to check whether my analysis of the discourse was correct and whether the actors could recognise some of the linguistic patterns I based the storylines on, as Hajer recommends. Due to the time restrictions of the PhD research process doing follow-up interviews was not feasible.

The data collection of this thesis took place during the global Covid-19 pandemic. The conditions during which the data collection took place were so highly unusual and unprecedented which was then particularly evident in the limited availability of access to participants, most of whom during the interview process were in lockdown as a result of the global pandemic and were presumably also faced with the unprecedented levels of stress associated with working from home during this time. Whilst I was still successful in finishing data collection, it is worth reflecting that because of these conditions, the data

collection was particularly challenging as I reflect on in greater detail in the Methodology chapter.

The discursive struggle does not take place in a social vacuum as Hajer (1997) writes, but in the context of institutional practices. It is therefore especially powerful to focus on the study of this struggle in the current context as it is unfolding. Therefore, focusing on the discursive struggle of shale gas and BECCS in the context of the net zero transition is then particularly powerful when done at the time of the net zero transition unfolding. At the same time, studying the discourse in real-time, as opposed to retrospectively, in a rapidly progressing field of energy transition has its challenges and limitations. Whilst the thesis provided an insight into shale gas and BECCS discourse in the context of the net zero transition, this was also during a particular time of early development of the net zero transition. It is unlikely that repetition of the study in future, even with an identical sample of key actors, would yield the same results. For example, since the writing up of the data analysis, new developments in the field of carbon capture and storage have taken place, with Drax power station being in the spotlight of two BBC documentaries (BBC One Panorama, 2022), which focused on its wood supply. Because of the timing of the release of these new perspectives and the timing of writing up this thesis, they weren't considered or discussed. Despite this, the research represents an important snapshot of a particularly dynamic period of the net zero transition, shale gas and BECCS development.

8.3 Final Remarks and Suggestions for Future Research

The construction of energy systems and environmental policies are by no means uncontested. Much of the social science literature on BECCS and shale gas focuses on public acceptance, and so one could get the impression that if there is a discursive tension and contestation of the meaning of energy technologies it is between policy actors and the public. However, this research has shown that even within a sample of key actors, there are many discourse coalitions contained and a wide range of storylines, revealing the degree to which both energy technologies are contested. Hajer (1997) argues that it would be useful if we moved away from a technocratic focus, and rather opened up the energy policy institutions and policies to accommodate this

discursive struggle to help us best determine what sort of energy/decarbonisation future we want.

Not being aware of the discursive structures and struggles Hajer, warns can lead to unduly optimistic thinking about policy change. Therefore, this excavation of the discursive struggles contained within the net zero transition and within the energy technologies that both are and are not part of the effort to decarbonise the sector is necessary to gain a good sense of the net zero transition's trajectory. It illuminates the discrepancy between policy and discourse. The net zero transition and any other environmental policy of this scope will constantly produce and reproduce conditions which determine what is acceptable and what is not, which technological and energy solutions should be relied upon and at what scale and which should be abandoned. Not least, as Hajer writes, the degree to which discourse contains structures can be as effective in resisting political change as *'walls and barbed wire can in preventing trespassing*' (Hajer, 1997 p.275) And so, extending the possibilities for open deliberation would enable finding those strategies of modernization, which are socially acceptable and at the same can produce better results in terms of problem closure.

Storylines are to be viewed as signposts for action within these institutional practices. Hajer talks about the acid rain case study and writes about the essential role of emblematic issues and their role in shifting the policy discourse. Acid rain then became an emblem *'for the general understanding of what environmental problems were about'* (Hajer, 2005b, p. 75). And so, this thesis makes the case that BECCS and shale gas and their discourses, and the coalitions and storylines contained within them, are emblematic of the wider discourse of the net zero transition and '*what it is about'.* This then feeds into the question of what is the right policy approach to decarbonisation and climate change mitigation, to what extent does this involve carbon removal, negative emissions technologies, and fossil fuels?

Based on the findings of this thesis, there are two key recommendations to current policy makers in charge of the net zero policy implementations. Firstly, if BECCS is to be relied upon as an important factor in reaching net zero

emissions, then there needs to be a stronger effort made to change the discursive narrative and create a more robust linguistic and policy mandate for BECCS. As this thesis takes the position that the discourse coalitions are linked to power and therefore hold significant weight in the shaping of the public and policy discussions, there needs to be a clearer and dominant positive narrative on BECCS if it is to be expanded and implemented into the UK's energy mix. At the moment there is a wide gap between the policy expectations of the deliverables of this energy technology and the way in which it is made sense of and understood by key actors. I argue that it will be very difficult to scale this technology up and operationalise it as there is not currently a dominant discourse on BECCS, and there is an ambivalence over its ability to deliver on the promise of negative emissions which needs to be addressed.

Secondly, this thesis also shows that there is not a strong case being made for the return of shale gas by key actors, rather the actors engage in a retrospective sense-making of the technology's failure. Based on the previous argument, that the discourse has a significant impact on energy and environmental policy development, this lack of a future-facing shale gas narrative suggests that any attempt to revive this technology will not be successful. From a technological perspective, there is not a need for a domestic supply of shale gas, from a policy perspective pursuing shale gas would be in contradiction with the goals and aims of the net zero policy, and from a discursive and linguistic perspective, the key actors are not making a case for the energy technology's return. This thesis then presents that an attempt to revive shale gas may be a waste of resources and time, which in the context of the climate emergency and thus the crucial importance of reaching the net zero transition would be better place elsewhere.

This thesis also used Maarten Hajer's framework in a novel way, by applying it to study the discourse of two energy technologies simultaneously. Whilst comparative discursive work has been done before, this was mostly in a way where the discourses of one technology have been compared at different time points. Thus, a natural continuation of this work would be to compare other energy technologies similarly. This could be done for example by focusing on other negative emission technologies, such as direct air capture with carbon

capture and storage (DACCS) and BECCS. Most recently, sustainable hydrogen has gained prominence. Within the social media energy discourse, sustainable hydrogen and heat pumps are frequently discussed within the context of providing a decarbonised solution for home heating. The nature of the discussions is very contested, and so these two energy technologies would be a good fit for future discourse analytical research.

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Appendix

Interview Topic Guide

Interview questions (Questions in bold are main questions, questions not in bold are sub-questions that may have already been covered by main questions)

Introduction: what, where and how questions

Could you tell me something about who you are and how you get involved with BECCS/ Shale gas?

What are your general thoughts on BECCS/Shale gas? /What do you think of the use of BECCS/Shale gas?

What do you see as the most important reasons for using it?

Are there any drawbacks?

What do you see as the biggest drawbacks of BECCS/shale gas?

Are there any challenges facing BECCS/shale gas?

Can you tell me whether you have always had this view on BECCS/shale gas or whether there was a point where your opinion changed?

Net zero energy transition

Do you see BECCS/shale gas as a part of the low carbon/net zero energy?