Language, knowledge, power

The Discursive Construction of Climate Engineering Governance

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The Discursive Construction of Climate Engineering Governance

**Taal, kennis, macht:
de discursieve constructie van klimaatengineering-governance**

(met een samenvatting in het Nederlands)

Proefschrift

Proefschrift ter verkrijging van de graad van doctor
aan de Universiteit Utrecht op gezag van
de rector magnificus, prof.dr. H.R.B.M. Kummeling,
ingevolge het besluit van het college voor promoties
in het openbaar te verdedigen op
woensdag 16 maart 2022 des ochtends te 10.15 uur door

door

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geboren op 26 december 1986
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List of acronyms

BECCS – Bioenergy carbon capture and storage
CBD – Convention on Biological Diversity
CCS – Carbon capture and storage
CCU in EOR – Carbon capture and utilization in enhanced oil recovery
CDR – Carbon dioxide removal
CDM – Clean Development Mechanism
CE – Climate engineering
CO2 – Carbon Dioxide
C2G(2) – Carnegie Climate (Geoengineering) Governance Initiative
DFG – Deutsche Forschungsgemeinschaft/German Research Fundation
ENMOD – Environmental Modification Convention
ESG – Earth System Governance
ESS – Earth System Science
EU-ETS – EU Emissions Trading Scheme
EuTRACE – European Transdisciplinary Assessment of Climate Engineering
FCEA – Forum for Climate Engineering Assessment
GeoMIP – Geoengineering Model Intercomparison Project
GGR – Greenhouse Gas Removal
GHG – Greenhouse Gas
GRIP – Greenhouse Gas Removal Instruments & Policies
GRGP – Geoengineering Research Governance Project
HFCs – Hydrofluorocarbons
IAGP – Integrated Assessment of Geoengineering Proposals
IAM – Integrated assessment modeling
InSIS – Institute for Science, Innovation and Society
IASS – Institute for Advanced Sustainability Studies
IPCC – Intergovernmental Panel for Climate Change
LC/LP – London Convention/London Protocol
NAS – National Academy of Sciences
NETs – Negative Emissions Technologies
NRC – National Research Council
OECD – Organisation for Economic Co-operation and Development
OF – Ocean fertilisation
RDD&D – Research, development, demonstration and deployment

REDD+ – Reducing emissions from deforestation and forest degradation in developing countries
RRI – Responsible Research and Innovation
SAI – Stratospheric Aerosol Injection
SEC – Socio-Ecological Care
SKAD – Sociology of Knowledge Approach to Discourse
SLCPs – short-lived climate forcing pollutants
SPICE – Stratospheric Particle Injection for Climate Engineering
SRM – Sunlight reflection methods, or solar radiation management
SRMGI – Solar Radiation Management Governance Initiative
STS – Science and technology studies
TWAS – The World Academy of Sciences
UNEA – United Nations Environment Assembly
UNEP – United Nations Environment Programme
VERs – verified emissions reductions

PART I

1 Introduction

1.1 Topic overview

The climate is changing rapidly, and the causes are anthropogenic – through the release of carbon dioxide into the atmosphere, humanity has unintentionally been modifying the global climate for decades, thereby putting the world on a pathway towards dangerous warming, rising sea levels and disrupted rainfall patterns. The question as to how humanity will face this global challenge has become central within scientific, political and societal debates about climate futures. Will we manage to decarbonize the global economy fast enough to avoid the worst effects of climate change? Or may we be forced to adapt to living in a significantly warmer world, with today's cities having to be relocated to escape sea level rise and large areas of the world becoming unable to support food production? In addition to mitigation and adaptation as major strategies for governing climate futures, a third way of responding to climate change is now emerging: The idea of intentionally intervening into the global climate system, often termed 'climate engineering' (CE). The heterogeneous range of proposals included under this umbrella term focus on either actively removing carbon dioxide from the atmosphere – known as carbon dioxide removal (CDR), Negative Emissions Technologies (NETs) or Greenhouse Gas Removal (GGR) – or reducing the amount of solar radiation entering and being trapped in the atmosphere by changing the reflective properties of the stratosphere, clouds and other surfaces – Solar Radiation Management (SRM) (Royal Society, 2009).

While some argue that certain types of climate engineering are going to be an essential part of future climate response strategies and *enabling* governance is therefore needed to responsively incentivize the development of the technologies, others emphasize the need for *restrictive* governance to anticipate and mitigate the potential environmental and socio-political risks of CE research, development, demonstration and deployment (RDD&D) (Bellamy, 2018, McLaren et al., 2019, Biermann, 2021b, Biermann, 2021a). There is a growing awareness that *de jure* governance of research and development of some types of CE is going to be needed in the coming years, and that *de facto* governance is already being shaped by the discourses and practices of CE research and assessment (Gupta and Möller, 2019). Increased attention is being paid to the types of scientific and societal knowledge that are shaping the way in which the idea CE and its governance is emerging (Gupta and Möller, 2019, Low and Schäfer, 2020, Low and Buck, 2020, Carton, 2020, McLaren and Markusson, 2020, Low, 2021, Muiderman et al., 2020, Kreuter, 2021).

Contributing to this growing pool of literature, this thesis asks the broad research question as to *how the discursive construction of climate engineering governance is taking place in science, industry, civil society, and politics.*

Guided by this research question, I address the CE governance challenge from a post-structuralist discourse theoretical perspective which emphasises that, as discourse is the source code with which contested futures are written, 'cracking the discursive code'[1] underpinning the CE governance debate can help anticipate and critically reflect upon the emergence of future governance practices and infrastructures (Muiderman et al., 2020, see also Chapter 5). Premised on the understanding that there is a performative link between discursive structures and governance development, I use the concept of governmentality as a heuristic lens to map the discursive structures underpinning several spheres of the CE governance debate, showing how they may be forming 'discursive blueprints' for emerging climate engineering governmentalities.

1.2   Aims and relevance

This project emerged as a result of both empirical and theoretical curiosity. As such, I hope to add to both practical understanding of and engagement with the way in which CE governance is emerging. In addition, I aim to contribute to the ongoing academic debate on the role of discourse theoretical approaches in political science and global environmental governance more broadly.

The empirical relevance of understanding how CE governance is emerging is evidenced by deliberate interventions into the climate system becoming increasingly politically relevant (Geden and Schenuit, 2020, Schenuit et al., 2021, McLaren and Corry, 2021). With global CO_2 mitigation policies currently lagging behind what scientists consider to be necessary reductions in order to prevent dangerous climate change, the consideration of deliberate interventions into the climate system to mitigate climate risk is gaining momentum (Horton et al., 2016). This is especially the case for carbon dioxide removal in light of Intergovernmental Panel on Climate Change (IPCC) scenarios that show active removal of CO_2 from the atmosphere will be needed to achieve the temperature targets agreed upon at the Paris Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, and to meet the subsequent 'Net-Zero' emissions targets set by many national governments. It seems increasingly clear that NETs will play a role in national and international climate policy in the coming decades (Honegger and Reiner, 2018, Geden et al., 2019).

As the need for near-term CE governance, becomes clearer, calls for the integration of wider societal perspectives and knowledge types into the development of responsible, reflexive and anticipatory governance have become louder. Prominent proposals for responsible CE governance are based on the assumption that 'opening up' governance debates will move discussions beyond the bounds of technocratic, neoliberal discourse, thereby paving the way

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1   This metaphor refers to a technique employed by computer programmers and hackers: By 'reverse engineering' a finished programme, they attempt to 'crack' and reproduce the 'source code' which was used to write the programme. This is much the same as what discourse analysts do – by looking at the finished discursive products (texts), we try to identify the underlying discursive structure that is constitutive of the statements manifested in the texts.

for more inclusive, responsible governance of technologies (Bellamy, 2018, Stilgoe et al., 2013, Low and Buck, 2020).

This thesis' practical relevance in this vein is as follows: In addition to developing hypotheses to help anticipate the future development of CE governance, my analyses aim *to expose the contingent nature of emerging CE governance frameworks by mapping how certain types of (technocratic, neoliberal) governance are discursively being rendered thinkable and practicable, thereby enabling critical reflection upon how to 'open up' seemingly self-evident governance developments to other types of knowledge.* In addition to emancipating individuals (i.e., academics, policy-makers, stakeholders) engaged in the CE governance debate to recognise and reflect upon the discursive power/knowledge structures they are reproducing; my discursive mapping approach may also have the potential to inform the design of participatory processes which attempt to overcome discursive power imbalances (Turnhout, 2018).

From an academic perspective, this project has relevance for the ongoing debate on the operationalization of discourse theoretical approaches in the field of political science. As section 3.2 outlines in more detail, much of the discourse analytical work in the field of political science broadly, and environmental governance more specifically, has focused on 'discourse' as communicative interaction between political actors to strategically further their interests (Kerchner and Schneider, 2006, Leipold et al., 2019). This project contributes to a growing body of literature that takes an alternative approach, looking at discourse through a structural lens and thereby shifting the analytical perspective on the role of discourse in governance development processes (Stielike, 2017, Larsson 2018, Keller et al. 2018, Hajer, 1995). By assessing discourses as underpinning power/knowledge structures which can manifest in *de facto* and *de jure* governance, this approach presents an alternative way of conceptualising and critically reflecting upon the constitutive link between discourse and governance development, emphasizing that "social objects, subjects and relations […] are contingent and co-constituted through discursive practices that render some […] knowable and governable and others not" (Leipold et al., 2019: 446).

This thesis further contributes specifically to the empirical social science literature on CE, which has expanded significantly in recent years, and includes a range of analyses different aspects of CE 'discourse' (Oldham et al., 2014, Belter and Seidel, 2013). However, these analyses are often based on different definitions of what 'discourse' is, and what the analysis aims to achieve. At the risk of oversimplifying a complex breadth of academic work, it is possible to cluster the contributions to the analysis of CE discourse into two overarching groups.

The first group of contributions are based on an agency-driven, Habermasean concept of 'discourse' as a public debate carried out by strategic actors who interact with each other using a set of communicative strategies outcomes (Habermas, 1996, Habermas, 1987). The purpose of analysing a given discourse is to identify the strategies employed by actors to communicate their beliefs or advance their interests on a certain issue (Kerchner and Schneider, 2006). Most work on framing (Scholte et al., 2013, Huttunen and Hildén, 2013, Huttunen et al., 2014, Markusson, 2013, Corner and Pidgeon, 2015, Porter and Hulme, 2013, Raimi et al., 2019, Kreuter, 2021), metaphors (Nerlich and Jaspal, 2012) argumentative strategies (Sikka, 2012, Surprise, 2019), and epistemic networks (Biermann and Möller, 2019, Gupta and Möller, 2018) in the field of CE are (implicitly or explicitly) based on this understanding of discourse.

The second group of contributions uses a more structural, Foucauldian concept of 'discourse', defined as an underpinning system of power/knowledge; a set of concepts and categories that shapes what it is possible to think and say in a specific debate structures (Foucault, 1969 (2002), Foucault, 1978, Foucault and Gordon, 1980). This structural lens abstracts from the agency of those speaking in a debate, and thus allows a bird's eye view of the interrelated system of ideas, concepts, and categories that that bounds what is thinkable and practicable in relation to a given issue. The aim of a discourse analysis based on this characterization of the term is then to understand the underlying discursive structure within which the social meaning is being constituted (Keller, 2011, Keller et al., 2018, Hajer, 1995). Only a few CE discourse analyses have so far explicitly employed this structural understanding of discourse (Matzner and Barben, 2018, Cairns, 2016, Harnisch et al., 2015, Uther, 2014, Boettcher, 2012, Anshelm and Hansson, 2014). My project contributes to this emerging pool of literature and expands it by linking the implications of discursive structures to CE governance development using the concept of governmentality (see section 3.4).

This thesis therefore pursues several interrelated aims: (1) *Exploring* a framework for shifting the analytical perspective on the role of discourse in (CE) governance development processes; (2) *Anticipating* and critically reflecting upon how given discursive structures may be making certain types of CE governance more/less thinkable and practicable, (3) *Emancipating* those engaging in the CE governance debate to recognize and (potentially expand the bounds of) the discursive power/knowledge structures they are reproducing, and (4) *Informing* the design of participatory processes to further "open up" discursive diversity in CE governance development.

1.3   Organization of the thesis

This thesis is organised into three parts. In addition to this general introduction, the remaining chapters in **Part I** proceed as follows:

Chapter 2 details the historical development of the CE governance debate and gives an overview of some of the central issues structuring current discussions on CE and its governance, showing that the CE debate is characterized by an orientation toward speculative futures that fundamentally shapes how CE is entering the collective imagination of scientists, policymakers, and publics.

Chapter 3 details the social constructivist and post-structuralist foundations of my theoretical framework and summarizes the analytical concepts I use for my analyses.

Chapter 4 presents my methodological approach, outlining my research design and research sub-questions, my interview-based empirical data collection process, and how I undertook the iterative data coding and discursive structural mapping analyses in each empirical case study.

Part II then presents the four empirical case studies and two interpretative reviews that form the core of this thesis:

Chapter 5 presents the analysis of a series of interviews with experts from the **science/ policy spheres** in US, the UK and Germany about a proposed Code of Conduct for climate engineering research. The analysis illustrates how – by shaping what is defined as the object(s) of governance, why governance is considered necessary, and who is assigned the authority to govern – the underlying discursive structure within the science/political spheres in these three countries may shape the emergence of polycentric structures focused on enhancing democratic legitimacy in CE research governance (**Cracking the Code**).

Chapter 6 presents the analysis of a series of interviews with UK representatives from the **industry/policy spheres** about what they consider to be appropriate governance instruments for NETs. The paper shows that strategic and utilitarian knowledge and social actors are being privileged within this sphere of the UK NETs governance debate, and highlights ways in which discursive mapping can play a key emancipatory role in 'opening' up governance development processes to wider knowledge types (**Coming to GRIPs with NETs Discourse**).

Chapter 7 details analysis of a series of interviews with faith leaders and religious scholars from the transnational **civil society sphere** to critically discuss how religious discourse on humanity's role in and responsibility towards nature may shape the emergence of climate engineering governance specifically, and the reconceptualization of socio-ecological earth system governance more broadly (**A Leap of Green Faith**).

Chapter 8 highlights how rethinking discourse as structure allows connections to other structural approaches to analysing global environmental governance development. The chapter brings neo-institutionalist and post-structuralist perspectives together in an innovative framework to explore how governance of climate engineering is being shaped by discursive and institutional structures in three international forums: the London Convention and its Protocol; the Convention on Biological Diversity; and the United Nations Environment Assembly (**Arguments and Architectures**).

Chapter 9 provides a conceptual exploration of the ways in which different types of discourse may shape emerging governance of ocean-based negative emissions techniques. In combination with public acceptability and policy assessment approaches, the analysis shows that that the very idea of ocean NETs is likely to set the stage for a whole new range of contested governance futures (**Casting a wider net on ocean NETs**).

Chapter 10 zooms out to explore how meta discourses may be shaping a longer and wider arc of climate governance. The analysis uses a governmentality lens to point out common trends in how a seemingly disparate range of climate response strategies emerged, evolved, and took effect between 2005-2015 (**Delaying decarbonization**).

Part III (Chapter 11) then summarizes the overarching empirical and theoretical conclusions from each chapter as well as the thesis as a whole and discusses insights generated by the project for global environmental governance more broadly.

2 Climate engineering governance challenges in historical perspective

2.1 History of weather and climate modification

Although the idea of intentionally attempting to influence the global climate in response to climate change is often perceived as a relatively recent development, it has a longer history reaching back as far as the 1930s (Fleming, 2010, Fleming, 2006, Uther, 2014). CE has its historical roots in the idea of deliberately controlling the weather. Although there are major differences between weather and climate modification, in particular related to the geographic and temporal scale of the respective intervention, they share similarities in methods and rationales – to reduce the extreme risk of weather events, and/or to control the weather to increase the quality of human life. Some have also emphasised similarities between rationales for CE and those motivating early attempts to control the weather for strategic political or military purposes (Surprise, 2020, Fleming, 2012).

Some of the most well documented early attempts to influence the weather included 'seeding' cumulus clouds – usually with silver iodide particles – to increase precipitation. A well-known example was *Stormfury*, a US project carried out between 1962 and 1983. The primary aim was to try to induce the premature precipitation of the moisture contained within a hurricane to ensure it dissipated before making landfall/reaching populated areas. However, dual use for military purposes was also seen as possible – i.e., to increase the intensity of a hurricane, or encourage it to precipitate over a given area (Willoughby et al., 1985).

Other examples of weather modification for strategic purposes can be found in the history of the Soviet Union, where the Leningrad Institute for Rainmaking was founded in 1932. Weather control was a key area of research in both the USA and Russia during the Cold War. One well known example is *Operation Popeye*, a US cloud seeding campaign during the Vietnam War intended to extend the length of the monsoon season and hamper enemy supply chains. Concerns about escalation led to the establishment of the Environmental Modification Convention (ENMOD, full name Convention on the Prohibition of Military of Any Other Hostile Use of Environmental Modification Techniques) by the UN in the 1970s (Parkinson, 2010, Fleming, 2010).

The first documented call for the large-scale manipulation of the global climate to 'improve our planet and make it more suitable for human life' was published in 1960 (Rusin and Flit, 1960: 17). In 1977, Russian climate scientist Mikhail Budyko published what is often cited as the first academic paper on the idea of injecting particles into the stratosphere to reduce global temperatures (Oldfield, 2016, Budyko, 1977). In the subsequent decades the idea largely languished, until it was brought back into the spotlight as a potential 'climate solution' by renowned atmospheric scientist Paul Crutzen in 2006 (Crutzen, 2006).

2.1   The emergence of CE as a possible 'solution' to a policy dilemma[2]

The idea of using CE as a climate response strategy arguably first entered the political sphere in 1965, when the US Presidential Science Advisory Committee published a statement suggesting that "the possibilities of deliberately bringing about countervailing climatic changes […] need to be thoroughly explored" (PSAC, 1965: 127). However, this idea did not emerge on the international political agenda until several decades later as the risk of accelerated climate change started to become more apparent. In 1992, US National Academy of Sciences (NAS) published a report entitled 'Policy Implications of Greenhouse Warming' which included a section on a range of proposals for intervening into the climate system. The focus of the report was the relative cost-effectiveness of these proposals in comparison to other suggested climate policies (NAS, 1992).

In 2006, Nobel laureate Paul Crutzen published a paper in Climatic Change entitled "Albedo enhancement by stratospheric sulfur injections: A contribution to resolve a policy dilemma?" (Crutzen, 2006). In his essay, Crutzen noted that attempts at reducing greenhouse gas emissions to limit global warming had thus far been "grossly unsuccessful" and called for research to investigate whether injecting sulphur particles into the stratosphere could effectively reflect incoming sunlight and thereby limit temperature rise (Crutzen, 2006: 121). He emphasized that such research should aim at assessing potential positive and negative effects of the proposed stratospheric modification schemes, stating that "if positive effects are greater than the negative effects, serious consideration should be given to the albedo modification scheme" (Crutzen, 2006: 216). Across academic disciplines, Crutzen's intervention was followed by a surge in interest in and research on proposals for what is at the aggregate level often referred to as 'geoengineering' or 'climate engineering' – an unbounded set of heterogeneous proposals for intentionally intervening into the climate system to reduce the risks of climate change. The umbrella term climate engineering commonly encompasses proposals for reflecting sunlight away from Earth (SRM) as well as removing carbon dioxide from the atmosphere at a scale sufficiently large to alter climate (CDR) (IPCC, 2014).

Crutzen stated that his essay was motivated by a twofold policy dilemma, which he perceived as arising from the need to reduce global emissions of both carbon dioxide and harmful air pollutants such as sulphur dioxide (for a more detailed discussion of Crutzen's article and the commentaries which accompanied it, see Lawrence and Crutzen 2017). Crutzen was concerned about the slow political progress on the former, and understood that the latter would result in more rapid warming of the Earth's atmosphere as the reflective effect of the air pollutant particles was reduced. His concerns about political inertia on emissions reduction attracted the most attention at the time of publication and formed the basis for his compelling call for climate engineering research. He argued:

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2   This section is based on a co-authored paper: BOETTCHER, M. & SCHÄFER, S. 2017. Reflecting upon 10 years of geoengineering research: Introduction to the Crutzen + 10 special issue. *Earth's Future,* 5, 266-277. **Boettcher:** Conceptualization; writing-original draft; writing-review and editing. **Schäfer:** writing-review and editing.

> Given the grossly disappointing international political response to the required greenhouse gas emissions […] research on the feasibility and environmental consequences of climate engineering of the kind presented in this paper, which might need to be deployed in future, should not be tabooed (Crutzen, 2006: 214).

Crutzen argued that research on solar climate engineering was needed to investigate its potential positive and negative effects, in case emission reduction efforts were inadequate, the rate of climate change and its associated detrimental impacts accelerated, or both. However, he was also careful to point out that solar climate engineering should not be considered a substitute for mitigation, writing:

> Nevertheless, again I must stress here that the albedo enhancement scheme should only be deployed when there are proven net advantages and in particular when rapid climate warming is developing […]. Importantly, its possibility should not be used to justify inadequate climate policies, but merely to create a possibility to combat potentially drastic climate heating (Crutzen, 2006: 216).

Crutzen was far from the first to suggest the idea of climate engineering, but his status as a Nobel Prize laureate and a respected member of the atmospheric science community meant that his essay in Climatic Change attracted a great deal of attention among his peers. The years that followed the publication of Crutzen's essay saw a strong increase in interest in and research on climate engineering across academic disciplines (Oldham et al., 2014), and he is therefore often credited with "breaking the taboo" surrounding climate engineering research (Harnisch et al., 2015, Stilgoe, 2015).

Crutzen's publication invigorated academic discussion about and investigation of climate engineering techniques. The publication of his article was followed by a significant increase in the number of academic publications on the topic of climate engineering (Oldham et al., 2014). Several national and multinational climate engineering projects were established subsequently, including the German Research Foundation (DFG) Priority Programme on Climate Engineering, the EU-funded Implications and Risks of Engineering Solar Radiation to Limit Climate Change (IMPLICC) Project, the European Transdisciplinary Assessment of Climate Engineering (EuTRACE), the Mechanism and Impacts of Geoengineering Project (supported by the National Key Basic Research Program of China), the Norwegian Research Council's EXPECT project, the UK Research Council funded Integrated Assessment of Geoengineering Proposals (IAGP) and Stratospheric Particle Injection for Climate Engineering (SPICE) projects, and the international Geoengineering Model Intercomparison Project (GeoMIP).

Although the United States does not have a national climate engineering research program, research is being carried out at individual institutions: a research group dedicated to climate engineering has been established at Harvard University, where currently a broader research program is being set up, and researchers at several other US institutions including Pacific Northwest National Laboratory, the US National Center for Atmospheric Research, Cornell University, the Carnegie Institution for Science, Rutgers University, the University of Montana and the University of Washington are investigating aspects of climate engineering from various disciplinary and interdisciplinary perspectives. In Germany, more than 18 German, Swiss,

and Austrian universities and research institutions conducted climate engineering research as part of a DFG Priority Programme from 2013-2019, and several federally funded research consortiums – primarily focusing on CDR – have subsequently spun out of this.[3] In the United Kingdom, ongoing climate engineering research is being carried out by groups at multiple universities, and the UK government has recently established a 'Greenhouse Gas Removal Research Programme' to investigate the feasibility of large-scale removal of carbon dioxide and other greenhouse gases from the atmosphere to achieve climate policy goals. Researchers at Japan's Agency for Marine-Earth Science and Technology and the University of Tokyo are likewise assessing the potential risks and benefits of geoengineering, as are academics at universities in Australia, Canada, the Netherlands, and an increasing number of other countries.

The first major international, transdisciplinary conference series on geoengineering, CEC14, was held in Berlin in 2014 and again in 2017 and 2021 to facilitate discussions about the future development of climate engineering research among representatives of academia, the policymaking community, non-governmental organizations (NGOs), and wider society. In addition, a Gordon Research conference entitled Radiation Management Climate Engineering: Technology, Modelling, Efficacy, and Risks was held in 2017 in Maine, USA. In the last 10 years, increased research into solar climate engineering has led to an expansion of the range of approaches under consideration to include not only stratospheric aerosol injection of the kind suggested by Crutzen, but also a range of other options, including marine cloud brightening and cirrus cloud thinning.

Over the years, improvements in global climate models have allowed more detailed simulations of various solar climate engineering techniques and multi-model comparisons have begun examining areas of agreement and disagreement between different models (Kravitz et al., 2011, Schmidt et al., 2012, Caldeira et al., 2013, Robock, 2014, Kravitz et al., 2015, Irvine et al., 2016). Modelling and laboratory research has also begun to investigate the potential negative effects of geoengineering, including effects on ozone, ultraviolet radiation, and precipitation patterns (Robock et al., 2008, MacMartin et al., 2016, Robock, 2016). Social science and humanities research has investigated some of the fundamental legal, economic, geo-political, ethical, and societal challenges that climate engineering research and potential deployment pose (for overviews, see Royal Society, 2009, Schäfer et al., 2015). However, both natural and social science investigation of the various techniques remain in the early stages, and the call for more research into climate engineering continues to be voiced inside and outside the academic community (Harnisch et al., 2015, NAS, 2021, NAS, 2019, NRC, 2015a, NRC, 2015b).

The proliferation of scientific interest in climate engineering has been mirrored by an increase in awareness of the issue within the policy space. Several governmental institutions, including the US National Academy of Sciences (NRC, 2015a, NRC, 2015b, NAS, 2019, NAS, 2021) the US Government Accountability Office (Government Accountability Office, 2010, Government Accountability Office, 2011), the US Congressional Research Service (Bracmort and Lattanzio, 2013), the German Federal Environmental Agency (Bodle and Oberthuer,

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3 See https://www.bmbf.de/bmbf/shareddocs/bekanntmachungen/de/2020/06/3047_bekanntmachung
  and https://www.bmbf.de/bmbf/shareddocs/bekanntmachungen/de/2020/05/3017_bekanntmachung

2014), the German Federal Ministry of Education and Research (Rickels et al., 2011), the Office of Technology Assessment of the German Bundestag (Caviezel and Revermann, 2014), and the European Commission (Schäfer et al., 2015), have commissioned reports on climate engineering. The US House of Representatives and the UK House of Commons held a series of hearings on the scientific and governance challenges of climate engineering in 2009 and 2010 (United States House of Representatives, 2009, United States House of Representatives, 2010a, United States House of Representatives, 2010b, United Kingdom House of Commons, 2010). The UK and German governments have stated their positions on the issue, supporting ongoing research to inform future decision making, but not endorsing the deployment of any climate engineering technologies (German Parliament, 2012, UK Government, 2013).

In the international climate change arena, the Intergovernmental Panel on Climate Change (IPCC) held a joint working group expert meeting on climate engineering in Lima in 2011, and the panel's three most recent assessment reports (AR4, AR5 & AR6) included references to climate engineering techniques. Additionally, the IPCC Chairman Hoesung Lee was quoted calling for the panel to explore the technical and governance aspects of climate engineering (The Guardian, 2016). The historic agreement reached at COP21 in Paris to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels has led to increased debate about what role carbon dioxide removal and solar climate engineering measures may play in achieving climate targets, especially given that the removal of large quantities of carbon dioxide is already assumed in most of the IPCC's scenarios for limiting temperature rise to 2°C or 1.5°C (Parker and Geden, 2016, Anderson and Peters, 2016, Horton et al., 2016).

The increased academic and societal interest in climate engineering has additionally led to the establishment of several climate engineering governance initiatives. The Solar Radiation Management Governance Initiative (SRMGI), which seeks to expand the discussion of SRM research governance in developing countries, was launched in 2010 by the Royal Society, The World Academy of Sciences (TWAS), and The Environmental Defence Fund. Building upon the Oxford Principles on Geoengineering Governance (Rayner et al., 2013), the Universities of Oxford and Sussex partnered with University College London in 2012 to conduct the two-year Climate Geoengineering Governance project, which focused on assessing possibilities for public participation and transparency in climate engineering decision-making. More recently, the Forum for Climate Engineering Assessment (FCEA) initiated an Academic Working Group on International Governance of Climate Engineering, an international group of senior academics assembled to formulate recommendations on the international governance of climate engineering research and potential deployment, with a focus on solar climate engineering technologies. Responding to the Royal Society's call for the development of a code of practice for climate engineering research (Royal Society, 2009), in early 2016 the University of Calgary, the Institute for Advanced Sustainability Studies (IASS) and the University of Oxford's Institute for Science, Innovation and Society (InSIS) jointly launched the Geoengineering Research Governance Project (GRGP) aimed at further developing a Code of Conduct for climate engineering research that had previously been co-published between the IASS and the University of Oxford (Hubert and Reichwein, 2015, Hubert, 2017). Most recently, the Carnegie Council for Ethics in International Affairs announced the commencement of

Figure 1: Timeline of key developments in CE 2006-2016 (Boettcher & Schäfer, 2017)

NAS Reports
US National Academy of Sciences publishes reports assessing the potential impacts, benefits, and costs of two different proposed classes of climate intervention: carbon dioxide removal and albedo modification (reflecting sunlight)

IPCC Chair calls for research
Lee says the IPCC should also be looking at geoengineering, or climate intervention on a planetary scale. He says he "would like to see the climate panel explore the governance of geoengineering, and not just its technical aspects"

German Research Foundation (DFG) Priority Programme (SPP) Launch
The German Research Foundation (DFG) Priority Programme (SPP) 1689 examines the risks and side effects of Climate Engineering

EUTRACE Report
European Trans-disciplinary Assessment of Climate Engineering (EuTRACE) formed to complement other national and international assessments of CE by providing a distinctly European perspective that draws upon contributions from a range of scientific and non-expert stakeholders

FCEA AWG Launch
The Forum for Climate Engineering Assessment convenes an international group of senior academics assembled to formulate recommendations on the international governance of climate engineering research and potential deployment

US Congressional Research Service Report
Report provides an overview of geoengineering technologies and relevant US and international regulatory structures

German Federal Environmental Agency Report
Report by an independent team of scientists to collate current knowledge on geoengineering, assess it on the basis of their scientific expertise, and clearly indicate contentious issues and gaps in knowledge

Timeline

2011	2012	2013	2014	2015	2016

IASS Microcosm Launch
Institute for Advanced Sustainability Studies in Germany launches an interdisciplinary "microcosm", with representatives from as many of the relevant natural, social science and humanities disciplines as possible to assess the possibilities and risks of geoengineering

EXPECT Project Launch
Norwegian project launched to explore – through climate model simulations – the potential, as well as side effects, of proposed climate engineering techniques

Paris Agreement
Agreement reached by the parties at the 21st Conference of the Parties of the UNFCCC in Paris to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels

GRGP Launch
University of Calgary, the Institute for Advance Sustainability Studies (IASS-Potsdam) and the University of Oxford's Institute for Science Innovation and Society (InSIS) jointly launch the Geoengineering Research Governance Project (GRGP) aimed at developing a Code of Conduct for geoengineering research

Office of Technology Assessment of the German Bundestag Report
Report summarizing the state of natural and social science knowledge on geoengineering

CGG project Launch
Project launched which aims to provide a timely basis for the governance of geoengineering through robust research on the ethical, legal, social and geopolitical implications of a range of geoengineering approaches

Chinese Mechanism and Impacts of Geoengineering Project Launch
Launch of the Mechanism and Impacts of Geoengineering Project, supported by the National Key Basic Research Program of China

Carnegie Governance Project Launch
Carnegie Council for Ethics in International Affairs announced the commencement of the Carnegie Climate Geoengineering Governance Project, led by Janos Pasztor, senior advisor to the UN secretary-general (UNSG) on climate change, which aims to encourage intergovernmental dialogues on geoengineering governance

IPCC working groups
All three IPCC working groups assess several geoengineering options

First major international geoengineering conference CEC14
Major international conference is held to facilitate discussions about the future development of geoengineering research among representatives of academia, the policymaking community, NGOs and wider society

the Carnegie Climate Geoengineering Governance initiative (C2G2),[4] led by Janos Pasztor, former senior advisor to the UN Secretary-General on climate change, which aims to encourage intergovernmental dialogs on climate engineering governance. An overview of key developments in the climate engineering field during the decade between 2006 and 2016 (in which the field exponentially expanded and established itself) is illustrated in Figure 1.

It has been argued that recent scientific and societal discussions of emerging CE proposals are characterized by a future-orientation that fundamentally shapes how climate engineering is entering the collective imagination of scientists, policymakers, and publics, and by a mode of knowledge production that recognizes the risks that may result from new knowledge. As the technologies and their governance are currently in the process of being defined and designed, reviewing the development of discussions of CE provides those engaged in the debate with an opportunity to consciously reflect upon possible future developments. Such reflexive moments are especially relevant at the early, constitutive stages of technological emergence, when science and society alike still have important roles to play in shaping their future trajectories (Jasanoff and Kim, 2009, Boettcher and Schäfer, 2017).

2.3   CE as a governance challenge

The idea of deliberately intervening into the climate system is increasingly being discussed as a global environmental challenge (Pasztor et al., 2021, Sovacool, 2021). Although heterogeneous, the wide range of proposed techniques for deliberately altering the climate would all have (indirect or indirect) global implications and effects, and this has increasingly led to calls for governance through international and intergovernmental forums (Morrow, 2017, see also Chapter 9). Key global environmental governance questions raised by this suite of proposed techniques include: How could an inclusive and accountable local-to-global decision-making process be put in place? What risks and benefits, and whose interests, would have to be taken into consideration when decisions about CE research and deployment are made? How can adequate local-to-global monitoring, reporting and verification systems be put in place for various types of climate interventions? What forms of compensation would be available for transboundary impacts which may be attributed to such interventions? What regulatory arrangements could guard against a 'moral hazard' or 'mitigation deterrence' response, where the very prospect of the future availability of CE technologies may result in lower global emissions reduction efforts? What steps could prevent a 'slippery slope' processes, where small-scale research could lead to large-scale deployment of some of the technologies even in the face of continued scientific and/or societal uncertainties? Is there a need for a moratorium on

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4   The initiative has since been renamed the 'Carnegie Climate Governance Initiative' (C2G). In a blog post explaining the change, director Janos Pasztor wrote that "As an initiative with the term 'geoengineering' in its title, C2G2 was sometimes – mistakenly – viewed as promoting 'geoengineering'". To avoid "negative connotations and misunderstandings", they thus decided remove the term 'geoengineering' from their name. See https://www.c2g2.net/whats-in-a-name-why-we-became-c2g/

some types of CE research and deployment until global governance frameworks have been established? (Boettcher et al., 2017a and 2017b, Biermann, 2021b).

It has been pointed out that "discussions of CE governance stand now at a crucial juncture […] while the CE research community's ideas about governance have become increasingly sophisticated and specific over the last decade, they have by and large not been translated into actual governance mechanisms" (Morrow, 2017: 3).

Given that many of the proposed technologies are largely nascent, and if implemented would have intergenerational effects, the CE governance debate remains inherently future oriented and speculative (Low and Schäfer, 2019, Boettcher and Schäfer, 2017, Gupta et al., 2020). Harking back to the Collingridge dilemma of control, complex questions are being raised about how to develop societal responsible governance for a set of potentially powerfully technologies that do not yet exist (Genus and Stirling, 2018).

Recent work has highlighted the discursive politics of knowledge evident in the emergence of *de facto* and *de jure* CE governance (Gupta and Möller, 2018, Cox et al., 2020a, Jinnah et al., 2021). While scientific, technocratic knowledge was seemingly privileged in the early stages of the debate, there are indications that socio-political dimensions have since more central to conceptualising future governance (Muiderman et al., 2020).

Given the complex, global, intergenerational governance issues associated with governing CE research and development, it has been argued that current governance architectures and processes are not suited to meeting these future-oriented challenges (Craik et al., 2013, Armeni and Redgwell, 2015, Morrow, 2017). Therefore, recently there has been an increasing focus on the need for upstream, anticipatory forms of CE governance development which involve diverse discourse/knowledge types (Stilgoe et al., 2013, Bellamy, 2016, Chhetri et al., 2018, Jinnah et al., 2021, Foley, 2018). This thesis connects to this body of literature – by mapping discursive power/knowledge structures to help anticipate and critically engage with how discursive power/knowledge structures shape CE governance development (c.f. Muiderman et al., 2020).

2.4   Summary

Climate engineering is not a new idea, but it is gaining political salience in a post-Paris world. As a nascent set of globally and intergenerationally relevant technologies, CE poses complex governance future governance challenges that cannot be met by existing architectures and infrastructures. Scientific knowledge about and governance of CE have long been co-evolving – *de facto* governance is emerging. There are increasing indications that the CE governance discussion is expanding to include other forms of knowledge. Discursive mapping can help to anticipate how different forms of knowledge may shape future governance development, emancipating those engaging in the CE governance debate to recognize and (potentially expand the bounds of) the discursive power/knowledge structures they are reproducing, perhaps making future governance developments less unknowable and more inclusive.

The following chapters outline the analytical framework (Chapter 3) and present the methodological approach (Chapter 4) I use to undertake discursive mapping to anticipate governance CE development in this thesis.

3 Analytical framework: From discursive structure to anticipatory governance[5]

3.1 Social constructivism in environmental governance

Social constructivism provides the underlying theoretical ideational concept of this study that social and political reality is not objective, but rather constituted by socio-discursive processes. Social constructivism emphasises that;

> The social and political world […] is not a physical reality or material object that is outside human consciousness […] it exists only as an inter-subjective awareness, or common understanding among people; in this sense [social reality] is constituted by ideas, not by material forces (Jackson and Sørensen, 2010: 160)

A well quoted example of the way ideas construct the meaning and social effects of an event in the physical world is the one presented by Purvis and Hunt, who write; "Of course earthquakes occur, and their occurrence is independent of consciousness: but it is their construction in discourse that determines whether they are 'movements of tectonic plates' or manifestations of 'the wrath of the gods'" (Purvis and Hunt, 1993: 492). Thus, although it does not create physical reality, "discourse provides the symbolic resources out of which the meaningful world is created" (Weldes and Saco, 1996: 374).

As the quote above makes clear, the importance of investigating the role of discourse in the constitution and perpetuation of the meaningful world is emphasised in social constructivist approaches to understanding governance developments. In particular, interpretative and critical constructivists in political science focus on the discursive creation and mediation of meaning through language. These authors reiterate that "to understand discourses is to understand the underlying logic of the social and political organisation of a particular arena and to recognise that this arrangement and the structures of power and meaning are not natural, but socially constructed" (Crawford, 2004: 22). According to this perspective political scientists should, "when confronted by ostensibly 'material' explanations, [for political outcomes] always inquire into the discursive conditions which make them work" (Wendt, 1998: 135).

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5 The elements of the analytical framework outlined here are most relevant for the four core analytical chapters (Chapters 5-8). Although my contributions to the two comparative reviews (Chapters 9 & 10) where informed by the same theoretical assumptions, the resulting papers represent a mixture of my own analytical framework and those of my co-authors.

However, although the role of discourse in the social (re)production of ideas which influence perceptions of phenomena and ultimately the discursive legitimisation of action is emphasised by many social constructivists in the field of political science, the definitions of 'discourse', the underlying assumptions of the role of discourse in societal processes, and correspondingly the analytical methods they employ differ greatly (Kerchner and Schneider, 2006, Leipold et al., 2019). The varying understandings of discourse and discourse analysis and how they relate to the analytical framework as used in this project are outlined in the following section.

3.2   Political discourse between structure and agency

The role of discourse in politics and governance has been increasingly recognized. However, the concept of 'discourse' has a variety of theoretical origins and understandings of the exact nature of its role in political and societal processes are correspondingly diverse (for overviews see: Leipold et al., 2019, Kerchner and Schneider, 2006). One school of thought on the role of discourse which has often been (implicitly or explicitly) taken up within the field of environmental politics is that of Jürgen Habermas. The Habermasean theory of discursive ethics puts forward an **agency-focused** understanding of 'discourse' as a debate carried out by strategic actors behaving according to the logic of 'communicative rationality'. Based on the idea that social actors will argue rationally and equally within an egalitarian 'discursive space', this understanding of discourse posits that bringing a range of perspectives and arguments into play will lead to more collectively acceptable, 'better' governance outcomes (Habermas, 1996, Habermas, 1987, Kerchner and Schneider, 2006, Kerchner, 2010b).

The understanding of 'discourse' as a space of rational and strategic debate has increasingly been taken up within the field of environmental governance since what some have termed "the deliberative turn […] an increased attention in environmental politics to procedural qualities such as participation, dialogue, transparency and accountability" (Bäckstrand et al., 2010: 3). The implicit assumption about the nature and role of discourse – namely that deliberation by a wide range of public and private actors in (carefully designed) participatory discursive processes can facilitate more legitimate and effective policy outcomes – has been central to calls for new modes of environmental governance to 'open up' politics and make environmental governance development more inclusive and reflexive (Bäckstrand et al., 2010: 4).

However, deliberative engagements and participatory political processes seldom recreate the ideal Habermasean egalitarian 'discursive space'. Quite the opposite, such deliberative processes are more commonly "underpinned by large asymmetries of power and voice" which privilege certain types of knowledge and knowledge (re)producers, thereby shaping what can be authoritatively said, and by whom (Young, 1996, Bäckstrand et al., 2010: 18, see also Turnhout, 2018, Turnhout et al., 2015, and 2020). In practice, this can mean that participatory processes – rather than leading to the integration of diverse discourse/knowledge types – instead prioritize and reinforce dominant modes of knowledge, meaning certain speakers are privileged as holders of authoritative knowledge while other stakeholders' voices are marginalized (Turnhout et al., 2020: 17). For example, in participatory processes involving experts and non-experts (i.e., scientists and stakeholders), experts are often assigned the role of

explaining the nature of the problem to be addressed. This gives experts the discursive power to define the issue at hand, rather than allowing an open discussion of what the problem (and solution) space contains. Whether the main problem to be solved in relation to the German transition away from coal-fired energy is an economic one (i.e., compensating the coal industry for financial loses) or a social and cultural one (making sure the furloughed miners do not lose their sense of purpose and belonging) depends largely on what types of knowledge are assigned discursive authority within deliberative decision-making processes.

I argue that a **post-structural** understanding of discourse can help to shine more light on these underlying asymmetries in *language, knowledge and power* and the ways they may bound and shape emerging CE governance development. The discourse analytical framework I use in this project draws on the post-structuralist discourse theory outlined by Michael Foucault. Foucault's discourse theory shares some foundations with the structural linguistic tradition originally developed by Ferdinand de Saussure (Saussure, 2006). Saussure conceptualised language by differentiating between langue (an idealized abstraction of language, or language system) and parole (language as it is actually used in daily life). These two elements influence each other – the system of language makes using language possible, and the use of language can ultimately alter the system (Saussure 2006: 16f). Saussure saw the language system (langue) as a system of 'signs'. The signs, which constitute the smallest units of the language system, have two elements – the signified, an abstract concept or idea, and a signifier, the word used to name the concept. According to Saussure, there is no intrinsic reason why a specific sign is used to express a given signifier. It is thus arbitrary, and signs only gain their meaning from their relationships and contrasts with other signs in the language system (Saussure 2006: 78f). This means that the structure of relations within the language system creates meaning. These concepts were carried over into the field of social sciences by Claude Lévi-Strauss (Lévi-Strauss, 1963, Lévi-Strauss, 1980), who conceptualized cultural and social phenomena, such as myths, as being similar to Saussure's parole. He saw the telling of a myth as being based on an underlying culturally created mytheme structure, comparable to Saussure's langue. It is this structure that allows the creation of meaning in a narrative, rather than the subject telling the myth. For example, a story about a 'knight in shining armour' is inextricably entangled with culturally entrenched understandings of Western class and gender relations.

Foucault's work takes similar structural concepts and develops them further with the aim of analysing the connection between discourse, knowledge systems and the role of power. Foucault's equivalent to Saussure's langue (the structural system of language) is the episteme, which constitutes the discursively (re)produced knowledge system. Like Saussure, Foucault focused on deconstructing power/knowledge systems (discourses) into their smallest elements in order to reconstruct their underlying systemic structure. Whereas for Saussure the smallest elements were 'signs', for Foucault they are 'statements'. Like Saussure's signs, such statements have only arbitrary meaning, and thus only gain their meaning from their relationships and contrasts with other statements in the discourse. This means that the structure of the discourse as a whole creates meanings (Foucault and Gordon, 1980, Mills, 2003). For example, the statement 'he is insane' is only meaningful if there is a corresponding concept of 'sane', and if there is an established categorical dichotomy between the two concepts.

Foucault's theory introduces a political element to the creation of meaning within the discursive structure, which he conceptualises as a constant battle, as a "strategic game of actions

and reactions, questions and replies, attempts to dominate and evasive manoeuvres" (Foucault et al., 1994: 671). However, true to his structuralist roots, Foucault emphasises that this battle is facilitated by discursive power. According to this concept, power does not originate in agents but in discursive structures (Foucault, 1969 (2002), Foucault, 1978, Foucault and Gordon, 1980). Power is thus systemic and productive; "the socially diffuse production of subjectivity in systems of meaning and signification [...] which defines what constitutes legitimate knowledge and shapes whose knowledge matters" (Barnett, 2005: 4). As one author who applies Foucault's power concept in analysing environmental governance puts it; "the supreme power is the power to delineate the boundaries of thought – a feature of discursive practices rather than of specific agents. What becomes important, then, is how certain discourses come to dominate the field" (Litfin, 1994: 37).

In accordance with this concept, I conceptualise power throughout the chapters of this dissertation as systemic and discursive – the power to limit what it is possible to say. This power originates in the discourse itself and the overarching regulation of a political field by discursive structures "transcends the generative and critical capacities of any individual speaker" (Terdiman, 1985: 39). This concept of discursive power is central to Foucault's notion of the discursive constitution of meaning and the role of actors in this process. Foucault shares the view of post-positivist political science that discourse is not to be seen as a medium through which individuals can manipulate the world. According to this concept, authoritative social actors are relevant, but they should be seen as the effects rather than the source of power: power resides neither in actors nor objects, but in systems; "discursive practice involves actors, but they do not function as autonomous agents wielding the power of discourse on behalf of transparent interests" (Giddens, 1977: 348, quoted in: Litfin 1994: 23).

For example, if an indigenous leader attending a marine science forum were to put forward a call for fishing to be banned in a specific area because it is considered a 'scared site', this may be outside the 'discursive bounds of possibility' because (s)he is not assigned a role as an authoritative speaker within the scientific discursive sphere, and (s)he is not reproducing established elements of the dominant scientific discursive structure. If (s)he made a call for fishing to be banned because it was posing a risk to marine biodiversity, (s)he might have better chances, because (s)he is then speaking within the bounds of the existing dominant (scientific) discursive structure within that setting. The locus of power is thus seen as skewed towards the structure of the discourse itself.

Foucault's theory of discourse shows that the sole reference to the role institutional positions or individual actors' vested interests play in the creation of discursive meaning is an unsatisfactory circular explanation because institutions or individuals are only powerful in so far as they are constituted as authorities through discourse. Hence, according to Foucault's concept, the focus is not on an *a priori* thinking subject trying to express or transcribe his or her preconceived ideas in language. The social actor rather operates within the context of the discursive structure according to which his or her own ideas are formed and through which he or she is empowered to speak authoritatively.

In summary, the central elements of Foucault's discourse theoretical 'tool box' which are relevant for this project are as follows:
• A specific discourse can be broken down into its smallest elements

- Meaning is created through the relationships and contrasts between elements in the discourse
- Power is discursive
- The production and reproduction of social meaning is a constant battle
- Social actors are discursively constituted as authoritative subjects/speakers and cannot completely 'control' discourse

3.3   Sociology of Knowledge Approach to Discourse

A broad range of political discourse analysis approaches have been developed based on Foucault's discourse theory (Keller, 2008, Kerchner and Schneider, 2006, Torfing, 1999, Howarth and Torfing, 2004, Leipold et al., 2019). Many approaches that have been developed, however, lack a theoretically well-founded connection between Foucauldian discourse theory and the role of social actors. While the social interactive perspective often used in political analysis conceptualises actors as "active, selecting and adapting thoughts, mutating and creating them in the continued struggle for argumentative victory against rival thinkers" (Billig, 1987: 82), the Foucauldian discourse theoretical approach excludes the assessment of actors as discoursing subjects (almost) entirely. On the contrary, rather than seeing actors as actively creating and controlling discourse, Foucauldian discourse theory postulates that it is the discursive structure which constitutes the actors as subjects and empowers them to (re)produce discursive meaning (Foucault, 1980). This dichotomy between structural and actor-based analytical concepts calls for an innovative approach allowing the combination of elements of both theoretical perspectives, allowing the assessment of both the overall structural discursive 'conditions of possibility', and the investigation of how social actors adopt, reproduce, perpetuate and potentially alter elements of that structure.

One such a framework is the Sociology of Knowledge Approach to Discourse (SKAD), which I apply in my research. SKAD extends Foucauldian discourse analytical premises, combines them with social constructivist assumptions, and includes the concepts of speaker and subject positions. The focus of this approach to discourse analysis is on social relations of knowledge and knowing and politics of knowledge and knowing, with the aim of revealing discursively constructed hierarchies of truth and constellations of symbolic world ordering (Keller, 2018b).[6]

The SKAD approach conceptualizes discourse as an underpinning system of knowledge that structures what it is possible for social actors engaged in a specific debate to truthfully and legitimately say. Rather than being completely free agents, this approach assumes that

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6   SKAD shares similarities with the Argumentative Discourse Analysis (ADA) approach developed by Maarten Hajer, (cf: HAJER, M. A. 1995. *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process,* Oxford, Oxford University Press.) In many cases the analytical concepts of SKAD and ADA are interchangeable. However, whereas Hajer's approach focuses on the performative power of narrative storylines in drawing together discourse coalitions, the SKAD assesses more directly the politics of knowledge – how certain types of knowledge are privileged or excluded within a given discursive structuration.

"in performing their articulations, social actors draw upon the rules and resources that are available via the present state of a given discursive structuration" (Keller, 2018b: 20). Actors (re)producing elements of a discourse have to conform to the structural 'rules' set by past statement practices. Each discursive structuration thus provides a range of **speaker positions**; discursive templates within the structure of the discourse which can be occupied by social actors. Social actors then adopt discursive speaker positions, which allows them to authoritatively (re)produce the discursive structures associated with them. Consequently, the identification of speaker positions is not the same as identifying the actors themselves, but rather the discursive locations which allow social actors to legitimately and authoritatively (re)produce discursive structures. Mapping the speaker positions available in a specific discourse allows the range of possible positions to be identified and, through their adoption of these positions, social actors to be discursively located and positioned within said discursive structure. Groups of social actors who share speaker positions by (re)producing analogous discursive elements (such as narrative rationales or object categorization patterns) create **discourse coalitions** (Keller et al., 2018, Keller, 2008, Hajer, 2005). Discourse coalitions are not necessarily formed intentionally: groups of social actors may share analogous speaker positions without being aware of it.

These concepts remain true to Foucault's emphasis on the predominant role of the discursive structure in the constitution of socially meaningful problematizations. As Keller emphasizes, "discourse is superordinate to social actors. Not individual actors, but discursive structures regulate the access of actors to the discourse through speaker positions. Social actors thus do not operate freely as creators of discourse" (Keller 2008: 255, author's translation). Social actors are, however, not completely controlled by discourse, and through their individual (re)production of discursive elements, they can ultimately alter the overall structure of the discourse. This co-constitutive process is reminiscent of Saussure's concept of the relationship between langue (the language system) and parole (language as it is actually used in daily life). These two elements influence each other – the system of language makes using language possible, and the daily use of language can ultimately alter the system (Saussure, 2006).

Analogue to this, although the origins of speaker positions are located in the discursive structure itself, through their adoption of speaker positions and the (re)production of specific elements of the discourse, discursively legitimized social actors may ultimately alter the overall discursive structure (Keller, 2008). Thus, SKAD-based discourse research is not about unmasking the hidden agenda or intent of social actors, but about tracing the discursive structure without which the authoritative (re)production of certain statements would not be possible. Rather than negating the fact that social actors have interests and engage in governance debates strategically, the SKAD approach abstracts from this to focus on their discursive legitimation as authoritative speakers, the kinds of knowledges they use in order to (re)produce legitimate statements, and the potential effects resulting from this on the overall discursive structuration of a given discursive sphere (Keller, 2018b: 35).

In addition to active speaker positions, the structure of a given discourse can also offer passive **subject positions** to social actors. These are nascent identity and action templates for specific roles within a given issue area (Keller, 2018b: 35). An example of such a discursive subject position highlighted by Keller in relation to environmental discourses is the 'eco-citizen', "the friend of the environment who in principle does not take airplanes, reduces water

consumption, has a bike instead of a car, works to lower his/her carbon footprint and so on" (Keller, 2018b: 36). This example is positively connoted. However, subject positions can be negative as well: subjects which have to be "educated, disciplined, punished, excluded, like the ecologically irresponsible type which isn't concerned about questions of climate change" (ibid).

In sum, discourse analytical concepts I adopt for this study are as follows:

- **Discursive structure:** The systemic, historically contingent manifestation of power/ knowledge relations within a given discursive sphere: an interrelated system of ideas, concepts and categories that bounds what it is possible to know and say about a given phenomenon.
- **Speaker positions:** Discursive positions which are created by the structure of the discourse which allow social actors to legitimately and authoritatively (re)produce discursive elements
- **Subject positions:** Nascent/passive identity and action templates for specific roles
- **Social actors:** Individuals who adopt discursive speaker positions and (re)produce the discursive elements associated with them
- **Discourse coalition:** A group of social actors who adopt shared discursive speaker positions and (re)produce the discursive elements associated with them

3.4   Governmentality as a heuristic lens

The concept of governmentality was originally introduced by Michel Foucault as analytical framework to identify a concrete historical assemble of 1) objects of knowledge, 2) technologies of governing, and 3) practices of the exercise of power involved in 'the art of governing' (Kerchner, 2010b: 15, Foucault, 2007 [1978]. See also Gordon, 1991, Burchell et al., 1991). Foucault states that he understands governmentality in three ways:

- First, by 'governmentality' I understand the ensemble formed by the institutions, procedures, analyses and reflections, calculations and tactics that allow the exercise of this very specific, albeit very complex, power which has the population as its target, as its major form of knowledge political economy, and apparatuses of security as its essential technical instrument.
- Second, by 'governmentality', I understand the tendency, line of force, that over a long period and throughout the West, has constantly led towards the pre-eminence over all other forms – sovereignty, discipline and so on – of the type of power which we can call "government", and which has led to the development of a whole series of specific governmental apparatuses (*appareils*) on the one hand and, [on the other] to the development of a series of knowledges (*savoirs*).
- Finally, by 'governmentality', I think we should understand the process, or rather, the result of the process by which the state of justice of the Middle Ages became the administrative state in the fifteenth and sixteenth centuries and was gradually 'governmentalized' (Foucault, 2007 [1978]: Lecture 4: 108).

Foucault here lays out a broad description of liberal governmentality (as the governing logic/ the system of thinking about the nature of practice of governing in the 18th century). However, in laying out this definition of liberal governmentality, Foucault also lists the elements of 'governmentality' as an analytical concept more generally – a given 'governmentality' has a 'target' or object to be governed, a principle form of knowledge, and involves certain types of technical governing 'instruments'. In his lectures on Security, Territory and Population in 1977 and 1978, Foucault used this analytical tool to investigate how historically contingent power/ knowledge structures shaped differing objects, subjects and practices of governing from the 16th to the 20th centuries (Foucault, 2007 [1978]).

These elements of the original Foucauldian analytical concept has been taken up by the field of Governmentality Studies as "a system of thinking about the nature of the practice of government (who can govern; what governing is; what and who is governed), capable of making some form of that activity thinkable and practicable to both its practitioners and to those upon whom it is practiced" (Gordon, 1991: 3)

The governmentality concept thus concept offers a lens which "problematizes the collective and often taken for granted systems of thought that make governing strategies appear natural and given at certain times in history" (Stripple and Bulkeley, 2014:10). Governmentalities "define both the objects (what should be governed) and nature (how they should be governed) of governing, in effect rendering reality governable through the collecting and framing of knowledge" (Bulkeley et al., 2007: 2736).

Building on these definitions, for this project I conceptualize **governmentality** as **a system of thinking about the nature and practice of governing** which;
a. is underpinned by a principal form of **knowledge**,
b. is linked to particular governance **rationales (why)**,
c. shapes particular governance **objects and subjects (what and who)**, and
d. makes the development of specific governance **modes and instruments (how)** thinkable and practicable

The concept of governmentality has proven to be a useful analytical tool in investigating the constitutive link between discourse and environmental governance emergence (Lövbrand and Stripple, 2014, Stripple and Bulkeley, 2014). As discursive power/knowledge structures are theorized as being (one of the) constitutive factors shaping the emergence of governance practices and infrastructures, mapping these structures is aimed at "the making visible […] of the different ways in which an activity or an art called government has been [is being] made thinkable and practicable" (Burchell et al., 1991: ix).

In this vein, I use the components of my above definition of governmentality as a heuristic lens to structure my SKAD-based analyses (see section 4.3), which aim to anticipate which discursive blueprints for 'systems of thinking about the nature and practice of governing' may be emerging in different spheres of the CE debate by reverse engineering the discursive construction of the objects, speakers and subjects, rationales, modes and instruments of CE governance.

3.5   Summary

In this project I understand discursive structures as the systemic, historically contingent manifestations of social power/knowledge relations within a given discursive sphere: an interrelated system of ideas, concepts and categories that bounds what it is possible to say about a given phenomenon or issue. As such, these structures shape what types of governance objects, subjects, rationales, modes and instruments are 'thinkable and practicable' within a given discursive sphere.

Furthermore, I conceptualize discursive power/knowledge structures as constitutive of governance practices and infrastructures. This means that discursively constructed, societally meaningful 'systems of thinking about the nature and practice of governance' that link subjects, objects, rationales, modes and instruments – discursive blueprints of governmentalities – can shape formal and informal governance arrangements and instruments.

My analysis is thus premised on an understanding of a link between discourse and governance development that accepts (but does not endorse) the performative power of certain discursive structures. By selecting this approach, I am deliberately choosing to abstract from the agency of social actors in the emergence of governance. This is not to stay that political agency does not play a key role in the development of governance – I am simply bracketing these elements for the purpose of an analysis that focuses on the performative power of discursive structures in the dynamic co-constitution of governance between structure and agency. I assume that we can uncover and critically assess the performativity of given discursive structure, and by doing so emancipate ourselves and others to be more reflexive about the structures we/they are (re)producing, but discursive structures have a certain robustness and cannot be easily altered. Premised by this understanding of the power of discursive structures (in the sense that they shape what types of governance are 'thinkable and practicable'), I use the analytical concept of 'governmentality' to map discursive blueprints for 'systems of thinking about the nature and practice of governing' emerging in different spheres of the CE debate. The following section details my 'reverse engineering' methodological approach to mapping discursive structures.

4 Methodological approach: Reverse engineering discursive structures

4.1   Research design

The research design of this dissertation project consists of a series of qualitative empirical case studies (Chapters 5-8). These core analyses are complemented by two chapters (Chapters 9 & 10) which use an interpretive review approach to explore how elements of the analytical framework developed in the previous stages of the project may be applied in combination with other social science approaches to assess and anticipate the development of wider areas of climate governance.

   All the analyses carried out in this project are *interpretive*. Interpretive analyses do not claim to be able to test hypotheses or provide evidence of direct causal mechanisms, but rather aim to reconstruct the constitutive conditions (in this case discursive structures) which make certain ideas and actions thinkable and practicable (McNabb, 2010). The connection between the discursive structure of the CE debate and the development of CE governance is therefore conceived of as constitutive, rather than directly casual. Consequently, this thesis as a whole addresses a constitutive, 'how' research question: *How is the discursive construction of climate engineering governance taking place in science, industry, civil society, and politics?*

Reflecting the elements of my governmentality definition as a heuristic lens (see section 3.4), the following six sub-research questions guided my analysis in each empirical case study (see section 4.3 for a detailed description of this process):

1. **Govern what?** What is being constituted as the object(s) of governance?
2. **Why govern?** What rationales are structuring the call for governance?
3. **Who governs?** What governance speaker/subject positions are available?
4. **How govern?** Which governance modes and instruments are thinkable and practicable?
5. **'Discursive blueprints' for governmentalities?** Is a/are system(s) for thinking about the nature and practice of CE governance emerging?
6. **Discourse coalition(s)?** Is one or more **discourse coalition(s)** of social actors which (re)produce the discursive elements of this/these system(s) becoming apparent?

By mapping spheres of the CE debate, the research design of this thesis thus aims to identify the constitutive discursive structures which make certain 'systems of thinking about the nature and practice of governance' thinkable and practicable, as outlined in Figure 2. The SKAD approach to discourse analysis used is compatible with this approach, as it "does not presume

Level of analysis				
		Objects	Rationales	Speakers/Subjects	Instruments

Type of analysis	Case Studies	**1. Govern what?** What is being constituted as the object(s) of governance?	**2. Why govern?** What rationales are structuring the call for governance?	**3. Who governs?** What governance speaker/subject positions are available?	**4. How govern?** Which governance modes and instruments are thinkable and practicable?
	Comparison	**5. Discursive blueprints' for governmentalities?** Is a/are system(s) for thinking about the nature and practice of CE governance emerging			
		6. Discourse coalition(s)? Is one or more discourse coalition(s) of social actors which (re)produce the discursive elements of this/these system(s) becoming apparent?			

Figure 2: Research design

or imply a general and explanatory theory of what discourses are and how they seek to perform the work they do in the world […] Instead, SKAD takes a case study approach, insisting that each case we deal with is a case of its own *sui generis*, or at least has to be approached as such, via a heuristics of research which ultimately provides some theorisation about that case, but does not offer a definite causal theory" (Keller and Clarke, 2018: 63).

Although the analytical framework outlined above was used to guide the approach to each case study, the detailed analysis of the data and interpretation of the results was done iteratively, with the categorizations of discursive structures emerging from the data itself (see section 4.3 below for more details on the concrete data analysis methods used).

Each of the papers presented in chapters 5, 6, 7 & 8 represent one such case study. The case selection process took place within the bounds of a broader transdisciplinary project entitled 'Climate Engineering in Science, Society and Politics' being carried out at the Institute for Advanced Sustainability Studies (IASS) Potsdam,[7] where I was employed as a Research Associate while completing this thesis. In line with the transdisciplinary approach of the IASS, the wider project – and thus the analyses that make up the empirical chapters of this thesis – was premised on the understanding that the development of CE governance includes (and should include) diverse types of knowledge and perspectives from a range of societal groups including science, civil society, industry and politics. The case studies were correspondingly selected to include these discursive spheres – with Chapters 5 and 8 focusing on the science/policy sphere, Chapter 6 on the policy/industry sphere, and Chapter 7 on the civil society sphere. I do not claim that these spheres are exhaustive. However, they have been identified as key in the development of wider environmental governance and policy (Litfin, 1994), and (re) produce some of the key discourse/knowledge types that have been shown to be relevant for the emergence of CE (Uther, 2014, Harnisch et al., 2015).

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7   More information on the project can be found on the IASS website here: https://www.iass-potsdam.de/en/research/climate-engineering-science-society-and-politics

4.2   Primary data collection: Semi-structured interviews

The data pool for analysis in each of the case studies detailed in chapters 5, 6 & 7 (and partially chapter 8) was the transcripts of qualitative interviews containing rich narrative and contextual data (see sections 5.4.1, 6.3.1, 7.2. & 8.3). Between 20 and 25 qualitative interviews (45-60 min long) were the basis for analysis in each of the case studies (separate groups of interviewees in each case). The transcription of these interviews resulted in approximately 175,000 words of text for analysis per chapter.

Qualitative interviews can be differentiated as unstructured, semi-structured and structured. Structured interviews often produce quantitative data, whereas semi-structured formats aim to produce the kind of detailed, context-rich qualitative data which lends itself to discourse analysis. Qualitative, semi-structured interviews are intended to combine structure with flexibility. Even the most unstructured interviews will generally be based on some form of guide setting out the key topics and issues to be covered. However, the structure should still be sufficiently flexible to permit topics to be covered in the order most suited to the interviewee, to allow responses to be fully probed and explored, and to allow the interviewer to follow up on relevant issues raised spontaneously by the interviewee. Semi-structured interviews are therefore often organized around a set of open-ended questions, with further questions emerging from the interaction between the interviewer and interviewee (Yeo et al., 2013). To this end, for each case study, an interview guide was established which included 15-20 guiding questions, divided into thematic blocks (see the methodology sections in each empirical chapter in Part II for further details). In practice, the interviews themselves were conducted according to the following overarching structure (compare: Yeo et al., 2013, Kvale and Brinkmann, 2008):

- **Introduction**
  - Overview of research topic, purpose and nature of the interview
  - Reaffirming terms of confidentiality/permission to record the interview, as agreed upon in the consent form
- **Opening questions**
  - Widely framed questions to encourage spontaneity, engaging issues relevant to the interviewee
  - Gathering important contextual information (professional affiliations, experience with the topic(s) to be discussed)
- **Conceptual questions**
  - Exploring key themes and concepts relevant to the research topic
  - Identifying points for further in-depth discussion
- **In-depth questions**
  - Discussing attitudinal/evaluative/explanatory questions
  - Probing alternative perspectives on key themes and concepts
- **Wrap-up**
  - Signalling that the interview is coming to a close
  - Reviewing the topics discussed, inviting additional inputs

The interviewees for each case study were selected according to two main criteria: Having previous experience with the topic of CE governance,[8] and being active within one of the spheres of the debate that are the focus of this thesis: science, politics, industry or civil society (see also sections 5.4.1, 6.3.1 and 7.2 for further details on the interviewee selection process).

4.3   Data analysis: Inductive coding and iterative structural mapping

The SKAD discourse analysis approach I apply in each of the following empirical case studies (chapters 5-8) is designed to systematically reverse-engineer discursive structures underlying a pool of individual utterances: it is an *empirical deconstruction* and *interpretative reconstruction* of discursive power/knowledge structures, with the aim to map these structures and to make visible the contingencies in the work they do (Keller, 2018b: 29).

Following the SKAD approach, for each of the case studies (chapters 5-8) in this thesis, I first created a data pool of discursive products (i.e., interview transcripts, meeting reports) which contained an assortment of individual utterances related to CE governance, and a detailed set of heuristic questions to guide the search for structuring rules (compare sections 5.4, 6.3, 7.2 & 8.2). Reflecting my sub-research questions – which in turn reflect the elements of my heuristic governmentality lens (see section 3.4) – these included:

What is being constructed as the object(s) of CE governance?
- *How is CE mentioned in the text(s)?*
- *How is CE defined in its relationship to other types of activities? (External differentiation)*
- *Are systematic 'individualizing differences' becoming recognizable between what CE is and what it is not? (External differentiation)*
- *How are types of CE defined in relation to each other, grouped or organized into overarching categories? (Internal specification)*
- *Are any implicit classification criteria for defining what sort of CE activities should (not) be governed becoming evident? (Internal specification)*

What governance rationales are underpinning calls for CE governance?
- *What governance themes are problematized?*
- *Which themes are recurrently contrasted or categorized in relation to each other?*
- *Are standards and assumptions/logics of different knowledge systems (i.e., academic disciplines) evident in the rationales about why CE should (not) be governed?*
- *Are broader rationales becoming evident that are structuring the call for/rejection of CE governance?*

What speaker and subject positions are available within the structure of the CE governance debate?
- *What types of individuals and groups are referred to?*

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8   This was primarily to avoid having to provide interviewees with informational material on CE which may have biased their responses.

- *How are parties in the CE governance debate referred to and in what way are they being assigned/denied a role in CE governance?*
- *Which references, oppositions, characterizations, connotations, and denotations etc. are associated with individuals and groups?*
- *Are any implicit classification principles for the individuals or groups' governance roles becoming evident?*

What governance modes and instruments are being discursively constituted as thinkable and practicable?
- *What types of governance instruments/modes are problematized?*
- *Which instruments/modes are recurrently contrasted or categorized in relation to each other?*
- *Are logics of different knowledge systems (i.e., academic disciplines) evident in the way CE governance instruments/modes are categorized?*

What knowledge types are linking these discursive elements into emerging systems of thinking about the practice of governing (governmentalities)?
- *Are there shared knowledge types underpinning the formation of governance objects, subjects, rationales, and instruments?*
- *Are there overarching discursive structures systematically linking the what, who and how of CE into overarching systems of thinking about the nature and practice of governance?*

Guided by these questions, I first undertook a preliminary analysis of the material in each case study to identify how the discursive elements 'rationales' (why) 'governance objects' (what), 'speaker/subject positions' (who), and 'governance modes/instruments' (how) appeared in the documents which made up the data pool for each case. I then systematized the textual data using an 'open coding' approach, inductively organizing the elements identified in the documents into categories with the help of the text analysis program MAXQDA (Hardy et al., 2004). Two broad types of coding are possible: deductive and inductive coding. Deductive coding, which involves the definition of code categories prior to the coding process, has been criticized as being overly positivist and thus incompatible with the epistemological and ontological principles of post-structural discourse analysis (Crawford, 2004, Hardy et al., 2004, Herrera and Braumoeller, 2004, Hopf, 2004, Laffey and Weldes, 2004). Inductive coding, however, remains true to the interpretive tradition of post-structural discourse analysis in that categories emerge from the data itself during the coding process (Hardy et al. 2004: 21). Coding thus becomes an iterative process of working backwards and forwards between the texts and the categories, allowing the constant dynamic development of the category system (Hardy et al. 2004).

The next step in each case study involved using axial coding methods to identify recurring formation rules with which discursive elements were related. These included – for example – patterns of classification and differentiation, as well as relationships of equivalence and contrariety between elements of the discourse. This recursive process involved several iterative loops in which I compared my preliminary findings to further empirical material from the given data pool, and where necessary revised the categories created in the initial coding
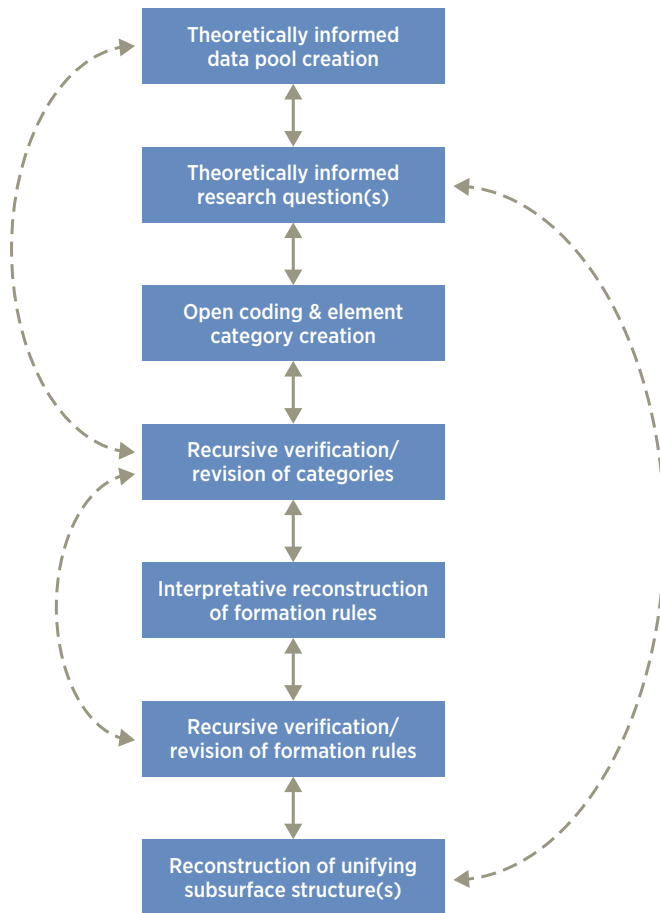
Figure 3: Iterative analytical approach to mapping discursive structures.

run. The end result of these case-study analyses was a map of discursive structures shaping governance rationales, objects and subjects, modes and instruments in each analyzed sphere of governance debate, and the identification of the discourse/knowledge structures linking them into systems for thinking about the nature and practice of governing. This iterative analytical approach is outlined in Figure 3 (see also sections 5.4.3, 6.3.2, 7.2 & 8.3)

4.4   Positionality

We too are performers of discourse about discourses. There is no escape (Keller, 2018b: 25).

This project was carried out based on an interpretative, co-constitutive understanding of a researcher's relationship to data. All empirical research is based on data, and the results of sound empirical analysis should reflect and be supported by that data. But all analysis of data

is shaped by researchers' choices and filtered through researchers' brains – we ourselves act as analytical tools by deciding how we sample data and what questions we ask of it. Different questions will lead to different 'responses' from the empirical material we analyze. Every definition or categorization of a term, a phenomenon or a situation is an interpretive process. In this way, every analyst is continually interpreting while researching – no data truly 'speaks for itself':

> The basic problem for the […] researcher when he or she is reflecting upon his/her work, is making it transparent for him or herself and for others how (s)he understands that which (s)he believes to understand, and how (s)he knows that (s)he thinks she knows (Hitzler and Honer, 1997: 23).

There is therefore a tension between the idea that an underlying, constitutive discursive structure 'exists' and has only to be 'discovered' by the analyst, and the knowledge that discourse analysis is in and of itself an interpretive and co-constitutive discursive process in which the analyst to some extent 'imposes' a structure upon the material. A clear statement of positionality and reflexive self-monitoring on behalf of the analyst, together with careful descriptions of his/her theoretical framework and methodology, and a constant re-evaluation of results against new empirical material are therefore essential to this type of analysis. While the above sections outline the latter points, here I explicitly lay out my positionality.

I grew up as part of an alternative family, largely outside of the 'system' my parents had attempted to escape. I originally wanted to study sociology to better understand how this mysterious societal system 'worked'. As I came to realize that larger, transnational systems were key to structuring societal processes from above, I became interested in political science. I enjoyed the way in which applying different theoretical lenses allowed completely different perspectives on understanding political and societal developments. Among wide range of lenses on offer, systemic social and political theories always made more sense to me. I especially delved into Luhmann's System Theory. During my studies, I pursued a minor in Linguistics, with a focus on structural linguistics and performative speech act theory. Within my political science major, my interest in the role of language in politics almost inevitably led me to social constructivism, and I found my epistemological and ontological home in the idea that societally and politically meaningful reality is socially and discursively constructed. My inherent affinity towards structural and systemic social theories made Foucauldian discourse theoretical approaches most appealing. Thus, my personal and academic background means that I primarily see structural or systemic power at play in social and political processes and tend to neglect the role of agency, which has shaped my research design(s) during this project.

I first engaged with the idea of climate engineering when completing my master thesis as part of an interdisciplinary group of social scientists interested in understanding the potential societal and political *risks* of considering deliberate interventions into the climate system – i.e., to disincentivize or slow societal transition to a low carbon economy, to cause international conflict. Social scientists often see themselves as the critical counterpart to more techno-optimistic (natural science) perspectives. As the meme goes – "A natural scientist can tell you how to clone a dinosaur. A social scientist can tell you why that might not be a good idea." Social scientists are often conditioned by our training to be inherently – and not always

constructively – critical. I approached the topic of CE in this way – as a risky idea that should be critically assessed by social scientists with an eye to highlighting the ways in which CE activities could be potentially societally or politically harmful. Although my embedded work within the interdisciplinary CE research community has since shown me that it is important to also explore the potential societal and political benefits of CE approaches, my critical perspective of course had (and has) an effect on the way I approach my research.

4.5   Summary

The research design of this thesis is centred around a series of four empirical case studies, supplemented by two reviews. My methodological approach is interpretative, and the connection between the discursive structure of the CE debate and the development of CE governance is conceived of as constitutive, rather than directly casual. The overarching research question of this thesis is: *How is the discursive construction of climate engineering governance taking place in science, industry, civil society, and politics?*

The elements of my governmentality definition (section 3.4) function as a heuristic lens to develop research sub-questions, and to guide the empirical analysis. The data for the empirical analyses was gathered primarily by means of semi-structured interviews, which were recorded, transcribed, and subsequently analysed using inductive and axial coding techniques in the qualitative text analysis programme MAXQDA. I have included a clear statement of positionality, which – together with careful descriptions of my theoretical framework and methodology, and a constant re-evaluation of my results – serves to increase transparency about the way in which I undertake my interpretative research. The following chapters present the four empirical case studies (chapters 5-8) and two interpretive reviews (chapters 9 & 10) which form the core of this thesis.

PART II

5 Cracking the Code [9]
Discursive structures shaping the development of a Code of Conduct for Climate Engineering Research Governance

There is increasing interest in developing future-focused, anticipatory governance of climate engineering research. Discourse is the source code with which contested futures are written, shaping how future governance options can be imagined, designed and institutionalized. 'Cracking the code' underpinning the CE research governance debate can therefore help anticipate and critically reflect upon the ongoing constitution of governance. This paper presents a sociology-of-knowledge-based discourse analysis (SKAD) of a series of interviews with governance experts from US, the UK and Germany about a proposed Code of Conduct for climate engineering research. The analysis illustrates how – by shaping what is defined as the object(s) of governance, why governance is considered necessary, and who is assigned the authority to govern – the underlying discursive structure of a given governance debate can shape governance development.

5.1   Introduction: From discursive structure to anticipatory governance

The already complex discussions about governing climate futures have become even more convoluted with the idea of climate engineering (CE); a set of heterogeneous proposals for intentionally intervening into the global climate system to reduce the risks of climate change (Royal Society, 2009)[10]. The idea of intentional, large-scale manipulation of the global climate has been called a "quintessential anticipatory governance challenge, wherein the perils and promises associated with a suite of CE options remains uncertain, contested and to a large extent unknowable" (Gupta and Möller, 2018: 2). There is therefore increasing interest in developing 'anticipatory' – that is, future-oriented, reflective, upstream-focused – governance of CE research and development (Stilgoe et al., 2013). The underlying discursive structure of a given governance debate has a constitutive effect on how future governance options can be imagined, designed and institutionalized. However, to date there has been little empirical analysis of the discursive structure of the emerging CE research governance debate, and a lack of corresponding discussion of its shaping implications for the development of CE governance.

Some preliminary work has been done to trace how the development of CE definitions has had a *de facto* governance effect on CE research (Gupta and Möller, 2018), and to explore the implications rationales underlying the call for CE governance may have for *de jure* governance development (Jinnah, 2018). Adding to the conceptual work of these colleagues, in this paper I present an empirical sociology-of-knowledge-based discourse analysis (SKAD) of a series of interviews with governance experts from United States, the United Kingdom and Germany about a proposed Code of Conduct for Responsible Climate Engineering Research (Hubert, 2017, Keller et al., 2018). My analysis illustrates how – by shaping what is defined as the object(s) of governance, why governance is considered necessary, and who is assigned the authority to govern – the underlying discursive structure of a given governance debate not only has ongoing *de facto* governance effects, it also shapes how future *de jure* governance options can be conceptualised. By mapping one sphere of the discursive structure into which a concrete proposal for CE governance is being introduced, I aim to draw out the possible shaping implications of these discursive patterns for the development of the Code of Conduct specifically and CE research governance more broadly.

The next section gives a brief introduction to the CE governance debate and introduces the proposed Code of Conduct (2). The following sections situate this paper in the wider literature on the role of discourse and governance in CE (3), outline the methodological approach (4), detail the results of the analysis, and discuss the possible implications of the results for the development of CE research governance (5 & 6).

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10 The terms climate engineering or geoengineering (hereafter CE) are used interchangeably and encompass proposals for reflecting sunlight away from Earth (often called solar radiation management [SRM]) as well as permanently removing greenhouse gases such as carbon dioxide from the atmosphere (sometimes called carbon dioxide removal [CDR], Greenhouse Gas Removal [GGR] or negative emissions technologies [NETs].

5.2   Background: Climate Engineering research governance challenges

Climate engineering is not a new idea: Proposals for deliberately intervening into the global climate have been around for several decades and have been receiving increased attention in academia since 2006 (Fleming, 2010, Boettcher and Schäfer, 2017, Crutzen, 2006, Oldham et al., 2014). As it is becoming questionable whether current global mitigation commitments are consistent with achieving the Paris temperature targets, discussion of the need for intensified research and outdoor testing of some CE techniques is picking up speed (Anderson and Peters, 2016, Horton et al., 2016, IPCC, 2018, Dykema et al., 2014, Keith, 2013).

Research into deliberate, large-scale interventions into the global climate system arguably presents a novel spectrum of upstream governance challenges ranging from *enabling* research into the prospective benefits of CE approaches, to *restricting* the potential environmental and socio-political risks associated with such research. Several reviews have indicated that existing national and international governance structures are not fully suited to meeting these future-oriented challenges (Morrow, 2017, Craik et al., 2013, Armeni and Redgwell, 2015, Schäfer et al., 2015, Royal Society, 2009).

Therefore, recently there has been an increasing focus on the need for upstream, anticipatory forms of CE governance which fulfil both enabling and restrictive functions, and are flexible enough to enable linkages between different stages of CE research at various institutional levels (Chhetri et al., 2018, Bellamy, 2016, Stilgoe et al., 2013, NAS, 2018). Although the groundwork for such governance frameworks has previously been laid out in broad principles (Rayner et al., 2013, Asilomar Scientific Organizing Committee, 2010), there have so far been few examples of concrete, actionable proposals to meet these needs in the short term. One example of such a proposal has been put forward by legal scholars Anna-Maria Hubert and David Reichwein (Hubert and Reichwein, 2015, Hubert, 2017). According to the authors, the Code aims to "provide further practical guidance on the responsible conduct of geoengineering research and development […] It is designed as a voluntary instrument, though one that is based upon existing legal sources, including general principles, rules of customary international law, treaty-based rules, regulations, international decisions, and policy documents. The guidance provided in the Code is global in scope, but relevant for various State, sub-State and non-State actors […]. The Code seeks to balance three main functions of [CE] research governance: to prevent and minimise the risk of environmental and other harms; to promote responsible geoengineering research with a view to better understanding the potential efficacy, benefits, and risks of proposed techniques; and to enhance legitimacy" (Hubert, 2017: 4). The Code includes a set of principles and practices for responsible CE research (Article 6), and provides a set of practical guidelines for the assessment of outdoor CE experiments (Article 7 & Appendix I). It also lays out guidance on public participation (Article 8), research monitoring (Article 9) and the public provision of information on CE research (Article 10) (Hubert, 2017).[11]

In 2016 the Geoengineering Research Governance Project (GRGP) was launched by the University of Calgary, the Institute for Advanced Sustainability Studies (IASS), and the

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11   The Code can be accessed here: https://www.ucalgary.ca/grgproject/files/grgproject/revised-code-of-conduct-for-geoengineering-research-2017-hubert.pdf

University of Oxford to further develop the draft Code of Conduct by incorporating input from a variety of stakeholders. This paper details the results of one part of the GRGP project: A SKAD discourse analysis of a series of interviews about the Code carried out with governance experts from United States, the United Kingdom and Germany. The Code has explicitly been presented as living document which is being developed within an "ongoing process of engagement" (Hubert, 2017: 21). Mapping one sphere of the discursive structure within which the Code is emerging therefore provides a unique opportunity to highlight the potential shaping effects of discursive structures on the continuing development of CE governance.

5.3   Analytical approach: Discourse and governance between agency and structure

The social science literature on CE has expanded quite dramatically in recent years, and now includes a range of papers that focus on analysing different aspects of CE 'discourse' (Oldham et al., 2014, Belter and Seidel, 2013). However, these analyses are often based on different definitions of what 'discourse' is, and what the analysis aims to achieve. At the risk of oversimplifying a complex breadth of academic work, it is possible to cluster the contributions to the analysis of CE discourse into two overarching groups:

The first group of contributions are based on an agency-driven concept of 'discourse' as a public debate carried out by strategic actors who interact with each other using a set of communicative strategies. The purpose of analysing a given discourse is to identify the strategies employed by actors to communicate their beliefs or advance their interests on a certain issue (Kerchner and Schneider, 2006). Most papers on framing (Scholte et al., 2013, Huttunen and Hildén, 2013, Huttunen et al., 2014, Markusson, 2013, Corner and Pidgeon, 2015, Porter and Hulme, 2013, Raimi et al., 2019), metaphors (Nerlich and Jaspal, 2012) and argumentative strategies (Sikka, 2012, Surprise, 2019) in the field of CE are (implicitly or explicitly) based on this understanding of discourse.

The second group of contributions uses a more structural concept of 'discourse', defined as an underpinning system of power/knowledge; a set of concepts and categories related to a specific issue. This structural lens abstracts from the agency of those speaking in a debate, and thus allows a bird's eye view of the interrelated system of ideas, concepts and categories that that bounds what it is possible to say about a given issue. The aim of a discourse analysis based on this characterization of the term is then to understand the underlying discursive structure within which social meaning is being constituted (Keller, 2011, Keller et al., 2018). Only a few CE discourse analyses have so far explicitly employed this structural understanding of discourse (Matzner and Barben, 2018, Cairns, 2016, Harnisch et al., 2015, Uther, 2014, Boettcher, 2012, Anshelm and Hansson, 2014). I aim to contribute to this emerging pool of literature, and to expand it by linking the implications of discursive structures to CE research governance development.

In following with the Sociology of Knowledge Approach to Discourse Analysis (SKAD), I understand discursive structures as the systemic, historically contingent, relatively robust manifestation of power/knowledge relations within a given discursive sphere. The SKAD approach posits that there is a difference between utterances made by individuals and the underpinning structures that shape such utterances, and aims to identify such underlying

structures and highlight their performative role in shaping social reality. (Keller et al., 2018, Keller, 2011). In a governance debate, these structures correspondingly shape what type of governance objects, subjects and rationales can be thought of and discussed by social actors; discursive structures therefore have an enabling *de facto* governance effect by constituting socially meaningful governance objects, subjects and rationales, and a restrictive *de facto* governance effect by limiting what it is possible to know and say about a given issue. Furthermore, discursively constructed, societally meaningful objects, subjects and rationales can solidify into formal institutional arrangements and infrastructures: in other words, *de jure* governance structures appropriate to deal with the phenomena constituted by the discourse. Thus, discursive structures are conceptualised here as constitutive of d*e facto* governance and pre-conditions for the development of *de jure* governance (Stielike, 2017, Gordon, 1991).[12]

Premised on this understanding of the performative link between discursive structures and governance development, the following analysis aims to identify the structures underpinning one specific sphere of the CE governance debate (the governance expert sphere in three OECD countries in which CE research is taking place) and critically discuss the shaping effects they may have on the future development of the Code of Conduct and CE research governance more broadly.

5.4 Methodology: Reverse-engineering discursive structures

5.4.1 Interviewees

The data pool for analysis is made up of the transcripts of 22 semi-structured qualitative interviews. The interviewees included a range of governance experts at the science/policy interface: Current and former employees of government departments, as well as governance experts from academia and civil society organisations (for an anonymised list of interviewees, see Supplementary Table 1). The interviewees were sourced from the United States, the United Kingdom and Germany as these three countries are currently considered to be leaders in CE research, with relatively well developed debates on the complex issues related to the governance of CE (Harnisch et al., 2015). The group of people interviewed is not taken to be representative of the broader CE governance debate, and I make no claim that the discursive structures identified in this analysis are the only ones underpinning the CE governance debate as a whole. Likewise, I do not mean to argue that the discursive structures I have identified will (or should) exclusively shape the development of the Code or other forms of CE research governance: Rather, this analysis maps *one* sphere of the complex discursive landscape within which CE research governance is emerging. The structures identified underpinning this specific discursive sphere can (and will) form the basis for further comparative analysis to

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12 In focusing on the role of discursive structures, I am deliberately choosing to abstract from the agency of social actors in the development of governance. This is not to stay that agency and politics do not play a role in the development of governance - I am simply bracketing these elements for the purpose of an analysis that focuses on the performative power of discursive structures in the dynamic co-constitution of governance.

assess whether similar (or different) discursive formations are structuring wider spheres of the debate.

5.4.2 Semi-structured qualitative expert interviews

The semi-structured interviews were organized around a set of 15 open-ended questions, divided into three blocks, with further questions emerging from the interaction between the interviewer and interviewee. The first block was designed to elicit information on the interviewees' understandings of the concepts 'CE', and 'governance' and to explore their general opinions on the need for governance of different types of CE research. The second block sought to discuss the ways in which governance of other emerging technologies has developed and the roles of different stakeholder groups in the development of governance. The final block focused on the potential advantages and disadvantages of the implementation of a Code of Conduct for CE research. All interviews were recorded and transcribed for analysis.

5.4.3 Inductive coding and iterative structural mapping

The SKAD discourse analysis approach employed in this study is designed to systematically reverse-engineer a given discursive structure: It involves the deconstruction of discursive outputs (i.e., newspaper articles, interview transcripts) into their smallest elements, the identification of the formation rules with which the smallest elements are linked, the subsequent reconstruction of these elements into categories, and the relation of these categories to one another to identify the underlying structures (Keller et al., 2018).

I systematised the transcribed interview data for analysis by inductively organising elements of the transcripts into categories with the help of the qualitative text analysis program MAXQDA; a process known as 'open coding' (Hardy et al., 2004). The iterative analytical approach which guided the coding process is outlined in Figure 3 on page 50 (cf. Diaz-Bone, 2006, Keller et al., 2018). In a first step, I created a data pool of discursive products (in this case interview transcripts) which had been produced within the bounds the same discursive structure and on the basis of which this underlying structure could therefore be reconstructed. I then developed a set of theoretically informed research questions to guide the search for elements and rules of discursive formation. Using the guiding research questions, I undertook a preliminary analysis of the material to identify how the discursive elements 'governance terms and objects' (what), 'demand rationales' (why), and 'speaker positions and governance roles' (who), appear in the texts. The next step involved the iterative, interpretative reconstruction of the formation rules with which the identified discursive elements were related to reconstruct the discursive structures underpinning the elements in the texts. This involved looking for recurring patterns of differentiation, identifying underlying relationships of equivalence and contrariety, and mapping fundamental oppositions between elements of the discourse (Diaz-Bone, 2006, Torfing, 1999, Keller et al., 2018). This was a recursive process in which preliminary findings were checked against further empirical material to ensure that the formation rules identified applied consistently across the data pool.

Each of the subsections below is similarly structured: In each I first outline the theoretical research question which guided the analysis in that section, then summarize the discursive patterns identified when analysing the interview data on the basis of that question.

Subsequently, I discuss the potential implications of the identified discursive structures for CE research governance development in general and the Code of Conduct specifically.

5.5 Results: Mapping structures: The what, why and who of CE research governance

5.5.1 Govern what?

Discourses "systematically form the objects of which they speak" (Foucault, 1969 (2002): 54). This is especially important in relation to emerging technologies, as the way such technologies are discursively 'formed as objects' early on affects the way they are governed, and the way they are governed affects the way technologies are, in turn, further conceptualized and developed (c.f. Gupta and Möller, 2018). Therefore, the discursive formation of the object(s) which should (not) be governed has the potential to shape the development of the Code and other CE governance mechanisms. The question that guided this section of the analysis was therefore:

- *What is being constructed as the object(s) which should (not) be governed?*

The analysis of the interviewees' definitions of the concept of CE resulted in the identification of underlying patterns of systematic external differentiation and internal specification which formed differing boundaries of the object(s) of governance.

On the one hand, patterns of external differentiation were evident in the way some defined the broad concept of CE by drawing lines between what CE is and what it is not. Interviewees established this differentiation by referring to other ways to deal with climate change (i.e., societal transformation or emissions mitigation), thereby defining CE as a governance object through reference to external objects. The categorization of what is (not) CE was related to the intent of the action – things that were 'dealing with the underlying cause of climate change' (i.e., by reducing emissions) were considered external to CE, whereas activities that aim to 'mediate the effects of climate change' fell within the boundaries of the CE object (see Figure 4).

On the other hand, underlying patterns of internal specification were evident underpinning the way some interviewees split up the concept of CE: The process of internal differentiation of types of CE approaches was based on to concepts related to the scale of their direct impacts (ranging from local to transboundary) and their primary effect (altering solar radiation [SRM] or removing atmospheric CO_2 [CDR]) (see Figure 4).

The implications of these two types of discursive categorisation for governance conceptualisation was evident in that those interviewees who used patterns of external differentiation to define CE tended to argue for the continued use of the umbrella term CE for governance purposes, while those interviewees who drew upon patterns of internal specification based on scale and effect to define CE tended to argue against the continued use of the umbrella term CE when designing CE research governance (see Table 1).

These findings have a range of potential implications for the development of CE governance in general, and for the Code of conduct specifically: On the one hand, if patterns of external differentiation related to intent became central to definitions of CE for governance purposes,

Discursive categorization	Examples	Key Statements
	I understand that there are people who want to restrict the definition of geoengineering just to SRM, and not also include CDR; I think that the two technologies are very different, […], the two classes of technologies are extremely different, for different reasons. They present different risk profiles, and, um, but nonetheless I think that there is already a kind of a sense that when we are talking about [CE], let's talk about both of these different kinds of things that intervene in the climate system. (Interviewee 04)	• Despite the fact that the two sets of technologies have different risk profiles, the character and intent of both sets of technologies remain the same; intentional intervention into the climate system to mitigate the effects of climate change.
External differentiation to argue for umbrella term for governance purposes.	I use the broadest definition of geoengineering: Any large-scale technology intervention in systems to do something about the climate situation, and, I think there's some benefit to that because, although we do need to look at technologies one by one, and assess their risks, their risk-profiles, their positive characteristics, we also have to think about technology in particular ways. Any large-scale intervention seems to have a character to it that deserves at least some joint categorization. (Interviewee 21)	• Having a label for the larger category of intentional action is necessary for developing policy. We need a workable label we can use in order to invoke broader polices or practices that can make the Earth a better place.
	So, while, in detail, especially from a technical standpoint, putting a label on anything, any several things as either in or outside of [CE] has its flaws, if we don't have a label for it, we don't have a way for describing it in terms of developing the policies that we need. Because that's what it really boils down to at the end of the day. It's not just understanding and describing what it is we are doing for some technical reason, but actually having something that we can utilize in order to invoke policies or practices that can make the earth a better place. (Interviewee 22)	• It is easier to have a broad, catch-all term to avoid definitional disagreements during policy development processes.
	Well, the term has its problems, as we are all aware, but we seem to be sort of stuck with it I suppose. […] Unless someone is gonna come up a new term that everyone is going to accept, and that seems unlikely, given the various terms that are being bandied about and no one's really accepted – not a substantial number at least – any of them, so I think a fairly broad term about CE needs to be used […] otherwise it could become very messy (Interviewee 08)	

Table 1: External differentiation & internal specification in definitions of CE for governance purposes.

Discursive categorization	Examples	Key Statements
	I think if we start trying to set very strict limits around what is [CE] and what isn't based on the fact that the definition itself is very broad, it becomes quite a difficult discussion. And I think to some extent, that's why it is very difficult to come to a simple view about how best way to regulate [CE] research because there is such a broad definition [...] It is very difficult if you were trying to design a single regulation that would cover all [CE] activities. I think it would be unlikely to get anywhere beyond some fairly top level statements as to, you know what's acceptable or not. (Interviewee 1l)	• Implications and applications of the range of CE technologies are too diverse to be able to say anything useful about their governance as an aggregate group.
Internal specification	[CE] is a useless phrase, there's almost nothing useful you can say about the highly diverse group of technologies which are often grouped together as [CE]. So at the very, very minimum you need to break things down into carbon-removal and SRM techniques, because the implications and the applications are so different. And that's expressed most clearly when we talk about governance (Interviewee 05)	• Lumping CDR into the CE definition muddies the waters: It is difficult to impossible to design a governance framework that would equally restrict/ enable research into CDR and SRM – there is a need to (at least) differentiate between these groups of approaches for governance purposes.
to argue against umbrella term for governance purposes.	The CO2 removal I think is, ah, I know it has also been lumped into the category [CE], but.my gut sense is that I don't know if that makes sense to also call that [CE], because I think it is quite different, and I think probably continuing to simply call that carbon removal is better. So that we can start distinguishing these things more. Because they are very different, and I think to have a better governance discussion of it, it is actually good to start using terms that are more distinguishing among the types (Interviewee 07)	• Having an overarching term is counterproductive for effective research governance, only the most general of governance principles could sensibly be agreed upon as applying to the whole range of CE research activities
	I think having an overarching term in this [governance] discussion is actually counterproductive. We have two very different sets of techniques, um, those for removing carbon from the atmosphere, and those for potentially reflecting sunlight back to space, that come along with very different issues. And even within those individual overarching terms, there are very different issues related to the individual technologies. So this summing up into the large term [CE], I think is actually counterproductive (Interviewee 12).	

Table 1: External differentiation & internal specification in definitions of CE for governance purposes.

Figure 4: Formation of objects in the CE governance debate. External differentiation of what is (not) CE according to intent of the action: 'dealing with cause' vs. 'dealing with effects' dichotomy. Internal specification of types of CE activities according to scale and effect.

the governance object 'CE' would be singular. However, the boundaries of this unified object of governance would be extremely broad, and governance frameworks would correspondingly need to be flexible and adaptable to the wide range of CE research activities which fell within such an encompassing definition. On the other hand, if patterns of internal specification related to scale and effect became fundamental to definitions of CE for governance purposes, the governance objects would be pluralized. As the boundaries of these multitude objects of governance would be much narrower, governance mechanisms would need to be more specific to individual CE research activities.

Currently the proposed Code of Conduct is written in a way that makes it flexible and adaptable enough to be applied to the board range of CE research activities that could be unified into single governance object by continued patterns of external differentiation. If, however, patterns of internal specification led to the solidification of multiple objects of CE research governance based on the intersection of the scale and effect of each research activity, specific versions of the Code could conceivably develop to apply more explicitly to each of the resulting governance objects.

5.5.2   What is 'governance?'

The term 'governance' has been used in the field of CE to refer to concepts ranging from international regulations restricting CE deployment, to domestic policies enabling relevant research, and informal norms guiding individual research practices. The fuzziness of the
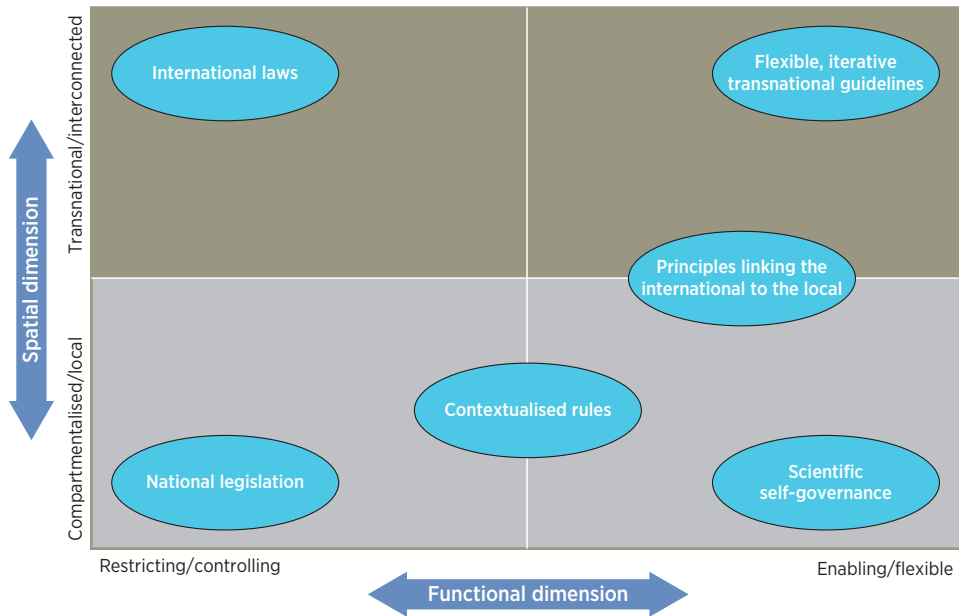
Figure 5: Formation patterns of CE governance definitions.

term can lead to misunderstanding about the need for 'governance' of CE. Understanding the discursive patterns structuring the ways in which interviewees conceptualise governance is essential to understanding their evaluation of the need for and potential effectiveness of the proposed Code of Conduct, as well as the way in which they envisage its implementation. The question that guided this section of the analysis was therefore:

- *How is the term governance being defined in relation to the Code?*

My analysis showed shared discursive structures underpinning the way in which definitions were conceptualised by interviewees: The diversity of definitions were located within a conceptual space with a functional governance dimension (controlling/restricting versus enabling/allowing flexibility) and a spatial governance dimension (local/compartmentalised versus transnational/interconnected) (see Figure 5). Interviewees implicitly or explicitly positioned their different conceptualisations of what constitutes governance within this two dimensional space, often by means of contrast in relation to opposing positions on one or more of the spectrums, as the following examples illustrate:

- **Positioning on the functional spectrum:** "Well, ideally, it is something that has got some legal backing, but there is soft governance, and there are voluntary codes of governance… it is a spectrum. I think I, being a policy-maker and a law-maker, believe that things should be legally underpinned, and that it should be a binding legal framework" (Interviewee 03).
- **Positioning on the functional and spatial spectrums:** "Governance should be national and international. I mean, I think that if you don't have national guidelines, you know, the full gambit from voluntary guidelines to more robust sort of forms of governance at

the national level, then the sub-national actors will back-fill it, and then you get a chaotic environment which is not good. […]." (Interviewee 04)

These findings have implications for the development of CE research governance in general, and the proposed Code of Conduct in particular: Generally, highlighting the relative positioning of definitions in a given debate can aid in understanding which governance developments may be appropriate (i.e., imaginable, possible) within the spatial and functional dimensions of the resulting governance space. Concretely, these findings indicate that the spatial and functional dimensions of governance definitions underpinning calls for CE research governance may influence the development of pathways towards implementation of the Code within this sphere. The results suggest that if the CE research governance debate centres around governance definitions located in the upper left of Figure 5, the Code may inform the development of binding international regulations on CE research. A dominance of governance concepts in the lower left would indicate that the Code may be used to inform the development of binding national or sub-national legislation. A consolidation of governance concepts positioned in the upper right may indicate the possibility of adoption of principles from the Code as a set of non-binding translational guidelines for responsible research. If the debate, conversely, focuses on governance definitions located in the bottom right corner of Figure 5, the Code may rather develop as the basis for systems of scientific self-governance.

However, the results indicate that this sphere the CE research governance debate currently includes a wide range of understandings of governance. Correspondingly, emerging governance frameworks appropriate to these varying definitions would be both functionally flexible and adaptive to local, regional and international governance spatial contexts. As the draft Code is designed to provide an adaptive, flexible basis for developing a range of governance mechanisms on different levels and fulfilling different functions, it would seem to be well positioned to form the basis for multi-layered CE research governance developments imaginable within the current heterogeneous definitional debate.

5.5.3   Why govern?

Differing logics underlying calls for CE governance will have varying implications for the perceived usefulness of the proposed Code of Conduct, and the ways in which it may eventually be institutionalised. This section relies heavily on Jinnah (2018), who illuminates how possibilities for institutional design are shaped by the nature and constellation of 'demand rationales' for the governance of emerging issues (Jinnah, 2018). The question that guided this section of the analysis was therefore:

- *What demand rationales are structuring calls for CE research governance?*

An overview of the governance demand rationales identified underpinning interviewees' reasoning as to why CE research should be governed is provided in the first column of Table 2. The range of demand rationales within this sphere of the CE debate delineates the boundaries of the discursive space within which calls for CE research governance can be made. Such discursive boundaries shape what it is possible to authoritatively or appropriately say within a given debate. Therefore, arguments for the governance of CE research which do not locate

themselves within the boundaries of this discursive space by implicitly or explicitly adhering to one or more of these underlying demand rationales may be considered less authoritative or legitimate.[13]

Jinnah (2018) proposes a framework to link empirical findings on demand rationales to governance design principles (Jinnah, 2018: 5). I assessed the extent to which the rationales I had identified underpinning calls governance of CE research empirically supported the three (non-mutually exclusive) conceptual demand rationale categories suggested by the author of this paper:

- The **functional rationale** underscores that governance involves efforts towards rational problem solving, and which are driven by utilitarian cost-benefit calculations and risk management concepts (Jinnah, 2018: 6). I correspondingly demands for governance of CE research identified in the interview transcripts as belonging to this rationale if they emphasised the need for governance of CE research to either reduce the risk of (environmental and societal) harm, and/or to ensure the utility of CE research activities.
- The s**trategic rationale** emphasises that governance is driven by the need to protect (national) interests, particularly relating to security and economic stability, and motivated by a desire to influence (change or maintain) the balance of power (Jinnah, 2018: 6). I categorised demands for CE research governance as being underpinned by this rationale if they focused on conflict prevention and interest balancing.
- The **normative rationale** posits that governance reflects a desire to strengthen existing norms or create new ones, and is motivated by a desire to ensure/increase global justice and equality (Jinnah, 2018: 6). I categorized governance demands as normative if they accentuated promotion of participation, transparency, legitimacy and responsibility.

Table 2 summarizes the categorization of demands for the need for CE research governance according to these rationale categories, and provides examples of each type from the data pool, showing that slightly wider range of reasons for CE research governance that adhered to the normative demand rationale (five types of normative arguments versus three functional and three strategic) where identified in the interview data. This may indicate a slight trend towards a structural dominance of normative rationales for CE research governance in this discursive sphere.

These findings are especially interesting in light of the suggestions put forward by Jinnah for translating empirical findings on demand rationales into governance design principles. Applying insights from theories of global governance, she suggests a given constellation of functional, strategic and normative demand rationales can inform the development of control mechanisms and the suitable degree of polycentricity when designing governance mechanisms for emerging technologies: If demands predominately adhere to a **functional** demand rationale, governance suited to meeting these demands would likely be technocratic in nature; if demands are largely **strategic**, the demand-based framework would suggest the appropriateness of hegemonic governance structures; and if **normative** demands dominate,

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13 The demand rationales identified in this study are not taken to be exhaustive, but can form the basis for further comparative analysis to assess whether similar (or different) discursive formations are structuring the wider CE governance discourse

CE research governance is needed for the purpose of:	Examples	Underlying demand rationale
Protecting the environment and human health from potential harm from CE research	[Governance is needed] to ensure that there is a level of protection for, you know, not only for human societies but also for wildlife and natural systems, natural processes. (Interviewee 11)	**Functional**: Governance as rational problem solving, driven by utilitarian cost-benefit calculations and risk management concepts.
Reducing the risk of unintended (environmental and societal) consequences of CE research	I think there needs to be some level, inherent level of governance that makes sure that the research that we are doing either locally, nationally, regionally, nationally, internationally is within some set of controlled parameters, so that, again, we obviate or we at least ameliorate the possibility of unintended consequences. (Interviewee 22)	
Encouraging and enabling 'useful' research	The advantages [of research governance] are that scientists and scientific organisations and countries would have a green light to go ahead with useful research, which I think is necessary. (Interviewee 14)	
Averting conflict as a result of CE research	Some categories of geoengineering research, since it does cover a lot of different things, ah, could probably work under a non-binding governance regime, whereas others at some point will definitely need some binding measures where there's compliance and, uh, behaviours of actors, involved in the research potentially could start to suffer conflicts of interest. (Interviewee 16)	**Strategic:** Governance to protect (national) interests, particularly relating to security and economic stability, and motivated by a desire to influence (change or maintain) the balance of power
Preventing 'rogue' CE research against the will/ without the knowledge of others	At the same time it could put some appropriate constraints on others who wanted to... who might be a little less conservative and a little bit more aggressive about, um, some large-scale research. (Interviewee 07)	
Preparing: Someone is going to continue with CE research, 'we' need to be prepared	It is quite clear in the end that someone is gonna do something and if at that point all we've done is say it shouldn't happen, then we're not really any further ahead in terms of having any influence on the way in which decisions are being made. (Interviewee 11)	
Facilitating inclusive global discussions about CE research governance	So that's what I mean by the kind of a softer governance that goes around, it is much more about the way in which the society engages with geoengineering as a concept and discusses which activities should be regulated and how (Interviewee 11)	**Normative:** Governance to strengthen existing norms or create new ones, motivated by a desire to ensure/ increase global justice and equality.
Setting shared norms for CE research	So this is largely I think at the moment, um, an exercise in norm-building. [...] It's about making sure we spark appropriate conversations inside scientific circles, um, with appropriate oversight from publics and from, you know, regulatory agencies that have some mandate when it comes to scientific investigation (Interviewee 21)	
Ensuring CE research and development is conducted responsibly	I think that it is critically important that the role of governance is that it allows for a sort of a better pathway towards responsible development (Interviewee 04)	
Creating transparency about CE research	I mean, the advantages to having a code of conduct are that they are a transparent statement of intent about how an entity is going to approach the governance of research. So, that, that's the desirable thing (Interviewee 05)	
Establishing (democratic) legitimacy for CE research	I think that, in order to create legitimacy for these kinds of technologies, the further up-stream you go with building social consensus, the more likely it is you are able, finally, to have a, a solution that is, you know, socially acceptable, that is, that is likely to be adapted to ethical and other concerns societies might have. (Interviewee 02)	

Table 2: Demand rationales structuring calls for CE research governance

		Demand constellations		
		Heterogeneous	**Moderately heterogeneous**	**Homogeneous**
Demand rationales	Functional	Technocratic & strongly polycentric	Technocratic & moderately polycentric	Technocratic & centralized
	Strategic	Hegemonic & strongly polycentric	Hegemonic & moderately polycentric	Hegemonic & centralized
	Normative	Democratic & strongly polycentric	Democratic & moderately polycentric	Democratic & centralized

Table 3: Implications of demand rationales and constellations for principles of CE governance design. Own figure based on Jinnah 2018.

democratic governance structures focused on enhancing legitimacy and inclusiveness would be deemed more suitable (Jinnah, 2018: 7). Further, if all three types of demand rationales are equally present, strongly polycentric governance architecture would be most appropriate. Conversely, if one type of demand rationale clearly dominates calls for governance of a given technology, the framework suggests that a centralized governance structure may correspondingly be more suitable to satisfy these demands (Jinnah, 2018: 8).

Table 3 outlines the intersecting relationships between demand rationales and the resulting implications for governance, and indicates the type of CE research governance development suggested by applying this demand-based theory of governance design to the demand rationale constellations I identified: Given that my analysis revealed that all three types of governance demand rationales are present in the calls for CE research governance, the demand-based theory of governance design would suggest that a strongly polycentric governance structure would be most appropriate. The fact that a slightly larger range of reasons for the need CE research governance adhering to the normative rationale were identified suggests that democratic governance structures focused on enhancing legitimacy and inclusiveness in decision-making on CE research could be most suitable to address the governance demands present in this sphere of the CE discourse.

The potential implications of these findings for the perceived usefulness of the proposed Code of Conduct, and the ways in which it may eventually be adopted and/or institutionalised are two-fold: Firstly, opinions about the usefulness of the Code differ based on the underlying governance demand rationale: The Code was perceived to able to fulfil normative demand rationales such as instigating inclusive discussions about CE research, setting shared norms among researchers and creating transparency about the way in which research is being carried out. It was, however, posited as being less able to be able to fulfil most of the strategic and functional demand rationales unless it was institutionalised as the basis of a more binding governance mechanism. This suggests that if further research indicates that the wider CE research governance discourse is predominantly structured by a normative demand rationale, as these first results would seem to suggest, the Code could form the basis of informal governance mechanisms to enhance legitimacy and inclusiveness in decision-making on CE research. Secondly, the indication that a polycentric governance structure would be most appropriate within the structure of demand rationales I identified suggests the possibility of the

development of pluralistic pathways towards implementation of the Code in a diverse range of fora on sub-national to international levels.

5.5.4   Who governs?

The underlying structure of a given discursive sphere not only defines the boundaries of what is it is possible to legitimately say; within these boundaries, the structure also provides a limited range of speaker positions which can be adopted by social actors who wish to speak in the discourse with authority (Keller et al., 2011, Keller et al., 2018). What types of speaker positions are available in the CE research governance discourse and which governance rationales and roles are associated with them is relevant for understanding how different types of actors can be expected to enter the CE research governance debate generally, and engage with the Code specifically. The question that guided this section of the analysis was therefore:

- *What authoritative speaker positions are available within the structure of the CE research governance discourse?*

My analysis identified four speaker positions available within the structure of this sphere of the CE governance discourse: 1) Principled gatekeeper, 2) Responsible information provider, 3) Strategic controller, and 4) Self-benefit-maximizer). Each speaker position is bounded by a distinct constellation of demand rationales and governance roles, as outlined in Figure 6 (and Supplementary Table 2).[14]

The **'principled gatekeeper'** speaker position incorporates the normative demand rationale which posits governance as a way to strengthen existing norms related to legitimate, transparent and inclusive decision making to ensure/increase justice and equality. This underlying rationale is reflected in the types of governance roles associated with this speaker position, which include: 1) ensuring accountability in the development of governance; 2) pushing issues onto the governance agenda by bringing emerging topics to the attention of policy-makers; 3) facilitating communication by increasing the level of public attention to emerging governance issues; and 4) representing the rights and interests of those under-represented, such as minorities, future generations and the non-human environment, in the development of governance frameworks. This speaker position was often assigned to/adopted by civil society organisations (predominantly environmental NGOs). An example of this type of speaker position assignment by an interviewee was; "I think NGOs have an important role in governance: Apart from anything else, just in keeping everyone else on their toes" (Interviewee 08).

The **'responsible information provider'** speaker position incorporates the functional rationale, which focuses on governance as rational problem solving, driven by utilitarian cost-benefit calculations and risk management concepts. Governance roles associated with this speaker position include are all suited to informing this type of functional governance development by 1) providing objective information to decision-makers to inform the development of problem-specific governance mechanisms; 2) explaining or demonstrating the

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14 Speaker positions are non-mutually exclusive. They can be adopted by different types of social actors, and social actors can adopt a range of speaker positions.

scientific grounds for the need for governance of a particular activity; 3) providing ongoing input into the decision-making process to inform the iterative design of adaptive governance for emerging technologies; and 4) producing evidence of the effectiveness of specific governance mechanisms to deal with governance problems. Scientists were often associated with a responsible information provider speaker position, as one interviewee put it "Science tells you the size and shape of the box you are trying to regulate" (Interviewee 05).

The **'strategic controller'** speaker position is incorporates the strategic demand rationale, in which the call for governance is driven by the need to protect (national) interests, particularly relating to security and economic stability, motivated by a desire to influence (change or maintain) the balance of power. Governance roles associated with this speaker position include 1) developing leverage to constrain (undesirable) research activity and prevent conflict; 2) providing robust authorization for desirable/useful research activities; 3) engaging in long-term strategic societal and environmental planning to inform governance goals. This speaker position was assigned to/adopted by political decision makers, as the following example illustrates: "In our society, I think governments have to make the strategic decisions and have to put the resources behind whatever they want to get done" (Interviewee 14).

The '**self-benefit-maximizer**' speaker position is associated with an underlying logic of money- and or power maximization. It is not associated with any of the identified governance demand rationales, and correspondingly, positive governance roles (in the sense of roles which actively contribute to governance development) were largely not associated with this speaker position. Rather some negative governance roles (in the sense of roles that necessitate the development of governance) were associated with this speaker position. These included 1) Generating profit through research and technology development; 2) Close-holding information gained from research in an attempt to maintain competitiveness, and; 3) Incentivizing and bank-rolling profitable (but not always useful) research. It must be pointed out that this speaker position, although being offered by the discursive structure, was not actively adopted by or assigned to any social actors in the data used for this analysis. Rather it was being 'assigned' to nebulous 'others,' sometimes with implicit reference to unnamed industrial actors, as the following quote from one interviewee shows: "The government is basically put into a situation where they have to just trust that the industry is telling the truth because it can't give away all the information, because that would allow the proprietary data to given up and would allow, you know, competing companies to take advantage of that" (Interviewee 16).

My analysis identified some distinct patterns in the way in which different types of social actors are entering the CE governance debate: On the one hand civil society representatives, scientists and policymakers are commonly associated with separate sets of positive governance roles and can enter the debate via the authoritative speaker positions of the 'principled gatekeeper', the 'responsible information provider' and the 'strategic controller' respectively. Conversely, industrial actors are associated with negative governance roles and the only speaker position available to them is one which, by way of negative contrast, creates the need for the other three. Interestingly, the presence of this negative speaker position within the structure of governance debate is therefore necessary, as it makes the other three (positive) speaker positions possible and gives them purpose (c.f. Torfing, 1999) (see Figure 6).
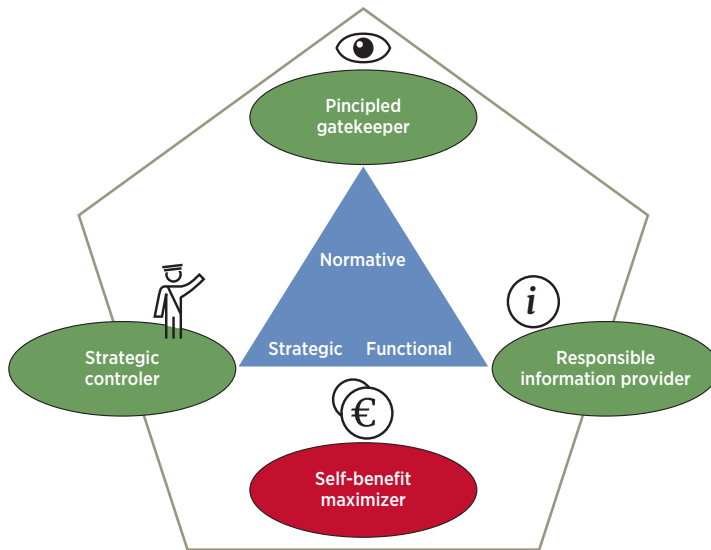
Figure 6: Speaker positions available in the structure of the CE research governance debate and their associated demand rationales & roles. Green = positive governance roles, red= negative governance roles.

Again, the question that remains is to ask; what could this mean for CE research governance development generally, and the Code of Conduct specifically? Generally, improving the understanding of range of speaker positions available can help stakeholders engage in the governance debate more reflectively, and improved understanding of the underlying constellation of speaker positions may facilitate communication between social actors adopting differing types of speaker positions. Furthermore, the mapping of the speaker positions available in the CE research governance debate helps to clarify how different types of social actors may engage with the Code. NGOs who adopt the 'principled gatekeeper' speaker position may tend see the Code as tool to ensure transparency, accountability and legitimacy. Policymakers who adopt the 'strategic planner' speaker position may be more likely see it as a way to facilitate coordinated and strategic research planning. Scientists who enter the debate via the 'responsible information provider' speaker position may perceive the Code as a way to support (or hinder) their ongoing production and provision of information to decision-makers.

5.6   Discussion & Conclusion: Cracking the Code

When it comes to drawing conclusions about my discourse analysis work, I am often reminded of a cleverly cutting comment made by a colleague during a late-night academic exchange: To her discourse analysis seemed like producing detailed instructions on how to deconstruct and subsequently reconstruct an IKEA table; afterwards you might have a better understanding of how such tables are put together, but the function of the newly re-assembled table itself remains unchanged. The underlying criticism is clear – improving our understanding of the

structure of a given debate may be interesting, but 'so what'? At the risk of mixing metaphors, I prefer to think of discourse analysis as a type of reverse engineering – a way of cracking the discursive 'source code' with which a given debate is being continually written and re-written. An improved understanding of the workings of the constitutive 'code' underlying the CE governance debate, when paired with the discourse theoretical assumption that governance discourses constantly (re)form the objects and subjects of which they speak, can provide a novel way to address some of the key challenges of the anticipatory governance of emerging technologies. Rather than simply providing us with static understanding of how the CE debate is constituted, reverse engineering the dynamic discursive structure within which CE governance objects, subjects, roles and rationales are being (and may continue to be) formed can help us understand and critically discuss how governance may develop. My analysis has provided four initial insights in this vein.

Firstly, diverging patterns of external differentiation and internal specification are currently underlying definitions of what should be governed by the Code of Conduct or other CE research governance mechanisms. The results suggest that if patterns of external differentiation based on the intent of the CE activities become more central, CE research will be defined as a very broad, but nevertheless unitary object for governance purposes. This would correspondingly require the Code (and any other governance mechanisms) to be flexible and adaptable enough to be applied to the wide range of CE research activities that would be contained within such an internally heterogeneous governance object. Conversely, if the CE governance debate becomes predominantly structured by patterns of internal specification based on the scale and effect of CE activities, the result would be the formation of a plurality of governance objects. Governance, either in the form of the Code of Conduct or other mechanisms, may congruently be specified to apply to each of these narrowly defined governance objects.

Secondly, the heterogeneous understandings of what constitutes 'governance' in the field of CE research are all situated within a shared conceptual space bounded by a spatial (local to transnational) and a functional (restrictive to enabling) dimension. The relative positioning of individual governance definitions within this two-dimensional space suggests corresponding implications for governance development: Given the current heterogeneity of governance understandings in the field of CE research, emerging governance frameworks appropriate to these varying definitions will likely have to be both functionally flexible and adaptive to local, regional and international contexts.

Thirdly, this sphere of the debate as to why CE research requires governance is structured by three types of demand rationales; one functional, one strategic, and one normative. Although all three types of demand rationales were present, a slightly wider range of reasons for the need CE research governance adhered to the normative rationale. According to a demand-based theory of governance design, the emergence of a strongly polycentric governance structure may be most appropriate within the heterogeneous nature of the demand rationale constellation (Jinnah, 2018: 8). Further, the fact that a slightly larger range of normative reasons for the need CE research governance were identified could suggest that polycentric governance structures focused on enhancing democratic legitimacy and inclusiveness in decision-making on CE research may be most imaginable within the governance demand structure identified in this study.

Fourthly, I showed that the discursive structure underlying CE research governance discussions offers four speaker positions: Civil society actors tend to adopt and/or be assigned the 'principled gatekeeper' speaker position, scientists the 'responsible information provider' and policymakers the 'strategic controller' speaker positions. The negative speaker position available in the structure of the discourse, the 'self-benefit-maximizer' is necessary, as its antagonistic exclusion makes the other three (positive) governance speaker positions possible. Identifying which speaker positions are being adopted can provide insights into how actors can be expected to engage with the proposed Code of Conduct (and other governance mechanisms): Actors who adopt the 'principled gatekeeper' speaker position may tend see the Code as tool to ensure transparency, accountability and legitimacy, those who adopt the 'strategic planner' speaker position may be more likely see it as a way to facilitate coordinated and strategic research planning, and those who enter the debate via the 'responsible information provider' speaker position may perceive the Code in light of how it will affect their ongoing production and provision of information to decision-makers.

Overall, the mapping of the discursive structure has shown that there are clear interconnections between definitions of governance, types of demand rationales, speaker positions adopted, and understandings of how the Code (or other CE research governance mechanisms) could/should be implemented.

But this is far from the end of the story. Structural mapping offers an alternative lens for critically discussing the potential future development of CE research governance and provides a spring-board for further research. Are similar (or different) discursive formations structuring wider spheres of the debate in different countries, and among broader range of stakeholder groups? How do the governance terms, objects, roles and rationales underpinning *demands* for CE research governance correspond to other concrete governance proposals being put forward on the *supply* side of the equation? To what extent may elucidating power/knowledge structures underpinning the CE research governance debate enable those engaged in the debate to be more reflexive about the structures we/they are (re)producing? Could those who become cognizant of the potential shaping effects of discursive structures on the emergence of CE governance be emancipated to propose anticipatory governance that attempts to counteract such developments?

Additionally, such a mapping exercise provides a framework to investigate what types of terms, objects, rationales and roles are being systematically excluded by the bounding effects of these discursive structures: What is it *not* possible to say about CE research governance? What types of actors are being privileged or excluded within this discursive structure? What effects may this have on future governance developments? For example, the patterns of external differentiation and internal specification of CE governance objects I identified are both based on the quantifiable relation of certain activities to the effects of climate change. Activities which deliberately intervene in global systems but which have a negligible effect on climate change would seem be systematically excluded from consideration as governance objects within this sphere. Likewise, the definition of governance objects based on more qualitative criteria such as the potential intangible or aesthetic effects of a given CE research activity does not seem conceivable within this structure (cf. Betz and Cacean, 2012). Notably, the speaker position structure I mapped does not include a position through which publics could enter the debate and adopt specific governance roles (cf. Frumhoff and Stephens, 2018). Furthermore,

the demand rationale constellation within this sphere seemingly incorporates a limited range of knowledge types – the functional rationale seems to reflect a utilitarian economic epistemology, the strategic rationale a pragmatic 'realpolitik' logic, and the normative rationale arguably elements of prescriptive ethics and distributional justice (cf. McLaren, 2018b). This would seem to suggest that the performative discursive structures within this sphere may privilege some types of knowledge over others when it comes to the formation of governance objects, rationales and roles, with potential corresponding effects on the development of future governance which warrant further investigation.

To conclude: Climate engineering may well be the "quintessential anticipatory governance challenge" in the sense that the future developments of the technologies and their governance remain "uncertain and contested", but I would argue that they are not entirely "unknowable" (Gupta and Möller, 2018:2). Discourse is the source code with which contested futures are written. Reverse engineering the underlying discursive structure of the CE research governance debate can help critically reflect upon the ongoing constitution of governance objects and subjects, rationales and roles. Hence, if we – as social scientists engaged in the CE governance debate – are to take the call for the anticipatory, reflective development of CE research governance seriously, it is important we continue work on 'cracking the code' to strengthen our understanding of the dynamic relationship between discourse and governance.

6 Coming to GRIPs with NETs Discourse [15]

Implications of discursive structures for emerging governance of Negative Emissions Technologies in the UK

As the international community rallies around Net-Zero emissions targets, there is increasing interest in the development of governance for Negative Emissions Technologies (NETs), a range of proposed approaches which involve removing greenhouse gases from the atmosphere. It has been pointed out that the governance development process should include 'opening up' the discussion NETs governance, moving the debate beyond the bounds of technocratic, neoliberal discourse and thereby paving the way for more responsible, inclusive governance of technologies. However, despite the implicit assumption that there is a link between discourse and the development of governance, so far there has been little empirical work done to map the discursive power/ knowledge structures in the NETs governance debate, and to critically discuss how these discursive structures may shape governance development. This paper presents a sociology-of-knowledge (SKAD) discourse analysis of a series of interviews with UK representatives from the industry/ policy interface about what they consider to be appropriate governance instruments for NETs. Linking discursive structures to governance development using the concept of governmentality, the paper critically discusses how discursive structures currently underpinning the industry and policy spheres of the UK NETs debate may be shaping governance development. The paper shows what types of knowledge and social actors are being privileged/excluded within the structure of the UK NETs debate, and highlights ways in which discursive mapping can play a key emancipatory role in 'opening' up governance development processes.

6.1   Introduction

As the international community rallies around Net-Zero Emissions Targets, there is increasing interest in the development of governance for Negative Emissions Technologies (NETs) – a range of proposed approaches for removing greenhouse gases, such as carbon dioxide, from the atmosphere (Honegger and Reiner, 2018).[16] Some argue NETs will be an essential part of future climate response strategies, and that enabling governance is needed to incentivize development. Others emphasize the need for regulatory governance to anticipate and mitigate the potential environmental and socio-political risks of NETs research, development, demonstration and deployment (RDD&D) (Bellamy, 2018, McLaren et al., 2019). However, as the need for near-term governance of NETs RDD&D becomes clearer, calls for the integration of wider societal perspectives into the development of responsible, reflexive governance have become louder on both ends of this spectrum. Prominent proposals for responsible NETs governance are based on the assumption that 'opening up' governance debates will move discussions beyond the bounds of technocratic, neoliberal discourse, thereby paving the way for more inclusive, responsible governance of technologies (Bellamy, 2018, Stilgoe et al., 2013, Low and Buck, 2020). The implication is that there is a constitutive and qualitative link between discourse and governance – that governance development is shaped by discourse. However, so far there has been limited work done to link empirical mapping of the discursive structures in different spheres of the NETs debate to theoretically-informed anticipation of how these structures may influence governance development.

In this paper I contribute to filling this gap by presenting a Sociology-of-knowledge Discourse Analysis (SKAD) of a series of interviews – conducted as part of the Greenhouse Gas Removal Instruments & Policies (GRIP) project – with UK representatives from the industry/policy interface about what they consider to be appropriate governance instruments for NETs. Linking discursive structures to governance using the concept of governmentality, I critically discuss how a set of **political, economic and discourse ethical** structures currently underpinning the industry/policy sphere of the UK NETs debate may shape governance development.

The following section outlines my analytical framework, and illustrates how it can complement existing understandings of the role of discursive diversity in governance development. The subsequent sections present my methodological approach and detail the results of my analysis, showing how discursive structures are bounding and shaping the **why (rationales), what (objects), who (subjects and speakers) and how (modes and instruments)** of NETs governance in the UK, and highlighting three potentially emergent systems of thinking about the nature of governance, or 'governmentalities'.

The final section concludes by reflecting upon how coming to 'grips' with the structuring role of discourse can contribute to the development of responsible NETs governance by; 1)

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16   Hereafter, NETs. Also known as Carbon Dioxide Removal (CDR) and Greenhouse Gas Removal (GGR). Often included under the umbrella term "climate engineering" (CE), which designates a set of heterogeneous proposals for intentionally intervening into the global climate system to reduce the risks of climate change ROYAL SOCIETY 2009. Geoengineering the climate: science, governance and uncertainty. London: The Royal Society.

anticipating and critically reflecting upon how given discursive structures may be making certain types of governance more/less thinkable and practicable, 2) emancipating those engaging in the NETs debate to recognize and (potentially expand the bounds of) the discursive power/knowledge structures they are reproducing, 3) identifying what types of knowledge may be missing in the current debate, and 4) informing the design of deliberative processes to further 'open up' discursive diversity in NETs governance development.

6.2   Analytical framework: Mapping discursive structures to anticipate governmentalities

The role of discourse in governance development has been increasingly recognized. However, the concept of 'discourse' has various theoretical origins, and understandings of the exact nature of its role in political and societal processes are correspondingly diverse (cf. Leipold et al., 2019). A school of thought driven by the work of Jürgen Habermas has often been (implicitly or explicitly) taken up by those who emphasize the need for new modes of responsible and reflexive governance development. The Habermasean theory of discursive ethics puts forward an **agency-focused** understanding of 'discourse', as an debate carried out by strategic actors behaving according to the logic of 'communicative rationality'. Based on the idea that social actors will argue rationally and equally within an egalitarian 'discursive space,' this understanding of discourse posits that bringing a range of perspectives and arguments into play will lead to more collectively acceptable, procedurally and substantively 'better' governance outcomes (Habermas, 1996, Habermas, 1987, Kerchner and Schneider, 2006, Kerchner, 2010b).

This understanding of the role of discourse has increasingly found resonance within the field of environmental governance, in what some have termed "the deliberative turn […] an increased attention in environmental politics to procedural qualities such as participation, dialogue, transparency and accountability" (Bäckstrand et al., 2010: 3) As others have pointed out, calls for new modes of environmental governance which aim to 'open up' politics and make environmental governance development more inclusive and reflexive rest upon this underlying assumption about the nature and role of discourse – that broad participation by public and private actors in (carefully designed) collective discursive processes can "bring about both more legitimate and effective policy outcomes" (Bäckstrand et al., 2010: 4). This school of thought has also been taken up within the literature on Responsible Research and Innovation (RRI) of NETs (and climate engineering more broadly), which discusses the potential for egalitarian-consensual deliberative processes to 'open up' NETs governance development (for a comprehensive overview of this literature, see: Low and Buck, 2020). However, deliberative engagements on governance development are often far from Habermas' ideal egalitarian discursive space. On the contrary, such deliberative processes are more commonly "underpinned by large asymmetries of power and voice" which privilege certain types of knowledge, shaping what can be authoritatively said, and by whom (Young, 1996, Bäckstrand et al., 2010: 18).

I posit that a **structural** understanding of discourse can help to illuminate these underpinning power/knowledge asymmetries and how they may shape ongoing NETs

governance development. In following with the Foucauldian-inspired Sociology of Knowledge Approach to Discourse (SKAD), I conceptualize a 'discourse' as an often unrecognized power/ knowledge structure – an interrelated system of ideas, concepts and categories – that shapes what it is possible to (legitimately, truthfully, authoritatively) know and say within a given debate. While not completely negating the agency of those engaged in debates, the SKAD approach posits that there is a difference between utterances made by individuals and the underpinning structures that shape such utterances. Rather than being completely free agents, this approach assumes that "in performing their articulations, social actors draw upon the rules and resources that are available via the present state of a given discursive structuration" (Keller, 2018b: 20), and thus that specific utterances by individuals are (re)producing pre-existing discursive structures.[17] A SKAD analysis therefore aims to reverse-engineer such underlying structures from a pool of individual utterances, and to highlight the role they play in shaping social reality.

This understanding of the shaping function of discursive structures has twofold implications for how to conceptualize and analyze the role of discourse in environmental governance development. First, as discourses constrain how societal and political entities understand social and physical phenomena that are at stake in environmental governance, bringing more voices into deliberative processes may not change or 'open up' the debate if all are operating within the bounds of same discursive structures. Rather, these privileged power/ knowledge structures may continue to shape all new contributions to the debate, unless they are elucidated. Exposing such discursive structures may result in emancipating participants in a given debate to be more reflexive about the structures we/they are reproducing, and to potentially expand them. A structural understanding of discourse can therefore highlight the need for a different kind of 'opening up' in governance development processes: There is a need to find the existing bounds of the discursive 'blueprints' before the appropriate knowledge 'walls' can be torn down. This is the main aim of mapping discursive structures underpinning governance debates: To assess what knowledge(s) and what truths about governance are influential and predominant, to explore the respective relationships of knowledge and power, and to subject them to criticism (Stielike, 2017, Kerchner, 2010b).

Secondly, a structural understanding of discourse posits a constitutive link between discourse and governance development, emphasizing that "social objects, subjects and relations […] are contingent and co-constituted through discursive practices that render some […] knowable and governable and others not" (Leipold et al., 2019: 446). By limiting what knowledges and truths about a given issue can be imagined and debated, discursive structures shape the formation of socially meaningful governance rationales, objects, and subjects, and can manifest themselves in the development of corresponding governance modes and instruments (see Chapter 5).

The concept of governmentality has been shown to be a useful analytical lens for exploring this constitutive link between discourse and environmental governance development (Stripple and Bulkeley, 2014, Bäckstrand and Lövbrand, 2016). The concept of governmentality was

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17　Although resilient, a given discursive structuration is not set in stone: by (re)producing selective elements of a given structure, social actors may in turn alter the structure over time. This is aided by the elucidation of the contingency of such structures.

originally introduced by Michel Foucault as "analytical framework" to identify a "concrete historical assemble of elements (objects of knowledge, technologies of governing, practices and fields of the exercise of power)" involved in governing society (Kerchner, 2010b: 15, author's translation). Foucault used this analytical tool to investigate how historically contingent power/ knowledge structures shaped differing objects, subjects and practices of governing in Western Europe from the 16th to the 20th centuries (Foucault, 2007 [1978], Kerchner, 2010b). The concept has since been taken up by the field of Governmentality Studies and further defined as "a system of thinking about the nature of the practice of government (who can govern; what governing is; what and who is governed), capable of making some form of that activity thinkable and practicable to both its practitioners and to those upon whom it is practiced" (Gordon, 1991: 3)

The governmentality concept offers a lens which "problematizes the collective and often taken for granted systems of thought that make governing strategies appear natural and given at certain times in history" (Stripple and Bulkeley, 2014: 10). Governmentalities "define both the objects (what should be governed) and nature (how they should be governed) of governing, in effect rendering reality governable through the collecting and framing of knowledge" (Bulkeley et al., 2007: 2736). As discursive power/knowledge structures are conceptualized as (one of the) constitutive preconditions of governance practices and infrastructures, mapping these structures is aimed at "the making visible […] of the different ways in which an activity or an art called government has been [is being] made thinkable and practicable" (Burchell et al., 1991: ix).

For my analysis, I conceptualize a governmentality as a system of thinking about the nature and practice of governing which (a) is underpinned by a principle form of **knowledge**, (b) is linked to a particular governance **rationale (why)**, (c) shapes particular governance **objects and subjects (what and who)**, and (d) makes the development of specific governance **modes and instruments (how)** thinkable and practicable (Foucault, 2007 [1978], compare Stielike, 2017, Burchell et al., 1991, Gordon, 1991, Kerchner, 2010a, Kerchner, 2010b, Stripple and Bulkeley, 2014 for discussions of both the Foucauldian original and the recent iterations of the concept).[18]

I use this concept as a heuristic lens to structure and discuss the results of my SKAD analysis. The discursive mapping of the emergence of governmentalities is often done retroactively – tracing the 'history of the present' to see how past discursive structures have manifested into current institutions, practices, policies and technologies of governing (Kerchner, 2011, Stripple and Bulkeley, 2014). However, based on the SKAD understanding that the *ongoing* social construction of reality can be discursively traced (Hornridge et al., 2018), I use the concept in an **anticipatory** manner – by mapping how current discursive structures underpinning the UK NETs governance debate may be forming the 'discursive blueprints' for three emerging governmentalities, and critically discussing how they may shape

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18 I am using a limited governmentality concept which focuses on the discursive elements of emerging governmentality ensembles (which I call discursive 'blueprints'). Other elements of mature governmentality ensembles (i.e., infrastructures, practices, policies, technologies) are not yet able to be assessed because they are in the process of being formed.

the development of future governance arrangements. Before I present and discuss the results of the analysis, the following section outlines my methodological approach.

6.3   Methodological approach: Breaking down discourses to open them up

6.3.1   Data collection: Interviews

The data pool for my analysis was a series of 25 transcripts of interviews carried out with representatives from the intersection of the UK industrial and policy spheres,[19] as discursive structures at the policy/industry interface have previously been shown to be particularly influential in shaping climate and technology governance (Hajer, 2005, Litfin, 1994, Hajer, 1995, Stripple and Bulkeley, 2014). Sourcing the interviewees was based on two criteria: 1) an active role at the industry/policy interface in the UK, and 2) prior knowledge about NETs.[20] The initial interviewees were asked to suggest further relevant interview partners who fulfilled the above criteria. The resulting pool of interviewees included parliamentarians, ministerial employees, policy advisors, investment advisors, industrial advocacy group members, and industrial organization representatives. The UK was selected for this analysis as it was one of the first major economies to commit itself to achieving a Net-Zero emissions, and as such is one of the few countries with a relatively well-developed debate on the complex issues related to the development and governance of NETs (Cox et al., 2020a, Daggash et al., 2019). However, although the interviewees were sourced to be representative of the industry/policy sphere in the UK, the discursive structures identified in this paper are certainly not the only ones being reproduced in the broader NETs governance debate. Rather, this analysis outlines one set of discursive structures at play within what is considered to be one key sphere of the NETs governance debate. Other analyses have shown the importance of assessing discourses and their potential effects on the development of NETs governance in a range of countries, and among diverse stakeholder groups (see e.g. Biermann and Möller, 2019, Möller, 2020, Cox et al., 2020a). Mapping discursive structures in wider spheres (i.e., science and civil society) and countries (i.e., other leaders in NETs research such as Germany and the USA, as well as countries of the Global South) to allow for critical comparison with the results presented here is therefore the focus of ongoing research (see also Chapters 5 & 7).

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19 This sample size in line with the standard practice in qualitative interview-based research of including between 15 and 30 interviews in case-studies such as this. This ensures that data saturation can be achieved, but does not result in a data pool too large to permit detailed in-depth qualitative analysis. GUEST, G., BUNCE, A. & JOHNSON, L. 2006. How Many Interviews Are Enough?:An Experiment with Data Saturation and Variability. *Field Methods,* 18, 59-82, BAKER, S. E. & EDWARDS, R. 2012. How many qualitative interviews is enough? National Centre for Research Methods Review Paper. London: Economic and Social Research Council (ECRC) National Centre for Research Methods (NCRM).

20 The initial interviewees had all previously attended workshops, conferences and engagement events on NETs and Climate Engineering more broadly and thus were known to be well-informed on the topic.

The interviews were conducted as part of a larger NETs governance project, entitled the Greenhouse Gas Removal Instruments & Policies (GRIP) project.[21] The stated primary purpose of the interviews was to understand the policy instruments and policy pathways that could help encourage (or if necessary constrain) the research, development, demonstration and deployment (RDD&D) of NETs. Each interview was semi-structured around a series of fifteen questions eliciting the interviewees' opinions on (1) what sorts of NETs approaches should (not) be the focus of policy instruments, (2) why, and (3) how such instruments might be implemented in the UK context. The semi-structured nature of the interviews was designed to encourage further questions to arise as the interviews progressed, to allow responses to be fully probed and explored, and to allow the interviewers to follow up on relevant issues raised spontaneously by the interviewees (cf. Yeo et al., 2013).

6.3.2   Methods: Open coding and iterative structural mapping

The SKAD discourse analysis approach employed in this study is designed to systematically reverse-engineer discursive structures underpinning a pool of individual utterances: it is an empirical deconstruction and interpretative reconstruction of discursive power/knowledge structures, with the aim to map these structures and to make visible the contingencies in the work they do (Keller, 2018b: 29). Following the SKAD approach, I first created a data pool of discursive products which contained a range of individual utterances related to a specific topic (in this case a series of interview transcripts about NETs governance), and a set of heuristic questions to guide the search for discursive elements and structuring rules. Reflecting the above elements of governmentality as a heuristic lens, these questions included: *What types of governance rationales are underpinning calls for NETs governance? What is being constructed as the object(s) of NETs governance? What speaker and subject positions are available within the structure of the UK NETs governance debate? What knowledge types are linking these discursive elements into emerging systems of thinking about the practices of governing (governmentalities) in which certain governance modes and instruments are thinkable and practicable?*

I undertook a preliminary analysis of the material to identify how the discursive elements 'rationales' (why) 'governance objects' (what), 'speaker/subject positions' (who), and 'governance modes/instruments' (how) appeared in the transcripts. I then systematized the transcribed interview data for analysis through a process known as 'open coding,' which involved inductively organizing the elements identified in the transcripts into categories with the help of the qualitative text analysis program MAXQDA (Hardy et al., 2004). The next step involved identifying recurring rules with which discursive elements were related. These included patterns of classification and differentiation, relationships of equivalence and contrariety between elements of the discourse. This was a recursive process in which preliminary findings were checked against further empirical material from the data pool. My iterative analytical approach is outlined in Figure 3 (page 50) and has been described in more detail elsewhere (see sections 4.3 & 5.4). The result of this analysis was a map of discursive structures shaping governance **rationales, objects, subjects, speakers, modes and instruments** in this sphere of the NETs governance debate, and the identification of the types of knowledge

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21   The interviews were carried out by a two-person team (a social scientists and a natural scientist) with extensive background knowledge on proposed NETs technologies and policies.

linking them into systems for thinking about the nature and practice of governing. The results and their potential implications for NETs governance development are detailed and discussed in the following section.

6.4   Results: Three emergent NETs governmentalities

My analysis showed that the individual discursive elements structuring this sphere of the NETs governance debate are bound by distinct types of **political, economic** and **discourse ethical** knowledge, in what may be three 'discursive blueprints' for emergent NETs governmentalities (Table 4). The following section describes individual elements of these three emergent governmentalities, showing how each (a) is underpinned by a principle form of **knowledge**, (b) linked to a particular governance **rationale (why)**, (c) shapes particular governance **objects (what),** provides certain **speaker and subject** positions **(who)**, and (d) makes the development of specific governance **modes and instruments (how)** thinkable and practicable.

6.4.1   Governmentality 1: "Keeping it real"

Key discursive elements of emergent governmentalities are **rationales** for **why** governance is needed. Such rationales provide a narrative basis for the formation of the what, who and how of governance. Among the range of rationales (re)produced by interviewees for why they considered the governance of NETs necessary, three categorization patterns based on differing knowledge types emerged (Table 5).

The discursive governmentality template G1 is underpinned by a form of **realist political knowledge** which focuses on power balancing. This is reflected in the strategic governance **rationales** which provide the **'why'** within this emerging system of thinking about the nature of governing, positing that the purpose of NETs governance is relative power and responsibility balancing, and strategically positioning the UK within a wider system (i.e., of international climate politics). (cf. Jinnah, 2018, Boettcher, 2019). According to these strategic rationales, governance is deemed necessary for planning of NETs to ensure that the UK is able to meet its agreed political climate targets and establish/solidify its leading position relative to other nations as this new branch of climate policy accelerates, as the following example illustrates: "So our current Conservative government could press ahead with this, with relatively little opposition and a lot of political agreement from Lib Dem and Labour opposition. So if we have that consensus in Britain, why not carry on with this political pretence that the UK is a world leader in tackling climate change, showing how to decarbonise our economy?"(I21)

The interviewees discussed a wide range of proposed NETs approaches, including, peat bog enhancement, biochar, enhanced weathering, ocean alkalinity enhancement, ocean fertilization, bioenergy and carbon capture at source (BECCS), ocean afforestation, direct air capture and storage of carbon dioxide (DACS), and methods for enhancing carbon drawdown through agricultural and forestry management practices. As is to be expected when governance for an as-yet nascent set of technologies is being discussed, there was little agreement among interviewees on what specific set of criteria should make a certain NETs technique an **object (what)** of (enabling or restrictive) governance. However, the cross-cutting analysis revealed two shared structures underpinning the multitude of ways in which interviewees referred to

	Knowledge type	Rationales (Why)	Objects (What)	Speakers & subjects (Who)	Mode (How)	Instruments (How)
G1 "Keeping it real"	Political realism	**Strategic:** governance as relative power & responsibility balancing, strategic positioning	**External differentiation** I.e. approaches suited to achieving strategic aims/political targets	Ambitious leader Conflicted strategist Uninformed optimist	**Coercion:** Punishment and control within a hierarchical structure	Regulation, enforcement of technology standards, MRV, licensing/certification procedures
G2 "Winners come out on top"	Utilitarian economics	**Functional:** governance as problem solving, risk management, cost-benefit implementation	**Internal differentiation** I.e. approaches with best cost/benefit rating	Innovation catalyser Responsible information provider Profit-maximizer Unconstructive agitator	**Incentive:** Competition within an egalitarian marketplace	Financial incentives, tax rebates, subsidies, prizes, government expenditure
G3 "Let's talk about it"	Discourse ethics	**Normative:** governance to strengthen existing norms or create new ones, to ensure/ increase justice and equality	**Internal differentiation** I.e. approaches which are the most societally acceptable, just, equitable	Principled gatekeeper Wise policy demander Passive policy recipient	**Persuasion:** Arguing & bargaining, strategies of communication within a 'flat' deliberative space	Education, public deliberation, moral persuasion, political signaling

Table 4: Discursive blueprints for emergent NETs governmentalities in the UK industry/policy sphere.

Governance rationales	Examples	Rationale & knowledge types
NETs governance is need for long-term strategic planning to meet political targets	We need a strategy for developing options to remove greenhouse gases from the atmosphere because they will be vital for the kinds of deep de-carbonisation targets. We already have 80 per cent by 2050, but also on the path to Net-Zero emissions and possibly beyond (I2)	**G1: Strategic/ political:** Governance as relative power & responsibility balancing, strategic positioning
NETs governance is needed for the UK to keep up, get ahead: China, America, Germany and other nations are moving ahead on NETs RDD&D.	There are questions around whether the UK wants to – the UK government wants to be a world leader, as it were, in CCS, or whether it would prefer to allow a sort of technology transfer from abroad (I6)	
Mitigation is not enough to mitigate climate risks. Governance should also incentivize development of deployable NETs approaches.	We're not going to make it by mitigation alone, we're failing on mitigation anyway, and that there are these potentially cost-effective win/win solutions that are not being explored (I19)	**G2: Functional/ economic:** Governance involves efforts towards rational problem solving, driven by utilitarian cost-benefit calculations and risk management concepts
Governance policy should not pick winners, but support development of everything that might be useful	My interest I guess is in maintaining a broad sweep of solutions in as far as they are solutions and providing policy to support them (I11)	
The role of governance is to provide market security to ensure investment into NETs development	I think there's enough unused innovation that you could use price signals to unleash some of that (I12)	
Governance is needed to build trust in and understanding of NETs.	That's why I talked about trying to build trust, because at the moment there is very little. And if we could generate that and get people to understand, get governments to commit themselves; [...] I think could generate some more trust, and maybe a sense of contracting and converging at the same time (I22)	**G3: Discourse ethical/normative** Governance to strengthen norms such as justice and equality through the promotion of participation, transparency, legitimacy and responsibility
Governance should ensure broad perspectives are taken into consideration to make decision-making on NETs RDD&D legitimate and robust	If you can actually get to those true constructive multi-stakeholder dialogues you can design really cool policies that are genuinely win-win, internalising all of that external complexity, have a lot of momentum and support behind them because everyone was involved in their creation, be less likely to fall foul to nature in the real world because you've got more perspectives feeding into it before it needs to go out there and get tested in the real world (I23)	

Table 5: Governance rationales in the UK NETs debate

the 'what' of NETs governance: The categorization and classification of NETs approaches drew upon patterns of **external differentiation** – what counts as an a NETs governance object and what does not – **and internal specification** of specific types of NETs as the objects of enabling or restrictive governance, based on differing types of knowledge (Table 6).

The object – the **'what'** of governmentality G1 – is in keeping with the underpinning political knowledge type: NETs is conceptualized according to the structuring rule of external differentiation as a unified governance object. **External differentiation** refers to the ways in which objects are defined in contrast to what they are not. As the examples in Table 6 exemplify, external differentiation of NETs for governance purposes focused on the technologies' intent:

According to this broad categorization structure, all proposals with the intent to remove CO_2 from the atmosphere to achieve climate targets (temperature or emissions targets) can be lumped together for governance purposes. Those proposals that do not intend to remove CO_2 from the atmosphere for the purpose of achieving climate targets would not be categorized as NETs for governance purposes (for example CO_2 capture and utilization for enhanced oil recovery). Likewise, measures that aim to achieve climate targets through other means (i.e., emissions reductions or altering the earth's solar radiation balance) are externally differentiated as not falling within the bounds of a broad NETs governance object. External differentiation based on intent is therefore linked to strategic rationales and the associated political logic of G1which posits NETs governance should enable strategic planning to achieve political ends.

The discursive structures underpinning a given debate offer a range of active speaker positions and passive subject positions to social actors who engage with the topic. Whereas active **speaker positions** provide access points for social actors to actively contribute by reproducing certain power/knowledge structures, passive **subject positions** are discursive 'templates' for roles which are commonly associated with silent 'others' (Keller, 2018b: 36). My analysis revealed a relatively wide range of discursive templates for governance roles available within the structure of the UK NETs debate, as outlined in Tables 7 and 8. Six of these are active speaker positions ('**conflicted strategist**', '**ambitious leader**', '**wise policy demander**', **responsible information provider**', '**innovation catalyst**' and '**self-benefit maximizer**'). Three are passive subject positions ('**passive policy recipient**', '**unconstructive agitator**' and '**uninformed optimist**'.).[22]

The configuration of speaker and subject positions (**'who'**) available within governmentality G1 privileges political knowledge: If the 'what' of governance consists of all NETs approaches that help the UK achieve strategic political goals, and the 'why' is relative power balancing by the UK in international (climate) politics, a limited spectrum of active speaker positions are available to social actors who (re)produce this type of political knowledge, while relegating other societal actors to passive subject positions. For example, the '**conflicted strategist**' speaker position provides a discursive template for social actors strategically balancing long-term NETs policy planning and acting in the short-term to maintain political power. On the one hand, this speaker position is associated with enabling strategic NETs planning to achieve long-term climate targets; on the other, there is also a focus on short term gains, associated with office-seeking policy-makers. An example of an interviewee assigning this speaker position is: "Governments with their short-term views and so forth will wriggle as much as

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22 Speaker and subject positions are not mutually exclusive. They can be adopted by different types of social actors, and social actors can adopt or be assigned a range of speaker and subject positions, as indicated in Tables 7 & 8.

Categorization structures	Classification Criteria	Examples	Rationale & knowledge types
External differentiation Lumping NETs for governance purposes based on intent	All techniques that help achieve political climate targets by removing CO_2 from the atmosphere	Potentially all negative emissions, one day, will be playing a pivotal role as well, in order to achieve the temperature cap (I5) Well, in the context of the Paris Agreement I suppose it's the concept of Net-Zero that's the key thing, so yes we probably will need GGRs to offset the hard-to-treat sectors to reach net-zero (I8)	**G1:Strategic/ political:** governance as relative power & responsibility balancing, strategic positioning
Internal specification: Splitting NETs for governance purposes based on specific criteria according to underpinning knowledge type	Cost-effectiveness	Cost per tonne of carbon removed is an obvious metric. It's a kind of bread and butter metric that's used and there is guidance for policy appraisal on what the value of carbon should be in thinking about whether a strategy is sensible to pursue or not (I2)	**G2:Functional/ economic:** governance as problem solving, risk management, cost-benefit implementation
	Verifiability	From a policy perspective if our reporting and the inventory shows no change but we're deploying all these technologies then it might be good for the atmosphere and the greenhouse gases but it means we can't actually demonstrate that we deliver it. So there is a need to develop the methodologies of how we actually acknowledge the reductions, well the capture (I4)	
	Permanence	But in terms of the interventions required in the carbon cycle, probably 100 years is the target time line. If it isn't going to stay locked up and somehow repurposed for 100 years then it's not going to deliver the climate stability that we need (I21)	
	Scalability	It's the scalability and the impact that we're going to get at the end, isn't it? So how much of this could actually be done really matters, because we're short of capacity to get the job done (I12).	
	Co-benefits	At the other end, it has to be that this is big business. You run the cobenefits properly, you get big numbers (I12).	
	Social acceptability	In terms of public engagement and how the very necessary conversation with the public or involved actors more generally would be, be they individuals or some companies or farmers, whatever, my sense is a more useful engagement for all involved may hang on discussing specific technologies and their range of characteristics going beyond climate change than it would by having a discussion about greenhouse gas removal technologies and how that specific technology fits into the greenhouse gas removal picture (I5).	**G3: Discourse ethical/normative:** governance to strengthen existing norms or create new ones, ensure/increase justice and equality

Table 6: Governance objects in the UK NETs debate

Speaker position	Roles in governance	Examples	Social actors	Knowledge types
Conflicted strategist	Strategically balancing planning long-term policy to prevent dangerous climate change, and acting reactively short-term to maintain political power	Politicians have become less interested in development of ideological thinking that they sell to their constituents, and actually just want power now (I24) If there is a sort of deeper strategic reasoning behind that for how to still actually get to the end goal of 1.5 degrees and saving the future of humankind and back to stable climate and healthy oceans, I've not yet see that manifest within that strategic reasoning. I think it is often thinking one move ahead (I23)	Policymakers, government leaders	G1: Political
Ambitious leader	Taking the lead on NETs, setting an example, developing governance standards for the world.	[...] people are saying the UK is one of the more forward thinking countries on GGR against a very sparse background of competitors (I2).	Policymakers, government leaders	
Responsible information provider	Providing unbiased information on risk/benefits of NETs to inform the development of governance	[...] understanding of climate science and the requirement of what needs to be done and then set the challenges around what needs to be done and demonstrate the practicality of achieving some of those challenges (I13)	Scientists, civil society	G2: Economic
Innovation catalyst	Bridging the policy gap to catalyze innovation through investment, thinking long-term, acting rationally to incentivize NETs	I do think the sort of private sector groupings be it within their own industries or with charitable organisations is very important in giving government sometimes a catalyst for action I would say (I1)	Philan-thropists, investors	
Self-benefit maximizer	Calling for/ supporting NETs polices which maximize their own (financial) benefit/ profit	We think regulatory certainty around carbon price is a very good thing, but needs careful thought. In terms of what the money is used for I think there will be lots of people saying it should be used for me, me, me please and Net-Zero technology should be one of a number of things (I15)	Industry	
Wise policy demander	Calling for action in the form of long-term NETs/climate policy for the common good	We think the wider climate change discussion at the moment is about sacrifice and it's about altruism, but it's really taking direct sacrifice and taking a direct hit to your stakeholder group to benefit another stakeholder group (I23)	Publics, civil society	G3: Discourse ethical

Table 7: Speaker positions in the UK NETs debate

Subject position	Roles in governance	Examples	Social actors	Knowledge types
Uninformed optimist	Optimistic about climate governance, without understanding what needs to be done to achieve political climate targets	There's this huge gap between what people believe is possible and what is actually needed to address the two degree target" (I25) So I would say most people would say you need GGRs in the 2050s without understanding that [...] the Committee on Climate Change has set it out as they see I think 48 million tonnes of [...] CO2 being removed by BECCS by 2050 and that's just there in the model without any understanding of that's a lot and also how [...] do we get to that position? (I1)	Civil society, publics	**G1:** Political
Uncon-structive agitator	Raising (unjustified) concerns which risk putting undue restrictions on development of (cost) effective (NETs) solutions to address climate risk	The NGOs [are] all screaming about how this is watering down efforts to invest [in] the things that they want to see delivered (I11) [...] but were very clear cut that green groups were being unhelpful and being essentially a blocker to CCS (I14).	Civil society, publics	**G2:**Economic
Passive policy recipient	Passively waiting to be persuaded, placated, convinced that a given NETs policy is in their best interests	Again, in fields where you could have strong benefits that people get behind, but I feel like you'd need to convince people, you'd need to get the information strategies right (I9) Just giving meaning to the greenhouse gas removal so that people understand it better, and then are able to align the values with what these effectively technical solutions might bring. It just needs to soften them up a bit (I24)	Civil society, publics	**G3**: Discourse ethical

Table 8: Subject positions in the UK NETs debate

they can and seize on anything instead of tackling the really difficult issues of reducing our energy consumption and emissions" (I22).

Likewise, the **ambitious leader** speaker position offered within G1 involves taking the lead on NETs by setting an example and establishing governance standards for the world, and is associated with policymakers and government leaders, as reflected in the following example: "So both in terms of [...] scale up within the UK but also potential where UK has a natural leadership or expertise which it can become a market leader in really. I think that's something it is always quite keen on" (I1).

Also in accordance with the privileging of political knowledge, the **'uniformed optimist'** subject position available within this governmentality provides a template for a governance subject who does not fully understand the seriousness of the (climate) situation and what needs to be done, but trusts that political actors will be able to solve the problem. This subject

position implies elements of technological optimism and a lack of understanding of the socio-political complexity of dealing with climate change. This subject position locates non-political actors (i.e., publics, industries) at the end of the governance development pipeline, where they can only wait to be informed why a policy is in their best interests (see Table 8 for examples).

My analysis of the shared structures underpinning the multitude of ways in which the interviewees categorized the **'how'** of NETs governance, and revealed three categorization patterns of **coercive, incentivizing and persuasive** governance modes and corresponding instruments (Table 9).

The **'how'** of NETs governance within G1 is linked by the realist political logic to the **coercive mode of governance** which focuses on punishment and control within a top-down, hierarchical structure. This could translate into governance instruments such as bans and moratoria for those types of NETs deemed unsuitable to help achieve strategic political aims, and the enforcement of regulatory control over the development of those that are deemed suitable (Table X). Concretely, this mode of governance can be linked to instruments, including regulations to restrict certain types of NETs activities, the establishment of NETs technology standards and licensing/certification procedures, the enforcement of monitoring, reporting and verification (MRV) procedures, and the development of policy frameworks forcing polluters to finance and/or implement the development of NETs.

6.4.2 Governmentality 2: "Winners come out on top"

This potential governmentality is structured around **utilitarian economic knowledge** that focuses on the pragmatic weighing of overall costs against overall benefits. As Table 5 shows, this system for thinking about the nature of governance incorporates **functional governance** rationales **(why),** positing that NETs governance is primarily about problem solving, risk management, and cost-benefit implementation (cf. Boettcher, 2019, Jinnah, 2018). Economic rationales emphasize that governance policy should not pick NETs winners, but rather allow free competition between alternative options, and that the primary the role of governance is to provide market security to ensure investment into NETs development, as the examples in Table 5 illustrate.

As shown in Table 6, in contrast to the 'lumping' categorization of NETs based on external differentiation evident in G1, the economic logic of G2 underpins patterns of **internal specification** which split NETs into specific objects of governance **(what)** based on a range of cost-benefit criteria, for example by specifying governance for more versus less cost-effective NETs techniques, as the following passage illustrates, "I think anything in the UK context, in the current context, at least, everything is within the current sort of financial – the tone of finances at the minute. Everything must be cost-effective, there's very much a policy focus on making sure that we get the most cost-effective solutions for everything. And I think that would apply to GGR as a whole" (I6).

Within this emergent governmentality, active speaker positions **(who)** are offered to those social actors who (re)produce economic knowledge, while passive subject positions are associated with those who do not conform to the utilitarian logic, as illustrated in Tables 7 and 8. For example, the **self-benefit maximizer** speaker position provides a template for social actors to push for governance which maximizes their own (financial) benefit and is associated

Governance mode	Governance instruments	Examples	Knowledge types
Coercion: Prohibition and punishment within a hierarchical structure	Regulations to restrict certain types of NETs activities, and/or require polluters to implement NETs to comply with emissions limits Enforcement of NETs technology standards, licensing, monitoring, reporting and verification (MRV)	I think that ought to be regulation [...] I think with financial incentives, you could create, very quickly, false incentives which you haven't really foreseen (I5) Something else which I think is important is enforcement. [...] If you are operating any of these systems and offering any incentives to them, you've got to have a system for monitoring whether or not they are doing what they said they would do, because mostly they don't do it. (I12) I suppose technology standards – we could think about emissions limits. Which would essentially mean that some embitters would require [NETs] in order to comply with those (I14)	G1:Political
Incentive: Competition within an egalitarian marketplace	Financial incentives to conduct certain types of NETs RDD&D, carbon pricing, tax rebates, subsidies, prizes, government expenditure	So you want to get it down to something that's cost effective in a market, which has a sensible carbon price. [...] To get there you probably need some kind of tax break or prize and then a little bit more support. And ideally you would bring down that support at the right rate, that you don't spend too much of tax payer's money, but you'd get it into a position where, where there is a carbon tax or a carbon price of some sort, it can compete on its own two feet (I2) [..] effectively a subsidy or a prize for people who are building units of kit, whether it's BECCS or direct air capture or something along those lines. Because then you show that there is financing in here and that the government is serious about trying to make a route to a market of some sort. And also you can flush out what price people think they need to get their stuff to run (I2) It's about incentivising a change in land management which is perceived to have a negative impact on the income of land owners and land managers, so they are looking for some sort of compensatory payment so payment for ecosystem services we think is the most likely way of doing that. (I4) I would see the way forward in the financial incentives, and that is the push via the research support and that, potentially, the pull via carbon price (I5)	G2:Economic
Persuasion: Arguing & bargaining within a 'flat' deliberative space	Education, moral persuasion, political signaling, public deliberation & dialogue on the potential advantages/ disadvantages of NETs	It's really important that if we're going to do big things, like making some interventions in the balance of land use around the planet, in order to help stabilise our planetary system for future generations, there needs to be a dialogue to explain to the people who can be bothered to read about it why this is necessary and why on balance it's the right thing to do (I4) And then the other kind of model that's coming out of this discussion is one where communities feature in some kind of sense [...] because they have a certain interest in preserving a certain kind of environment or a certain kind of livelihood, and that therefore they have to be the arbiters of what works (I22)	G3:Discourse ethical

Table 9: Modes and instruments in the UK NETs debate

with industrial actors, as the following quote illustrates; "Well, strategy and governance, I mean I would have thought you'd be looking at the fit with our existing economic pressures, so the potential for this to be of benefit to us given market opportunities etc. would be influential" (I16).

The utilitarian logic likewise underpins the **responsible information provider** speaker position available within G2. Social actors adopting this speaker position are offered a privileged role in providing unbiased information to help weigh up the risks and benefits of NETs and thus inform the development of governance. This speaker position is associated primarily with scientific experts, as can be seen in this example, "You need simplification and clarity around the regulation. So you need a scientific consensus over what is the lifecycle of the various kinds of materials that might be used in this way" (I12).

The **innovation catalyst** speaker position available within G2 likewise reproduces an economic logic, providing a template for governance roles: acting (economically) rationally to incentivize NETs RDD&D, and bridging the policy gap by driving innovation through investment. This speaker position is associated with both private and public financial investors. An example of an interviewee reproducing this speaker position is: "Another way to this has got to be the institutional investors. If you can convince the institutional investors that they need to take this more seriously, that is as powerful as BlackRock – [as the] top 10 largest countries in terms of the size of their funds. If you can get them to start paying, I think that's just as powerful as the government coming out with strategies. It's never going to be great, but the institutional investors are highly rational, they think long-term" (I25).

Conversely, the '**unconstructive agitator** subject position within this governmentality assigns a discursive template for social actors raising (unconstructive and unjustified) non-utilitarian concerns about NETs governance which risk putting undue restrictions on the development of potential (cost-effective) solutions to address climate risks. Rational economic actors are thus posited as being confronted with "the wrath of the highly polarized argumentation that the NGO and advocacy movement has around greenhouse gas removal" (I25).

The constellation of economically informed rationales, objects and subjects within this governmentality has consequences for the '**how**' of NETs governance: The economic logic translates into the governance mode of **incentivisation** to promote competition among different types of NETs activities within an open market place, and could materialize into governance instruments such as direct government expenditure or subsidies for NETs development, as outlined in Table 9. Concretely, this can be related to the establishment of instruments which provide financial incentives to conduct certain types of NETs RDD&D, including carbon pricing, tax rebates, subsidies, prizes, and direct government expenditure.

6.4.2   Governmentality 3: "Let's talk about it"

The elements that make up the discursive blueprint for this potentially emergent governmentality are organized around a form of **discourse ethical knowledge** that focuses on consensus-building around the 'common good' and the persuasive powers of communication in deliberative democratic processes. This governmentality incorporates **normative governance rationales (why),** which advance that governance should strengthen norms such as justice, equality, transparency, legitimacy and responsibility through, inter alia, the promotion of stakeholder participation in deliberative democratic practices (Table 5).

The governance objects **(what)** within the nascent governmentality G3 are shaped by patterns of internal specification based around ethical criteria in line with its underpinning knowledge type, primarily resulting in a split between more (potentially) socially acceptable versus less socially acceptable NETs approaches as potential governance objects, as the following example shows (see also Table 6): "So some of these techniques are actually quite radical and will require some strange things to happen, so understanding how the public perception would be on this, especially as you're looking at something which needs to be approved by ministers and MPs and they reflect the public opinion of their constituents. So if it's something that's going to engender a lot of negative public reaction you've got to be aware of that quite early on" (I4).

The configuration of speaker and subject positions **(who)** within G3 offers the '**wise policy demander**' as an active speaker position to publics to participate in calling for long-term NETs policy for the common good (Table 7). This stands in contrast to the passive subject positions assigned to publics in the other governmentalities (Table 8), and is associated with publics and civil society actors. An example of an interviewee reproducing this speaker position is: "And so I think the public [...] can be very wise on these subjects and worth consulting; and I think that is a policy option is for governments at many levels [...], to consider proper public consultation [...] Then they will very likely come out with a wise suggestion" (I22).

The discourse ethical knowledge that links governance rationales, objects and subjects in this 'system of thinking about the nature and practice of governing' also has implications for the types of governance modes and instruments **(how)** which may emerge if this governmentality manifested: In accordance with the discourse ethical assumption that persuasive communication with an egalitarian deliberative space will lead to a consensus around the most collectively acceptable governance options, the governance mode '**persuasion**' is key: facilitating societal decision-making on NETs RDD&D through communication, education, moral persuasion, political signaling, public deliberation and dialogue on the potential advantages and disadvantages of individual NETs approaches (Table 9). This could, in turn, materialize in NETs governance instruments that focus on education, moral persuasion and political signaling, with increased emphasis on deliberative and participatory governance processes.

6.5   Discussion

These three discursive blueprints for emerging governmentalities are not to be taken as firmly established, mutually exclusive, or exhaustive. As pointed out in the methods section, the selection of interviewees from the UK policy/industry sphere means that the results outlined here only represent discursive structures underpinning *one sphere* of a larger NETs debate within the UK, which is in turn part of a much larger transnational discussion. This means that the discursive blueprints detailed above and outlined in Table 4 are ideal types, elements of which are being reproduced by those engaged in this specific sphere of the UK NETs debate. Using these ideal types as a reference, we can inquire if similar systems of thinking about the nature and practice of governance may also be underpinning broader discussions of NETs and

climate policy, and help to identify what types of knowledge present in the wider debate may be marginalized in the UK industry/policy sphere.

In their review of multilevel policies with potential relevance for NETs in Sweden, Fridahl and Bellamy identified a similar set of incentivisation, coercion, and persuasion governance modes as those outlined above, which – building on a categorization of policy instruments introduced by Bemelmans-Videc et al., – they call 'carrots, sticks, and sermons' (Fridahl and Bellamy, 2018, Bemelmans-Videc et al., 2010). Their mapping exercise showed that the majority of current policy instruments with relevance for NETs in Sweden fell into the 'carrots' or economic incentivisation category, underpinned by an economic logic analogous to the one I identified as being key to **G2**. Similarly, in their exploration of potential policy levers for negative emissions technologies, Cox and Edwards highlight the predominance of economic incentivisation logics in policy proposals based on carbon taxation in the NETs literature (Cox and Edwards, 2019). Further recent examples of NETs policy proposals which similarly reflect an economic logic include: Direct governmental payments to land managers and farmers for the provision of ecosystem services through carbon sequestration in soil and the biosphere (Lal, 2020), including bioenergy with carbon capture and storage (BECCS) in the Swedish carbon tax incentive mechanism (Karlsson et al., 2017), an international market mechanism to link financing of NETs to sustainable development (Honegger and Reiner, 2018) and the proposed introduction of negative emissions credit mechanism in the UK (Platt et al., 2018).

The literature also contains NETs policy proposals reflecting coercive, political logic similar to the one I identified underpinning **G1**. Fridahl and Bellamy call policies which reflect a coercive governance mode 'sticks', and the examples they highlight in the Swedish case include regulatory instruments to provide "clarity on rules and responsibilities related to prospecting, building, and operating transport and storage facilities" for captured CO_2 (Fridahl and Bellamy, 2018: 66). Other authors have similarly highlighted proposals for the enforcement of top-down regulatory control over NETs RDD&D processes, for example via Environmental Impact Assessment procedures (EIAs) and the establishment of legal authorisation processes for (surface and subsurface) land use (Hester, 2018, Hubert and Reichwein, 2015). Others have called for the establishment of centralized monitoring, reporting and verification (MRV) procedures to hold companies, industries and states accountable for their NETs achievements, identify 'leaders and laggards' and ensure that those who lag behind politically prescribed Net-Zero targets can held (financially) responsible (Geden and Schenuit, 2020). Some have also suggested direct coercive measures which place an obligation on emitters to implement NETs – for example by "requiring new and/or existing fossil fuel power plants to be converted to biomass and fitted with a CCS [carbon capture & storage] facility" (Bellamy, 2018: 533).

In contrast to the economic and political logics, the discourse ethical knowledge type I identified underpinning **G3** seems less well represented in the wider NETs policy literature. In their abovementioned review, Fridahl & Bellamy noted there was a "dearth" of NETs policy instruments in line with the persuasive governance mode in the Swedish case (Fridahl and Bellamy, 2018: 67). Similarly, in an international comparison of emerging policy perspectives on climate engineering more broadly, Huttunen et al. noted a dominance of techno-economic logics in policy documents which may preclude the participatory integration of wider societal and political perspectives in policy development (Huttunen et al., 2014). In one of the first reviews of the international peer-reviewed literature on the social and political dimensions of

large-scale NETs, Waller et al. also show that techno-economic framings of NETs feasibility remain predominant, but that a 'responsible development' framing is emerging which focuses on 'opening up' NETs governance to include perspectives, reflecting a similar discursive logic to that outlined in G3 (Waller et al., 2020). Some concrete suggestions have been brought forward from within the Responsible Research and Innovation (RRI) community on how to develop policy for NETs in ways which adhere to the discourse ethical logic (Stilgoe et al., 2013). Proposals in this vein include deliberative workshops with both experts and members of the public designed to elicit diverse understandings of NETs experiments and their governance (Bellamy et al., 2017) and deliberative mapping processes with citizen panels to 'open up' socio-technical appraisals of NETs for governance purposes (Bellamy, 2016, Bellamy et al., 2017, Bellamy et al., 2016).

Zooming out even further, the above results – outlining what may be discursive precursors to future 'systems for thinking about the nature of NETs governance' – also allow comparison with established governmentalities which have been shown to be structure climate change and environmental governance more broadly. Historical analyses of climate governance by Bäckstrand and Lövbrand have identified three competing 'meta discourses' underpinning climate governance in the last 20 years: 'green governmentality' which is based on a hierarchical, administrative logic, 'ecological modernization', which reflects an neoliberal market logic, and 'civic environmentalism', which is built upon a logic of democratic participation (Bäckstrand and Lövbrand, 2006, Bäckstrand and Lövbrand, 2016). The political knowledge system of G1 outlined above shares the top-down logic of green governmentality. G2 and ecological modernization are both based on economic knowledge. The discursive structures which make up G3 share much with what Bäckstrand and Lövbrand term the 'reformist' strand of civil environmentalism, which calls for 'opening up' decision-making processes to deliberation by a wider range of stakeholders (ibid). These governance meta-discourses, in turn, can be tied to a longer arc of liberal and neoliberal governmentalities outlined by historical Foucauldian analyses of western democracies (Kerchner, 2010b, Kerchner, 2010a, Foucault, 2007 [1978]). Governing logics which have historically underpinned climate and carbon governance (and western democratic governance per se) are therefore seemingly being reproduced within NETs governance discourse, highlighting the persistent shaping function of existing power/knowledge structures on the emergence of new objects, subjects and instruments of governance (Low and Boettcher, 2020, Carton et al., 2020, McLaren and Markusson, 2020).

Comparing the discursive structures I identified in my analysis with those present in wider NETs and climate governance literatures can also help point out what types of knowledge may be being marginalized in UK industry/policy sphere of the debate. Multiple authors have shown that principles of distributive and intergenerational justice and equity will be key to developing responsible governance of NETs and other global climate response strategies, and have correspondingly called for the integration of relevant knowledge types into policy development processes (McLaren, 2018b, Clingerman and O'Brien, 2014, Clingerman and Gardner, 2018, Jenkins, 2016, Schneider, 2019, Lenzi, 2018a, Lenzi, 2018b, Cox et al., 2018). Although governmentality G3 is based on the rationale that deliberative democratic practices are needed to strengthen norms such justice, equality, transparency, legitimacy and responsibility in governance development processes, the discourse ethical logic that underpins

it focuses on issues of procedural justice. Rationales, objects and speaker positions focusing on issues of distributive and intergenerational justice and equity were not integral to this emergent governmentality. The discursive structures I identified only offered one active speaker position to social actors who may reproduce a limited kind of (discourse) ethical knowledge ('**wise policy demander**'), as compared to much wider range of active speaker positions available to political and economic social actors in this sphere of the UK NETs governance debate (see Table 7).

Similarly, the 'system critical discourse of climate justice' identified as having emerged in wider discussions of climate change governance in recent years, which calls for fundamental power/knowledge shifts to give marginalized groups democratic control over climate governance, was not directly reflected in my findings (Bäckstrand and Lövbrand, 2016). Indeed, the presence of the negative '**unconstructive agitator**' subject position being assigned to non-utilitarian 'others', and the way in which it is juxtaposed with economic and political speaker positions, indicates that this type of system critical discourse *is* present, but is being constituted as external to the discursive structure that shapes what it is possible to (legitimately, authoritatively) know and say within the industry/policy sphere of the NETs debate (Hajer, 2005, Torfing, 1999). The triad of political, economic and discourse ethical power/knowledge types I identified at the UK industry/policy interface may therefore be marginalizing ethics and justice-based knowledge types that have been posited as having relevance for the governance of NETs specifically and climate governance more broadly.

6.6   Conclusion: Coming to GRIPs with the shaping effects of discourse

As the above results highlight, a structural discourse analytical approach can illuminate discursive power/knowledge relations at work within the industry/policy sphere of the UK NETs governance debate. I have shown that three types of knowledge are currently present at the industry/policy interface; one political, one economic, and one discourse ethical. Each of these knowledge types links a particular governance **rationale (why),** certain governance **objects (what),** particular **speakers and subjects (who)**, and specific governance **modes and instruments (how)** into a system of thinking about the nature and practice of governing.

Correspondingly, I have shown that three 'discursive blueprints' for political, economic and discourse ethical governmentalities may be emerging in this sphere of the NETs governance debate: **The political governmentality** 'Keeping it real' is based on a strategic governance rationale, lumps NETs approaches together for governance purposes based on their suitability in achieving political climate targets, privileges political actors in the development of top-down NETs governance, and is linked to coercive, hierarchical governance instruments. **The economic governmentality** 'Winners come out on top' is based on a functional governance rationale, splits NETS approaches for governances purposes based on their relative costs and benefits, privileges utilitarian actors in a competitive governance development space, and is linked to instruments of incentivisation. **The discourse ethical governmentality** 'Let's talk about it' is based on a normative governance rationale, splits NETs approaches for governance purposes based on their relative social acceptability, privileges rationally arguing actors in a deliberative governance development process, and is linked to persuasive governance

instruments (Table 4). My analysis has shown that these three discursive blueprints for systems of thinking about the nature of NETs governance may also be present in wider discussions of NETs policy instruments, and be further reproducing elements of green governmentality, ecological modernization and civic environmentalism which have historically shaped wider climate governance. This raises the question as to whether NETs governance may end up being shaped by the same power/knowledge structures that have been criticized for producing climate governance arrangements which delay the decarbonization of the global economy, and how this could be circumvented (McLaren and Markusson, 2020, Low and Boettcher, 2020).

In this vein, my findings have implications for recognizing, reflecting and acting to overcome the power dynamics both between and within different knowledge systems in the NETs governance debate. First of all, contrary to expectations sometimes put forward by those who call for the NETs governance debate to be 'opened up', my analysis has shown that the technocratic, utilitarian, neoliberal knowledge system is not the only one currently underpinning NETs discussions at the policy/industry interface in the UK (cf. Bellamy et al., 2012, Low and Buck, 2020). While the 'Winners come out on top' governmentality (G2) adheres to this type of knowledge system, the other two are based on different types of knowledge (political and discourse ethical). Interestingly, the deliberative democratic approach to governance often advocated by those calling for more perspectives to be integrated into NETs governance development is already present in the debate in the form of the discourse ethics governmentality (G3).

Second, although it highlighted that there is more than one type of discourse/knowledge system at play within this sphere of the NETs governance debate, my analysis has shown that the range of knowledge(s) being systematically reproduced is still limited. Comparing my findings with the wider literature has shown that the discursive structures I have identified in this sphere of the NETs debate reflect western, liberal-democratic and anthropocentric dynamics that have been shown to be dominant in broader climate governance (Bäckstrand and Lövbrand, 2016, Hamilton, 2018, McLaren and Markusson, 2020). Climate ethics and justice knowledge is seemingly being constituted as largely external to the discursive structure that shapes what it is possible to (legitimately, authoritatively) know and say within the industry/policy sphere of the NETs debate.

Third, my analysis has shown that 'publics' in this sphere of the NETs debate are often constructed within systems of knowledge that perpetuate external control and decision-making structures in which they are constituted as passive governance *subjects* rather than active governance *speakers*. As Table 7 shows, the range of active speaker positions offers multiple access points for political and economic social actors to actively contribute to the UK NETs governance debate, but only one speaker position (**wise policy demander**) is associated with publics. Conversely, as Table 8 illustrates, passive subject positions provided by the structure of this sphere of the NETs governance debate were all associated with publics and civil society actors. These are the **passive policy recipient:** A governance subject who is passively waiting to be persuaded, placated, convinced that a given NETs policy is in their best interests; the **unconstructive agitator:** A governance subject who is counter-productive, raising (unjustified) concerns which risk putting undue restrictions on the development of potential (cost-effective) solutions to address climate risks; and the **uninformed optimist:** A governance subject who does not fully understand the seriousness of the (climate) situation and what needs to be done.

This imbalance in the distribution of active speaker positions and passive subject positions may give social actors who reproduce political and economic knowledge more privileged positions in this sphere of the NETs governance debate.

These findings emphasize the continued need for increased recognition of the shaping effects of discursive power/knowledge structures on governance development, and improved strategies for those engaged in these processes to reflect upon and expand them. In this vein, those attempting to 'open up' the NETs governance debate should ensure that they (and those they are encouraging to enter the debate) are able to recognize and critically reflect upon of the discursive power/knowledge structures within which they are operating (and may end up reproducing), and how these may solidify into governance instruments and infrastructures. Herein lies the emancipatory function: By mapping how certain types of governance are discursively being rendered thinkable and practicable, my analytical framework exposes the contingent nature of emerging NETs governance, and enables critical reflection of seemingly self-evident or necessary governance developments (Lövbrand and Stripple, 2011: 188). Such critical reflection may help anticipate how NETs governance can avoid the pitfalls of previous climate governance (Low and Boettcher, 2020).

In addition to this emancipatory function, my structural analytical approach can have some practical value when designing and facilitating future deliberative processes which aim to increase discursive diversity in NETs governance development: As my findings suggest, simply bringing together a diverse range of types of stakeholders to discuss NETs governance does not guarantee that a broad range of discourses will be represented equally, as existing power/knowledge dynamics may mean diverse stakeholders reproduce the same discursive structures. Rather, before designing a deliberative process, it is important to first have a structural overview which types of discourses are being privileged/excluded in a given debate and context. Subsequently, this 'map' of the discursive structures could inform pre-screening of potential participants (i.e., in the form of a questionnaire or an interview) to see what sort of discursive structures they reproduce, which subject/speaker positions they assign or adopt, and which types of knowledge they privilege or exclude. This can build upon existing approaches to 'unframing' in deliberative processes (Bellamy and Lezaun, 2017): Discursive mapping prior to deliberative workshop could be used to show participants the 'structure' of their own discursive positioning and how they relate to others, thereby exposing, comparing and contrasting different knowledges underpinning 'reality inputs' into deliberative processes. Mapping underpinning knowledges involved in the co-production of objects and subjects explicit could help participatory processes overcome systemic inequalities (Chilvers et al., 2018).

The results of discursive mapping could thus inform the design and facilitation of a deliberative process which (a) includes participants who (re)produce diverse discursive structures, and/or (b) encourages them to recognize and potentially expand the bounds of existing power/knowledge dynamics. The Foucauldian approach iterates that discursive structure is "not so much like a steel web as a spider's"; while we are unable to completely escape its grip, "we are not so trapped as to be immobilized" (Lipschutz, 2014: xvi). Elucidating the bounds of a given structure can therefore afford social actors some wriggle room to expand the discursive conditions of possibility (Keller, 2018b). Additionally, these sorts of discursive mapping exercises may result in the co-production of diverse discursive templates that can be built upon to facilitate discussion and action on NETs governance in the UK. For example,

the sorts of results outlined above could provide the elements of several (complementary or competing) speculative NETs policy narratives which could be used as the basis of participatory processes to deliberate upon different types of NETs governance.

In sum, these results demonstrate that coming to 'grips' with the structuring role of discourse has clear benefits for the development of responsible NETs governance: Anticipating how given discursive structures may be coalescing into systems of knowledge that make certain types of governance thinkable and practicable, and elucidating their contingent nature can enable those engaging in the NETs debate to recognize (and potentially expand) the discursive power/knowledge structures they are reproducing. Such structural mapping helps to identify what types of knowledge may be missing in the current debate, and could inform the design of deliberative processes to further 'open up' discursive diversity in NETs governance development.

7 A Leap of Green Faith [23]
The Religious Discourse of Socio-Ecological Care as an Earth System Governmentality

The Anthropocene is fundamentally altering concepts of human agency and responsibility in the governance of Earth systems. These concepts are paramount in discussions about governing deliberate interventions into the global climate – often referred to as 'climate engineering'. Reflections on what it might mean for humanity to 'play God' by controlling the climate have brought religious knowledge to bear in these discussions, as it provides resources that individuals and communities draw upon to understand humanity's role in and responsibility towards non-human nature. Using climate engineering as a paradigmatic example of deliberate human interventions which may come to define the Anthropocene, this paper presents a sociology-of-knowledge discourse (SKAD) analysis of interviews with environmentally active multi-faith leaders and scholars. Showing how green religious discourse provides a blueprint for a governmentality of Socio-Ecological Care (SEC), the paper argues that religious knowledge has a key role to play alongside other global systems of knowledge in reconceptualising the who, what, why and how of responsible and sustainable Earth system governance in the Anthropocene.

7.1   Introduction

In the Anthropocene, no longer is humanity a "spectator of a natural drama to which we have to adapt" (Biermann and Lövbrand, 2019: 1). Rather, humans are increasingly being cast in the dual roles of puppets and puppeteers in a post-natural production. Humanity is not only posited as having a dominant impact on global environmental processes, but also increasingly vulnerable to the agency of the Earth system with which it is inextricably connected. These conceptual shifts have resulted in a range of new challenges for global environmental governance. Do existing understandings of objects, subjects, rationales, modes and instruments of environmental governance still apply in a world increasingly of our own making? How are concepts of human agency and responsibility in governing the coupled socio-ecological Earth system being redefined?

In seeking answers to these questions, recent work has shown that a range of knowledges are involved in the reconceptualization of environmental governance in the Anthropocene (Nikoleris et al., 2019, Lövbrand et al., 2020). One type of knowledge which has been highlighted as having played a key role in reshaping understanding of the relationship between humanity and the non-human world is Earth System Science (ESS) (Lövbrand et al., 2009b, Uhrqvist and Lövbrand, 2014). As Lövbrand et al. puts it; "by advancing the 'coupled human and ecological system' as a new analytical category, Earth System Science is not only offering a novel way of seeing and conceptualising the interplay between nature and society: A new political space for government intervention is also in the making', an Earth system governmentality (Lövbrand et al., 2009b: 11). However, the mechanistic understanding of the 'Earth as an engine' inherent to some branches of ESS, with humanity correspondingly being cast as 'engineers', has been criticised for embodying an optimistic view of human control – which may result in the perpetuation of technocratic or neoliberal governance modes unsuitable for dealing with complex global environmental governance challenges (Hamilton, 2018). As ESS evolves, its stated 'grand challenge' is 'to achieve a deep integration of biophysical processes and human dynamics to build a truly unified understanding of the Earth System' (Steffen et al., 2020: 54). Bringing broader types of knowledge into the conversation has been posited as a way to expand understandings of socio-ecological systems as governable domains, grapple with the moral and ethical implications of humanity's role as Earth-shaping agents, and provide alternative epistemological and ontological foundations for Earth system governance in the Anthropocene (Lövbrand et al., 2015, Brondizio et al., 2016, Steffen et al., 2020).

This paper focuses on *religious knowledge* as a relevant lens through which the Earth system may be rendered 'thinkable and governable' (Gordon, 1991). As global systems of knowledge and practice, world religions provide resources that societies have historically drawn upon to understand moral and ethical questions related to humanity's role in and responsibility towards nature (Roltson, 2006, Clingerman and O'Brien, 2016, Koehrsen, 2021). Therefore, it is argued that 'religion has a role to play alongside other forms of knowing in any environmental discussion' (Clingerman and O'Brien, 2016: xviii). This with especial regard to discussions about deliberate human interventions into the Earth system. One such case is 'climate engineering' – proposals for the deliberate large scale manipulation of the planetary environment to counteract anthropogenic climate change by either removing carbon dioxide from the atmosphere and storing it, or by changing the reflective properties of the Earth (i.e.,

by injecting aerosols into the stratosphere) to reduce warming (Royal Society, 2009). The idea of CE has been deemed akin to 'playing God with the climate', and as such is a 'social, cultural, and ethical issue that requires humanity to marshal its deep moral, religious and spiritual resources as it ponders the appropriate response' (Tirosh-Samuelson, 2018: 50). It has been highlighted that thinking about CE through a religious lens can help humanity reflect upon its understanding of itself and its responsibility in the Anthropocene (Jenkins, 2016). There have therefore been calls for the inclusion of religious knowledge in the discussion and development of climate engineering governance (Clingerman and Gardner, 2018, Clingerman and O'Brien, 2016, Clingerman and O'Brien, 2014).

Using the case of climate engineering (CE) as a paradigmatic example of deliberate human interventions which may come to define the Anthropocene, this paper contributes to investigating how religious knowledge could contribute to the reconceptualization of governing the Earth system. Using a Sociology of Knowledge Approach to Discourse (SKAD) and the conceptual lens of governmentality, I analyse a series of interviews with *environmentally active multi-faith representatives* to map how religious knowledge may contribute to re-conceptualizing the *who, what, why and how* of CE governance and global environmental governance more broadly. In the following sections I first outline my methodological approach before presenting and critically discussing the results of my analysis, showing how religious knowledge may provide the 'discursive blueprint' for a new variant of Earth system governmentality which I call *Socio-Ecological Care (SEC)*. I conclude by highlighting the potential for synergies between religious discourse and wider bodies of knowledge, arguing that religion – given its significant role in shaping how societies engage with environmental governance – can play key role in rethinking global environmental governance in the Anthropocene.

7.2   Methodological approach: Discourse through the lens of governmentality

The governmentality concept I use as a heuristic lens to structure my discursive analysis is a system of thinking about the nature and practice of governing which; a) is underpinned by a principle form of knowledge, b) is linked to a particular governance rationale (*why*), c) shapes particular governance objects and subjects (*what* and *who*), and d) makes the development of specific governance modes and instruments (*how*) thinkable and practicable (Gordon, 1991, Foucault, 2007 [1978]). Governmentalities 'define both the objects (what should be governed) and nature (how they should be governed) of governing, in effect rendering reality governable through the collecting and framing of knowledge' (Bulkeley et al., 2007: 2736).

Discourse analytical approaches have proven to be particularly suitable to mapping the emergence of governmentalities because they seek to interrogate the discursive and social constitution of (environmental) problematizations as governable (Bulkeley and Stripple, 2014: 248). The Sociology-of-Knowledge Approach to Discourse (SKAD) that forms the basis of my methodological approach conceptualises discourses as underpinning systems of knowledge which shape understandings of why governance is necessary, what is to be governed, by whom, and how. SKAD offers a discourse analytical methodology which lends itself to tracing the emergence of governmentalities, as it posits a constitutive link between discourse and governance, emphasizing that social objects, subjects and relations are contingent and

co-constituted through discursive structures that render some knowable and governable and others not (Boettcher, 2020, Leipold et al., 2019). SKAD thus offers a 'theory-methodology-methods package to examine the discursive construction of realities in social relations of knowledge' by systematically reverse-engineering discursive structures underpinning a pool of individual utterances (Keller, 2018b: 29).

My data pool of individual utterances consisted of transcripts of 20 interviews I carried out with faith leaders and religious scholars about CE governance. The interviewees were sourced based on three criteria: 1) They identified as belonging to and/or being an expert on a world religion, 2) they were environmentally active, and, 3) they had previously engaged with the topic of CE. The interviewee pool included members of Christian, Muslim, Jewish, Buddhist, Hindu, and Neo-Pagan religious communities in the USA, the UK, Germany, Indonesia, Turkey, Sweden, Nepal, Chile, South Africa and Belgium.[24] Each interview was structured around a series of open-ended questions focusing on identifying religious understandings of humanity's relationships with the non-human environment and how they may relate to the idea of deliberate, large-scale human interventions into global systems via CE approaches.

I systematized the anonymized interview transcripts through a process known as 'open coding,' inductively organizing the discursive elements identified in the transcripts into categories with the help of the qualitative text analysis program MAXQDA. Using the elements of the governmentality concept as a heuristic lens to guide the search for recurring rules by which discursive elements were related, I created a map of discursive structures shaping governance *objects (what) subjects, speakers (who), rationales (why), modes and instruments (how)*.

7.3   Results: An emerging governmentality of Socio-Ecological Care

My analysis revealed that multi-faith religious knowledge may provide the 'discursive blueprint' of a novel variant of Earth system governmentality: *Socio-Ecological Care (SEC).* The discursive elements of SEC shift the focus away from a mechanistic, technocratic understanding of Earth system management and towards ethical environmental governance in world in which humanity is only one part of an interconnected, socio-ecological whole. The elements of this system of thinking about the nature and practice of governance are underpinned by a *relational logic,* which focuses on reciprocal relationships between interconnected human and non-human nature, making new governance *subjects and speakers*, *rationales*, *objects*, *modes and instruments* thinkable and practicable (see Table 10). In the following sections, I describe the discursive construction of each of the individual elements of this emerging governmentality, and critically discuss how they may help rethink existing concepts in global environmental governance.

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24   The initial interviewees were sourced through the *GeenFaith* network, and were asked to suggest further interviewees. Given that the topic of CE is only beginning to be discussed within religious communities, the number of interview partners available was limited. While the group of interviewees is not taken to be necessarily representative of their respective religious communities, nor of all world religions writ large, it does constitute a representative cross-cut of the religions which have so far engaged publically with the topic of CE.

	Subjects (Who)	Rationales (Why)	Objects (What)	Mode (How)	Instruments (How)	Speakers (Who)
Governmentality of Socio-Ecological Care (SEC)	Humanity as part of an interconnected, socio-ecological whole	Governance to create collective, relational norms (care, balance)	Approaches suited to maintaining/ restoring eco-systemic balance (cooperating with vs. controlling nature)	Participatory collaboration within a subsidiary structure of systemic interdependence	Open dialogue, participatory decision-making processes	Bridge-builders, moral narrators, voice of the weak

Table 10: A discursive blueprint for a governmentality of Socio-Ecological Care

7.3.1 Subject positions: Humanity between benevolent domination and socio-ecological interconnection

The idea of CE gives humanity a glimpse into an imagined future where it accepts its role as an Earth-shaping agent. Building on the recognition that humanity has long been unintentionally modifying the global climate through its use of fossil fuels, CE can be seen as a way to embrace this agency, and move on to internationally intervening to counterbalance some of the damage caused. From a religious perspective, would CE then be the ultimate hubris, or a culmination of humanity's responsibility to shape creation? How is human agency in relation to the non-human world being constituted? What discursive subject positions are available for humanity within the religious sphere of the debate on CE governance? My analysis identified three distinct subject positions being offered to humanity by religious discourse: *Benevolent Dominator, Responsible Steward and Part of an Interconnected Whole*, as outlined in Table 11.

The *Benevolent Dominator* subject position constitutes humanity as a powerful co-creator or vice-regent with specific responsibilities. Based on the understanding that humanity is the most intelligent being on Earth, and the only one with the ability for self-reflection, this subject position affords humans a position of power relative to 'nature', which is something separate from humanity over which it can and must exercise domination in order to fulfil its destiny and prosper. This hegemonic understanding of human agency in relation to non-human nature makes deliberate intervention into Earth systems a logical continuation of humanity's God-given right and responsibility to shape their environments. Failure to exercise that responsibility could even be seen as a sin. Humans are thus seen as:

> Managers, as people who are supposed to take control and subdue the Earth and all its harshness, and to rule over it. And so climate engineering is an extension of that call. So if that is our task, we'd better make sure that we do that well, and therefore, a failure to take up that responsibility is simply a form of sloth. So, that's a kind of theological legitimation of climate engineering. It's not one that I warm to, I need to say immediately, but that is certainly one version of the story that you find around (CH18).

As the above quote illustrates, although present in religious discourse, this understanding of humanity's role in relation to non-human nature was consistently reproduced as a negative

Subject position	Humanity's role	Examples
Benevolent Dominator (negative)	A powerful co-creator in a position of power relative to 'nature', which is something separate over which it can and must exercise domination in order to survive and prosper	But we have been given a certain way to reflect on ourselves, we are the conscience, the only part of this creation that can reflect on itself and reflect on what we are doing. So, we have a certain freedom and that makes – in Christian tradition they call that we are made in the image of God, so that we have some part in this divine order, so that we can be co-creators. (CH16)
		The hegemonic understanding of Islam is not very different from the hegemonic understanding of Christianity or Judaism. They are on the same page, looking to an 'other' nature, something independent from their well-being and their existence. And they are trying to dominate this 'other' nature, or their environment, because it is surrounding them, and it threatens them, and they are trying to control it (MU12)
		For me, the climate engineering piece is very much focused around this – like the saving of human civilisation at any cost. And if it means mass ecological disruption, for the sake of human civilisation to survive, then that's not taking care of the natural world, it's putting the humans on top (HI6)
Responsible Steward (negative)	An accountable trustee, a steward of God's creation, which it must protect for future generations	In Islam, there is a verse in the Quran that says that, "Human being[s] are the maintainers or the guardian on this Earth." With that, it means that we are given trust by God to maintain, to take care of the planet, that means all his creation. So, we're not the sole controller of everything, but then we are maintaining to ensure what I mentioned earlier about the limits, not to transgress the limits, to maintain and to care for all His creation" (MU14)
		Once you begin to develop a more sophisticated conception of God and you think that the world does not belong to the human, but the human is part of a created process, that one belongs to God ultimately, means that the world is not for us to destroy. And I treat the world as an empirical right, as a gift, and a gift that was given as a trust, and I think that the Jewish tradition really makes it very clear that our job is not to use the world for our own benefit and just for our own enjoyment, although enjoyment is part of life. But the world is not there for me to just take whatever I want to take out of it, but rather, to protect it, and to ensure there's the perpetuation of the world for future generation (JE8)
		I think of one, the one that is maybe most prevalent to the mainstream conception, would be a kind of stewardship model. Where humans are accountable to God for a trust that they do not own (CH3)

Table 11: Subject positions available to humanity within religious discourse

subject position by interviewees. Associated with older interpretations of Abrahamic religions, the *Benevolent Dominator* subject position was posited as embodying outdated, linear, hierarchical and mechanistic understandings of human agency in natural processes which have contributed significantly to causing environmental harm.

In contrast, the *Responsible Steward* subject position was much more diversely represented in the data pool. In this understanding humanity is God's trustee on Earth. As on interviewee put it;

Human being[s] are the maintainers or the guardians on this Earth. With that, it means that we are given trust by God to maintain, to take care of the planet, that means all his creation. So, we're not the sole controller of everything, but then we are maintaining

Subject position	Humanity's role	Examples
Part of an inter-connected whole (positive)	One part of an interconnected, organic whole, embedded within a global web of relationships of reciprocal care	Hinduism sees humans as just one part of the manifestation of a divine whole. There may be differences in kind, but not an essential nature between humanity and other animals, and even humanity and plants in general. And all of manifest existence, Hinduism would see that everything that we experience is part of the same divinity. It's a difference of kind, rather than essence. So, while there's a functional difference between a human and a whale, and an insect and a tree outside my window, they're all part of the same divinity. So, all are deserving of respect [...]. It's all seen as one part of interconnected divinity around us (HI7)
		One million species will be extinct within the next 20 years. [...] Those are creatures that play – we are creatures, also, creatures of God – that play in a significant role somewhere in the systems. Those large physical systems, those natural systems that God has put in place to keep things – to allow the Earth to stay in balance. They're not there for window dressing, as we say. Each of those creatures has a significant role (MU15)
		They're very eco-centric – humans are just part of this network of relationships. [...]. This idea that we are just one of many species. [...] there is a sense that for all of those, the Earth is a sacred being, that it is alive (PA20)
		So, it's nature all over and so, when you look at the very first ethical precept of not taking life., and when we think of nature, it's not just trees, but including all of the fauna and even flora, to some extent, there is life there, and they would have utmost respect for any plant life or animal life, the life of fish, etc. And so, what this means is that in Buddhist understanding, we see ourselves as part of nature (BU1)
		Christianity has often been an anthropocentric religion; we are sort of reluctant to see the interconnectedness between the ecosystem and humanity, that we are actually a living ecosystem. Every breath we take, we are relying on a stable climate, on oxygen, on water and everything that is a part of the ecosystem [...] we have to understand our interconnectedness and our so – and also, this has to do with a solidarity between – not just between humans, but also between all of creation (CH9)

Table 11: Subject positions available to humanity within religious discourse

to ensure what I mentioned earlier about the limits, not to transgress the limits, to maintain and to care for all His creation (MU14).

This speaker position makes deliberate interventions into Earth systems thinkable – if it were a way for humanity to fulfil its God-given responsibly to protect and care for the planet. While some variants of the *Responsible Steward* subject position – those focusing on precaution, balance and care – were reproduced as a positive subject position, others were reproduced negatively due to the dualism and inequality implied between humans – as having God-given rights and agency – and the rest of passive non-human life on Earth. Interviewees of multiple faiths emphasised that this hierarchical dualism goes against the idea 'that there's a relationship of one level of equality between humanity and the natural world' (HI6) and implies that 'we somehow think of ourselves as an ecologically segregated species' (CH18).

The final subject position, *Part of an Interconnected Whole*, was the most commonly and positively reproduced in the data pool, emphasizing that humanity is 'just one part of

the manifestation of a divine whole' (HI7), that 'humans are just part of this network of relationships […] there is a sense that for all of those, the Earth is a sacred being, that it is alive' (PA20). While there are differences between humans and non-human nature, this is a difference of kind rather than an essential difference. So, 'while there is a functional difference between a human and a whale, and an insect outside and a tree outside my window, they're all part of the same divinity. So all are deserving of the same respect […] It's all seen as one part of interconnected divinity around us' (HI7).

This subject position focuses on the interconnected character of an Earth system which encompasses all of creation. Humanity is not separate from nature, but rather part of it, 'related to everything' (CH10). The 'whole' that humanity is part of is organically interconnected – a body, a family, a congregation of creation, a web of life. And the question is then 'what is our role within ecosystems [and] biotic systems? It is about the place and the role, the vocation of human beings within Earth's systems' (CHR18). From this embedded perspective, humanity can imagine 'treating that natural world not just as an 'it', as a thing, as a place to get resources from, to suck dry, but […] as a living being, as an integral entity or an integral being with different components' and correspondingly, 'it's a totally different way in which I will now work on making decisions that are going to affect that creature and, of course, affect me' (MU15).

> In this understanding, deliberate human intervention into the Earth system could only be undertaken with respect and care, because 'whatever we do will have consequences and impacts for the whole creation. We learn that the creation is not composed of many different small ecosystems, but it is one big ecosystem. If you interfere in one part of the system you can't say what the impact will be on the other parts of the world. So we have to be very careful and see what the rhythms of this creation are' (CH19).

These three subject positions offer humanity contrasting ways to conceptualise their agency and responsibility when considering deliberately intervening into the Earth system. From the *Benevolent Dominator* subject position, such interventions may be a logical manifestation of humanity's right and responsibility to control the non-human environment to perpetuate human development and prosperity. From the *Responsible Steward* position, deliberate intervention may be part of humanity's responsibility to maintain and care for the non-human environment to ensure it can sustain future generations. Finally, from the *Part of an Interconnected Whole* subject position most commonly reproduced by interviewees, humans are themselves part of the holistic, organic entity into which they would be 'intervening'. From this *relational perspective*, CE would only be thinkable if undertaken with reflexive humility, care and respect, taking the existing rhythms of complex living systems into account.

7.3.2   Rationales: Care, balance and humility in CE governance

Mapping the rationales for why CE governance is needed that were being reproduced by the interviewees further highlighted this relational logic. The three key rationales that emerged were: *Responsibility of Care, Maintaining Balance, and Ensuring Humility*, as outlined in Table 12.

Emphasising the inherent interconnectedness of the Earth system, the unique ability of humans to be able recognize their complex reciprocal relationships with non-human life on

Earth, and the correspondingly expanded concept of (self)responsibility that this recognition implies, the *Responsibility of Care* rationale calls for governance to ensure that all deliberate human interventions into Earth systems are governed according to ethics of responsibility and care:

> I'm responsible not just for me personally, not just for the human beings with whom I interact in the social environment, but also for all forms of life […] So we need to create a different ethic – ethics of care, ethics of responsibility, which is connected to ethics of sharing, ethics of collaboration, ethics of consultation, and focuses not on domination, but on help (JE8).

Rather than preventing human intervention into 'natural' systems per se (which is impossible given the entanglement of human and non-human systems), the *Maintaining Balance* rationale posits that governance is needed to prevent humanity from overstepping critical thresholds in complex systems by perpetuating or instigating 'exploitative' relations with the non-human environment through the use of CE:

> Humans cannot live without causing disruption to the natural world, that's inherent. And that's why there's this teaching, which is: okay, how do you maintain that balance, knowing that we're always causing disruption? […] We always are, and we can't avoid that. So, with that understanding, climate engineering is just another way that we're going to be disrupting the natural world, but how do we minimise that as much as possible? (HI6)

The *Ensuring Humility* rationale emphasizes that the purpose of governance is to ensure that humanity's tendency towards hubris is constrained, and that human relations with (and within) Earth systems remain humble. Drawing upon religious narratives about the moral risks of humans assuming that they know too much, or are capable of complete control, this rationale underscores that recognition that humanity is just one part of a web of socio-ecological relationships should inspire humility in governing Earth systems:

> What I think would be a better alternative, would be to corroborate with the Earth's natural processes. […] Having some humility, because we are human, made out of the dust of the Earth, and we need that humility in making decisions about how to support recovering from or moving away from climate change (CH11).

These rationales offer alternatives to strategic and functional rationales for CE governance identified in other spheres of the CE debate, which posit that the purpose of CE governance is relative power and responsibility balancing within international climate politics, and/or primarily about problem solving, risk management, and cost-benefit implementation (Boettcher, 2020). By bringing relational, ethical perspectives to the forefront, rationales of *responsibility of care, balance and humility* have potential relevance for re-conceptualising governance of human interactions with the non-human environment more broadly, and CE governance specifically.

Rationales	Description	Examples
Responsibility of care	Governance to ensure that humanity fulfils its responsibility to care for the coupled socio-ecological systems that it is part of	As Buddhists, we have a responsibility to look after our common heritage (BU1)
		And religiously, as a Christian for me, it's very important to understand, to maintain the distinction between created and creature. We are not halfway round the side of the creator trying to take over some responsibilities of the created. Instead, we are part of creation and we need to exercise what Helmut Thielicke described as the solidarity of the sixth day. On the sixth day we were created with all other species and we should not think too highly of ourselves. For that reason, I'm also rather critical of notions of stewardship and priesthood, as ways of expressing human responsibility. Sure, we have some responsibilities and that I would not want to move away from at all, but whether we are self-appointed stewards, who need to manage God's household, I would not want to put it that way (CH18)
		The ability to respond means that everything is not limited to the self. We are always in a relationship, so that's the first point of departure from the Jewish discourse about responsibility, is that everything is the self and the other, so the question is, who is the other, right? So the other is, first of all, God, and second, the other human beings with who we operate together in a society, and third, includes all biotic life. So, responsibility means that I cannot just see myself, the human and this life is just for me or everything that we take from the natural, just for me and I'm there to control it as much as I can. [...] So if I'm responsible, I'm responsible not just for me personally, not just for the human beings with whom I interact in the social environment, but also to all forms of life (JE8)
		I think the best way to answer that is that the sense of duty I'm referring to is, goes back to a Hindu concept known as Rta, [...] which a concept of cosmic cycles and cycles of being. And that duty is to sort of align all of our individual actions, towards maintaining that and perpetuating that (HI7)
		Taking care of creation or taking care of creation, it is part of Christian faith [...] it is part of our understanding of the world as a creation, and responsibility for taking care of it (CH17)
		The idea that I have special responsibilities to my mother, I have to take care of my mother. I have put parentheses on the word 'father' as well, but the idea that if the Earth was really our mother, would we treat her in that same way? (MU15)
		There is a sense that we should worship the Earth and we also have a responsibility to take care of the Earth (PA20)

Table 12: Rationales for governance within religious discourse

The *responsibility of care* rationale also adds a new discursive model of responsibility to those previously identified in the CE debate (Matzner and Barben, 2020). In contrast to the 'responsibility to manage the planet' pattern identified by Matzner & Barben in the science/policy sphere of the debate, which lacks an underpinning norm and an entity to which humanity is accountable, the relational responsibility model present in religious discourse is based on the *ethic of care* and posits that humanity is responsible to both themselves (as part of a socio-ecological whole), and to God (as embodied in all creation on Earth), to care for the Earth system (see Figure 7).

Rationales	Description	Examples
Maintaining Balance & harmony	Governance to restore the balance of coupled earth systems	I would say the Hindu perspective isn't that nature left alone flourishes. Of course it can flourish, but that humanity needs to interact and engage with nature, in order to create a liveable ecosystem both for nature and for human civilisation, which is part of nature. And so that interaction is important and essential and actually cannot be avoided. But that interaction has to be on the basis of understanding that we are in harmony and balance and not in an exploitative relationship, with the natural world – we may get to that, which is where we are right now. But there needs to be this understanding that we both survive – the natural world thrives and human civilisation thrives – when both are in balance and harmony with each other (HI6)
		So that's why in the Quran we have a reminder again, to remind the people, the followers, that we have to not exceed the balance (MU13)
		Hinduism is very clear on is that humans cannot live without causing disruption to the natural world, that's like inherent. And that's why there's this teaching, which is: okay, how do you maintain that balance, knowing that we're always causing disruption? Like, we always are, and we can't avoid that. So, with that understanding, climate engineering is just another way that we're going to be disrupting the natural world, but how do we minimise that as much as possible? (HI6)
Humility	Governance to ensure that hubris is constrained, and humanity's relations within earth systems are humble	You can read the Tower of Babel as a story about arrogance, in which case, you know, people tried to build the tower to reach all the way to God and were punished. If the story of Babel is a story about arrogance, then you don't solve a problem of climate change by saying, "Now we can run the world," right? We need to be more humble (CH10)
		So we really came at the end of the world, at the very end and yet we are the image of God (laughs). And I think that's a very nice picture because it shows us that on the one hand we have every reason to be humble. And I have learned and like to say in my lectures that this comes from 'humilitas', and there is 'humus' in it, and humble means being connected to the earth (CH19)

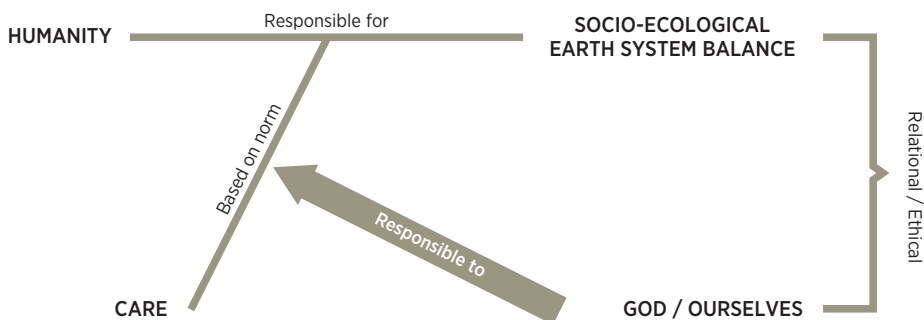**Table 12:** Rationales for governance within religious discourse

Figure 7: A relational, care-based model of Earth system responsibility (adapted from: Matzner and Barben, 2020)

Categorization structures	Classification Criteria	Examples
External differentiation Lumping CE for governance purposes	Fixing vs. dealing with cause/treating the symptoms vs. healing	You know from a Buddhist point of view, what's the use of just simply just artificially reducing the average global temperature for a couple of years? And then to stop it and suddenly the temperatures go way up, and this is not addressing the root causes of the problem (BU1)
		We should not merely treat the symptoms, which is one of my concerns about climate engineering – that that's what they do. To what extent we need to try to offer a diagnosis of the underlying causes and even the deep causes and then you need to address the roots of the disease, not just the symptoms (CH18)
		Some of these more interventionist techniques just dodge essentially, getting to the heart of the matter, which is about how we reduce the climate pollution at its source in the first place? Which sometimes feels like that is a potential real outcome, that these techniques sometimes feel like they get supported by politicians and bureaucrats in industry, because there seem to be ways like, "Well, we can continue doing what we've been doing, if we just add this other layer of technology to it."(HI7)
		We have a technological fix, but if you have a technological fix for a problem that technology has exacerbated, but it's not the root of the problem. The root of the problem has to do with human greed, disproportionally impacting the environment and the world in which I live more than my neighbour. By taking more, I'm allowing my neighbour to have less […] I think, one of the problems with the idea of climate engineering is the fix is not discussed as a general rule, in terms of generations. It's a stopgap measure. "This is a quick way. Take this pill, you'll feel better." […] And you might feel better for an hour or two, but that masks the real problem. We're not dealing with the real issue and the real issue, in my mind, is that we need to address human consumption, especially in the Global North (MU15)

Table 13: Governance objects within religious discourse

7.3.3 Objects: CE as fix vs. cure, control vs. collaboration

The relational logic is further evident in two ways in which CE is being constituted as an object of governance within religious discourse: *External differentiation* of what constitutes CE as a lump category based on the dichotomy 'fix' versus 'cure', and *internal specification* of different types of CE based on those that 'control' nature versus those that 'collaborate' with nature (see Table 13).

In externally differentiating CE as a lump category for governance purposes, the interviewees focused on the understanding that CE is a 'fix' to mask a deeper-seated problem – namely that of humanity having disrupted the relational balance within the Earth system. In contrast, responsible behaviour such as mitigation and/or economic reform which deal with underlying imbalances in socio-ecological relations are conceptualised as the real 'cure' for the underlying causes of climate change:

This [CE] is not addressing the root causes of the problem. The root causes, lay in our greed, our collective greed. They lie in our ignorance and also, our whole disregard and disrespect for nature (BU1).

Categorization structures	Classification Criteria	Examples
Internal specification: Splitting CE for governance purposes	Controlling vs. Collaborating with nature	To me, it covers everything from things that are an objective good thing to do, even if the climate wasn't changing like planting more trees and improving our soils, so they sequester more carbon; to things that are much more interventionist and technologically focused, in the sense of like a hard technology, you know, like spraying and particles into the atmosphere to reflect the sun (HI7).
		We don't know where this technology's going to take us. And is it really worth us going down that road or relying on various types of technology that are already in our hands, that enhance – not undermine – enhance the natural systems of the world, which was given to us as a trust, the Earth, which was given to us as a trust, and was given to us, in a balance, in an ecological balance? […] and also recognize and honour and respect the physical systems that have been put in place and kept this world of ours together for all these years and all these centuries, and not seek to undermine it, but maybe to enhance it, like Adam tended the garden, to become the tenders of the garden, using scriptural language, and not the dominators of the garden, we can enhance the natural beauty of the world. We can enhance the ecosystems, which are currently functional (MU15)
		Some kinds of CE as I understand it may use "natural systems" – as you see I put this in quotes because I'm wary of that nature/human divide being too strict, but to get to the point some of them are things like massive tree planting efforts and then some of them are more artificial like sulphur compounds into the upper atmosphere to shield the earth from the rays from the sun (CH2)
		Anything that is an attempt to increase biodiversity and the health of ecosystems as a whole would be seen more positively, and anything that could be done at a local community-based level, and not a global, capitalist, corporate-level would not be supported […] you're supposed to be working with the earth. Listening to her, working with her, in relationship to all other species and creatures and ecosystems. Whereas they would see some scientific and technological solutions as being separate from the earth (PA20)

Table 13: Governance objects within religious discourse

Governing CE as a lump category in an interconnected world is correspondingly an exercise in ensuring that technological hope cannot be used as an excuse to avoid doing that needs to be done – i.e., restoring balance in socio-ecological relationships – to address the underlying causes of climate change:

[..] it's [CE] not an easy fix and it's often used to say, "We don't need to do the difficult things, because there's another solution just down the road". And I feel that that the biggest danger, then, is a political one, rather than a technological one. The biggest danger is that it will stop us doing the things we need to do, because, obviously, in five years another person says, "Oh, well, my successors will be able to fix things, they'll have the technology by then." (CH5)

When internal specifying different types of CE approaches for governance purposes, the interviewees focused on a division between approaches which attempt to perpetuate human control over nature, and those that attempt to collaborate with the web of socio-ecological relations that make up the Earth system:

> Anything that is an attempt to increase biodiversity and the health of ecosystems as a whole would be seen more positively […] you're supposed to be working with the Earth. Listening to her, working with her, in relationship to all other species and creatures and ecosystems. Whereas they would see some scientific and technological solutions as being separate from the Earth (PA20).

Governance of specific types of CE would then involve assessing each approach according to how it affects existing (and future) relations within the global socio-ecological Earth system:

> So that any kind of development to add to the implementation of such CDR technology would be done properly with the right motivation and considering the needs of nature, considering the needs of the humanity, considering the needs of future generations (BU1).

These categorization and classification criteria based on the relational implications of CE within the interconnected socio-ecological Earth system differ from economic (i.e., cost effectiveness) and political (i.e., ability to help achieve political climate targets) criteria which often define CE as an object of governance in the scientific, political and industrial spheres of the debate (Boettcher, 2020). By expanding the range of criteria for defining and assessing specific CE approaches, the relational perspective may thus provide a way to integrate a wider range of knowledges into decision-making on CE governance.

7.3.4 Modes and instruments: Governance between technocratic management, principled guidance and participatory collaboration

The relational logic underpinning the religious sphere of the CE governance debate shapes a positive governance mode that focuses on relational *collaboration and participation* in governance development, as well as subsidiary practice from the local to the global (see Table 14). The call for interaction between many perspectives in governance discussions and decisions is based primarily on the idea of shared rights. Building upon religious understanding that all living things are equally part of the same creation, they therefore should have the same right to decide about things that affect their lives. It follows that decision-making on CE should be inclusive, deliberative, and participatory, taking as many (human and non-human) perspectives into consideration as possible:

> You need to have Surah. Surah means the idea of consultation […] And I think that the idea of having, in any room, the idea of "where are those one million species, how are they being represented in this conversation?" We need to take consultation for them. And you may say, 'you're crazy, trees don't talk'. Actually, they do talk, trees do worship God, but we don't know how they worship God. But I think we can get an

inkling of what trees would like in the future. For sure, they don't like to be chopped down and not replaced. So, I think that there has to be consultation by those of us who are human, and for all the stakeholders represented, "From the least of these," as Christ said, to the most powerful (MU15).

This relational mode of governance focuses on the quality of the process of governance development, rather than prescribing the morally correct outcomes of such decision-making processes. This focus on process is informed by the understanding, echoed in virtue ethics, that practices and process are key to developing habits that can help humanity to become the kind of people who can make responsible decisions (Hursthouse, 1999). As one interviewee pointed out, while religious tradition and virtue ethics cannot tell humanity concretely what they should do about CE governance, 'what it tells us is, here's what it means to train yourself to be the kind of person who could be trusted to make a decision like that' (CH10). In this line of thinking, inclusive deliberation and open dialogue are not just means an end, but rather learning processes which may facilitate virtuous, responsible decision-making behaviour.

Concretely, this mode of participatory collaboration may be translated into CE governance instruments such as deliberative forums of relevant stakeholders on all decision-making levels, linking the local to the global according to the principle of subsidiarity:

On the larger scale, there has to be ways to make decisions that have input for people who are affected, and of course we're all affected by geoengineering decisions. But that includes – and really is most important for – the people who are bound to be impacted the most. And how can we do that? I think [via] local decision-making. There's a concept called subsidiarity, where decisions are made locally first and you only go to the next level of region and perhaps state or nation, you go to the other level when those decisions don't – can't have as much impact. For instance, human rights or climate change, or climate engineering, let's say that, climate engineering, that you can't just decide on a local scale. So then you'd have to go up higher. But you have input from regions, from smaller associations of people who can actually impact decision-making at a small scale, and then have it move up to the larger scale (CH11).

The positive governance mode of *Participatory Collaboration* is contrasted within the religious sphere with two other CE governance modes: *Technocratic Management* and *Principled Guidance* (see Table 14). *Technocratic Management* is linked to an expert (scientific) management governance mode in which decisions are made according to a utilitarian cost/benefit logic, based implicitly on a consequentialist ethic. It would correspondingly involve multilevel, expert driven instruments for the regulation of CE activities based on the expected cost/benefit of their outcomes. The *Principled Guidance* mode is based on alternative mode of hierarchical steering with an implicit deontological ethic, in which top-down decision making – via instruments such as codes of conduct, international guidelines or agreements – on interventions into socio-ecological systems would be made according to universal principles derived from ethical and/or religious knowledge (i.e., 'protect the most vulnerable' or 'do unto others as you would be done by').

Both of these governance modes were reproduced negatively within the religious sphere. The *Technocratic Management* mode was associated with perpetuating the logic of anthropocentric, utilitarian domination over the non-human environment. The *Principled Guidance* mode was posited as impracticable, given that universal ethical norms or moral principles that may guide top-down governance of interventions into the socio-ecological Earth system have not (yet) been established, and it is unclear how such principles would be weighed against each other. However, religious knowledge is advanced as one possible resource for the development of these shared global governance principles.

7.3.5 Speaker positions: Roles for religious knowledge reproducers in CE governance

Religious discourse provides social actors with *active speaker positions* through which they can authoritatively adopt roles in the development and practice of CE governance. These differ from the speaker positions offered to other major social actor groups engaged in the debate – scientists and political actors. Other analyses have identified that scientific and political discourses constitute *functional and strategic* speaker positions such as *Responsible Information Provider* (providing unbiased scientific information to improve the understanding of the risks and benefits of CE and thus inform the development of governance) and *Strategic Planner* (engaging in long-term strategic societal and environmental planning to inform CE governance goals) (Boettcher, 2020). In contrast, the religious discursive structure offers social actors several *relational* speaker positions focusing on establishing and maintaining relationships between knowledges and perspectives: *Moral Narrator, Bridge Builder, and Voice of the Weak* (see Table 15).

The *Moral Narrator* speaker position provides the discursive template for a governance role that focuses on telling moral stories, bringing historical moral knowledge to bear, and thereby helping humanity make sense of novel moral and ethical governance challenges. This speaker position affords religious knowledge reproducers the authority to offer narrative understandings about what is or should be important to humanity, and how to relate this to the ways in which emerging technologies (such as CE) and their interaction with socio-ecological systems should be governed. This speaker position is therefore associated with facilitating reflection upon what sort of vision(s) for an anthropogenic future humanity may find morally acceptable/desirable. Speakers fulfilling this role are not expected to provide definitive answers, but rather to help humanity develop a range of ethically-informed, big-picture governance narratives about human interventions into the Earth system:

> We know we need work on climate engineering governance […] Stories are absolutely essential because the work now is to tell people what we mean by climate engineering and help people start to think about how they would make decisions about it. And the people who are going to get on board that conversation with purely technical terms and charts and graphs are already in the conversation, and the people we desperately need in the conversation – a broader array of global citizens – are people who will understand this best when it is told in relatable stories, when it is told in the human terms that come from stories. So, I think good stories, thoughtful stories and stories that present genuine choices about how we interpret the world we live in and what we can do about it are the most important thing we've got to do right now (CH10)

I think that climate engineering is – and climate change itself – is involved in an ethical narrative that is quasi-religious in its significance, and that the deep story, or the big story implications of it, should be surfaced. And one way that happens is letting people with big stories offer their frames. I think religious – explicitly marked religious people – have a role in helping other people realise that there's not a normal story about climate change or climate engineering, there's not a **natural** account (CH3).

The *Bridge Builder* speaker position provides a discursive template for governance roles that involve bringing people together, overcoming divides and promoting collaboration and cooperation in governance development and practice:

We – as religious people within the environmental movements – have this role of facilitating dialogue, of trying to keep the vision going to say, "why are we doing this altogether? Why do we need to be in this altogether? Why is this thing transcending all our small differences and conflicts and tensions and ego problems?" And that helps to unite – religion can be a very divisive thing and it has been used a lot to divide people, but it can also be a force to unite and to harmonise and to promote peace and to promote collaboration (CH16).

Modes	Instruments	Examples
Participatory collaboration within a structure of systemic inter-dependence	Open dialogue, participatory decision-making processes	So, that means also, that we have to collaborate and co-operate with other users because we have different claims, and different stakeholders. So everything in this conversation requires collaboration, co-operation, legislation, and on all levels, on the local level, on national level, on international level (JE8)
		I would hope there's some kind of very transparent decision-making process that takes place at an international level. But I think I would only like to see it be deployed in a very localised way. And so, if it if it was to take place here […] I would hope there's, conversation and consultation with people here. And people are fully aware of the implications, both positive and negative, the cost implications, the timeframe (HI6)
		We NEED this cooperation, we need to acknowledge each other's interests, each other's concerns or even problems and countries from different parts of the world, they may not always speak with the same language, but still it is necessary to make this effort. And each one of us, individuals, as well as communities and countries can contribute. And faith communities, churches, among other things, have a task to speak about the need for cooperation in these efforts. Respecting each other, respecting each other's situations, and to do what is necessary to do things together (CH17)
		When people make decisions, with regard to CE technologies, those technologies are going to impact physical systems that will affect people in neighbourhoods outside of my multimillion dollar gated community, air conditioned controlled, temperature-controlled area, with all the wealth and power that I have […] I'd need to get the consent of those people. Those closest to the pain, those most likely to be hit, as a result of my use of this technology. So, that's one issue of governance (MU15)

Table 14: Governance modes and instruments within religious discourse

Modes	Instruments	Examples
Principled guidance within a hierarchical structure (negative)	Guidelines, codes of conduct, treaties, based on universal (moral) principles	Well, ideally, this certainly would mean the humanity may agree on some international body, some recognised body that takes responsibility for the safe development and implementations and the operation of these technologies, and that a proper legal framework is present.[...] the ethical precepts, or, code of conduct, as outlined earlier on, and the five precepts of most basic formulation, this could be used to, for instance, influence the legislation at some – to be appointed – world organisation or global organisation to make sure that any kind of decision-making takes place in that kind of a context, And to ensure that mental qualities, wholesome qualities like loving, kindness, compassion, sympathetic joy and, certainly, equanimity are being – yeah, and those qualities, that inform or influence the decision-making process (BU1)
		When it comes to policymaking and political decisions, I think that all political decisions also come from a value – a base. There are values in the bottom of all political decisions, and the values might be the same, but the political decisions or the political understanding might be different. But I think, when it comes to this, on a basic level, values like you should not hurt, you should let other people have food and water and so on, I think that it could be helpful (CH9)
		I'm hoping through this CE we will bring this discussion on the table to the Islamic jurists [...] And then they will come up with the fatwā, whether they can encourage that, or they can forbid that [...] Maqasid al-Shariah, which is the objectives of the Sharia – the Islamic law – those five, protection of the faith itself and protection of life, and then, protection of knowledge. And then offspring, generations, lineage, and also, protection of property or wealth. So they will look at those, whether it's [CE] going to harm any of this that needs to be protected or not. That's the first, the basic thing before they go forward on something. They look up in this, kind of, a checklist, these five things (MU14).
Technocratic management within multi-level structure (negative)	Regulation based on relative cost/ benefits	Politics has changed into a lot of technocracy [...]it's just about how to keep the economy going and how to arrange things at a very technocratic level, with very little vision about what we really want. So, it's all within what what's economically possible, but which, sort of, makes you feel that the way that we've organised the world is the only way possible (CH16)
		Human minds just capture reality from a dominance-based understanding or domination tendencies, and this is everlasting tendency. It is not a new one. And then, capitalist, economic relations became part of this tendency, and nowadays new technological awareness or advancements are becoming part of this idea of governance (MU12)
		The very well-known, "Greatest good for the greatest number," or "The least harm for the greatest number idea." So, whatever action – you know, if I build another motorway around Berlin, you weigh up the benefits and the harm. [...] So, that's the way they do it, cost-benefit, that's important, that's the way that utilitarianism tends to be acted out [...] everything from the individual is scaled up to be global and they say, "Okay, well, it might harm X group of people, but Y is such a much bigger group." (CH5)

Table 14: Governance modes and instruments within religious discourse

In addition to facilitating dialogue between groups of social actors already active in the CE governance debate, the religious discourse offers an additional speaker position, entitled *Voice of the Weak*, which affords religious actors a role in bringing underrepresented perspectives

Speaker position	Roles in governance	Examples
Moral narrator	Telling moral stories, bringing historical moral knowledge to bear, helping people make sense of new moral, ethical governance challenges Facilitating reflection upon what sort of vision for the future people find morally acceptable/ desirable.	There are hundreds verses of Quran regarding creation that could easily guide Muslims, and if its put on the context today it can be a generally answer the need of how humans can be caring to the Earth and other creations (MU13)
		That's the business of religion and spirituality, which is to really cut at the essence of something, and we question like, why are we doing this? And I think questions around geoengineering point to a broader question, which is, why are we doing this and what are we really trying to get to? [...] And so, you know, part of the solution to the climate crisis is this fundamental question of, why do we exist? What is the purpose of human life? That's really cutting at the heart of the climate solution, and so, it needs to be at the heart of the climate engineering discourse as well. What is the essence? What is the purpose? Are we doing climate engineering, so that we can continue living as we have? Or are we doing climate engineering, which I said earlier, which will be a stopgap, which will help us do the – do that reorientation of human civilisation, which is what we really need to do, right? So that's why I feel that spiritual moral voice would need to be included [...] think that's the moral, ethical voice that spiritual groups, religious groups can bring is to frame climate engineering in a bigger discourse around, what does human civilisation look like in the age of the Anthropocene? (HI6)
		I think most of the scientists I know get very uncomfortable when we move from what is going on or what would happen if we did X, Y or Z to what should we do, or should we do X, Y or Z? And so once we get into that space of the 'should statements', the moral statements, most scientists seem to want to retract and say, "At least as a Scientist, I have no official position on that." I think part of the job of religion is to say, "Okay, well we can help people think about that" (CH10)
		There might be more interesting inputs from faith-based communities and churches in particular to the question of governance, what kind of governance is expected, or it needs to be related to this very new concept of geoengineering. And ethical questions, ethical dimensions which, yeah, can be, and we believe needs to be discussed. Many of them are very new, but we believe that history of churches, rootedness of churches in communities, and the thought concepts developed over centuries, maybe even more than centuries, millennia, can be used, or might be helpful in understanding everything geoengineering is putting in front of us (CH17)
		We have to – people have to be equipped to be able to discern what is right and what is wrong. And need to be empowered and that's the role of the spirit, to be empowered to make the right choices, to have moral agency, to do what they already know is the right thing to do. So, there are roles for religious leaders in equipping people to be able to make decisions, to participate in these kinds of decisions (CH11)

Table 15: Speaker positions within religious discourse

into CE governance development. Given their respected societal positions as carriers of moral and ethical authority, religious speakers may have access to processes where other, less authoritative voices would not be heard. This would allow (and perhaps require) them to speak on behalf of absent or marginalized groups in governance development and practice:

Speaker position	Roles in governance	Examples
Bridge builder	Bringing people together, overcoming divides, promoting collaboration and cooperation on governance	There is a real dichotomy going on here, so the Engineers and the Scientists and the – even the Politicians and all the people who are engaged in this, they don't care about the more ethical or social aspects. And vice versa, the people who give the value-based talk or even the religious or the faith-based talk, they don't really know, or they're not really involved in the mechanics of the technology. I think that that breakdown or that gap is part of the problem, you know? I mean, I think what they [religious actors], that what they try to do is, of course, bridge those perspectives (JE8)
		That is the role of the churches and faith communities – it is precisely here, to repeat over and over again, that this is necessary. We NEED this cooperation, we need to acknowledge each other's interests, each other's concerns or even problems, ah, and of course, countries from different parts of the world, they may not always speak with the same language, but still it is necessary to make this effort. And each one of us, individuals, as well as communities and countries can contribute. And faith communities, churches, among other things, have a task to speak about the need for cooperation in these efforts. (CH17)
Voice of the weak	Brining under-represented perspectives into governance development processes	The protection of the most vulnerable, it is an important task. Faith communities should stand in the first line to say that vulnerable communities need to be protected, and impacts of climate change are not equal everywhere. I am very much convinced that, ah, protection of the most vulnerable is, and needs to be, part of churches' argumentation in all climate change discussions, and including the geoengineering aspects (CH17)
		So, I hope the religious leaders can do that, can tell that it's important to look at people that don't have a voice or that are suffering, or that are – and that they have the same dignity (CH16)
		I think faith groups have so many strengths, and one of them is to act as a gadfly, the conscience, to say 'what about this?' or 'don't forget the poor' (CH4)

Table 15: Speaker positions within religious discourse

> While the person who is in absolute need might not be able to get past that security guard, the person with the religious collar, he might be able to get into that corporate office building and say, "Thanks for letting me in. Now I've got something to say to you about all the other people who you didn't let in." […] the most vulnerable, those closest to the pain, they will not be allowed there. But if they're not allowed there, then maybe in a poor way, we can represent their interests at that table and hopefully change the conversation, as we're speaking about issues of governance that will be decided in those rooms (MU15).

Based on the understanding that, in responding to global environmental challenges such as climate change in coupled socio-ecological systems, humanity is not just facing scientific, but also societal, political and ethical problems, these speaker positions allow religious social actors to authoritatively call for synergic relationships between different types of knowledge in deciding how to face these challenges.

7.4   Discussion & Conclusion: A leap of (green) faith towards global environmental governance?

As the above results have illustrated, religious knowledge may provide the discursive blueprint for a novel system of thinking about the nature and practice of Earth system governance: a *governmentality of Socio-Ecological Care*.

The governmentality of Socio-Ecological Care expands the scope of thinking about the nature and practice of CE and global environmental governance in several ways. First, by providing the relational concept of *humanity as just one part of the living web of reciprocal relationships* that up make the Earth system, it adds a new *subject position* to enable humanity to reconceptualise its role in the Anthropocene, moving away from the concepts of planetary managers, or enlightened stewards of the Earth.

Secondly, the *rationales of responsible care* (of and by socio-ecological systems), *balance*, and *humility* underpinning this governmentality reinforce a relational perspective that may be central to developing more holistic, non-hierarchical and non-linear understandings of human responsibility and agency in global environmental governance. Specifically, the SEC may offer a new model of human responsibility for deliberate interventions into socio-ecological systems that goes beyond the technocratic model of responsibility for 'planetary management' previously identified in the CE governance debate (Matzner and Barben, 2020).

Thirdly, by shifting the perspective from a bird's eye view of the Earth as a machine, and rather providing humanity a way of looking up and out from a position within an interconnected, socio-ecological whole, this governmentality rethinks what *object* is to be governed: Actions and approaches that focus on working *with* existing (and future) relations *within* the global socio-ecological Earth system are differentiated from those which attempt to externally control or 'fix' the system.

Fourthly, the relational, non-hierarchical logic of this system of thinking about the nature and practice of governance in turn makes thinkable and practicable governance *modes and instruments* which are *bottom up, situated, participatory*, and involve the integration of a range of knowledge types. Religious discourse could thus contribute to discursive blueprints for future architectures that enable the epistemological pluralism needed to adequately address democratic socio-ecological governance at the planetary scale (Mert, 2019).

And lastly, this governmentality offers discursive *speaker position*s through which religious social actors may authoritatively engage in development and practice of CE governance, and global environmental governance more broadly, *as moral narrators, bridge builders*, and by giving *voice to the underrepresented*.

Comparing the results of my analysis to the wider climate governance literature points to fruitful synergies between this religious 'system of thinking about the nature and practice of governing' the Earth system and wider bodies of knowledge. The discursive structures being reproduced by religious social actors share similarities with the system critical discourse of climate justice and civic environmentalism identified as becoming increasingly relevant in global climate governance (Bäckstrand and Lövbrand, 2016, Biermann and Kalfagianni, 2020), with both calling for changes in knowledge/power dynamics to integrate marginalized voices into environmental governance.

The results presented here reflect trends similarly highlighted by theology and religion studies' scholars towards "overcoming anthropocentrism and transforming the nature/culture divide into a symbiotic and inter-dependent relationality" in multiple world faiths (Conty, 2021: 224). Within political theory, religious discourse may also reinforce an emergent concept of 'global green civilisation' which connects the 'microlocal with the full planetary' and 'offers comprehensive guidelines for sustainable human habitation with the New Earth' (Deudney and Mendenhall, 2016: 63). It further shares similarities with wider post-humanist-post-modern scholarship which brings to the forefront 'a sense of organic connectedness with nature', calling for the dissolution of epistemological dualism and prudence in attempts to dominate nature (Fremaux and Barry, 2019: 174, Cudworth and Hobden, 2013).

The religious focus on the responsibility of care as a rationale for governance also resonates with care-based approaches within the fields of global environmental justice (Schlosberg, 2007) and global feminist ethics (Held, 2005, Tronto, 2015). Such approaches emphasize that global governance informed by an ethic of relational and responsible care is more likely to pay attention to and prevent potentially harmful shifts in socio-ecological relations (Preston and Carr, 2018, McLaren, 2018a, Tronto, 2015).

The relational logic underpinning the religious sphere of the CE debate may further be analogous to an emerging approach to integrating different valuations of human/non-human-nature relations into ecosystem service and sustainability governance – as exemplified by the United Nations' Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assessment processes (Díaz et al., 2015). In this context, the concept of care has been posited as a key component of a relational approach to governing socio-ecological relations, emphasising that a 'focus on care-directed interactions between humans and nature can complement science-based management measures with practices of care that are rooted in culture, tradition, religion, or personal relationships' (Jax et al., 2018), and as such, 'may be conducive to the development of more nuanced, ethical and effective pathways to sustainability' (West et al., 2018).

The results presented here also reflect the emphasis being advanced within the emerging field of Earth System Governance on the value of incorporating a range of normative discourses into the transdisciplinary development of governance processes, instruments and architectures to 'care for the stability of life-sustaining functions of the entire planetary system' (Biermann, 2016: 408).

The governmentality of Socio-Ecological Care being constituted within environmental religious discourse therefore resonates strongly with concepts being put forward by varied bodies of academic knowledge engaged with the reconceptualization of global environmental governance. Religions are deeply imbedded social systems of knowledge and practice with local to global reach, and have historically shaped how societies engage with global environmental governance (Rothe, 2020). The emerging green synergies of diverse religious traditions – which may be turning towards a more relational, care-based understanding of humanity's role in the world – therefore have the potential to bolster complementary systems of global knowledge in in facilitating a 'leap of (green) faith' towards reconceptualising the *who, what, why and how* of responsible and sustainable Earth system governance.

8 Arguments and Architectures [25]
Discursive and institutional structures shaping global climate engineering governance

The Anthropocene is giving rise to novel challenges for global environmental governance. The barriers and opportunities shaping the ways in which some of these complex environmental challenges become governable on the global level is of increasing academic and practical relevance. In this article, we bring neo-institutionalist and post-structuralist perspectives together in an innovative framework to analyse how both institutional and discursive structures together bound and shape the global governance opportunities which become thinkable and practicable in the face of new global environmental challenges. We apply this framework to explore how governance of climate engineering – large scale, deliberate invention into the global climate system – is being shaped by discursive and institutional structures in three international forums: the London Convention and its Protocol, the Convention on Biological Diversity, and the United Nations Environment Assembly. We illustrate that the 'degree of fit' between discursive and institutional structures made climate engineering (un)governable in each of these forums. Furthermore, we find that the 'type of fit' set the discursive and institutional conditions of possibility for what type of governance emerged in each of these cases. Based on our findings, we critically discuss the implications for the future governance of climate engineering at the global level.

8.1   Introduction

The Anthropocene is giving rise to a range of novel environmental challenges. The barriers and opportunities shaping whether and how these challenges become governable on the global level is of increasing academic and practical relevance. Questions that merit deeper exploration include; how a new environmental issue becomes an object of global governance, in which forum, and what bounds and shapes the governance opportunities which emerge. These questions are increasingly relevant as environmental challenges become all the more global, and the international institutional space is crowded by forums with potentially overlapping mandates (Newig et al., 2020).

Two broad approaches have recently been taken to investigating these questions. First, the institutional approach focuses on *material* structures as key determinants of governance (Miles, 2002, Young, 2002, Young et al., 2008). These include the ways in which the scope, mandate, principles and institutional arrangement of existing international forums shape how a new environmental problem is addressed (Biermann and Kim, 2020). The institutional approach explains how existing institutions limit the governance choices and opportunities available to address new problems. Second, the discursive approach is based on a constructivist understanding of how *discursive* structures shape the emergence of governance (Hajer, 2005, Schmidt, 2008, Leipold et al., 2019). The discursive approach highlights how an issue is discursively constituted as an object of governance, and how specific rationales, modes and instruments of governance come to appear natural and given (Bulkeley and Stripple, 2014, Lövbrand and Stripple, 2014).

Both these approaches have merit in identifying underpinning 'conditions of possibility' that shape whether and how environmental governance emerges. However, a perceived conceptual difference has kept these two approaches largely separate. While institutional analysis is understood as inherently structural by global governance scholars – focusing on the role of institutions in shaping governance outcomes – often 'discourse' is not similarly conceptualised as a structure in and of itself, but rather as a mere communication tool employed by strategic actors (Leipold et al., 2019). This seeming conceptual inconsistency has impeded fuller understanding of how discursive and institutional structures interact in international forums in the face of new environmental challenges to jointly bound and shape global governance decisions.

In this article, we bring together neo-institutionalist and post-structuralist discourse perspectives to address this gap. We draw on the Foucauldian reconceptualization of discourse as a (ideational) structure which has the power to shape the emergence of global governance arrangements in a similar way to institutional (material) structures, putting both these approaches on compatible conceptual footings and making their complementary nature clear. We create an innovative framework for analysing how both *discursive* and *institutional* structures bound and shape the global governance opportunities which become thinkable and practicable in the face of new global environmental challenges.

Our empirical analysis deals with climate engineering (CE), or the large-scale deliberate invention into the global climate system with the intent to mitigate the effects of climate change (Royal Society, 2009); a novel challenge becoming increasingly central to global environmental governance in the Anthropocene (Pasztor et al., 2021, Sovacool, 2021). The heterogeneous

range of proposed techniques for deliberately altering the climate would have global effects and has thus led to calls for governance through international forums (Morrow, 2017).

We focus on three international forums which have so far engaged with CE governance, with differing results: (1) the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol, known as the London Convention/London Protocol (LC/LP), which put a framework in place for *permitting and regulating* marine CE activities that can be classified as legitimate scientific research; (2) the Convention on Biological Diversity (CBD), which passed a decision focusing on the *prevention of harm*, and *precautionary restriction* of CE activities with the potential to endanger biodiversity; and (3) the United Nations Environment Assembly (UNEA), which deliberated upon and subsequently *rejected* a draft resolution calling for an assessment of CE proposals with an eye to establishing global governance frameworks.

Our aim is to explain the variation in CE governance outcomes of the LC/LP, CBD, and UNEA. Building on the problem of fit literature (Young, 2002, Folke, 2007, Galaz, 2008, Cox, 2012) that highlights the importance of 'fit' between problem features and intuitional structures, and post-structural governmentality literature (Lövbrand and Stripple, 2014, Stripple and Bulkeley, 2014, Bäckstrand and Lövbrand, 2006, Bäckstrand and Lövbrand, 2016) that highlights the co-constitutive interaction between discursive 'rationalities' and material 'techniques' of governance, we ask: How did the discursive and institutional structures co-shape the differing decisions on CE governance in these three international forums?

Building on the premise that the extent and nature of (dis)similarities between the discursive and institutional structures are key to making sense of a governance outcome, we analysed how (1) the *'degree of fit'* between given discursive structures (or 'software') and material institutions (or 'hardware') contributed to making CE an (un)governable issue in each of these forums; and (2) the *'type of fit'* across four different analytical levels – objects (what), rationales (why), modes (how), and speakers (who) – set the discursive and institutional conditions of possibility for the governance decisions which emerged in each of these cases. By analysing the 'fit' between discursive and institutional structures across these four levels, our aim is to reconstruct the constitutive 'conditions of possibility' that made certain governance outcomes thinkable and practicable.

In the following sections, we outline our analytical framework for exploring the degree and type of fit between discursive and institutional structures in emerging governance (section 2); describe data and methods (section 3); explore our research question in three case studies (section 4); before discussing the implications of our results for the future governance of CE techniques at the global level (section 5) and concluding (section 6).

8.2   Analytical framework

In following with neo-intuitionalism, we conceptualize institutional structures as 'hardware' with the power to bound and shape the governance opportunities available within each international forum (Biermann and Kim, 2020, Young, 2002). In this regard, our study builds on the literature on the origin and consequences of the design of international institutions (Mitchell, 2006, Mitchell, 1994, Koremenos et al., 2001, Guzman, 2005, Dür et al., 2014).

However, while institutional analysis posits that material structure is a key variable for explaining effectiveness, we suppose that it may also shape whether and how a new governance challenge becomes governable by certain institutions. Key elements of institutional structure include: A given forum's mandate which specify *what* it has the purview to govern; the institutionalized principles that provide the normative basis for *why* governance is necessary; the decision-making modes and instruments which prescribe *how* a given institution governs; and the membership and informational input structures which stipulate *who* is involved in governance within a specific forum.

But institutional 'hardware' is only half of the environmental governance development story. The other half is told by the shaping effects of discursive structure, which we understand as the 'software' or 'source code' underpinning a given governance debate (Boettcher, 2019). In following with Foucauldian-inspired post-structural analysis, we conceptualize a discourse as an often-unrecognized power/knowledge structure that shapes what it is possible to (legitimately, truthfully, authoritatively) know and say within a given environmental governance debate (Hajer, 1995, Keller et al., 2018, Boettcher, 2020, Lövbrand and Stripple, 2014). This approach assumes the shaping power of discursive structures, as "objects, subjects and relations … are contingent and co-constituted through discursive practices that render some … knowable and governable and others not" (Leipold et al., 2019: 446). Discursive structures thus make certain types of governance 'thinkable and practicable' by bounding understandings of *what* is to be governed, *why* governance is necessary, *how* governance should be implemented, and by *whom* (Gordon, 1991, Boettcher, 2020).

Our approach focuses on the co-constitutive interplay of discursive 'software' and institutional 'hardware' which determines whether and how an issue becomes governable within a given forum. We theorize that the *degree* and *type* of fit between these two kinds of structures bound and shape the governance opportunities deemed possible and appropriate in a given institutional context. We consider Möller (2020) as our point of analytical departure, who highlights that 'fit' (or lack of it) between the definition of objects to be governed and the scope of a given institution's mandate is central to determining whether and how the new CE issue is deemed governable within that forum (see also Jinnah et al., 2021). Yet, in our analysis, we go beyond this 'problem definition' plus 'institutional mandate' analysis of fit, with a view to overcoming the limitations of the conventional approach that leaves little room to consider the power of contextual values and principles in determining which governance discussions can be initiated in the first place (Möller, 2020).

We therefore assess more broadly the fit between discursive and intuitional structures on *four analytical levels*, as outlined in Table 16: *governance objects* (what is to be governed), *governance rationales* (why is it to be governed), *governance modes* (how is to be governed), and *governance speakers* (who is authorized to be involved in governance). For example, on the *'what'* level, fit between a discursive definition of CE as all 'deliberate, large-scale interventions into the global climate to mitigate the effects of climate change' and an international forum with a similarly geographically, sectorally and temporally encompassing mandate would create discursive and intuitional opportunities for CE writ large to become governable within that forum. On the *'why'* level, fit between discursive 'risk-benefit' rationales for governance of CE and a utilitarian risk-management principle institutionalized as a guiding norm within a given forum would make risk-benefit assessment-based governance 'thinkable and practicable'

	Discursive structure	Institutional structure
Objects (what)	What is discursively shaped as the object of governance? (E.g. Lumping all CE measures, or splitting based on i.e., efficacy, scale, impact)	Scope of mandate: broad vs. narrow (geographically, sectorally, temporally)
Rationales (why)	What rationales are structuring calls for CE governance? (E.g., Utilitarian, precautionary)	Guiding norms/principles (especially those relating to risk/precaution and burden-sharing/allocation)
Modes (how)	How should CE be governed? (E.g., Centralized, decentralized, coercive, participatory)	Regulatory instruments, decision-making procedures (consensus/majority, binding/non-binding etc.)
Speakers/roles (who)	Who is discursively authorized to be involved in shaping CE governance? (E.g., Experts vs. non-experts)	Input structures (expert scientific groups, NGO/stakeholder submissions, etc.)

Table 16: Analytical framework for comparing fit between discursive and institutional structures shaping decisions on CE governance.

within that forum. On the '*how*' level, discursive rationales for centralized modes of CE governance would 'fit' within institutional architectures which facilitate binding, top-down governance. On the '*who*' level, a fit between the discursive privileging of scientists as legitimate knowledge producers/speakers, and institutional input structures that afford scientists a key role in informing decision-making would present the discursive and intuitional 'conditions of possibility' for scientific assessment-based governance. A lack of 'fit' on one or more of these levels can conversely contribute to CE being deemed ungovernable within a given forum.

8.3   Methods & Materials

Our research design is based on *qualitative case studies* analysing the institutional and discursive structures that played a role in shaping decisions on CE governance in three international forums. We selected as our cases three international forums that have so far engaged with CE governance: the LC/LP, the CBD, and UNEA. Each of these forums produced a different *type* of CE governance outcome: one more permissive, one more precautionary, one a complete rejection of the issue as 'ungovernable'. Each forum has differing intuitional structures and initial analysis and commentary on the CE decisions made have suggested that varying discursive structures also played a role in shaping governance outcomes (Fuentes-George, 2017, Möller, 2020, McLaren and Corry, 2021, Jinnah and Nicholson, 2019, Gupta and Möller, 2018, Biermann and Möller, 2019, Jinnah et al., 2021).

To explore the co-constitutive effects of both discursive and intuitional structures on governance decisions in these forums, we used a mixed methodological approach, combining *neo-institutional analysis* with *post-structural discourse analysis* techniques.

Neo-institutional analysis aims to identify key elements of institutional structures shaping the *why, what, how and who* of CE governance in each forum. These attributes are

"significant features of institution that give individual forums their distinct character" such as "goals, principles, norms, rules and decision-making procedures" (Young and Zürn, 2006: 132). Although institutional structures are relatively resilient, institutional 'hardware' – like discursive 'software' – is subject to change. For the purposes of our analysis, we therefore focused on a snapshot of what the institutional structure of each forum looked like at the time decision was made. The data pool for the institutional analysis included a combination of following materials for each case: Treaty texts (for the identification of mandate, key principles, modes of governance, and the basic input structure); decisions of the parties (the details of governance mode); publications by the secretariat and other treaty bodies (the content of input); and secondary literature (for validation or as background). These materials where sourced from both the forums' websites and aggregated databases (Mitchell et al., 2020).

Post-structural discourse analysis aims to reverse-engineer underlying structures from a data pool of individual utterances (Keller et al., 2018, Hajer, 2005, Boettcher, 2020, Boettcher, 2019). Guided by the analytical categories outlined in Table 16 above, our discourse analysis aimed to identify recurring discursive structures shaping the *what, why, how and who* of CE governance in discussions leading up to the decisions in the three international forums. The data pool of materials for the discourse analysis included a combination of following types of materials for each case: Materials published by international forum in the lead up to decisions (meeting reports, decision documents, and member statements); independent reports from observers, (sourced from the Earth Negotiation Bulletin); and background interviews with people who were involved in and/or observers to discussions leading up to decisions in each forum.

Our analysis proceeded in two steps. We first independently identified institutional and discursive structures at play in each forum, with one co-author responsible for the institutional analysis, and the other for the discourse analysis. For both types of analysis, we used the qualitative text analysis programme MAXQDA to conduct iterative coding of the text materials – guided by the analytical categories outlined in Table 16 above, with analytical categories being revisited and consolidated as the analysis progressed. We then qualitatively compared the results of both types of analysis, assessing the fit between the categories coded in both the discursive and intuitional analyses in each case. The assessment of 'fit' was carried independently by both authors before the results for each case were consolidated.

8.4   Results

In each of the three case studies presented below, we first describe the type of governance decision reached in each forum, and then illustrate how a range of institutional and discursive structures jointly provided the 'conditions of opportunity' for this outcome.

8.4.1   LC/LP

Three resolutions on marine CE were passed by the parties to the LC/LP: "Ocean fertilization activities, other than legitimate scientific research should not be allowed" (LC/LP, 2008) "scientific research proposals should be assessed on a case-by-case basis using the Assessment Framework" (LC/LP, 2010); and the parties "should continue to develop guidance for listing

additional marine geoengineering activities", thereby subjecting them to assessment and regulation/permission according to the new Assessment Framework for Matter that may be Considered for Placement (LP, 2013). Thus, the LC/LP, in addition to *restricting* marine CE activities in general, also put in place a framework for *permitting* certain CE activities which classify as legitimate scientific research.

Institutional structures

The institutionalized mandate (what) of the LC/LP is narrowly defined, namely "to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea" (Article 1). To fulfil this mandate, the parties assess whether the dumping or "deliberate disposal" of specific substances at sea is likely to cause marine pollution.

The precautionary principle has been a key guiding norm (why) since 1996 (LC, 1996) and is prominently reflected in the 'reverse list' approach of the LP (Article 3(1)). Instead of prohibiting the dumping of listed substances, the LP prohibits the dumping of any substance (including iron) that is not listed in Annex 1, unless authorized under a permit. In accordance with the principle, if the parties are unable to determine the likely effects of a proposed disposal option due to the lack of information, they are not allowed to consider the disposal option further (Annex 2, paragraph 14).

The LC/LP mode of governance (how) has long been technocratic regulation based on scientific (risk) assessment. As the dumping of waste necessarily involves some degree of problem shifting to the marine environment (Kim and van Asselt, 2016), the parties to the LC/LP put in place assessment guidelines. Using these guidelines, the parties make a comparative (risk) assessment of dumping and alternative options, and balance any benefits of the disposal option against the cost in terms of human health and environmental risks. When benefits clearly outweigh the cost, a permit may be issued by the parties.

Institutional input for decision-making within the LC/LP comes largely from the Scientific Groups of the LC/LP (who), which evaluate and review the existing list of permitted or prohibited substances in light of new scientific information (Stokke, 1998, see also Verlaan, 2013). These Scientific Groups comprise experts nominated by the parties, and their expertise is largely concentrated on the marine environment. Non-governmental organizations may only participate in meetings of the LC/LP upon invitation by the Chair and with approval of the parties (LC, 1988), which is common for multilateral environmental agreements.

Discursive structures

A narrow governance object (what) was shaped within the structure of the LC/LP debate on CE. Ocean fertilization (OF) was discursively constituted as one specific type of 'placement of matter for a purpose other than the mere disposal thereof' into the marine environment and this concept was expanded to potentially include other 'marine geoengineering' activities in the lead up to the 2013 amendment (see Supplementary Table 5). The defining criterion for constituting OF activity as a governance object under the LC/LP was the potential for marine environmental harm through placement of matter in the ocean:

The London Convention and the London Protocol should continue to work towards providing a global, transparent and effective control and regulatory mechanism for ocean fertilization and other activities that fall within the scope of the London Convention and the London Protocol and have the potential to cause harm to the marine environment. (LP, 2013)

This specific governance object was then internally split into placement of matter for the purposes of 'legitimate scientific research' – to be permitted pending expert (risk) assessment – and other 'dumping' activities which fall outside this category, and are to be prevented:

To date, this debate has revolved around whether ocean fertilization research should be permitted, which is only possible under the current dumping controls, or subjected to "voluntary" controls under the existing placement regime. By creating a permitting authority for ocean fertilization research as a placement activity, a binding permit requirement is created without having to interpret ocean fertilization research as dumping. (LC, 2010a)

The rationales for governance (why) underpinning the LC/LP debate were largely utilitarian, balancing between the potential benefits and risks of OF and other marine geoengineering activities. Governance was correspondingly constituted as needed quantify and mitigate risks and benefits of activities:

Any specific framework developed for placement activities requires consideration of the following aspects: The details of the specific proposal, including its purpose and characteristics; A clear justification that the proposal is a placement activity with a description of the anticipated benefits and risks; Means to maximize any anticipated benefits and minimize disbenefits. (LC, 2011b)

Correspondingly, the governance mode (how) discursively constituted as practicable within the discursive structure of the LC/LP debate on CE was based on case-by-case expert assessment according to a prescribed framework to determine which activities to permit/restrict:

Scientific research proposals should be assessed on a case-by-case basis using an assessment framework to be developed by the Scientific Groups under the Convention and the Protocol. (LC, 2009)

The discursive structure of OF governance debate privileged scientific and legal experts, affording them authoritative speaker positions as legitimate producers of the knowledge on which governance decisions could (and should) be based (see Supplementary Table 5):

Where respondents considered the act to be dumping, it was generally not seen to be captured by Annex 1 (which allows the dumping of certain wastes or other matters with a permit) unless the iron could be classified as an "inert, inorganic geological material". Guidance on this was requested from the Scientific Groups, who responded,

	Discursive structure	Institutional structure
Objects (what)	A narrow, bounded governance object was discursively constituted (OF as one specific type of 'placement').	Scope of LC/LP mandate – focused, narrow (to prevent pollution of the sea by dumping of wastes and other matter)
Rationales (why)	Rationales for governance were largely utilitarian, balancing between the potential benefits and risks of OF activities.	Utilitarian risk-management principle as a guiding norm of LC/LP
Modes (how)	Regulatory governance mode based on scientific assessment of risks/benefits discursively constituted as practicable	LC/LP mode of governance – technocratic regulation/management based on case-by-case scientific (risk) assessment
Speakers (who)	Discursive structure of OF governance debate privileged scientific and legal experts as legitimate knowledge producers	Input for LC/LP decision making from expert working groups

Table 17: Comparing discursive and institutional structures shaping LC/LP decisions on CE.

and specifically noted, that it should not be considered as 'inert, inorganic geological material.' (LC, 2008d)

Fit

As Table 17 illustrates, there was fit between discursive and institutional structures within the LC/LP on several levels. Those calling for governance discursively shaped a narrow governance object (one specific type of marine-based CE as adding matter to the marine environment for a purpose other than the mere disposal thereof) and the LC/LP's scope is correspondingly narrow (prevent dumping of environmentally harmful materials in the ocean). The rationales and modes for OF governance were largely utilitarian, balancing between the potential benefits and risks of OF, this overlapped with the institutionalized risk-management principles and modes of the LC/LP. The discursive structure of the debate on OF governance within the LC/LP the privileged expert knowledge producers, and this was reinforced by the input 'hardware' of the LC/LP which are centred around scientific and legal expert working groups to inform governance decisions. As shown in Table 17, there was a considerable degree of fit across multiple 'hardware' and 'software' levels, and the type of fit provided the 'conditions of possibility' for governance in the form of expert-led risk-benefit assessment to permit certain activities on a case-by-case basis.

8.4.2 CBD

Two decisions on CE were made by the parties to the CBD. The parties decided that, "[i]n the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering […] no climate-related geo-engineering activities that may affect biodiversity take place, […] with the exception of small-scale scientific research studies that would be conducted in a controlled setting" (CBD, 2010). Furthermore, the parties decided that "[m]ore transdisciplinary research and sharing of knowledge among

appropriate institutions is needed in order to better understand the impacts of climate-related geoengineering on biodiversity" (CBD, 2016). The CBD's governance decisions thus focus on prevention of harm and precaution in relation to CE activities.

Institutional structures

In comparison to the LC/LP, the CBD has a broad institutional mandate and jurisdictional scope (what): the conservation of biodiversity in areas within the limits of national jurisdiction as well as in the area beyond the limits of national jurisdiction (Articles 1 and 4). Furthermore, the CBD has adopted the (holistic) ecosystem approach as the primary framework for action (CBD, 2000), where ecosystem is defined under the convention as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (Article 2). Accordingly, the CBD aims for "the integrated management of land, water and living resources" by focusing, for example, on cross-cutting issues such as climate change and biodiversity, where the contribution of biodiversity to climate-change mitigation and adaptation is recognized.

The CBD is guided by several principles (why), including the precautionary approach. The preamble notes that "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat". The application of such an approach has been most prominent in relation to the conservation of marine and coastal biodiversity. Decision II/10, for example, states that the work of the Executive Secretary on marine and coastal biodiversity "should not be impeded by the lack of full scientific information and will incorporate explicitly the precautionary approach in addressing conservation and sustainable use issues" (CBD, 1995).

The mode of governance institutionalized in the CBD (how) is generally not top-down. The implementation of measures for conservation and sustainable use is at the discretion of each party "in accordance with its particular conditions and capabilities" (Article 6). Importantly, however, there is an exception for activities which are deemed to endanger biodiversity. This is made explicit in Article 22(1), which is dubbed a "reverse" conflict clause. It obliges the parties to the CBD to give their rights and obligations under the convention precedence over their rights and obligations from other international agreements, if the exercise of those rights and obligations would "cause a serious damage or threat to biodiversity". Although the CBD has never elaborated on the content of Article 22 (Kim and van Asselt, 2016), the underlying premise is clear: serious harm to biodiversity must be avoided.

In terms of input structures, decisions are informed by both science and non-scientific knowledge (who). The parties receive scientific advice from the Subsidiary Body on Scientific, Technical and Technological Advice (Morgera and Tsioumani, 2011). Unlike the LC/LP, the parties to the CBD do not rely exclusively on scientific risk assessments of the impact of certain activities on biodiversity, but also on other forms of knowledge such as those of indigenous peoples and local communities. Decision-making is relatively open and inclusive at the CBD. The CBD Secretariat has been encouraging the participation of a number of major stakeholders, including business, children and youth, local authorities, non-governmental organizations, parliamentarians, universities and the wider scientific community. Notably, the preamble of the convention text stresses the importance of cooperation with the non-

governmental sector, which is exceptional for a multilateral environmental agreement (CBD Secretariat, 2005).

Discursive structures

A broad, unspecific governance object (what) was constituted with the discursive structure of the CBD debate on CE (see Supplementary Table 6). The defining criterion for constituting the idea of CE as a 'lumped', singular governance object was the various approaches' potential to have effects on biodiversity and coupled socio-ecological human/nature systems:

> An interim definition of geo-engineering includes any technologies that deliberately reduce solar insolation or increase carbon sequestration from the atmosphere on a large scale that may affect biodiversity. (CBD Secretariat, 2011a)

Rationales for governance (why) structuring the CBD debate on CE were precautionary, emphasising the potential (environmental and social/cultural) detrimental effects of CE activities. Precautionary governance was constituted as needed to prevent activities with the potential to have detrimental effects on socio-ecological systems:

> On geo-engineering, the COP invites parties and governments, according to national circumstances and priorities, to ensure, in line with decision IX/16 C on ocean fertilization, in the absence of a science-based, global, transparent and effective control and regulatory mechanism for geo-engineering, and in accordance with the precautionary approach and CBD Article 14, that no climate change-related geo-engineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify them and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts. (ENB, 2010)

In addition, emphasis was placed on the need for governance to facilitate transdisciplinary research and knowledge integration to better understand the potential biodiversity impacts of CE. Governance was posited as being needed for capacity building – to ensure that information can be gathered, integrated and shared especially on possible impacts on biodiversity and associated social, economic, cultural, ethical considerations:

> The COP reiterated the importance of the precautionary approach in relation to climate-related geoengineering, […] and the need for more research and knowledge-sharing in order to better understand the impacts of climate-related geoengineering. (CBD Secretariat, 2016)

A centralized, restrictive governance mode (how) was linked to this precautionary logic. Enforcement of broad 'ban' on all CE activities was constituted as appropriate, rather than regulation on case-by-case assessment of risk. This translated into the discursive constitution of global, transparent and effective control and regulatory mechanisms to prevent potentially harmful CE activities from taking place:

Informal exchanges also continued on a possible moratorium on geo-engineering, with conjecture surrounding the possible fate of one of the conditions for lifting the moratorium, namely the setting up of a global regulatory framework. (ENB, 2010)

The discursive structure of the CBD CE debate privileged both scientific and non-scientific actors as legitimate 'knowledge producers'. As biodiversity/sustainability involves 'people on the ground', socio-cultural knowledge was constituted as legitimate alongside science to inform CE governance decision making:

[The COP] recognizes the importance of taking into account sciences for life and the knowledge, experience and perspectives of indigenous peoples and local communities when addressing climate-related geoengineering and protecting biodiversity. (SBSTTA, 2015b)

Fit

As Table 18 outlines, there was a 'fit' between discursive and institutional structures within the CBD on several levels. Governance object (what) was broad/unspecific – lumping all CE measures together based on their potential to harm biodiversity (and related socio-ecological systems). This fits with the broad scope of the CBD mandate to protect biodiversity from potential harms. There was a fit between discursively constituted rationales (why) for governance structuring the debate on CE, and the guiding precautionary norm of the CBD. The mode of governance (how) being discursively constituted as practicable involved control and regulation in line with the top-down regulatory mode that the CBD employs for activities which are deemed to endanger biodiversity. The discursive structure of the CE governance debate in the CBD assigned discursive authority to knowledges in the plural, with scientific and local, indigenous knowledge producers (who) constituted as legitimate speakers. This fit with institutionalized input structures providing a range of actors with access to decision-making in this forum. In sum, there was a high degree of fit across multiple discursive and institutional

	Discursive structure	Institutional structure
Objects (what)	A broad, unspecific governance object was discursively constituted (CE as a whole, effects on socio-ecological systems).	Scope of CBD mandate – broad (the conservation of biological diversity)
Rationales (why)	Rationales for governance were precautionary, emphasising the (biodiversity and social/cultural) risks of CE	Precautionary principle as a guiding norm of the CBD
Modes (how)	Coercive, centralized governance mode constituted as practicable	CBD mode of governing activities which threaten to cause serious damage or threat to biodiversity restrictive, coercive
Speakers (who)	Discourse privileged both scientific and non-scientific knowledge producers	Input for CBD decision making open to scientific and non-scientific groups.

Table 18: Comparing discursive and institutional structures shaping CBD decisions on CE

levels, and the type of fit provided conditions of possibility which made precautionary prevention of harm through a coercive 'ban' on CE deployment thinkable and practicable.

8.4.3   UNEA

UNEA discussed and rejected a draft resolution in 2019 calling for an assessment of CE proposals to provide "conclusions on potential global governance frameworks" (UNEA, 2019). UNEA's decision therefore represents an example in which CE was deemed ungovernable within an international forum.

Institutional structures

UNEA is the governing body of the UN Environment Programme. It meets biennially "to set priorities for global environmental policies and develop international environmental law" (what) (UNEA, 2021). Its core function is to keep the state of the global environment under periodic review and to identify novel challenges for global environmental governance (Perrez, 2020).

As an overarching institution, its aim is to enhance the ability of UNEP to fulfil its coordination mandate, and to empower UNEP to lead efforts to formulate UN system-wide strategies on the environment (UNGA, 2012: para.88(c)). While the entire corpus of international environmental law applies in UNEA decision-making, the principles that aim to reconcile, integrate, or balance various conflicting global environmental goals and interests play a significant role in the operation of UNEA.

UNEA makes ministerial declarations and resolutions which are non-legally-binding but nonetheless authoritative (how). The authority is largely derived from the strengthened legitimacy of UNEA, which is an outcome of Agenda 2030 and a subsequent UN General Assembly resolution (UNGA, 2013), which reinforced and upgraded the UN Environment Programme by establishing universal membership in the then Governing Council (Kaniaru, 2014). This institutional reform has created some degree of hierarchy in global environmental governance (Kim et al., 2020), and established UNEA as "the world's highest-level decision-making body on the environment" (UNEA, 2021).

UNEA makes decisions not solely on a scientific basis, but seeks input from various experts and stakeholders (who). UNEA, for example, refers to the Intergovernmental Panel on Climate Change for scientific expertise. If necessary, it may establish expert groups or working groups (such as the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics) to generate input for decision-making (UNEA, 2016). Notably, UNEA also engages with stakeholder and private sectors: All Major Groups and Stakeholders' organizations accredited with UNEA are authorized to vote (UNEA, 2016).

Discursive structures

The discursive constitution of the object to be governed by UNEA (what) was disputed. There was a split between a broad vs. a narrow governance object – constituting CE as a whole, or only certain types of CE activities as the object of governance (see Supplementary Table 7). This was based on conflicting defining criteria for constituting CE as a governance object: Overall usefulness as a climate policy strategy on the one hand and potential environmental/socio-ecological risk on the other:

There are different factions who are either emphasizing "we need to govern this as an emerging risk issue", while others are saying "we need to govern this as an uncertain climate action avenue". (Interviewee A1)

Likewise, discursive governance rationales (why) were split between governing (some types) of CE for the purpose of precautionary control and oversight and not governing others to avoid infringing on the political realm of climate change, potentially placing inappropriate restrictions on (national) climate policy:

Several reports suggested that certain geotechnologies [sic] could pose a risk of severe environmental impacts, so more information was needed to enable Member States to have an informed discussion on the issue. (UNEP-EA, 2019)

Some delegates cautioned the negotiations were veering into the difficult political domain of climate change, while others said discussions on geoengineering and climate change are unavoidably intertwined. (ENB, 2019a)

The opponents called the resolution premature, and criticised it for threatening inappropriate restrictions, especially on carbon removal approaches.. (McLaren, 2019).

Three conflicting modes of governance (how) were discursively constituted as practicable – a centralized, expert-led, mode, a bottom-up, participatory mode and a decentralized, laissez faire mode. While the first emphasised that CE governance should be shaped by experts and informed by existing international principles/laws, as the basis of policy recommendations for UNEP parties, the second posited that such decisions should be taken with full participation of civil society and relevant affected parties, and the third put forward that CE governance on the global level was inappropriate and should rather be decentralized through national policy (see Supplementary Table 7).

The discursive structure of the CE governance debate at UNEA privileged several types of actors as potentially conflicting 'knowledge producers' (who). On the one hand, it was posited that governance decisions were to be made based on expert knowledge about risks and benefits of CE, while on the other privileged speaker positions were afforded to producers of indigenous and traditional knowledge:

Many representatives expressed regret that, due to the opposition of some Member States, no agreement had been reached at the current session on the draft resolution on geoengineering and its governance, which would have requested UNEP to collect information and prepare a factual report on the risks, potential and governance challenges of geoengineering technologies, in line with its mandate of keeping Member States apprised of emerging environmental issues. (UNEP-EA, 2019)

A representative of Asia Indigenous Peoples Pact made a statement on behalf of the major groups and stakeholders except business and industry. He noted with regret the abandonment of proposed resolutions on deforestation, agricultural supply

chains and the strengthening of geoengineering governance and the dilution of other resolutions, which would mean, inter alia, a lack concerted action on and resources for implementation […] intended to enhance their engagement in work programmes with the inclusion of indigenous traditional knowledge and practices. (UNEP-EA, 2019)

Fit

As Table 19 outlines, the failure of the UNEA resolution on CE may have been influenced by a lack of fit between conflicting discursive and institutional structures. The discursive structures were split between several competing logics: one top-down, expert-led; one bottom-up and participatory; and one decentralized and laissez faire, which resulted in the constitution of conflicting governance rationales (why), objects (what) and modes (how) and speakers (who). These logics were in turn at odds with some of the institutional structures of UNEA – in particular the forum's mode of non-binding but nevertheless politically authoritative global governance, which did may have fit with the top-down, expert-led mode, but not with the other two conflicting modes being discursively constituted. The institutionalized input structures which provided a range of actors access to decision-making in this forum fit with the discursive privileging differing social actors as legitimate knowledge producers. But given the low degree of fit between within and between discursive and institutional structures on other levels, this may have played a role in making the decision to not to govern CE within this forum the most 'thinkable and practicable' governance outcome.

	Discursive structure	Institutional structure
Objects (what)	Governance object formation disputed, broad vs. narrow. CE as a whole, or only certain types of CE	Scope of UNEA mandate – broad. To set and coordinate priorities for global environmental governance.
Rationales (why)	Discursive rationales for governance were split. Enable some types to help achieve (political) climate goals vs. precautionary restriction of others to reduce (political/environmental) risk	Guiding norm(s) of the UNEA: principles of integration, reconciliation, coordination, to ensure the **overall** state of the global environment improves
Modes (how)	Centralized, top-down mode conflicted with bottom-up, participatory and laissez faire, neo-liberal modes	UNEA mode of governance: non-binding, but politically authoritative guidance
Speakers (who)	Discourse privileged a range of knowledge producers/speakers	Input for UNEA decision-making from a range of actors

Table 19: Comparing discursive and institutional structures shaping UNEA decision on CE

8.5   Discussion

Faced with same emerging environmental issue, the three forums produced differing governance outcomes: the fit between software and hardware in the LC/LP provided the conditions of possibility for governance in the form of expert-led risk-benefit assessment to permit certain CE activities on a case-by-case basis, the fit between discursive and institutional

structures in the CBD made a precautionary ban on CE activities thinkable and practicable, and the lack of fit within and between discursive and material structures at UNEA contributed to CE being deemed (currently) ungovernable within the forum.

What might this mean for future governance of CE on the global level? Answering this question fully is beyond the scope of this paper, but to begin to consider it, we need to take a step back and relate the findings presented here to wider investigations of the interconnected roles of discursive and material structures in political and institutional stability and change.

The structuring power of discourse

Our work feeds into an ongoing academic debate on the role of discourse in the emergence, persistence, and transformation of political institutions. Representatives of various branches of social constructivist institutionalist theory such as Schmidt and Hay contributed significantly to understanding the roles played by ideas and discourses in institutional dynamics. Hay's Constructivist Institutionalism highlights the role of actors' perceptions and 'ideas of institutions' in pursuing institutional change (Hay, 2006, Hay, 2016, Hay, 2011, Hay, 2017), and Schmidt's Discursive Institutionalism focuses on the discursively mediated preferences, strategies, and normative orientations of actors in explaining the dynamics of institutional processes (Schmidt, 2008, Schmidt, 2011a, Schmidt, 2011b, Schmidt, 2010, Schmidt, 2017)). However, as argued by proponents of Post-structuralist Institutionalism (PSI) such as Larsson (2018), these approaches privilege the subjective ideational agency of actors and fall short of putting the inherent shaping power of discursive and material structures at the centre of analysis. PSI posits discourses as having constitutive causality, meaning discourse itself has the power to structure and shape institutional dynamics. Our framework builds upon similar theoretical footings, and thus parallels can be drawn between the potential for institutional change posited by PSI and future governance of CE within global institutions. While Hay and Schmidt may argue that new institutional outcomes can result from changing subjective and intersubjective ideas being brought forward by actors in a given institutional setting, PSI posits that existing discursive and material structures are more resistant to change. This hypothesis would seem to be in line with our findings, suggesting that whether CE is governable on the global level, and if so, how, will continue to depend on existing discursive and material structures in various international forums.

Post-structuralist theories, however, do not posit that structure is restrictive enough to preclude all change. Rather, they highlight the emancipatory function of elucidating reified discursive and material structures which make some types of governance more 'thinkable and practicable' than others (Boettcher, 2020). Mapping the discursive and material structures which form the 'conditions of possibility' making certain types of CE governance seem most appropriate within a given international forum may therefore enable those engaging in CE governance development to recognize and critically reflect upon their contingent nature – a necessary first step towards considering alternatives.

Navigating material and discursive structures in future CE governance

A look to the literature on climate governmentalities is also instructive for interpreting the wider implications of our results. Governmentality scholars such as Bäckstrand, Bulkeley, Lövbrand and Stripple have traced how persistent discursive and material ensembles have

shaped international climate governance in recent decades (Bäckstrand and Lövbrand, 2006, Bäckstrand and Lövbrand, 2016, Lövbrand and Stripple, 2014, Stripple and Bulkeley, 2014). Their detailed historical analyses have identified three competing 'meta discourses' underpinning climate governance – each of which shapes and is reinforced by a corresponding set of institutional structures: 'green governmentality' which is based on a hierarchical, administrative logic, 'ecological modernization', which reflects an neoliberal logic, and 'civic environmentalism', which is built upon a logic of democratic participation.

Building on this work, some effort has been made to identify if and how emerging CE governance is being shaped by these persistent 'meta discourses' and their associated institutional structures (Low and Boettcher, 2020, Boettcher, 2020). In a similar vein, it is possible to compare if and how the discursive and material structures identified in this paper 'fit' the broader governmentalities at play in climate governance. The expert risk-benefit assessment-based governance mode constituted in the LC/LP debate on CE governance may reflect the utilitarian logic of ecological modernization. The CBD discursive and material structures which emphasise precautionary control may reflect the elements of hierarchical 'green governmentality'. The UNEA debate seems to include competing elements of the neo-liberal ecological modernisation governmentality, top-down green governmentality, and elements of what Bäckstrand and Lövbrand (2016) dub the 'reformist' strand of civil environmentalism, which calls for including a wider range of stakeholders in governance development processes. Our results suggest that conflicting discursive and material ensembles which have historically shaped broader climate governance may therefore also be influencing the emerging governance of CE at the global level (see also Low and Boettcher, 2020). Looking to lessons of the past may help to anticipate and navigate the effects of these persistent meta structures in current and future CE governance development processes.

These broader implications highlight the emancipatory potential of our approach: Mapping how existing institutional and discursive structures create barriers and opportunities for the governance of new environmental challenges can help actors involved in governance development in specific forums "navigate a social reality that is saturated with structures" (Larsson, 2018:325).

8.6   Conclusion

Our combined institutional and discursive analysis has highlighted that the fit between discursive 'software' and existing intuitional 'hardware' shaped the governance choices and opportunities available in the three international forums that have thus far dealt with the same novel environmental challenge – whether and how to govern proposed deliberate inventions into the global climate system.

As we have shown in this paper, varying structural 'conditions of possibility' have the power to shape how the same environmental issue is governed differently in various forums. We have highlighted that neither an exclusive focus on institutional 'hardware' nor on 'discursive' software is sufficient to understand the emergence of governance. Existing institutional architectures at the global level influence whether and how a new environmental challenge becomes governable (Biermann and Kim, 2020). Discourse is the 'source code'

with which contested futures are written, shaping what governance options can be imagined and materialized (Boettcher, 2019, Boettcher, 2020). Developing an innovative analytical framework that brings together neo-institutionalist and post-structuralist discourse approaches, we have shown that reverse-engineering the fit between both the institutional architectures and the discursive blueprints underpinning governance development processes can help to anticipate, critically reflect upon, and more successfully navigate the emergence of global climate (engineering) governance in the Anthropocene.

9 Casting a wider net on ocean NETs [26]

Societal issues involving policies and publics are generally understudied in research on ocean-based Negative Emission Technologies (NETs) yet will be crucial if novel techniques are ever to function at scale. Public attitudes are vital for emerging technologies: publics influence political mandates, help determine the degree of uptake by market actors, and are key to realising broader ambitions for robust decision-making and responsible incentivisation. Discourses surrounding ocean NETs will also have fundamental effects on how governance for the techniques emerges, shaping how they are defined as an object of governance, who is assigned the authority to govern, and what instruments are deemed appropriate. This Perspective brings together key insights on the societal dimensions of ocean NETs, drawing on existing work on public acceptability, policy assessment, governance and discourse. Ocean iron fertilisation is the only ocean NET on which there exists considerable social science research thus far, and we show that much evidence points against its social desirability. Taken in conjunction with considerable natural science uncertainties, this leads us to question whether further research is actually necessary in order to rule out ocean iron fertilisation as an option. For other ocean NETs, there is a need for further research into social dimensions, yet research on analogous technologies shows that ocean interventions will likely evoke strong risk perceptions, and evidence suggests that the majority of ocean NETs may face a greater public acceptability challenge than terrestrial NETs. Ocean NETs also raise complex challenges around governance, which raise questions well beyond the remit of the natural sciences and engineering. Using a conceptual exploration of the ways in which different types of discourse may shape emerging ocean NETs governance, we show that the very idea of ocean NETs is likely to set the stage for a whole new range of contested futures.

9.1   Introduction

Given current atmospheric concentrations of greenhouse gases, it seems increasingly likely that both unprecedented emissions reductions and gigatonne-scale CO_2 removal will be required to keep global average temperature increase to 'well below 2°C' (NAS, 2019). NET proposals are heterogeneous, with large uncertainties around their risks and benefits. As a hedge against unforeseen risks, including the risk of technology failure, some technical experts advise that it would be wise to explore a diverse range of NETs alongside ambitious efforts to reduce emissions (Lomax et al., 2015, Nemet et al., 2018). The ocean has been posited by some as suitable for NETs because of its large available area, and the potential for CO_2 sequestration over extremely long timescales; yet the idea of intervening in complex marine ecosystems poses significant risks and societal concerns (GESAMP, 2019). Therefore more research will be needed to assess which ocean NETs, where, at what scale, and under what societal conditions, might be considered as part of the climate response 'toolbox'. A wide variety of ocean NETs have been proposed, operating at different scales, including proposals for coastal waters (for example, restoring sea grasses and mangrove ecosystems), and proposals for international waters and the deep ocean (for example, ocean iron fertilisation, direct injection of CO_2, or ocean upwelling/downwelling), as well as proposals ranging from utilisation of existing biological systems to the development of highly novel engineering technologies. The technological characteristics of various ocean NETs proposals have been explored in more detail within the literature than the social science aspects; see GESAMP (2019) and National Academies of Sciences, Engineering and Medicine (2019) for an overview.

In this Perspective, we emphasise that assessments of the potential of ocean NETs must not be limited to technical, physical and economic questions. Research on negative emissions tends to focus on 'supply-side' topics such as sequestration potential, resource availability, and cost (Nemet et al., 2018)we employ the framework of sequential stages in the innovation process, with which we code each NETs article in innovation space. We find that while there is a growing body of innovation literature on NETs, 59% of the articles are focused on the earliest stages of the innovation process, 'research and development' (R&D. Yet the demand side, including publics, policies and governance, will be just as important for assessing the 'real world' potential of ocean NETs. Engaging with social science questions early on may help to anticipate potential pitfalls in technology development and inform the design of responsible governance mechanisms to avoid them. Engaging with wider society can additionally help to identify broader issues which experts might have missed, because they come into the topic 'without blinkers on' (Cox et al., 2020a). It is also vital to assess policy options early in the innovation process, because most new technologies require the development of novel policy frameworks. Understanding the social science of ocean NETs also requires looking not only at the technologies and policies themselves, but also at the ways in which we talk about them. Understanding how discourses shape technology governance can help to avoid premature closure around solutions which may appear optimal according to particular types of knowledge, whilst simultaneously crowding out other options. This Perspective explores three fundamental aspects of the social science of ocean NETs: public perceptions, policy assessment, and the role of discourse in technology governance. The first three sections address these topics in turn, drawing on existing work on ocean NETs as well as analogous and related

technologies and systems. We then identify common threads across these diverse bodies of literature, concluding with insights into the roles social science can play in the ethical and effective assessment of ocean NETs' potential as a climate response strategy.

9.2   Public perceptions

There is little existing empirical work on public perceptions of ocean NETs. However, we can develop an idea of how perceptions are likely to emerge from research on public perceptions of the ocean, terrestrial NETs, and climate engineering (CE). Certain risk attributes have been shown to be important for a diverse range of technologies: these include the degree of control people have over the risk, its voluntariness, the possible severity of consequences, and the familiarity of the risk or system (Fischhoff et al., 1978, Slovic, 1987). In this respect, many ocean NETs proposals may be perceived as highly risky in the same way as nuclear power or Solar Radiation Management. One early UK study found lower support for ocean liming and ocean iron fertilisation than for atmospheric sulphate injection, because of concerns about the riskiness, unpredictability and uncontrollability of the ocean environment (IPOS MORI, 2010).

Previous work suggests that research carried out at small scale and under well-controlled conditions is likely to be generally acceptable (Cummings et al., 2017). However, in this respect the ocean presents challenges similar to atmospheric CE, because people may be sceptical of scientists' abilities to carry out controlled and accurate research in such an open, interconnected system (Pidgeon et al., 2013). A crucial determinant will be the extent to which ocean NETs are perceived to 'tamper with nature' (Corner et al., 2013, Wolske et al., 2019). For example, when discussing oceanic disposal of CO_2, people in the United States expressed concerns about the impact this would have on marine organisms and saw it as "…*messing with some form of life*…" (Palmgren et al., 2004). The ocean is often perceived as fragile and pristine (Cox et al., 2020b, Hawkins et al., 2016), and research in both OECD and non-OECD contexts finds that ocean NETs might be seen as overstepping the limits of human ability to understand and control the environment (Carr and Yung, 2018, Gannon and Hulme, 2018, Macnaghten et al., 2015, Wibeck et al., 2017). Research in Scotland and Norway found that people felt changes in the deep sea would personally impact them and they were not confident in the abilities of management to protect the marine environment (Ankamah-Yeboah et al., 2020). The concern people express about the ocean is commonly linked to a positive emotional connection with it (McMahan and Estes, 2015), shown to be important for perceptions of ocean acidification (Spence et al., 2018). Despite low levels of prior awareness of ocean acidification, research in the US and UK demonstrates consistently high levels of public concern and strong emotional feelings (Capstick et al., 2016, Cooke and Kim, 2019). Importantly, NETs research suggests that emotional connection to the ocean manifests similarly in coastal and inland populations (Cox et al., 2020b).

That said, some ocean-based techniques may be perceived as more 'natural' than others, for example restoration of coastal ecosystems such as mangroves, salt marshes or sea grass habitats which act as carbon sinks. Destruction of coastal ecosystems currently means that much of the carbon storage potential of these areas is being lost (Luisetti et al., 2019), and reversal of this could be perceived as a restoration of nature, rather than tampering. Similar terrestrial

techniques such as peatland restoration are generally assumed to be unproblematic in terms of public perceptions (Royal Society and Royal Academy of Engineering, 2018), and work on terrestrial afforestation demonstrates that it is generally preferred (Wolske et al., 2019). However, perceptions of what constitutes 'natural' are fuzzy, dynamic, and contested, partly because even 'pristine' landscapes are often the product of enormous human intervention (Corner et al., 2013). The specific context will be important: coastal restoration projects are not always without conflict, and can be socially or environmentally problematic (Myatt et al., 2003, Srivastava and Mehta, 2017). Work on terrestrial NETs also suggests that there may be trade-offs between the social and ethical impacts of a technique, and its scale of operation, which in turn affects its CO_2 sequestration potential (Cox et al., 2018); habitat restoration techniques may not benefit from the space afforded by transnational waters, and may be fundamentally constrained in their ability to sequester CO_2 over long timeframes (National Academies of Sciences and Medicine, 2019).

Importantly, support or opposition for a particular project or research trial cannot be easily predicted, because it depends on when, where, and how it is implemented (Gough and Mander, 2019). Perceptions are neither fixed nor immutable, particularly in the early stages of technology scale-up; meaningful public engagement, drawing on lessons learned from other technologies, will be crucial (cf. Dwyer and Bidwell, 2019, Lockwood, 2017, Williams et al., 2017). Such flexibility early on means that views can be influenced by those with a platform, including the media, environmental organisations, and influential individuals such as celebrities or scientific advocates. For example, the first ocean iron fertilisation projects encountered strong opposition from environmental organisations, which echoed people's feelings about the fragility, uncontrollability and inherent preciousness of the ocean (Fuentes-George, 2017). Such opposition was an important factor in the development of highly influential governance mechanisms which forbid the dumping of materials at sea (LC/LP, 2008). For lay publics, however, knowledge about novel ocean technologies is likely to be extremely low, meaning that at this stage perceptions may be mainly influenced by emotion and by risk attributes which cut across technology types (Macnaghten et al., 2015, Spence et al., 2018)2015; Spence et al., 2018.

Views will also be constructed through contextually-specific local meanings (Gannon and Hulme, 2018, Mabon et al., 2014)as part of larger carbon dioxide capture and storage (CCS, and cultural differences will be important, such as the extent to which the ocean is perceived as an important food provider (Potts et al., 2016). Acceptance will also be highly conditional: for example, NETs are more likely to be supported as part of a package of emissions reduction policies, thus reassuring people that the 'root cause' of climate change is being tackled (Cox et al., 2020b). Carbon capture and storage is widely seen as a 'non-transition' (Butler et al., 2013, Mabon and Shackley, 2015), and any perception that ocean NETs are being used to continue business-as-usual may be damaging. Thus, rather than asking whether ocean NETs are publicly 'acceptable', it is more useful to identify the conditions under which a proposal might be perceived as reasonable by many people (Cox et al., 2018). Western and developing nations may also differ (Carr and Yung, 2018, Pidgeon et al., 2013)developed countries. However, understanding perspectives from vulnerable populations is critical to inclusive, democratic debate on both research and governance. This study utilized in-depth interviews to explore the perspectives of vulnerable populations in the South Pacific, Sub-Saharan Africa, and the

North American Arctic. Interviewees in this study were desperate for solutions to climate change and therefore willing to consider climate engineering. However, their willingness to consider climate engineering could be characterized as both deeply reluctant and highly conditional. Interviewees expressed a number of concerns about potential social and political implications of engineering the climate. They also described conditions that may need to be met to ensure that future climates (engineered or otherwise, and in this respect we have precious little understanding of risk perceptions in non-western contexts. For example, a 2017 review of public perceptions research on climate engineering identified 23 studies, of which 19 included Western Europeans samples, 5 US/Canadian, and only one included a non-OECD nation. In more recent years, research on public perceptions has increased, yet the historical imbalance remains. A small number of studies find that risk perceptions in non-Western and non-affluent areas include several similar concerns regarding scale, unintended consequences, and irreversibility of techniques taking place in open environments (Carr and Yung, 2018, Winickoff et al., 2015). A study of Global South stakeholders on climate engineering found that even small experiments in open environments encountered concern regarding both physical and social risks (Winickoff et al., 2015).

9.3   Policy assessment

Publics – in combination with diverse experts and stakeholders – are also key to realising broader ambitions for robust decision-making on ocean NETs. The early stage of technology development makes assessments particularly sensitive to framing effects, i.e., the conditioning of outcomes from the ways in which assessors choose to organise and communicate their assessments. Early assessments of ocean NETs have been criticised for adopting narrow framings that, among other things, employ reductive methods, exclude diverse forms of expertise, marginalise alternative options, disregard social criteria, and downplay uncertainties (Bellamy et al., 2012). Such framings have made certain technologies appear to be optimal courses of action; yet they only appear optimal under the narrow set of framings upon which their ostensible optimality is based. Accordingly, efforts are underway to broaden out and open up the framings going into assessments of ocean NETs, and to thereby render decision-making more robust. Such methods involve diverse participants, include alternative options, factor in social criteria and are candid about uncertainties. The full range of ocean NETs are yet to be given this treatment; initial assessments of attitudes to ocean iron fertilisation in Europe and Japan show it to be among the options for tackling climate change with the lowest level of public support (Amelung and Funke, 2015, Asayama et al., 2017, Bellamy et al., 2017, Jobin and Siegrist, 2020), but open policy assessment must also recognise the variety of ocean techniques, and as shown above, some may not experience the same issues as ocean iron fertilisation.

These kinds of assessment are also key to growing calls for the responsible incentivisation of research (Bellamy, 2018). Research into ocean NETs is undoubtedly needed, but this must be done responsibly, through broad societal participation in choosing which, if any, ocean NETs to incentivise in the first place, and continued participation in how to incentivise those NETs and ultimately in how to govern them. Building on cognate concepts of responsible innovation (Owen et al., 2013) and development (Waller et al., 2020), such a framework for

incentivisation encourages policy institutions and actors to go beyond technical considerations of policy design that would treat ocean NETs as though they were already fixed technologies or approaches. Instead, they are encouraged to engage with the diverse geographies of knowledge-making through which the pros and cons of ocean NETs will be negotiated in real-world contexts (Hulme, 2010). In this way, incentive and governance regimes are not predefined for society, but defined through societal participation. So far, research is yet to gather social intelligence on what responsibly incentivised ocean NETs might look like. However, work on other NETs shows that incentives have so far been poorly aligned with societal values (Cox and Edwards, 2019) and that policy instrument choice can significantly affect public attitudes towards the technologies themselves (Bellamy et al., 2019).

More is known about preferences for governing ocean NETs. General principles drawn from the public include: (1) transparency of purposes, activities and reporting; (2) minimization and monitoring of environmental impacts; (3) independence from private interests, or at the very least sufficient oversight of them; (4) qualification of scales by perceived controllability; and (5) technology- and activity-specific governance protocols (Bellamy, 2018). Yet the dynamic and multi-faceted nature of public perceptions complicates matters, and experimental research has shown that views on what forms of governance should apply at different stages of research vary amongst people of differing underlying 'worldviews' (Bellamy et al., 2017). Some have felt that self-regulation by scientists constitutes sufficient governance for small-scale or 'contained' research, whereas others believe that only computational modelling should be left to self-regulation. However, people with various cultural worldviews often feel that international agreements will be necessary for large-scale, outdoors, or 'uncontained' research.

9.4   The role of discourse

Environmental and climate governance is shaped by discourse, therefore analysing debates around emerging technologies can help us to understand how governance 'truths' are produced (Leipold et al., 2019). Some work has investigated discourses on terrestrial NETs (Cox et al., 2020a, Low and Schäfer, 2020), but there has generally been little focus on ocean-based NETs apart from ocean iron fertilisation. Most focuses on a run of highly controversial iron fertilisation experiments between 2001 and 2012 (Buck, 2014, Fuentes-George, 2017, Gannon and Hulme, 2018, Horton, 2017), and the unique procedural dynamics of these experiments means that caution must be taken when extrapolating to other projects or technologies. However, they do provide useful lessons for other ocean NETs, in that controversy stemmed in part from divergent discursive framings around the value of scientific knowledge (Fuentes-George, 2017) and around humanity's relationship with nature (Gannon and Hulme, 2018).

A wider body of research on CE assesses how different types of discourse may be shaping the development of technology governance (c.f. Biermann and Möller, 2019, Boettcher, 2019, Harnisch et al., 2015, Gupta and Möller, 2018, Möller, 2020). This research has demonstrated how discussions on the feasibility and responsibility of various CE approaches have prioritised scientific and technical knowledge types (Low and Schäfer, 2020, Matzner and Barben, 2018, Matzner and Barben, 2020). This is seen as particularly problematic in the Global South, where

		Implications for emerging ocean NETs governance			
		Rationale (why)	Object (what)	Actors (who)	Modes & Instruments (How)
Knowledge system/discourse	Legal	Governance of ocean NETs is needed because many ocean-based interventions would have transboundary effects (positive & negative), thereby contravening national jurisdictions and raising the risk of conflict	Ocean NETs approaches with transboundary effects. Scale of effects defining criterion.	Legal experts, states and international maritime bodies (LC/LP, UNCLOS, IOC, CBD).	Global/international, top-down. International laws, guidelines.
	Bio-geo-chemical	Governance of ocean NETs is needed to prevent ecosystem damage, maintain marine biogeochemical systems, protect biological diversity	Ocean NETs approaches (regardless of scale) that have biogeochemical ecosystem effects. Environmental effects defining criterion.	Marine biology, biogeochemical & biodiversity experts, NGOs, international maritime bodies (LC/LP, UNCLOS, IOC, CBD)	Global to local, top-down, monitoring, enforcing compliance with regulations
	Economic	Governance is needed to balance costs and (co-)benefits of ocean NETs approaches.	Cost-effective NETs approaches to be enabled, non-cost-effective to be restricted. Cost-effectiveness as defining criterion.	Economic experts, assessment bodies, industrial & commercial actors.	Global to local, coordination/ competition in flat hierarchies to allow the most cost-effective solutions to emerge.
	Cultural	Governance is needed to preserve the cultural significance of the (natural) ocean.	NETs approaches that are non-natural or invasive, that change the character of cultural (human) interactions with the ocean, alter human understandings of the natural. Social acceptability within a given context as defining criterion.	Cultural anthropology experts, local communities, NGOs, indigenous groups	Regional to local, bottom up, participatory engagement.

Table 20: Shaping implications of different types of discourse for emerging Ocean NETs governance [27]

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27 LC/LP = London Convention/London Protocol on The Prevention of Marine Pollution by Dumping of Wastes and Other Matter, UNCLOS = United Nations Convention for the Law of the Sea, IOC= Intergovernmental Oceanographic Commission of UNESCO, CBD = Convention on Biological Diversity

memories of broken promises mean that NETs may be seen as means for the Global North to avoid their responsibilities to reduce emissions (Cox et al., 2020a, Möller, 2020). Although the heterogeneous range of CE proposals raise differing governance challenges, a bounded range of expert knowledges have been shown to have both direct *de facto* governance effects on how the various techniques are being researched and developed, and indirect effects on how *de jure* governance (policy) is emerging (Boettcher, 2019, Gupta and Möller, 2019). Yet analyses have also shown that the idea of intervening into global systems – in particular the oceans – raises a plethora of governance questions which lie beyond the scope of purely scientific knowledge (Buck, 2014, Gannon and Hulme, 2018, McLaren, 2018b). Given that ocean NETs research is still in its preliminary stages, there may be a greater opportunity to establish knowledge diversity before governance begins to emerge.

One promising analytical framework for exploring the link between discourse and ocean NETs governance is the Sociology-of-Knowledge Approach to Discourse (SKAD) (Boettcher, 2019, Keller et al., 2018). According to this approach, discourses are underpinning *systems of knowledge* which shape understandings of why governance is necessary, what is to be governed, by whom, and how. Therefore, discourses have a constitutive effect on what type of governance is "thinkable and practicable to both its practitioners and to those upon whom it is practiced" (Gordon, 1991: 3). If different systems of knowledge (discourses) become privileged in ocean NETs governance discussions, they will have varying implications for what types of governance become 'thinkable and practicable'. To illustrate this, Table 20 contains a set of knowledge types which are present in the current ocean NETs debate, and a conceptual exploration of the different ways they may shape the why, what, who and how of emerging ocean NETs governance. The table is based on an interpretative review of key literature on ocean NETs (Brent, 2019, Buck, 2014, Gannon and Hulme, 2018, Gattuso et al., 2018, Keller, 2018a, GESAMP, 2019, Horton, 2017, IOC, 2010, McDonald et al., 2019), using a SKAD-based approach to map underpinning discourse types (see Boettcher, 2019). This thought experiment is not intended to be exhaustive or conclusive; yet it illustrates the varied, and potentially conflicting, implications that foregrounding legal, biogeochemical, economic or cultural discourses in ocean NETs governance development may have.

9.5   Discussion & Conclusion

This exploration of existing social science research on ocean NETs has, first and foremost, highlighted how limited the state of knowledge currently is. The only technique that has received a significant degree of attention so far is ocean iron fertilisation, which has been roundly condemned in work on public perceptions and policy assessment (at least in OECD contexts) and has raised considerable concerns around prospective governance frameworks. Taken in conjunction with the exceptionally uncertain natural science of ocean iron fertilisation (Strong et al., 2015), we might reasonably question whether further research is necessary in order to rule this out as an option.

In the absence of empirical research into the various other proposals for novel ocean NETs, reasonable inferences can be drawn from work on analogous techniques, including terrestrial NETs and climate engineering more broadly. These literatures have demonstrated that

ocean interventions raise complex questions surrounding governance, which are not always within the scope of scientific/expert forms of knowledge. Discussions on the governance of ocean interventions seem likely to implicate an even wider range of discourses and types of knowledge than land-based NETs. Indeed, discussion over the emergent UNCLOS Global Ocean Treaty, which aims to protect biodiversity on the High Seas, reveals that different nations and people have very different understandings of the ocean, including whether it represents the "common heritage of mankind" (Silver et al., 2020). Similar differences concerning fundamental definitions and values were important in ocean iron fertilisation controversies (Gannon and Hulme, 2018). Researchers working on ocean NETs would benefit from understanding how these diverse knowledge types may affect upstream governance of their work. They also raise tricky questions for public attitudes, because of the way in which the ocean is perceived as fragile, vital to human life, emotionally valuable, interconnected, and challenging to experiment on in an accurate and controllable manner. Evidence therefore suggests that the majority of ocean NETs will face a greater public acceptability challenge than terrestrial NETs. People will need to be assured that controlled, reversible and reliable testing can be carried out, and attempting to 'communicate around' uncertainty or downplay risks is likely to backfire. That said, ocean NETs are highly diverse, and empirical research may reveal that some proposals encounter lower risk perceptions; our treatment of ocean NETs as a broad category in this short piece should not be taken to imply homogeneity. For example, some ocean NETs such as coastal habitat restoration do not claim to have transboundary effects, which means that they may not encounter the same governance challenges as NETs in the High Seas, and may not encounter public concerns about messing with nature. However, further research is needed, with no substitute for bespoke empirical testing. The remainder of this section sets out principles which can be used to guide responsible research and innovation in this field.

This paper has explored diverse bodies of literature on multiple social science topics, yet they all point toward the need for broad, participatory frameworks to address these issues. Engaging with a broader spectrum of actors early on can help to facilitate the development of techniques in an effective and ethical manner (Fiorino, 1990). The early stage of ocean NETs research creates unique opportunities in this regard, because the technologies and their governance are not yet 'locked in'. Therefore participatory approaches could enable flexibility for establishing options for ocean NETs, including how the problems are defined, what methods are used, what criteria are selected, whose perspectives are included, and how uncertainties are conveyed (Stirling, 2007). However, previous participatory approaches have revealed challenges and constraints which will need addressing in social science research on ocean NETs. Firstly, there is the need to ensure that broader perspectives are actually integrated into the technology development, rather than as an add-on, an afterthought, or a legitimisation exercise (Markusson et al., 2020). Secondly, more research is needed into frameworks for responsible incentivisation, including policy mechanisms which might be able to incentivise ocean NETs even in absence of a high carbon price (Cox and Edwards, 2019). Such work needs to be better integrated into public attitudes research, that we might better understand the two-way relationship between public attitudes and policy: the ways in which publics generate the policy mandate for the incentivisation of technologies, and the ways in which public attitudes depend on the policy frameworks used. Ocean NETs also raise challenges around the equitable

distribution of risks and benefits, particularly for communities who are highly dependent on the ocean for their basic needs, and research is needed into the perspectives of coastal communities which may be among the most vulnerable to ocean impacts. Addressing the imbalance which currently exists in social science research on NETs, wherein the majority of information comes from Western and OECD samples, should be a priority.

There remains a lot to be done to explore the link between discursively (re)produced knowledge and ocean NETs governance development. Discursive mapping of the wider ocean NETs debate would help to identify which types of knowledge are being privileged or neglected, and what implications this may have for the emergence of ocean NETs governance. Furthermore, bringing these discourses to light may help to anticipate tensions between knowledge systems, mitigate potential conflict by integrating different knowledge types in NETs decision-making, and design deliberative processes to further 'open up' discursive diversity in ocean NETs governance. The conceptual categorizations outlined in Table 1 could provide the basis for several (complementary or competing) ocean NETS governance narratives for use in deliberative engagement. Discourse has been called 'the source code with which contested futures are written' (Boettcher, 2019), and the idea of ocean NETS is likely to set the stage for a whole new range of contested futures. Further elucidating the shaping role of discourses underpinning the NETs debate is therefore key to anticipating and critically reflecting upon the emergence of ocean NETs governance.

Societal uncertainties are likely to play a key role in the emergence of NETs as a potential climate strategy. We therefore make a call for future research to "cast a wider net" on ocean NETs by taking societal and political 'demand-side' dynamics seriously.

10 Delaying decarbonization [28]
Climate governmentalities and sociotechnical strategies from Copenhagen to Paris

An era (2005-2015) centred around the Copenhagen Accord saw the rise of several immature sociotechnical strategies currently at play: carbon capture and storage, REDD+, next-generation biofuels, shale gas, short-lived climate pollutants, carbon dioxide removal, and solar radiation management. Through a framework grounded in governmentality studies, we point out common trends in how this seemingly disparate range of strategies is emerging, evolving, and taking effect. We find that recent sociotechnical strategies reflect and reinforce governance rationalities emerging during the Copenhagen era: regime polycentrism, relative gains sought in negotiations, 'co-benefits' sought with other governance regimes, 'time-buying' or 'bridging' rationalities, and appeals to vulnerable demographics. However, these sociotechnical systems remain conditioned by the resilient market governmentality of the Kyoto Protocol era. Indeed, the carbon economy exercises a systemic structuring condition: While emerging climate strategies ostensibly present new tracks for signalling ambition and action, they functionally permit the delaying of comprehensive decarbonization.

10.1   Introduction

In 2005, a long-brewing sea change in global climate governance became visible. The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) formally began negotiations for an agreement needed to succeed 1997's Kyoto Protocol. Now, a combination of historic grievances and contemporary challenges would swiftly stall progress on a new agreement. A large literature recounts how these efforts culminated disastrously at the 2009 COP in Copenhagen, and were resurrected with guarded optimism through the 2015 Paris Agreement (e.g. Falkner, 2016).

Many works have traced the history of climate governance in terms of institutions, negotiation agendas, and factional interests (e.g. Gupta, 2010), or hidden dynamics underlying more visible activities and alignments (e.g. Aykut, 2016). This paper is situated within the latter, and poses an account of recent climate governance as a history of emerging sociotechnical strategies designed to address climate change (e.g. Markusson et al., 2017). We focus on a 'Copenhagen' era (2005-2015) centered around the 2009 Copenhagen Accord, but that we stretch to include its negotiation, as well as evolution into the Paris Agreement.

The Copenhagen era saw the rise or consolidation of a range of sociotechnical climate strategies currently at play: carbon capture and storage (CCS), the forest emissions crediting mechanism of REDD+, next-generation biofuels, shale gas, short-lived climate forcing pollutants (SLCPs), solar radiation management (SRM) as a kind of 'climate engineering', and carbon dioxide removal (CDR) as novel carbon sinks. In this paper, we present an interpretative review of secondary literature, through a framework grounded in governmentality studies, to explore common trends in how this seemingly disparate range of strategies is emerging, evolving, and taking effect.

We make three arguments. Firstly, recent sociotechnical strategies reflect and reinforce governance rationalities emerging during the post-Kyoto Copenhagen era. Secondly, distinct characteristics link various sociotechnical systems to each other, and to the resilient market governmentality of the Kyoto era. Thirdly, the carbon economy exercises a systemic structuring condition. While emerging climate strategies ostensibly present new tracks for signalling ambition and action for reducing some palette of greenhouse gas emissions, they functionally permit the delaying of comprehensive decarbonization.

The following section outlines our conceptual framework, synthesizing insights from governmentality studies in global environmental governance, science and technology studies (STS), and critical political economy. Section 10.3 details our analytical approach. Sections 10.4 and 10.5 assess the fit between the Copenhagen era's governmentalities and sociotechnical climate strategies in a two-part analysis – section 10.4 maps the strategies sequentially, while section 10.5 steps back to map overarching relationships between these strategies in their rationales and practices. Section 10.6 concludes that as we move into the implementation of the Paris Agreement, understanding how climate strategies are shaped by persistent structuring conditions may help to develop guardrails to avoid repeating past mistakes.

10.2   Conceptual framework: Sociotechnical strategies, governmentalities, and 'fixing'

Following STS, we refer to various Copenhagen-era strategies as 'sociotechnical' infrastructures that combine technological hardware with the software of societal contexts, beliefs, and choices. 'Sociotechnical strategies' is a terminological compromise on two counts. We recognize that what we call sociotechnical (e.g. carbon markets) includes socio-ecological (e.g. forestry management) practices, and that 'strategies' is an imperfect attempt to capture a mix of scaled (e.g. shale gas), immature (unscaled beyond the project level, e.g. CCS), and imagined systems or interventions (e.g. SRM).[29] But our focus is not on precise types, stages, or scales. Rather, what bridges these strategies across their scales of implementation is their unfinished nature, and despite this – or possibly, because of it – their reified roles in climate discourse and policy.

This brings us into contact with the STS literature on 'expectations' (Brown et al., 2000) and a more recent one on 'sociotechnical imaginaries' (Jasanoff and Kim, 2015), which highlight the forcefully promissory nature of envisionings and projections of a technology's future. The latter, following Jasanoff's (Jasanoff, 2004) idiom of 'co-production', argues that polities design technological systems to mirror what they desire societally. Building on initial explorations of how these concepts can be applied to limited suites of climate strategies (e.g. Hansson, 2011, Markusson et al., 2017), we expand the scope of inquiry to the recent history of climate governance, and to tie them to that era's structuring rationalities.

Here, we refer to 'governmentality', a Foucauldian concept describing the logics and practices by which societies make themselves subject to control. Governmentality studies expand the climate governance literature's purview from states and institutions to strategies and practices dispersed at multiple levels (Okereke et al., 2009) and explore these activities as reflections of systemic understandings that coordinate governing of the climate, the market, polities, and even the individual (Stripple and Bulkeley, 2014).

We therefore see governmentalities as ensembles of climate governance rationalities, institutions, and strategies – in this paper, our main focus is on emerging rationalities, and how these condition sociotechnical strategies. Governmentalities and Jasanoff's 'imaginaries' overlap; both reflect some overarching rationality that manifests, respectively, as systems of (environmental) governance or techno-science. Our paper reflects a connection of these literatures. Indeed, governmentality and STS studies are part of the same wave of exchange between global governance studies and critical disciplines, and both governmentality (Stripple and Bulkeley, 2014) and STS (Miller, 2004, Hulme and Mahony, 2010) approaches encourage

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29 Using 'strategies' might connotate agency, or deliberate intent by particular agents, rather than the 'systemic structural conditioning' referenced in the introduction. This is not our intent: We could also have used neutral terms like 'practices' or 'activities', but chose a more overarching term commensurate to the scale of global climate policy. We also do not intend to come down definitively on either side of the agent-structure debate. This paper *emphasizes structures* and how choices and actions to address climate are thereby conditioned, but climate governance is a fluid interplay between the two.

the analyst to be aware of the rationales and processes by which 'climate change' – as a problem and adjoining solutions – is constructed.

We speak to governmentalities that came to animate climate governance in the extended period surrounding the 2009 Copenhagen Accord (2005-2015). We rely on seminal work by Bäckstrand and Lövbrand (Bäckstrand and Lövbrand, 2006, Bäckstrand and Lövbrand, 2016), who describe how Kyoto-era forest projects reflected discourses that remained resonant as political rationalities long into the Copenhagen era. Two of these retain importance in our paper's account: *green governmentality* describes the globally-focused and managerial rationality that underpinned the formation of the Intergovernmental Panel on Climate Change (IPCC), the UNFCCC, and the Kyoto Protocol; coupled with *ecological modernization*, the socialization of environmental governance within neoliberal market logics (ibid).

Over a decade, Kyoto's governmentalities morphed to account for the evolving demands of global politics. The shift in the regime's emphasis from operationalization of the Kyoto Protocol (1997-2007) to the Copenhagen era's search for a post-Kyoto framework was marked by numerous adjoining challenges: the rise of emerging economies; the US withdrawal from Kyoto in 2001; the erosion of multilateralism in post 9/11 geopolitics; the financial crisis of 2007-2009 (Ciplet et al., 2015). In the leadup to the Copenhagen COP – where a post-Kyoto framework was to have been agreed upon – it was clear that collective confidence in the UNFCCC had broken down. Key issues included global targets, a re-drawing of where responsibilities for emissions reductions would now lie, and issues of finance and adaptation in most vulnerable states; with a fragmenting global politics and austerity-driven lack of resources hanging over the regime (Gupta, 2010, Held and Roger, 2018). Layering Bäckstrand and Lövbrand's papers with concurrent analyses, we note that both governmentalities began to converge upon a set of overlapping characteristics that is still being cemented today.

'Green governmentality'- the Kyoto-era's regulatory, top-down, compliance-based logic – was rooted in a post-1970s tradition of centralized environmental regime design. With the Kyoto Protocol's failings increasingly exposed, and short on resources and attention, pre-Copenhagen COP negotiations pivoted from 'making Annex I larger' towards voluntary, non-binding, 'nationally determined' efforts (Held and Roger, 2018). This arrangement attracted support from states on either side of the Annex I divide. The ensuing 2009 Copenhagen Accord is recognized today as the in-between stage that was tweaked and formalized as the 2015 Paris Agreement's pledge-and-review system (Held and Roger, 2018, Falkner, 2016). This evolution reflects the fragmentation of climate governance towards what has been problematized as 'a regime complex' (Keohane and Victor, 2011), 'polycentricism' (Dorsch and Flachsland, 2017), or a 'global fractal' (Bernstein and Hoffmann, 2019). Discussion mirrored discourse of the era, still familiar today: 'coalitions of the willing', as well as all manner of public-private and multi-level networks. But its potentials, then as now, were in flux. For some, Kyoto's logics had always needed to cater to a more plural perspectives, sites, and activities than could be managed by an IPCC-UNFCCC duopoly (Prins and Rayner, 2007). For others, the cloud overshadowed the silver lining, with Copenhagen representing an 'enhanced status quo [in which] states did what they were willing' (Held and Roger, 2018) in a system of 'shared unaccountability' (Ciplet and Roberts, 2017).

Broadening the sites and objectives of post-Kyoto governance in a time of austerity also multiplied the rationalities by which the Copenhagen-era regime was kept alive. Dovetailing

with the trend towards polycentrism, there was an escalation of 'co-benefits' sought between addressing climate change and other governance issues, regimes, and sectors – from energy and food security, to land-use forestry, to air pollution and health (Bäckstrand and Lövbrand, 2016, Bain et al., 2016, with Mayrhofer and Gupta, 2016 indicating this was a wider governance trend). Relative gains were sought to sustain the negotiations agenda at the UNFCCC (Dimitrov, 2010, Khan and Roberts, 2013). Rationalities on the value of 'bridging' and 'time-buying' options began to solidify, ranging from transitional fuels that might temporarily substitute for high-carbon fuels on route to renewables, to wider strategies that might reduce climate impacts and allow room for polities and economies to adapt and transition in the near term. Appeals to an array of nongovernmental stakeholders and to the world's 'most vulnerable' became an increasing anchor for relevance and legitimacy (Bäckstrand and Lövbrand, 2016).

'Ecological modernization' converged upon the same characteristics. The marrying of economic imperatives and environmental ambitions through the Kyoto Protocol's carbon-accounting and trading 'flexible mechanisms' (e.g. emissions trading schemes and the Clean Development Mechanism, CDM) took on the trappings of emerging 'green economy' conversations, emphasizing low carbon transitions as part of co-benefits with health and energy security, to be executed by an ecosystem of clubs and networks, and with increased reference to civil society and 'the most vulnerable' as part of the new polycentricism (Bäckstrand and Lövbrand, 2016). It remains unclear if and how market governmentalities (Hajer, 1995, Bernstein et al., 2010, Paterson and P-Laberge, 2018) are adapting outward from Kyoto's focus on carbon accounting and trading. Michaelowa, Shishlov and Brescia (Michaelowa et al., 2019) note that carbon markets have not, since a 2012-2014 crash due to the financial crisis, excess credits, and low governmental support, recovered in visibility. 'Ecological modernization' might be ripe for a new mode that prioritizes low-carbon transitions. Yet, for many, the long-term trend is less optimistic: because the Paris Agreement institutionalizes the 'voluntarism' of Copenhagen, market mechanisms, reliance on private sector funding, innovation-facing rhetoric coupled with regulatory softening, and club-based decision-making can only intensify (Bernstein et al., 2010, Krüger, 2017, Ciplet and Roberts, 2017, Blum and Lövbrand, 2019).

The prevalence of both governmentalities is reflected in various literatures. The top-down, regulatory model of Kyoto is broadly acknowledged (Gupta, 2010, Held and Roger, 2018), and came to be the subject of critique as action endemically fell short of pledges (Prins and Rayner, 2007); the potentials of a turn towards polycentric governance remains debated (Ciplet and Roberts, 2017, Bernstein and Hoffmann, 2019). The market rationality in climate governance reflecting carbon capitalism as a hegemonic social system (Oels, 2005, Lövbrand and Stripple, 2011) is also the subject of liberal environmentalism, which explores norms (Bernstein et al., 2010), and climate capitalism or commodification, reflecting a vast political economy literature on carbon's marketization (Paterson and P-Laberge, 2018).

A characteristic of these governmentalities – particularly 'ecological modernization' – is not tackled by Bäckstrand and Lövbrand, but is the subject of literatures grounded in critical strands of geography, political economy, and STS. Emerging strategies – for example, novel carbon sinks, or sunlight reflection methods – are argued to present systemic disincentives for reducing emissions (McLaren, 2016) or reflect 'politics of delay' (Carton, 2019), by acting as 'fixes' for the carbon economy and its preferred modes of climate governance (Markusson et al., 2018). McLaren et al. (McLaren et al., 2019) issues a provocation to inquire after these

structural imperatives beyond recent debates on 'climate engineering'; this forms a strong motivation behind our study. According to this perspective, the animating logic of numerous climate governance strategies has arguably been to provide a functional, short-term 'technical fix': to circumvent deep-lying societal and economic structures through technical or biophysical solutions (Nightingale et al., 2019, an original definition comes from Weinberg, 1966). Such fixes, in effect, prolong the systemic 'lock-in' of the carbon economy at a variety of sites and scales (Unruh, 2000, Urry, 2014, Røttereng, 2018, Nightingale et al., 2019).

A number of recent works build on Harvey's (Harvey, 1982) interpretation, which considers how 'spatio-temporal' fixes 'reconfigure geographies' to delay global capitalism's tendencies toward crises. Carton (Carton, 2016) makes the case for carbon markets as an exemplary fix, and notes that carbon removal and sunlight reflection suites of climate engineering similarly promise to 'slow the rate of decarbonization' (Carton, 2019). Markusson et al.'s (Markusson et al., 2018) 'cultural political economy' model makes significant contributions. New fixes (e.g. novel carbon sinks) are arguably conditioned by and preserve the rationalities of pre-existing ones (e.g. carbon accounting and trading); moreover, the promissory nature of an imagined sociotechnical system, as much as implemented, scaled-up systems, can play as great a role in reflecting, legitimizing, and entrenching market environmentalism (ibid). Røttereng (2018) calls this 'symbolic signalling', where new tracks of signaled ambition substitute for actual implementation. The array of imagined and immature strategies of the Copenhagen era can, following Carton (2019), thus be seen as a 'mobilization of the future to legitimise and reproduce the present' (p.764).

Literatures on 'lock in' and 'fixes' follow critical (often, post-Marxist) traditions, but we see value in a looser adherence to their generalizable insights, and seek a working definition to that effect. We note several intersecting criteria through which a sociotechnical strategy – imagined, immature, or scaled – can embodying logics of fixing. Firstly, a fixing strategy primarily maintains infrastructures and rationalities for the exploitation and usage of carbon resources, often referencing the pragmatism of avoiding or easing profound changes to the carbon economy. Examples range from the sectoral to the systemic; in later sections, we specify ground-level, tangible examples whenever possible. Secondly, sociotechnical strategies can be as operative through framings (via projections and promises), as through implementation in industry practice or institutionalization in governmental policy (Markusson et al., 2017, Røttereng, 2018, Carton, 2019). Thirdly, strategies benefit from dovetailing with dominant market-facing rationalities entrenched during Kyoto Protocol era. Carbon accounting and trading mechanisms in particular, and certain emerging fuels and technologies, became or are becoming prominent because they are calculated as cost effective, and create additional opportunities for hype and the accumulation and re-distribution of capital (ibid). Fourthly, fixing strategies perform two kinds of 'substitutions' in climate ambitions. One presents nearer-term opportunities for the reduction of a palette of greenhouse gases (GHG), emerging proxies defined by global temperature increase, or kinds of climate-related harms – but that functionally put off strategies for long-term, comprehensive reductions in the use of conventional carbon fuels. The other comes from the emergence of seeking co-benefits with other areas of governance: success no longer stems solely from achieving goals and metrics defined by the climate regime, but from a hazier balance of interests between dilemmas and trilemmas of global issues.

Governmentalities of Kyoto era	Emerging rationalities in the Copenhagen era		'A fixing strategy …'
	Polycentrism or fragmentation of climate governance in a time of austerity; reflects wider governance trends		… primarily maintains infrastructures and rationalities for the exploitation and usage of carbon resources, often referencing the pragmatism of avoiding or easing profound changes to the carbon economy.
Green Governmentality: a post-1970s tradition of centralized and managerial environmental regime design	*Co-benefits* with economy and development, energy and food security, forestry, air pollution	Rationalities overlap and reinforce each other in ways specific to each sociotechnical strategy – see section 4, table 2.	… is operative through projections and promises as well as implementation in industry practice or institutionalization in governmental policy.
Ecological modernization: cost-effective, market facing climate governance based on offsets and credit trading	*Time-buying*: easing carbon transitions, dampening near-term climate impacts, catalyzing more deep-lying mitigation		… benefits from dominant market-facing rationalities entrenched during Kyoto era.
	Relative gains: lower-hanging fruit on the negotiations agenda to sustain momentum		… presents nearer-term opportunities for the reduction of GHG or emerging proxies harms – but that functionally delays deep-lying mitigation.
	Appeals to vulnerable demographics and civil society as anchors for legitimacy		… no longer needs to mark success solely from achieving climate goals and metrics, but from a hazier balance of interests between global issues.

Table 21: Emerging rationalities from Kyoto to Copenhagen eras. Column 1 describes two governmentalities (ensembles of governance rationalities and sociotechnical strategies) of the Kyoto Protocol era (Bäckstrand & Lövbrand, 2006, 2016). Column 2 describes emerging rationalities in the Copenhagen era, emphasizing that these are not mutually exclusive, and reinforce each other in ways specific to different sociotechnical strategies. Column 3 describes elements of 'fixing' the carbon economy, or carbon 'lock-in' that can be embodied by entwined governance rationalities and sociotechnical strategies.

Drawing upon these works, we developed a set of preliminary analytical concepts, as outlined in table 21, to conduct a consolidative mapping of how governance rationalities and logics of fixing manifested in sociotechnical strategies geared towards climate governance between 2005 and 2015. The following section outlines our iterative analytical approach before the results of our analysis are presented.

10.3   Analytical approach: Interpretative review

For our mapping of the ways in which governance rationalities and logics of fixing manifested in sociotechnical strategies between 2005-2015, we conducted an interpretive review of a broad range of secondary analyses – qualitative, multidisciplinary interrogations of the emergence

and implications of more limited groupings of strategies (for example, on biofuels alone, or carbon sinks). We sourced these materials via a keyword search of Google Scholar using the general search terms 'sociotechnical strategies', 'sociotechnical systems', 'climate strategies', 'climate governance strategies', and 'climate technologies', as well as search terms specific to each strategy or system (Kyoto's flexibility mechanisms, CCS, REDD+, next generation biofuels, shale gas, SLCPs, CDR, SRM). Analyses on conventional fossil fuels, renewables like solar, wind, and geothermal, energy efficiency, conventional and novel nuclear, and adaptation strategies provided valuable context, but do not form the bulk of analysis. Our data collection process was based on the principle of 'theoretical sampling' borrowed from Grounded Theory (Glaser and Strauss, 1967). According to this principle, data is collected in parallel to analysis and continues until 'theoretical saturation' is reached – the point at which all analytical concepts are well-represented and the addition of new materials begins to reiterate the same information (ibid). We do not claim that this process resulted in a comprehensive meta-review of all literature on this topic. Rather, we present an interpretative review which critically explores how synthesising insights from governmentality, STS, and political economy can contribute to understanding the emergence and evolution of sociotechnical climate strategies.

Our interpretative review process involved both authors independently undertaking a structured reading of the articles included in the analysis on the basis of the preliminary analytical concepts (Table 21). The review was an iterative process, with the analytical categories being revisited and consolidated as the analysis progressed. Specifically, we mapped how governance rationalities and logics of fixing were reflected in the ways various sociotechnical proposals were framed as part of assessments, projections, and promises; and where relevant, how they were implemented in partially-scaled systems, or institutionalized on resonant policy platforms. We inquired after how the means and ends of a particular system were conceptualised at their upstream stages (e.g. Brown et al., 2000). In doing so, we asked after their promissory roles in climate politics – how sociotechnical proposals backed an envisioned state of climate governance, and how that envisioning was recursively used to rationalize technological development. As an indicator of where certain rationalities and logics became comparatively resonant, we noted if they came to undergird existing policy platforms or projects and infrastructures in the process of being scaled up. Based on the mapping of these individual elements, we then asked if and how these emerging sociotechnical strategies reflected the governmentalities of the Copenhagen era. The following section details the results of this interpretative review process.

10.4   Analysis: Sociotechnical strategies of the Copenhagen era

In what follows, we undertake a two-part analysis. Here (section 10.5), we look at the following six sociotechnical strategies in turn: Kyoto's flexibility mechanisms, CCS, REDD+, next generation biofuels, shale gas, SLCPs, CDR, and SRM. We match them to governmentalities held over from the Kyoto era of 1997-2005 (green governmentality and ecological modernization) as well as rationalities that gained in visibility during the Copenhagen era of 2005-2015 (polycentrism, co-benefits, time-buying, relative gains, and appeals to the vulnerable). The reader can view a more summarized account of this section in Table 22. In

section 10.6, we step back to map overarching patterns of the relationships between these systems.

Kyoto's flexibility mechanisms

We begin by highlighting the ongoing significance of carbon accounting and trading mechanisms that marshalled much of the Kyoto Protocol's negotiation and operationalization. Dubbed the *'flexibility mechanisms'*, these were framed by the US and its allies as a means to reduce near-term stress on transitioning the carbon economy by incentivising the most cost-effective ways to reduce emissions, and by allowing actors to trade credits derived therefrom. The result was a widespread use of carbon offsetting. The mechanisms consisted of carbon markets (the most prominent was the EU Emissions Trading Scheme, EU-ETS), alongside Joint Implementation (allowing cooperation between developed states), and the Clean Development Mechanism (CDM), which allowed Annex I countries to receive tradable credits (including the EU-ETS, from 2004 onward) from emissions reductions projects in the developing world.

Carbon offsetting and credit trading was the original manifestation of the cost-effective, market-facing logics of climate governance of the Kyoto period (centrist reviews include (centrist reviews include Newell and Paterson, 2010, Calel, 2013, Paterson and P-Laberge, 2018, Michaelowa et al., 2019). They leave a complicated and unfinished legacy: engaging industry and finance at multiple levels with climate governance, and keeping heavy carbon consuming and extracting states on board with COP ambitions (Newell and Paterson, 2010). Yet, they may have retarded Annex I efforts to take on more comprehensive domestic emissions reductions. Offsetting and trading served as significant – though not exclusive – means by which Annex I states attempted to meet their commitments under the Kyoto Protocol, enjoying a 'gold rush' period of investment and capital creation between 2006 and 2011 (Michaelowa et al., 2019, Lövbrand et al., 2009a), but encouraging 'cheap and easy fixes' with limited potential for sustained, structural change (Calel, 2013, Carton, 2016, Ciplet and Roberts, 2017). Both the EU-ETS and CDM lie dormant currently, following a 2012 collapse due to the aftermath of the financial crisis and a fall in US and EU governmental support (Michaelowa et al., 2019). Some fault, tellingly, lies in abuse of the underpinning rationales of market mechanisms: the EU-ETS was flooded by 'hot air' credits from Russia and Ukraine (ibid). Lack of oversight in the CDM, meanwhile, created perverse incentives for false accounting and generation of credits (Schneider, 2009), and additionally often failed to create projects with development benefits in the hosting country (Olsen, 2007).

For a time, some emerging sociotechnical proposals of the Copenhagen era benefited from conforming to neoliberal rationalities, and more concretely, tied into accounting and trading structures. Yet, as conditions pushed climate governance towards polycentrism (recall Ciplet et al., 2015), knock-on rationalities would also be catered to. A suite of climate strategies exemplifying this direction of travel described *new arrangements of carbon sinks*.

Carbon capture and storage

Carbon capture and storage (CCS) came to prominence around 2005 as the subject of an IPCC Special Report. Portrayed by advocates as proven in (technical) concept, ripe for upscaling, and indispensable for meeting future emissions targets (Hansson, 2011), CCS was from the beginning tied into existing industry, investment, and – importantly – plans for international

credit trading (Krüger, 2017). As a supplement that would not fundamentally alter the carbon economy, the idea of CCS was aided by an additional framing as a feasible 'bridging' option for easing, or buying time for, the transition of entrenched carbon infrastructures; and as a catalyst for more ambitious actions in the future (Bäckstrand et al., 2011, Hansson, 2011, Markusson et al., 2017, Krüger, 2017). CCS did not go uncontested: the 'bridging' framing was opposed as an example of 'lock-in': an excuse for continuing carbon dependence, where incentives and resources would be reduced for renewables, and 'like nuclear… [be] a technological fix for an immediate problem with long-term negative consequences' (Bäckstrand et al., 2011: 275). Indeed, CCS was only included in the (by then, recognizably flawed) CDM in 2011, which coincides with the winding down of the Kyoto mechanisms. This framing juxtaposition becomes – and remains – a theme for many incoming sociotechnical strategies.

A significant aspect of CCS is that it has, for all its alleged potential, never been scaled. The bulk of large-scale CCS projects have emerged as an adjacent suite of *carbon capture and utilization in enhanced oil recovery (CCU in EOR)*, where emitted carbon is reused to expand the operational lives of existing oil fields. CCU in EOR has potential for 'technology spillover' back to CCS; yet it represents a downscaling of the original ambition, operationalised because it extends existing carbon extraction infrastructures (Markusson et al., 2017). For some, policy has failed to support CCS development in carbon markets or taxes (Scott et al., 2012, Haszeldine et al., 2018).

For others, the failure of policy is indicative: CCS serves its purpose as a promise (Markusson et al., 2018, Røttereng, 2018). In rhetoric, CCS is, but for some willpower, a readily-deployable 'bridge'. Yet, a clearer marker of its significance is that in investment and policy (or lack thereof), CCS functions most powerfully as the idea that atmospheric GHGs can be decoupled from the carbon economy (Hansson, 2011, Markusson et al., 2017, Krüger, 2017). Indeed, 'CCS-ready' serves as a legitimizing standard for new plants (Krüger, 2017), and CCS is heavily built into IPCC emissions scenarios that map pathways towards ambitious climate targets (Beck and Mahony, 2018). The latter becomes significant later, as we discuss schemes for carbon dioxide removal.

REDD+

Another emerging arrangement surrounding carbon sinks was based on 'reducing emissions from deforestation and forest degradation' (REDD+), which evolved into a mechanism for financing the reduction of forest emissions in developing countries.[30] REDD+ provides a structure for actors in developed countries to finance 'verified emissions reductions' (VERs) in developing, rainforest-heavy nations for managing a basket of practices that grew with each COP between 2005 and 2011 – eventually, deforestation, degradation, conservation and enhancement (Hein et al., 2018, Cadman et al., 2017). At the same time, forestry and land-use management is an old thread of conversation at the UNFCCC, with REDD+ negotiations (2005-2011) building on preceding negotiations on afforestation and reforestation, and their prospective inclusion in the CDM (2001-2004).

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30 REDD+, as a project-level instrument, should not be confused with UN-REDD, which is a multi-lateral programme coordinates and builds capacity for various forest management practices.

REDD+ represented the emergence in the 2000s of 'co-benefits' with other governance issues; here, between climate, local development, and biodiversity (Eliasch, 2008). Co-benefits also dovetailed with economic rationalities: managing forestry, particularly when these manifested as forest carbon projects in the developing world, was less costly and disruptive for developed countries than conventional mitigation efforts (Hein et al., 2018). A sense of pursuing relative gains – lower-hanging fruit on the agenda for sustaining the UNFCCC's visibility and relevance – became more important in the period marking fractious post-Kyoto negotiations; REDD+ negotiations and post-Kyoto talks both began in 2005. Moreover, forestry and land-use management had long been a track of UNFCCC negotiation that represented a balance of interests between the US and allied states seeking access to offsets, and forested developing nations seeking access to finance (Boyd et al., 2008).

In that vein, REDD+'s credit accounting structure reflects the resilience of 'market-based conservationism' (Hein et al., 2018). At the same time, REDD+'s VERs cannot (for now) substitute for domestic emissions reductions in donor states; it is unclear whether REDD+ will transition to a marketized offset mechanism or remain a financing instrument (Cadman et al., 2017). Recall that afforestation and reforestation had been included in the Kyoto Protocol's CDM; without the offsetting aspect, commentators have questioned the functional benefit of supporting REDD+ for developed states. Røttereng (2018) argues that this is evidence of a fix: REDD+ is virtue signalling for carbon consuming and extracting states that distracts from their actual agendas, with the same collection of states showing strong rhetorical support for both REDD+ and CCS as promissory carbon sinks.

Next-generation biofuels

It was not just (marketized) carbon sinks that reflected these rationalities. Over the turn of the millennium, rising oil prices led to energy security concerns in the global North, which provided context for two strategies with proposed co-benefits for addressing climate change as lower-carbon 'bridging' fuels. The first is biofuels: a sociotechnical strategy with multiple generations, each with unique characteristics. The 'first generation' of biofuels, generated from food crops, had for years been supported by US and EU policy (e.g. the EU's 2003 Biofuels Directive; the Energy Independence and Security Act of 2007 in the US) as a marrying of energy security and climate objectives. Uncommonly amongst the sociotechnical strategies assessed here, first generation biofuels in the mid-2000s represented an internationally scaled system of production and usage across the global North and South. But from 2007 to 2008, a global food crisis threw biofuels' conflicts with food security into sharp relief. A range of studies have since pointed out the effects of biofuels demand in moving production from traditionally food-growing areas into cash crops – although a number of factors, including escalating oil prices, acted in sum to generate food shortages (e.g. Naylor et al., 2007, Clapp and Cohen, 2009, Ajanovic, 2011).

Next generation biofuels – the second is based on non-food residues (prominently, cellulose), and further generations propose the use of algae and other materials – were then proposed to regain co-benefits across the 'biofuel trilemma' (Tilman et al., 2009, see also Hunsberger et al., 2014 on 'sustainable biofuels'). Despite tremendous hype, next generation biofuels remained commercially unscaled through the Copenhagen period, with the 2008 recession reducing incentives for bridging considerable technical gaps. Only towards the

present day has some biorefinery infrastructure been approached and growth projected; though these remain far short of original targets (Hayes, 2013, Valdivia et al., 2016, Hassan et al., 2019).

The value of these proposed biofuels over the past decade has, arguably, been as a promissory 'bridge' not only for higher-carbon fossil fuels (e.g. in transport), but for locking-in the older, more controversial version of itself. The idea of 'next generations' was a proxy for an imagined biofuels industry evolved to link climate, energy, and food imperatives – and has thus maintained the political positioning, policy support, and infrastructure of first-generation biofuels precisely by claiming that they would inevitably be substituted (Kuchler, 2014).

Shale gas

Shale gas, emerging around 2008 in the US, was another form of 'bridging' fuel with co-benefits – we use shale as an imperfect proxy for debates on the potentials of other unconventional, 'tight' fuels. As with biofuels, shale gas was a beneficiary of US energy security goals; its potentials as a new fuel sector during the 2008 recession gave it further visibility. Combined with the refinement of hydraulic fracturing and horizontal drilling approaches, the expansion of shale gas operations in the US has been widely termed a 'revolution'. And like biofuels, shale gas was advertised for its climate co-benefits, a kind of 'green carbon' that would substitute for higher carbon options – in this case, coal in electricity generation (Tour et al., 2010, Howarth et al., 2011). This 'bridge' was premised on shale gas disrupting the political resonance and infrastructures of the coal industry, but analysts were wary that shale gas would substitute for renewables rather than coal in the near term, as well as generate lock-in around its own policy support, structures, and markets in the long term (Schrag, 2012, Levi, 2015).

There is mixed evidence about which kind of substitution is coming to pass. US emissions fell during the scaling up of the shale gas industry, but gas-for-coal substitution was only one contributing factor (Feng et al., 2015), and methane leakage in upstream processes remained an issue (Newell and Raimi, 2014). Without concerted policy 'guardrails' – for example, limiting energy demand growth, reducing methane leakage, ensuring substitution with coal rather than renewables, and restricting low-carbon lock-out (Lazarus et al., 2015, Shearer et al., 2014) – the lock-in of shale gas interests may in the long-run produce comparable climatic impacts to coal, due to a combination of 'fugitive' methane, effects on depressing oil prices, and expanding infrastructure (Waxman et al., 2020). Moreover, shale gas was in this period a US-centered enterprise. With large global reserves and growing markets in Asia and the EU, shale's implications in multiple issues – geopolitical, economic, in energy systems – are still unfolding, from which impetus for its development may ultimately lie (Holz et al., 2015).

Short-lived climate forcing pollutants

Around 2011, the debate on *short-lived climate forcing pollutants (SLCPs)* repurposed efforts to reduce a heterogeneous range of aerosols from industrial production, agriculture (crop degradation), and other sectors as a co-benefit between air pollution, ozone layer governance, health, food security, vulnerable populations, and climate change (UNEP/WMO, 2011, Shindell et al., 2012). Discussion on SLCPs within the UNFCCC COPs were muted during this period, but as early as 2012, a still-growing Climate and Clean Air Pollution (CCAC) of states, cities, and organizations was lauded as an example of climate governance's new polycentrism.

Many saw an opportunity to sidestep the UNFCCC and to generate climate action at less fractious venues. SLCPs, indeed, saw rapid policy expansion at the international level, with the Gothenburg Protocol of the Convention for Long-range Transboundary Air Pollution taking on black carbon (BC) in 2012, the Montreal Protocol on ozone in 2016 addressing hydrofluorocarbons (HFCs), and the Arctic Council adopting BC targets in 2017.

Besides seeking co-benefits and spurring effective polycentrism, a key rationality underpinning SLCP actions was the capacity to reduce warming in the near-term (prior to 2050), since SLCPs remain in the atmosphere for a fraction of the time that carbon does, while in some cases embodying many times carbon's warming potential. Victor, Zaelke and Ramanathan (Victor et al., 2015) argued that tangible, feasible action in the near term (recall conversations on CCS, biofuels, and shale oil) might spur heavy carbon emitters to take on more comprehensive actions in the future, and disregarded the prospect SLCPs might distract from long-term carbon reductions as a 'curious political logic that imagines countries can't focus on more than one thing at a time' (p.796).

Scientific networks, generally, were circumspect, warning that SLCP reductions could not buy time or provide a bridge for low-carbon transitions. SLCP reductions could slow certain near-term risks (e.g. some ecosystems; sea level rise), but would not halt warming in the long term if carbon was not also reduced. More plainly, SLCPs could not allowed to be fungible with or substitute for carbon, as this might disguise and prolong emissions of the latter (Myhre et al., 2011, Bowerman et al., 2013, Shoemaker et al., 2013, Allen, 2015). Yet, some evidence indicates this is coming to pass in the post-Paris period, where Nationally Determined Contributions (NDC) include SLCPs under a single, economy-wide GHG metric, shading distinctions between actions on near-term SLCPs and long-term carbon in reaching their targets (Ross et al., 2018, Shindell et al., 2017).

Carbon dioxide removal

A final pair of sociotechnical strategies in this era emerged in the mid-2000s, originally grouped as forms of '*geoengineering*' or '*climate engineering*'. The term encompasses two technically dissimilar suites: carbon dioxide removal (CDR) proposes a variety of natural and technological sinks for filtering and storing carbon directly from the atmosphere (unlike CCS, which operates at source), while schemes for solar radiation management (SRM) propose that increasing the albedo of the planet's surfaces could reflect a degree of sunlight and thereby reduce warming and its impacts. The initial pairing of these suites was a function of scale and intent, with early conceptualizing of both CDR and SRM as transboundary, even planetary interventions in the climate system (Keith, 2000, Royal Society, 2009), with some harkening to Cold War era weather modifications (Fleming, 2010) or a renewed sense of stewardship as part of the 'Anthropocene' zeitgeist (Brand, 2009, see also Rockström, 2009).

CDR, or of late, '*negative emissions technologies (NETs)*', had a more circuitous rise to prominence. An early-2000s variant, ocean iron fertilization (OIF), was scientifically discredited following initial promise (Cox et al., 2021). The upscaling of a technologically-grounded range of direct air capture (DAC) approaches remains held back in part by high energy requirements (Wilcox et al., 2017). The collective prospects of the idea of carbon removal were revived in 2013 by the inclusion of *bioenergy carbon capture and storage (BECCS)* – an immature CDR proposal with a single pilot demonstration – in the vast majority of the

IPCC Fifth Assessment Report's emissions scenarios on which the Paris Agreement targets of 2C and 1.5C came to be based. This led to observations that the achievability of global climate targets was functionally propped up by a speculative technology and its underpinning assumptions (Anderson and Peters, 2016, Anderson, 2015, Geden, 2016).

BECCS has since been argued to implicitly commit climate governance to 'the promise of negative emissions', reflecting the promissory nature of CDR as well as the evolving framings of scientific assessment (Beck and Mahony, 2018). As a discursive totem, CDR or NETs continues to expand, and has come to marshal carbon sinks with diverse backgrounds: from DAC, to BECCS, to forms of terrestrial CDR often recategorized from existing land-use and forestry management practices, to ocean-based approaches. Conversely, CCS debates are referencing CDR to regain visibility (Bui et al., 2018). CDR's original framing as large-scale 'climate engineering' or 'intervention' is dissipating; the suite is increasingly normalized as carbon sink-based mitigation, and given impetus by platforms that aim at carbon neutrality by 2050 (Geden et al., 2019, Honegger et al., 2021).

Given CDR's growing profile, many called pragmatically for investment and incentivization (e.g. Lomax et al., 2015, Bellamy and Geden, 2019). Yet, BECCS in 2013 was (and remains) a projection of integrated assessment modeling (IAM) that calculates IPCC scenarios – BECCS was prominently featured in emissions projections because of model assumptions that it would become highly cost-effective post-2050. Moreover, BECCS is a chimera of biomass energy and CCS, two sociotechnical strategies with resilient controversies (Buck, 2016). Suggestions for improving BECCS' potentials rely on improvements to CCS infrastructures and a turn to next-generation biofuels to reduce land-use trade-offs – in this sense, BECCS is an imaginary that builds on the unfulfilled potential of previous ones (Markusson et al., 2018).

Despite these uncertainties, heavy BECCS deployment in modeling scenarios allows emissions to 'overshoot' in the near term before being sequestered later in the century – effectively, a time-buying scheme for climate policy created from modeling parameters (Anderson, 2015, Beck and Mahony, 2018, Markusson et al., 2018, Carton, 2019). The degree to which other CDR approaches may reflect similar logics is underexamined. Indeed, BECCS and direct air capture (DAC) share some of 'the same technical, regulatory, and financing frameworks needed for CCS' (Haszeldine et al., 2018: p.16) – and by extension, some potentials for prolonging carbon infrastructures. McLaren et al. (2019) proposes policy guardrails against perverse incentives in enhanced oil recovery (recall CCS), industry calls for CDR to serve as a source of (tradable) carbon offsets (recall carbon sinks and market mechanisms), and fungibility between conventional carbon reductions and negative emissions in setting targets (recall SLCPs in Paris NDCs).

Solar radiation management
For most of the Copenhagen era, the idea of *SRM as regional or planetary sunshades* drew greater and more fractious debate than CDR. A 2006 essay by Nobel laureate Paul Crutzen (of ozone layer governance) saw one SRM option as selectively allowing some increase of climate-cooling sulphate pollutants that are already by-products of shipping and industry – an uneasy trade-off between air pollution and climate goals (Crutzen, 2006). These early links with SLCPs would go dormant, with SLCP governance focusing on the co-benefits with reducing climate-heating pollutants. SRM schemes came to be dominated by more novel, earth systems

modeling-driven scenarios for a layer of reflective (often, sulphate) particles in the upper atmosphere, dubbed stratospheric aerosol injection, or SAI (Irvine et al., 2016).

SRM became active as a fringe but forceful idea – even now, it has negligible mainstream political support, and scarcely any development or demonstration projects (Doughty, 2018) and engineering beyond proof-of-concept calculations (Smith and Wagner, 2018). The perceived technical strength of SRM – using volcanic eruptions as a proxy – has been its potential to cool the climate within weeks or months (Crutzen, 2006). A ballooning amount of assessment pointed out that sunlight reflection, as modeled, could reduce warming and many attendant harms (Irvine et al., 2016) while presenting a systemic range of environmental and political challenges (Blackstock and Low, 2018 collects articles written 2012-2016). 'Cheap, fast, and imperfect' became a resonant shorthand particularly of SAI (Parson and Keith, 2013) as did a 'risk vs. risk' framing – SRM perhaps made sense only in comparison to the risks of poorly-mitigated climate change (Linnér and Wibeck, 2015).

Scientific networks sounded many cautious notes. An early framing of SRM as an 'emergency' mechanism was warned against for scientific uncertainties and playing into the politics of panic (Markusson et al., 2014, Sillmann et al., 2015). Deployment schemes by coalitions were studied but warily regarded (e.g. Ricke et al., 2013), and an initial assessment focus on regulation of prospective deployment (Victor, 2008, Virgoe, 2009) pivoted to a more polycentric governance of research itself (Nicholson et al., 2018). The most prevalent defense of SRM potentials came to be (and still is) as a time-buying strategy (e.g. Wigley, 2006), underpinned by scenarios that model SAI's capacity to reduce a broad spectrum of climate harms, especially if coupled with strong mitigation (e.g. MacMartin et al., 2014). These conclusions were accompanied by appeals to SRM's capacity to blunt impacts for vulnerable populations (Horton and Keith, 2016), that SRM could spur stronger recognition of and action on conventional mitigation (Reynolds, 2015), and calls for more enabling, mission-oriented research programs (Victor et al., 2013, Keith, 2017). Others described these scenarios as the use of modeling parameters to create as rose-tinted a depiction of deployment as possible, questioning benefits for the vulnerable as well as the capacities of a certain kind of model (and scientist) to set the terms of debate (Stilgoe, 2015, Flegal and Gupta, 2018, McLaren, 2018b) in critique that mirrors that of BECCS in integrated assessment models.

Much contention existed over SRM's potential – due particularly to the 'cheap, fast, and imperfect' trope – to reduce incentives for comprehensively reforming the carbon economy, as both an idea and as a sustained deployment. Recognition of these potentials remain pragmatic and prevalent; since the debate's earliest days, researchers have issued warnings is that SRM only masks warming, and cannot substitute for carbon reductions. For some, this so-called 'moral hazard' is ambiguously systemic and therefore unhelpful (Hale, 2012); for others, it is overstated (Reynolds, 2015). Of late, critical geography has revived SRM and its moral hazard as exemplary of a carbon economy fix, 'buying time for market-driven [mitigation] policy and reducing near-term risk' (Surprise, 2018, Gunderson et al., 2019) with a comparable logic to that of CDR and CCS (Carton, 2019). More concrete readings see moral hazard as forms of 'substitution' or 'deterrence' in mitigation efforts grafted onto existing sociopolitical issues and policy platforms, for which pre-emptive policy guardrails must be constructed (Lin, 2013, McLaren, 2016).

Sociotechnical strategy	Arrival period & circumstances	Degree of scaling	Match with Kyoto and Copenhagen governmentalities
Flexible mechanisms	1997 Kyoto Protocol	Kyoto Protocol 'flexibility mechanisms'	• Ecological modernization: cost-effective, market facing climate governance based on offsets and credit trading
CCS	2006-2010 debate on CDM inclusion	Permitted in CDM in 2011 but never scaled	• Ecological modernization: carbon markets, prolonging carbon infrastructures • Relative gains: sustaining carbon markets • Time-buying for easing carbon transitions
REDD+	Negotiated between 2005-2013; preceded by forestry and land-use debate	Modest number of projects, remains a financing mechanism.	• Ecological modernization: carbon accounting and credit generation • Relative gains: financing for forest nations • Co-benefits: development, biodiversity
Next gen biofuels	After 2007 food crisis, built upon early 2000s 1st gen biofuels	Only first-generation (food crop-based) scaled	• Co-benefits: energy and climate goals; pivoted to reducing trade-offs with food security
Shale gas	2005-2011, driven by energy security and industry innovations	Rapidly expanded in US; markets and reserves mapped in EU and Asia	• Co-benefits: energy and climate goals • Time-buying for easing carbon transitions based on gas-for-coal substitutions, catalyze more deep-lying mitigation
SLCPs	2011 recognition of air pollutants as climate heaters	BC, HFCs and methane listed in various platforms, including Paris NDCs	• Co-benefits: air pollution, ozone layer governance, health, food security, development and vulnerable populations, • Time-buying: accompany and catalyze more deep-lying mitigation
CDR	Early 2000s, with ocean fertilization; 2013 with BECCS in AR5	Increasing attention as part of Paris targets, but unscaled	• Ecological modernization: carbon markets, prolonging carbon infrastructures • Time-buying for easing carbon transitions based near-term carbon emissions overshoot
SRM	2006 Crutzen essay on sulphate forcing	Nascent small-scale mechanics tests	• Time-buying for easing carbon transitions by dampening climate impacts particularly for vulnerable populations, catalyze more deep-lying mitigation

Table 22: Sociotechnical strategies. Column 1 names emerging sociotechnical strategies of the Copenhagen era (2005-2015). Column 2 describes the period of arrival, while column 3 describes the degree of infrastructure scaling. Column 4 notes how sociotechnical strategies reflected evolving governmentalities of the Kyoto and Copenhagen eras, including logics of lock-in and fixing.

10.5   Analysis: Governmentality patterns

We previously noted how Copenhagen era (2005-2015) climate strategies were framed, how they embodied evolving governmentalities, and how they were beginning to appear as practices that prolong the near-term stability of the carbon economy. Here, we draw more

systematic insights. We observe distinct patterns in how these sociotechnical strategies referenced governance rationalities and engendered forms of fixing, and in how strategies built upon the rationalities and infrastructures of those that came before (see column 4 of Table 22, as well as Table 31). Markusson et al. (Markusson et al., 2017, Markusson et al., 2018) describe the latter as 'defensive fixes' – a path dependency of techno-fixes.

We observe a transition and continuity, rather than a clean break, between governmentalities of the Kyoto (1997-2005) and Copenhagen (2005-2015) periods. Fledgling strategies entrenched the carbon economy and mode of climate governance dominant during the Kyoto period in three ways: generating carbon credits, repurposing existing carbon infrastructures, and capitalizing on energy security.

The first shows the resilience of the market-facing practices of 'ecological modernization'. CCS, REDD+, and to a less clear degree, CDR, arose as *carbon sinks linked to offsetting, accounting, and trading mechanisms* (Røttereng, 2018). CCS was included in the CDM; as was the grouping of 'afforestation and reforestation' that is an antecedent to REDD+, which follows a similar logic of generating emissions credits. Strategies also *maintained infrastructures of carbon fuel extraction and usage* more directly. Fuels comparatively lower in carbon content – biofuels and shale gas – were argued to be substitutable for higher carbon variants in ostensibly limited circumstances, but in the process presented opportunities for lengthening the use of existing carbon infrastructures (e.g. the promise of next generation biofuels prolonging first-generation use; shale gas substituting for renewables as much as for coal, and expanding the long-term oil and gas economy), and for co-optation by industrial interests. Many argue that that CCS and kinds of CDR (e.g. direct air capture), through deployment in enhanced oil recovery, are beginning to follow in these tracks (Markusson et al., 2017, McLaren et al., 2019, Carton, 2019). BECCS is exemplary of path dependencies, linked to biomass energy and CCS, and further on to the logics of marketized carbon sinks (Buck, 2016, Markusson et al., 2018). The third positions climate goals as a *co-benefit with the pressing demands of energy security* (particularly in the US) emerging over the early 2000s, with the clearest examples being biofuels and shale gas.

At the same time, the shape of Copenhagen-era strategies shows the marks of emerging regime fragmentation in the mid-2000. A loss of confidence in the UNFCCC's centralized, managerial mode of governance in the fractious post-Kyoto negotiations, and an ensuing openness towards a *polycentrism of seeking climate-related goals* through adjacent UN regimes, minilateral coalitions, and multilevel arrangements of states, municipalities, industries, and civic organizations, became the Copenhagen era's prevailing rationality. The need to keep the climate regime alive took form as a strengthening of rationalities for seeking relative gains, co-benefits, and bridging strategies, which trickled down into the appeals to viability and legitimacy made of new sociotechnical strategies. At the same time, rationalities of co-benefits and time-buying in particular presented opportunities for locking in carbon structures in less direct ways than entrenchment of cost- and market- friendly governance, or governance directly coupled to systems of carbon extraction and use.

References to *co-benefits for legitimizing climate strategies* with energy security (biofuels, shale gas) and development (the CDM) were joined by the linked issues of land-use, forestry, and agriculture (REDD+ and various kinds of terrestrial CDR), and air pollution (SLCPs and biofuels). Food security became significant – as a minimization of trade-offs – for hyping new

biofuels after the 2007 food crisis; this issue was newly raised for BECCS as a combination of biomass energy and CCS systems. Mayrhofer and Gupta (Mayrhofer and Gupta, 2016) point out that the 'co-benefits' rationality's main potential is to incorporate climate objectives into more immediate processes of local and global governance. At the same time, there are dangers in treating climate goals as 'side effects of another goal that might be higher on the political agenda' (ibid, p.27). The perception and advocacy of a co-benefit can fade as contradictions surface during operationalization – REDD+ and development, or biofuels and food security, or shale gas and energy-related imperatives – and balancing interests between governance issues becomes subject to scientific uncertainties and political horse-trading. Indeed, a co-benefits agenda might also be understood partly as trying to reframe critiques of harmful side effects. In some cases, if the driving forces of a climate strategy come from rationales external to climate governance – for example, shale gas – 'co-benefits' actually disguises trade-offs.

Another manifestation of the regime's fragmentation was an *increased openness towards relative gains* in the negotiation agenda that might maintain some momentum at the UNFCCC. Though it stands outside the scope of our investigation, Khan and Roberts (2013) point out that adaptation funding received much needed support (at least on paper) under this rationale. Negotiations for REDD+ as a financing mechanism for forest nations (2005-2013), and including CCS in the CDM (2006-2010), similarly benefited in the post-Kyoto process. Dovetailing with these rationalities were resurgent appeals to demographics apart from governments and industry to sustain climate action – Bäckstrand and Lövbrand (2016) note that the visibility of civic and non-governmental organizations in this period rose as part of a move to polycentrism. Some of this manifested as appeals to the *welfare of 'most vulnerable'*: as presenting co-benefits (or at least minimizing trade-offs) with development (next-generation biofuels, REDD+, SLCPs), or for SRM, as a measure that might alleviate climate harms and buy time for developing adaptive capacities (Horton and Keith, 2016).

The emergence of the *'time-buying' or 'bridging'* rationality – easing the near-term strain for economies and societies on route to comprehensive low carbon transitions – came with many varieties, and displays the strongest potentials for lock-in. Some tied clearly into the cost-effective, market-facing climate governance of the Kyoto era. An ostensibly transitory low-for-high carbon fuel substitution (biofuels and shale) has been noted. CCS tied into the structures of tradable carbon credits, and was exemplary of the promise to ease transitions for carbon infrastructures; a logic expanded for CDR (e.g. BECCS) in permitting near-term 'overshoot' of emissions trajectories due to the promise that emitted carbon can be sequestered from the atmosphere in the future. SLCP reductions are projected to reduce certain near-term impacts, and SRM scenarios promise the same by slowing or halting temperature increase.

In debates that accompanied the growth of each of these proposals, scientific networks were careful to preface that none of these options can or should in the long run substitute for reducing emissions by replacing conventional fossil fuels. Advocates (for example, in CCS) extended the idea of a 'bridge' to argue that feasible compromises might catalyse more systematic reductions in the future (Bäckstrand et al., 2011); a variation of this for SRM argues that the prospect of a planetary sunshade might shock actors into stronger mitigation (Reynolds, 2015). Nevertheless, it is already clear that the bridging rationality presents opportunities for prolonging carbon structures. CCS has yet to be implemented at scale despite a decade and a half of investment and hype, indicating that its function is served as ambition

Kyoto era →			Copenhagen era
Green governmentality			**Polycentrism and fragmentation**
Ecological modernization			
Flexible mechanisms – carbon markets, Joint Implementation, Clean Development Mechanism (1997-2012 heyday).			Reduced activity (2012-)
	Credit generating carbon sinks (CCS and increasingly forms of CDR)		
	Financing mechanism for less-developed countries (REDD+)		
Co-benefits: energy security			
		Food security (next generation biofuels)	
			Air pollution (SLCPs)
	Relative gains		
	Co-benefits with development for most vulnerable (REDD+, biofuels, SLCPs)		
	Funding (REDD+) or protecting vulnerable populations (SRM)		
	Buying time/Bridging		
Substitution of lower-carbon fuels for high carbon variants (shale, biofuels)			
	CCS and CDR in enhanced oil recovery		
	Claiming to catalyze future mitigation instead of de-incentivizing it (CCS, CDR, SRM)		
		Substituting for long-term carbon emissions with a different emissions basket (SLCPs) or a proxy measure of harm (SRM)	
		Overshoot of near-term carbon emissions (CDR; functionally, SLCPs)	

Table 23: Governmentality patterns. We show the emergence or consolidation of governance rationalities and strategies of the Kyoto and Copenhagen eras (bolded script, dark grey), alongside variations of those rationalities (light grey) as they emerged with various sociotechnical strategies.

signalling (Markusson et al., 2018), and Røttereng (2018) notes this for REDD+ as well. US shale gas production (and biofuels, though this is not a fossil fuel) was deployed more due to energy security and intra-industry innovation rather than for climate objectives, and already displays self-sustaining logics (Lazarus et al., 2015, Kuchler, 2014). SRM and SLCPs present perverse opportunities for climate ambition based on proxies for comprehensive carbon emissions reductions: (rates of) temperature increase for SRM, or a more feasibly manageable basket of GHGs (e.g. HFCs) in SLCPs. Many countries, for example, combine HFC and methane reductions with carbon reductions through an economy-wide emissions target in the Paris Agreement's Nationally Determined Contributions (Ross et al., 2018); others warn that this fungibility must not be emerge between conventional carbon reductions and negative emissions (McLaren et al., 2019).

10.6   Conclusion

A bird's eye view reveals what smaller scale analyses might not. Most studies of climate's sociotechnical strategies are based on single examples or smaller groupings, and when linking these systems, qualifications abound at eye-level. But taken as a whole, patterns emerge. The Copenhagen era's proposals and systems navigated emerging rationalities that responded to the increasing fragmentation of the global regime. However, they strongly reproduced entrenched structures and rationalities of the Kyoto era, presenting numerous outlets for signalling climate ambition while delaying more deep-lying forms of decarbonization.

Our intent is not to denigrate considerable advances that have been made in mitigation efforts, nor to declare all incoming climate strategy hopelessly compromised. Indeed, we leave out a number of sociotechnical strategies from our assessment, particularly renewable energy and efficiency, nuclear energy, and adaptation strategies. When assessing how the near-term carbon economy is 'fixed' by emerging efforts, omitted systems may offer countering logics. Rather, we sound a cautionary note about hype and advocacy regarding immature and imagined sociotechnical strategies. From CCS to SRM, each debate in the course of emergence saw myopic claims made about that system's potentials, and even that they present opportunities for avoiding or altering conditions that hampered previous efforts. A longer and wider arc of climate governance – even limited to the decade between 2005 and 2015 – indicates that these proposals, for all their different technical specifications, filed into comparable and often well-worn political usages. Structure – governmentalities built around the carbon economy – does matter.

Yet, structure need not be deterministic. Pointing to these governmentalities has been accompanied by avenues for altering them, in the form of proposed policy incentives and safeguards – see Chhatre et al. (Chhatre et al., 2012) for REDD+, Lazarus et al., (Lazarus et al., 2015) for shale gas, Shindell et al. (Shindell et al., 2017) for SLCPs, McLaren et al. (McLaren et al., 2019) for CDR, and McLaren (McLaren, 2016) and Reynolds (Reynolds, 2019) for SRM. The question is whether these guardrails can be constructed, as we move into a period of governance marked by the implementation of the Paris Agreement, spurred further by carbon neutrality platforms, the European Green Deal, and of late, the opportunities and constraints set in motion by plans to restart the global economy in the aftermath of Covid-19. Whether these sociotechnical strategies come to 'repackage' Copenhagen governmentalities in a laissez-faire mode of climate polycentrism (Bernstein et al., 2010, Held and Roger, 2018, Ciplet and Roberts, 2017, Blum and Lövbrand, 2019) or offer opportunities for catalyzing a low-carbon transition, depends on our collective determination that the past assessed here need not be prologue.

PART III

11 Conclusion

11.1 Thesis summary

To recap: This thesis explored *how the governance of climate engineering techniques is being discursively constructed.* The exploration of this overarching research question was structured around the following six sub-research questions:

1. **Govern what?** What is being constituted as the object(s) of governance?
2. **Why govern?** What rationales are structuring the call for governance?
3. **Who governs?** What governance speaker/subject positions are available?
4. **How govern?** Which governance modes and instruments are thinkable and practicable?
5. **'Discursive blueprints' for governmentalities?** Is a/are system(s) for thinking about the nature and practice of CE governance emerging?
6. **Discourse coalition(s)?** Is one or more **discourse coalition(s)** of social actors which (re)produce the discursive elements of this/these system(s) becoming apparent?

The thesis addresses the climate engineering governance challenge from a post-structuralist perspective which emphasises that, as discourse is the source code with which contested futures are written, 'cracking the discursive code' underpinning the CE governance debate can help anticipate and critically reflect upon the emergence of future governance rationales, practices and infrastructures. Premised on the understanding – grounded in the concept of governmentality – that there is a constitutive link between discursive structures and governance development, the thesis has identified the structures underpinning several spheres of the climate engineering debate and critically discussed the shaping effects they may have on the future development of governance.

Chapters 5-8 presented a series of qualitative empirical case studies which made up the core analyses of the dissertation project. Chapter 5 (Cracking the Code) focused on the science/policy sphere of the debate on governance of climate engineering research in three countries spearheading research on the topic: the US, the UK, and Germany. Chapter 6 (Coming to GRIPs) zoomed in to look at governance discussions about a subset of carbon removal approaches in the UK policy/industry sphere. Chapter 7 (A Leap of Green Faith) explored the debate on governing climate engineering in one transnational civil society sphere – religion. Chapter 8 (Arguments and Architectures) focused on the international environmental governance sphere, investigating how discursive and material structures are shaping decision-

making on climate engineering governance in three international forums – the LC/LP, the CBD and UNEA.

These four core analytical chapters were complemented by two chapters which use an interpretive review approach to explore how the analytical framework and empirical insights developed in the previous stages of the project may be applied in combination with other social science approaches to assess and anticipate the development of wider areas of climate governance (Chapters 9 & 10). Chapter 9 (Casting a Wider Net) presents a conceptual exploration of the ways in which different types of discourse – in interaction with public perceptions and the shaping effects of policy instruments – could shape emerging governance of carbon removal in the ocean. Chapter 10 (Delaying Decarbonization) zoomed out further, looking at a longer history of climate governance and highlighting the historical shaping power of persistent governmentalities on how a range of climate response strategies – including carbon removal and sunlight reflection – have become or are becoming thinkable and practical in international climate governance.

In this final chapter of the thesis, I not only summarize my findings, but also critically reflect upon them and draw out their broader implications. To do this, I first discuss and reflect upon the results of each paper in light of the dissertation project's research questions (section 11.2). In doing so, I highlight what I see as the shortcomings of each chapter and reflect upon what I could have done differently. Section 11.3 then summarizes the overarching conclusions that can be drawn from the thesis as a whole and sketches some possible future avenues for delving more deeply into the problematics identified. The final section (11.4) concludes by outlining a set of broader insights and their potential relevance for global environmental governance writ large.

11.2   Chapter discussions and reflections

11.2.1   Cracking the Code

Chapter 5 presented the analysis of a series of interviews with experts from the **science/policy spheres** in US, the UK and Germany about a proposed Code of Conduct for climate engineering research. The analysis illustrated how – by shaping what is defined as the object(s) of governance, why governance is considered necessary, and who is assigned the authority to govern – the underlying discursive structure within the science/policy spheres in these three countries may have the potential to shape the emergence of polycentric CE research governance structures focused on enhancing democratic legitimacy.

Structured around the first four guiding research sub-questions outlined in section 11.1, the results can be summarised as follows:

Govern what? What is being constituted as the object(s) of governance? Governance object formation was based on either on the intent, or on the scale and effect of the proposed CE research activities, with corresponding implications for the type of governance deemed appropriate: Governance of research objects defined based on intent would need to be broad-stroke, flexible and adaptable, whereas governance of research objects based on scale and effect would need to be specific and tailored to each research activity and its context.

Why govern? What rationales are structuring the call for governance? Three types of rationales, functional strategic and normative were identified as structuring the calls for CE research governance, with a slightly larger range of normative rationales found to be present, indicating that polycentric, democratic research governance may be most thinkable and practicable within the given demand rationale constellation.

Who governs? What governance speaker positions are available? The analysis identified four positive speaker positions and types of social actors associated with them: Civil society representatives adopted and/or were assigned the '**Principled Gatekeeper**' speaker position, scientists the '**Responsible Information Provider**' and policymakers the '**Strategic Controller**' speaker positions. There was one the negative speaker position available – '**Self-Benefit-Maximizer**'- which was necessary, as its antagonistic exclusion made the other three (positive) governance speaker positions possible. Identifying which speaker positions are being adopted provided insights into how different types of social actors can be expected to engage with proposed governance frameworks: Actors who adopt the 'Principled Gatekeeper' speaker position may tend to perceive governance as a tool to ensure transparency, accountability and legitimacy. Those who adopt the 'Strategic Planner' speaker position may be more likely to see governance as a way to facilitate coordinated and strategic research planning. Those who enter the debate via the 'Responsible Information Provider' speaker position may perceive governance proposals in light of how they will affect their ongoing production and provision of information to decision-makers. It was interesting to note that no speaker position for 'publics' was identified in this sphere of the debate.

How govern? Which governance modes and instruments are thinkable and practicable? The analysis revealed that 'governance' of CE research can mean vastly different things both functionally and spatially. Governance frameworks emerging to reflect these varying definitions would have to be both functionally flexible and adaptive to local, regional, and international spatial contexts.

Although this chapter was a successful proof-of-concept for my structural discourse analytical framework, it did have some empirical and conceptual weaknesses: The data collection process required interviewees to have a certain level of expert knowledge and understanding of (international) governance, and to have read the lengthy Code of Conduct text. This restricted the number and type of people who were willing and able to engage with the topic, and thus likely influenced the results of the empirical analysis. On the conceptual front, during my interpretation of the results, I blurred the lines between actively 'designing' governance to reflect/counteract the existing structure of the debate and trying to critically anticipate how the structure of the debate may organically or unintentionally shape the emergence of governance without any intended 'design'. This conceptual lack of clarity highlighted that I was missing a theory expressly linking discursive power/knowledge to governance development. The next chapter grappled more directly with this issue.

11.2.2 Coming to GRIPs

Chapter 6 presented the analysis of a series of interviews with UK representatives from the **industry/policy** sphere about what they consider to be appropriate governance instruments for NETs. In contrast to the broad 'CE research governance' focus of the pervious chapter, this case study zoomed in on mapping the debate about policy instruments for a subset of proposed CE

techniques in a specific national context. In addition, in this chapter I expressly introduced the governmentality concept to theoretically link discursive structure to governance development. The analysis focused on highlighting how discursive structures were linked together into systems of knowledge for thinking about the nature and practice of governance.

Linking primarily to the fifth guiding research question outlined in section 4.1 (*Is a/are system(s) for thinking about the nature and practice of CE governance emerging?),* the results showed that three types of discursively reproduced knowledge systems were at play at the industry/policy interface of the UK NETs governance debate; one political, one economic, and one discourse ethical. Each of these knowledge types linked a governance rationale (why govern), certain governance objects (govern what), particular speakers and subjects (who governs), and specific governance modes and instruments (how govern) into a system of thinking about the nature and practice of governing.

Correspondingly, the chapter posited that three 'discursive blueprints' for political, economic and discourse ethical governmentalities may be emerging in this sphere of the UK NETs governance debate: The political governmentality is based on a strategic governance rationale, lumps NETs approaches together for governance purposes based on their suitability in achieving political climate targets, privileges political actors in the development of top-down NETs governance, and is linked to coercive, hierarchical governance instruments. The economic governmentality is based on a functional governance rationale, splits NETS approaches for governance purposes based on their relative costs and benefits, privileges utilitarian actors in a competitive governance development space, and is linked to instruments of incentivisation. The discourse ethical governmentality is based on a normative governance rationale, splits NETs approaches for governance purposes based on their relative social acceptability, privileges rationally arguing actors in a deliberative governance development process, and is linked to persuasive governance instruments.

This chapter was also not without weaknesses: One key shortcoming was that the interviews were carried out as part of a larger project that focused on identifying what policy instruments could *responsibly incentivise* certain carbon removal approaches within the UK context. Therefore, the framing of questions may have shaped interviewees' responses and thus the results of the analysis. Additionally, I used a limited governmentality concept which focused on the discursive elements of emerging governmentality ensembles (which I call discursive 'blueprints'). I justified this by reasoning that other elements of mature governmentality ensembles (i.e., materialised institutional structures, practices) were not able to be assessed because they do not yet exist for NETs in the UK. However, it may have been possible to look at the institutional structures and practices at play the UK (climate) policy-making process more generally, to make this a more comprehensive analysis. This interest in looking at institutional alongside discursive 'conditions of possibility' contributed to the development of Chapter 8 (Arguments and Architectures).

11.2.3   A Leap of Green Faith

Chapter 7 detailed the analysis of a series of interviews with faith leaders and religious scholars from a transnational **civil society** sphere to critically discuss how religious discourse on humanity's role in and responsibility towards nature may shape the emergence of climate engineering governance specifically, and the reconceptualization of socio-ecological Earth

system governance more broadly. This chapter attempted to take seriously the call for the consideration of the role of wider types of societal knowledge (outside the science/policy/industry nexus) in CE governance development. Additionally, the chapter used the analysis of the way religious knowledge is dealing with the ethical underpinnings of the CE governance debate to reflect upon alternative Earth system governmentalities more broadly.

The analysis showed that green religious knowledge – engaged around the idea of deliberate interventions into global systems – may provide the discursive blueprint for a novel system of thinking about the nature and practice of Earth system governance: a governmentality of Socio-Ecological Care (SEC). The elements of this system of thinking about the nature and practice of governance are underpinned by a *relational logic,* which focuses on reciprocal relationships between interconnected human and non-human nature, making new governance *subjects and speakers*, *rationales*, *objects*, *modes and instruments* thinkable and practicable.

Structured around the first four guiding research sub-questions outlined in section 11.1, the results can be summarised as follows:

Govern what? What is being constituted as the object(s) of governance? By shifting the perspective from a bird's eye view of the Earth as a machine, and rather providing humanity a way of looking up and out from a position within an interconnected, socio-ecological whole, my analysis showed that religious discourse on CE reconceptualises what object is to be governed: CE approaches that focus on working with existing (and future) relations within the global socio-ecological Earth system are differentiated from those which attempt to externally control or 'fix' the system.

Why govern? What rationales are structuring the call for governance? The rationales of responsible care (of and by socio-ecological systems), balance, and humility underpinning religious discourse reinforce a relational perspective that may be central to developing more holistic, non-hierarchical, and non-linear understandings of human responsibility and agency in global environmental governance. Specifically, the SEC may offer a new model of human responsibility for deliberate interventions into socio-ecological systems that goes beyond the technocratic model of responsibility for 'planetary management' previously identified in the CE governance debate.

Who governs? What governance subject/speaker positions are available? By providing the relational concept of humanity as just one part of the living web of reciprocal relationships that make up the Earth system, green religious discourse on CE adds a new subject position that enables humanity to reconceptualise its role in the Anthropocene, moving away from the concepts of planetary managers, or enlightened stewards of the Earth. Additionally, the structure of religious debate offers discursive speaker positions through which religious social actors may authoritatively engage in development and practice of CE governance, and global environmental governance more broadly – as moral narrators, bridge builders, and by giving voice to the underrepresented.

How govern? Which governance modes and instruments are thinkable and practicable? The relational, non-hierarchical logic of the emerging green religious system of thinking about the nature and practice of governance makes thinkable and practicable governance modes and instruments which are bottom up, situated, participatory, and involve the integration of a range of knowledge types.

Again, this chapter could have been stronger on some fronts. One weakness pointed out by reviewers was that I only sourced interviewees from a specific sub-set of the religious community – those who are environmentally active or 'green'. This means the results do not provide a representative crosscut of all ways in which religious discourse/knowledge could shape governance of CE. Abrahamic religions in particular have historically been associated with narratives of anthropocentric domination over the non-human environment, and such understandings are still prevalent in many religious discursive communities today. It is therefore unclear how influential the 'green' sub-sphere of the wider religious civil society debate is/could be on the development of CE and climate governance.

11.2.4   Arguments and Architectures

Chapter 8 looked concretely at discussions on CE governance within international forums – the London Convention and its Protocol (LC/LP) the Convention on Biological Diversity (CBD) and the United Nations Environment Assembly (UNEA) – to assess what types of discourse/knowledge are being privileged in the ongoing discursive construction of CE governance on the intergovernmental level. This chapter expands the understanding of the structural 'conditions of possibility' shaping the emergence of governance to include material(ized) institutional structures – which are shaped by and go on to shape discursive structures in turn. In doing so, the chapter speaks to ongoing theoretical discussions about where the limits of 'the discursive' are, or even if there is a line between the material and the discursive. In addition, the chapter engages with the issue of the role of discourse in institutional stability and change.

The results of the combined institutional and discursive analysis undertaken in this chapter highlighted that the fit between discursive 'software' and existing intuitional 'hardware' shaped the governance choices and opportunities available in the three international forums that have thus far dealt with whether and how to govern proposed deliberate inventions into the global climate system. Faced with same emerging environmental issue, the three forums produced differing governance outcomes: the fit between software and hardware in the LC/LP provided the conditions of possibility for governance in the form of expert-led risk-benefit assessment to permit certain CE activities on a case-by-case basis, the fit between discursive and institutional structures in the CBD made a precautionary ban on CE activities thinkable and practicable, and the lack of fit within and between discursive and material structures at UNEA contributed to CE being deemed (currently) ungovernable within the forum.

Linking primarily to the fifth guiding research question outlined in section 11.1, (*Is a/are system(s) for thinking about the nature and practice of CE governance emerging?*), the results showed that there seem to be multiple competing systems at play in these forums: The expert risk-benefit assessment-based governance mode being discursively constituted in the LC/LP debate on CE governance may reflect the utilitarian logic of the ecological modernization meta discourse (Hajer, 2005, Bäckstrand and Lövbrand, 2016). The CBD discursive and material structures which emphasise precautionary control may reflect the elements of what Bäckstrand & Lövbrand term 'green governmentality'. The UNEA debate seems to include competing elements of the neo-liberal ecological modernisation governmentality, top-down green governmentality, and elements of what Bäckstrand and Lövbrand (2016) dub the 'reformist' strand of civil environmentalism, which calls for including a wider range of stakeholders in governance development processes. The results suggest that conflicting discursive and material

ensembles which have historically shaped (and in many cases hindered) broader climate governance may therefore also be influencing the emerging governance of CE at the global level (see also Chapter 10).

The main weakness in of this paper is conceptual – the analytical line between material(ized) and discursive structures is quite fuzzy. For example, the chapter largely ignores the question as to at what point a discursively (re)produced norm becomes an institutionalised, 'materialized' principle. The analysis also faces somewhat of a chicken and egg problem – are discursive structures taken to be a precondition of material structures, or the other way around? We argue they are mutually constitutive but leave open the question of how exactly the interplay between the two accounts for stability and change. Another shortcoming is that the analytical framework does not consider the political agency of actors involved in decision making on CE. Others have pointed out that political interests have been hugely influential in shaping CE governance outcomes in forums such as these (McLaren and Corry, 2021, Jinnah and Nicholson, 2019, Honegger, 2019). One way to additionally highlight the dynamic interplay between structure(s) and agency in this analysis may have been to adopt a process tracing methodology to show how specific actors (re)produced certain elements of discursive structures during the decision-making processes.

11.2.5 Casting a wider net on Ocean NETs

Chapter 9 made the broad argument that assessments of the potential of ocean-based NETs must not be limited to technical, physical, and economic questions, but that public perceptions, policy assessment and discursive power/knowledge structures will be just as important in shaping the "real world" potential of these approaches. Guided by the first four research sub-questions outlined in section 11.1, the chapter presented a conceptual exploration of the ways in which several different types of discourse/knowledge currently at play may shape the *why, what, who and how* of emerging ocean NETs governance. The exploration was not intended to be exhaustive or conclusive; yet it illustrated the varied, and potentially conflicting, implications that foregrounding legal, biogeochemical, economic or cultural discursive structures may have on ocean NETs governance development:

Why govern? What rationales are structuring the call for governance? Within the structure of the legal discourse on ocean NETs, rationales for governance centred around the need for conflict prevention and resolution as a result of the expected (positive and negative) transboundary effects of the activities. This was in contrast to the need for governance to maintain biogeochemical systems, governance to balance costs and benefits of ocean NETs, and governance to preserve the ocean as a cultural good which were identified as central to the other discourse/knowledge systems at a play.

Govern what? What is being constituted as the object(s) of governance? The discursive constitution of NETs governance objects was based on differing definition criteria across the four types of discourse/knowledge analysed; within legal discourse the scale of NETs effects was key to defining them as governance objects; within biogeochemical scientific discourse, ocean NETs with the potential to have negative environmental effects (regardless of scale) were constituted as objects requiring (restrictive) governance; economic discursive structures categorized NETs approaches according to their cost-effectiveness, and cultural discourse

constituted governance objects based on their potential social (in)acceptability – largely based on their degree of perceived 'naturalness'.

Who governs? What governance subject/speaker positions are available? The four discourses afforded different types of actors authoritative positions according to the types of knowledges seen as key: Legal discourse/knowledge privileged states and organisations with international legal standing; scientific discourse afforded governance authority to bodies reproducing biogeochemical knowledge; economic discourse foregrounded the role of cost-benefit based assessment bodies in governance development, while cultural discursive structures assigned authority to local and indigenous knowledge producers.

How govern? Which governance modes and instruments are thinkable and practicable? The governance modes and instruments becoming thinkable and practicable within the structure of each of the discourses likewise differed. While the legal knowledge system highlighted the role of top-down governance based on broad international laws and guidelines, biogeochemical scientific discourse focused on monitoring, reporting and verification instruments, economic discourse posited that competition would allow the most cost-effective solutions to win out, and cultural discursive structures made bottom-up, participatory governance development modes more thinkable.

In sum, the chapter shows how – in combination with public perception and policy assessment approaches – discursive mapping may help anticipate tensions between different discourse/knowledge systems at play in CE governance development processes.

This chapter attempted to synthesise insights from several disparate branches of social science research on NETs governance. However, in doing so, it did not directly address the potential epistemological and ontological inconsistencies involved with placing different types of social science approaches side by side and using them to build upon each other. A more thorough exploration of how discourse, public perceptions and policy design interact to shape environmental governance development would have to address fundamental differences in the authors' understandings of concepts such as power and agency, causation and effect, language and knowledge.

11.2.6   Delaying Decarbonisation

As the final substantive chapter in this thesis, Chapter 10 zoomed out to look at the longer history of climate governance to contextualise the development of CE governance alongside other climate response strategies. By combining the governmentality lens with analytical concepts from science and technology studies and critical political economy, the aim of this chapter was to highlight the historical shaping power of persistent, systemic governmentalities on what becomes thinkable and practical in climate governance.

Linking primarily to the fifth guiding research question outlined in section 11.1, (*Is a/ are system(s) for thinking about the nature and practice of CE governance emerging?*), the chapter shows that elements of the neoliberal governmentality continue to structure the way in which strategies emerge in climate governance. The results showed specifically that recent climate governance strategies reflect and reinforce rationales which emerged during the post-Kyoto era. The analysis highlighted that, while emerging climate strategies could present new pathways towards ambitious action, the systemic structuring effects of the persistent neoliberal governmentality means they have functionally permitted the delay of decarbonization. If

this system of thinking about the nature and practice of governance continues to shape the emergence of CE governance, the chapter concludes that this new suite of proposed climate governance strategies is likely to face the same fate.

Again, a weakness of this chapter could be seen as an over-emphasis of the structural conditions of possibility, and a corresponding failure to discuss the role of (i.e., political, economic) agency and interests in the historical development of climate governance. Additionally, the chapter may have been strengthened by a more detailed discussion of some practical policy measures that have been proposed to prevent CE governance from repeating the mistakes of the past (see also Low, 2021 for further reflections on the limitations of this chapter).

11.3   Cumulative conclusions

In sum, this thesis shines light on the ways in which different discourse/knowledge systems underpinning the CE debate are constituting systems of thinking about the nature and practice of governance or 'discursive blueprints' for governmentalities, which link; (1) the objects over whom governance is to be exercised (what), (2) rationales as to the purpose of governance (why), (3) speakers, subjects and discourse coalitions involved in governance processes (who), and (4) governance modes and instruments (how). This section highlights cumulative conclusions from the thesis and sketches future avenues for delving more deeply into the problematics identified.

Objects
Overall, the results presented in all chapters show *that prioritizing certain types of knowledge in CE governance development will result in the emergence of differing objects of governance.* Simplifying the nuance of the results presented in each of the preceding chapters, it is possible to posit: Foregrounding economic discourse/knowledge in the development of governance would lead to the governance of CE 'objects' according to which are the most/least cost-effective (see especially Chapter 6). Privileging of political discourse/knowledge would lead to governance of CE based on which approaches are deemed most/least suitable for achieving strategic (climate political) goals (see Chapters 6 & 8). Emphasizing deliberative discourse ethical logics would shape the formation of governance objects based on which CE activities are most/least socially acceptable (see especially Chapter 6). Governance development based on virtue/care ethics would result in the discursive constitution of governance objects based on which CE approaches are deemed most/least likely to maintain reciprocally balanced relationships within complex socio-ecological system(s) (see Chapter 7).

The contrasting knowledge systems currently at play in the CE governance debate may thus lead to a mismatch of governance objects on different levels: Policymakers re-producing strategic political discursive structures may be most interested in prioritizing enabling governance for approaches which seem to promise 'big picture' solutions to climate policy dilemmas, i.e., helping to meet strategic temperature and emissions targets. These may not be the same 'governance objects' discursively constituted within economic discourse as the most cost-effective approaches, which may cause conflict between those re-producing elements

of these two knowledge systems. In addition, both the economic and political discursive structures seem to be at odds with ethical logics which focus on more situated, non-tangible criteria for defining CE for governance purposes: Discourse ethical knowledge re-producers (NGOs, RRI pundits etc.) may define 'politically effective' CE solutions as the object of restrictive governance (i.e., bans) if the key criterion of social acceptability is not met. Those reproducing ethics of care logics may even define 'socially acceptable' CE measures as the object of restrictive governance if they are seen to risk disrupting the balance of care between human and non-human elements within socio-ecological systems.

Looking forward, mapping the diverse ways in which different discourses shape the formation of CE governance objects could provide a springboard to integrating diverse knowledges into assessments to establish which types of CE may fall within the win-set of overlapping (political, economic, discourse & care ethical) criteria and as such be defined as transdisciplinary objects of governance.

Rationales

The results presented across all chapters of this dissertation have shown that *a dominant triad of political (strategic), economic (utilitarian) and normative (ethical) rationale types are structuring calls for governance across science, policy, industry, and civil society spheres of the CE debate*. Among these three, the economic, utilitarian rationality remains central, positing that CE governance should primarily involve efforts towards rational problem solving, and be guided by cost-benefit and risk management assessments. As Chapter 10 highlights, utilitarian, neo-liberal rationales have historically shaped a longer arc of climate governance and may continue to play a key constitutive role in the emergence of CE governance. However, the analysis of national policy and international governance spheres (Chapters 6 & 8) showed that strategic, explicitly political rationales are also increasingly at play – emphasising that CE governance should be primarily driven by the need to protect (national) interests, and to influence (change or maintain) the balance of power in the international system.

Lastly, the case studies also revealed *that explicitly normative/ethical rationales for governance were being reproduced in all the discursive spheres analysed*. The results showed that the widest range of types of overtly ethical logics were at play in the religious civil-society sphere of the debate – spanning virtuous, deontological, and consequentialist rationales for governance. The results outlined in Chapter 7 show that these may be partially complementary with the discourse ethical (norm creation through communicative practice as virtue ethics), political (legal, principle-based top-down enforcement as deontological ethics) and economic (neoliberalism based on utilitarianism as consequentialist ethics) discourse/knowledge systems underpinning calls for governance in both the industry/policy and science/policy spheres.

As CE governance discussions increasingly cut across scientific, industrial, political, and civil society spheres, there is a need to better understand the potential for complementarity and/or conflict between political (strategic), economic (utilitarian) and ethical (normative) rationales for governance. The results presented here indicate that ethical knowledge systems could play a bridging role in governance development by making explicit the integrative connections between 'normative' governance rationales that span wider spheres of the debate. Looking forward, a more detailed analysis of interconnected relationships between these types

of governance rationales may inform the development of transdisciplinary thinking about the nature and practice of CE governance that integrates different types of knowledges.

Speaker positions and discourse coalitions

Taking a step back to compare the speaker positions available within each of the spheres analysed in the preceding chapters can help to begin answering the question as to whether one or more discourse coalition(s) is emerging in the CE governance debate. As Figure 8 illustrates, there are some overlaps between the speaker positions available within the spheres analysed, indicating discourse coalitions may be coalescing around different knowledge systems spanning spheres of the CE debate.

Speaker positions which reproduce utilitarian logics (in blue) link the science/policy and industry/policy sphere. In particular, the **Responsible Information Provider** speaker position is key in both spheres. Governance roles associated with this speaker position include; (1) providing objective information to decision-makers to inform the development of problem-specific governance mechanisms; (2) explaining or demonstrating the scientific grounds for the need for governance of a particular activity; (3) providing ongoing input into the decision-making process to inform the iterative design of adaptive governance for
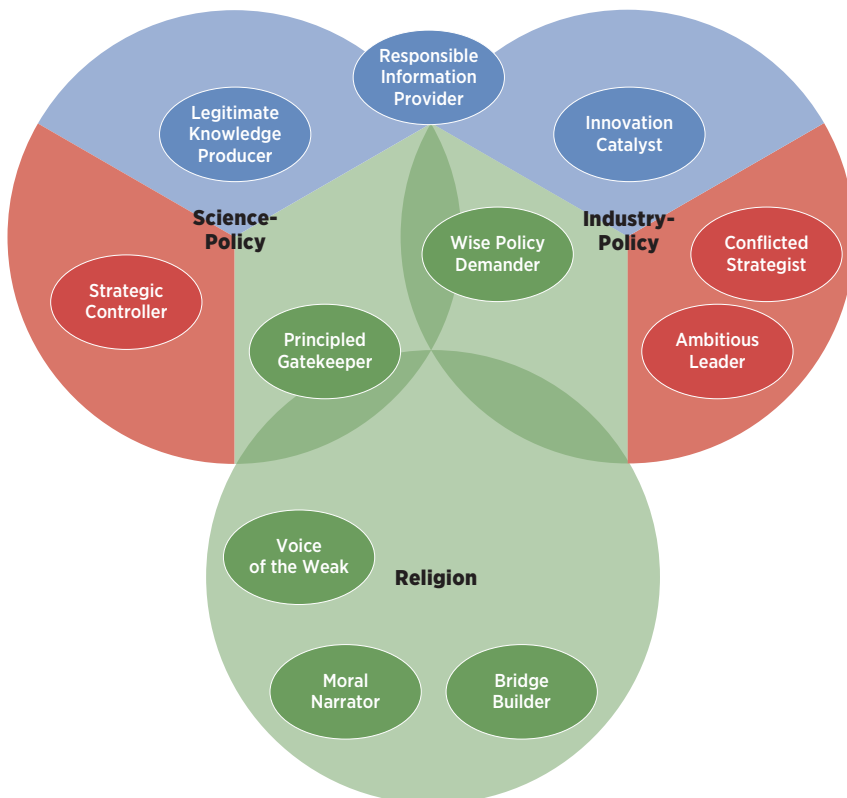

Figure 8: Emerging discourse coalitions spanning spheres of the CE governance debate. Blue = functional/utilitarian, Red = strategic/political, Green = normative/ethical

emerging technologies; and (4) producing evidence of the effectiveness of specific governance mechanisms to deal with governance problems (see Sections 5.1.5 & 6.4.2., Figure 6, Table 7, and Supplementary Table 2). Although this speaker position is often associated with scientists or other experts, there is some indication it may be being expanded to include a wider range of **Legitimate Knowledge Producers** – as the example of the speaker position being afforded to indigenous peoples and local communities (IPLCs) in the CBD shows (see Section 8.4.3. and Supplementary Table 6).

There are also similarities between some speaker positions which incorporate strategic logics (in red) in both the science/policy and industry/policy spheres. For example, the **Strategic Controller** speaker position identified in the science/industry sphere – associated with (1) developing leverage to constrain (undesirable) research activity and prevent conflict; (2) providing robust authorization for desirable/useful research activities; (3) engaging in long-term strategic societal and environmental planning to inform governance goals – can be seen as an amalgamation of two more differentiated speaker positions in the industry/policy sphere – the **Conflicted Strategist** and the **Ambitious Leader** (see Sections 5.1.5 & 6.4.1). Whereas the Conflicted Strategist is associated with balancing planning long-term policy for the common good (to prevent dangerous climate change), and acting reactively short-term to maintain political power, the Ambitious Leader is associated with taking the lead on the international climate policy stage by developing governance standards as an example for the world. This may indicate that there is a nascent discourse coalition forming around strategic speaker positions spanning the scientific, policy and industry spheres of the CE governance debate.

Lastly, the comparison of the case studies carried out in this project shows that several similar expressly normative/ethical speaker positions were provided in each sphere analysed (in green). For example, the **Principled Gatekeeper** speaker position available in the science/policy is associated with: (1) ensuring accountability in the development of governance; (2) pushing issues onto the governance agenda by bringing emerging topics to the attention of policy-makers; (3) facilitating communication by increasing the level of public attention to emerging governance issues; and (4) representing the rights and interests of those under-represented, such as minorities, future generations and the non-human environment, in the development of governance. As such, it shares elements of both the **Voice of the Weak** and the **Bridge Builder** speaker positions available in the religious civil society sphere, which are associated with brining underrepresented perspectives into governance development processes, and bringing people together, overcoming divides, and promoting collaboration on governance, respectively (see Sections 5.1.5 & 6.4.3). Likewise, it incorporates some elements of the **Wise Policy Demander** speaker position in the industry/policy sphere, which is associated with altruistically calling for long-term CE policy for the common good (see Table 7). This may indicate there is an emergent discourse coalition forming around shared (explicitly) normative speaker positions spanning the scientific, political, industrial, and civil society spheres of the CE debate.

Looking forward, further elucidation of the speaker positions being adopted by and assigned to social actors in the CE debate could highlight nascent or unrecognized linkages between discourse/knowledge systems – spanning multiple spheres of the debate – in the form of shared speaker positions. This could facilitate the emergence of a transdisciplinary discourse coalition which incorporates legitimate speaker positions from multiple knowledge systems.

Modes and instruments

Looking across all the case studies presented above shows that *three main governance modes and their associated instruments are being discursively constituted within the CE debate: Laissez faire neoliberalism (economic), top-down control/management (political), and participatory deliberation/co-creation (discourse/virtue ethical)* (compare e.g., Sections 5.1.5, 6.4 &. 7.3.4). Although the first two modes have played a significant role in global climate governance historically (see Chapter 10), contrary to my own expectations, less well-established governance modes based on participation and deliberation were within the 'discursive boundaries of possibility' in all spheres analysed. This would seem to suggest there may be a discursive basis for a transdisciplinary, participatory mode of governance development and practice which spans multiple spheres of the CE governance debate.

However, the results presented here show that there remains some tension between underlying understandings of the purpose of such a mode. While some social actors reproduce the idea of a deliberative mode in governance as a way to reach consensus on a set of pre-defined options through rational argumentation, others envisage a co-creative participatory process in which governance options emerge bottom-up (compare Sections 6.4.3 & 7.4.3). In line with recent developments in wider realms of global environmental governance, the CE governance debate may be reflecting a move away from political (control, top down management as not possible or desirable in an interconnected Earth system without a global government), and economic modes of governing (as relying on market logics to ensure that the governance option that will provide the greatest good to the highest number will naturally emerge neglects ethical questions of equity, justice and care in an interconnected Earth system), towards a systemic, relational logic that reconceptualizes Earth system governance as reciprocal and responsible care (see Chapter 7).

Looking forward, there is a need to further investigate how a discursive shift towards a relational governance mode (see especially Chapter 7) may allow for the emergence of a 'system of thinking about the nature and practice of governance' that involves the complementary integration of multiple CE governance modes and instruments in subsidiary (sub)systems.

Summary: Emerging discursive blueprints for CE governmentalities

The results presented in this thesis indicate that the CE governance debate is underpinned by elements of resilient neoliberal governmentalities which have long shaped climate governance, and arguably delayed decarbonisation. There is thus a real risk that discursive and material structures of CE governance may file into well-worn, perverse pathways. However, there is also an indication that wider discourse/knowledge systems are becoming involved in shaping the emergence of CE governance – perhaps as the idea of deliberately intervening into the global climate system may be emblematic of a broader and deeper reconsideration of the role of humanity in the Earth system.

Taken together, the results presented above show that elements of alternative blueprints for CE governmentalities – those which are more inclusive, participatory, reciprocal, just, responsible, and care-based – may become thinkable and practicable in the future. As the technologies and their governance are currently in the process of being constituted, critically assessing the structures underpinning CE discussions can provide those engaged in the debate with an opportunity to consciously reflect upon possible future developments. Such reflexive

moments are especially relevant at the early, constitutive stages of technological emergence, when science, politics, industry and wider society alike still have important roles to play in shaping their future trajectories (Jasanoff and Kim, 2009, Boettcher and Schäfer, 2017: 9). Critically anticipating how discursive structures at play today may manifest in *de facto* and *de jure* governance arrangements tomorrow is one way to help ensure that 'the past need not be prologue' in CE governance (Chapter 10).

11.4   Implications for global environmental governance

In this chapter so far, I have focused on summarising and reflecting upon the results of the thesis in light of the CE-specific research questions. This final section goes a step further by outlining a set of broader insights generated during this project, and discussing their potential relevance for global environmental governance writ large.

Discourse, knowledge, and power

Integrating a post-structural understanding of discourse into the investigation of global environmental governance development has fundamental effects on how to conceptualize power: Discourse – understood as a structuring system of knowledge – has the power to shape the who, why, how and what of global environmental governance. A post-structural understanding of discourse posits a constitutive link between discourse and governance development, emphasizing that "social objects, subjects and relations […] are contingent and co-constituted through discursive practices that render some […] knowable and governable and others not" (Leipold et al., 2019: 446). By limiting what knowledges and truths about a given issue can be imagined and debated, discursive structures shape the formation of socially meaningful governance rationales, objects, and subjects, and can manifest themselves in the development of corresponding governance modes and instruments (see especially Chapters 5 & 6). Discourse/knowledge and power are thus understood to be inextricably connected: "How one knows shapes how one governs. Knowledge practices are tied to political rationalities that make the application of power seem both natural and inevitable" (Hulme, 2015: 558, see also Turnhout et al., 2015).

The types of discourse/knowledge that are foregrounded in the development of environmental governance therefore have performative effects as "through knowledge, specific and selective representations of the environment are produced. […] these representations are much more than just (imperfect) mirrors of nature because they shape not only how we conceptualise and know the environment, but also how we enact it in policy and management" (Turnhout, 2018: 363). Specific types of discourse/knowledge thus constitute global environmental objects that are "amenable to certain specific governance logics and which privilege certain groups of actors. Consequently, these representations also inevitably exclude other actors and other governance logics" (Turnhout, 2018: 366).

As has been shown in the case of CE, elucidating the structuring power of discourse/ knowledge dynamics can have two-fold implications for the development of global environmental governance more generally. First, mapping discursive structures currently shaping the objects, subjects, rationales, modes and instruments of a given global

environmental issue can help to *anticipate and critically reflect upon* how governance of that issue may develop in the future. By mapping how certain types of governance are discursively being rendered thinkable and practicable, my analytical approach can help expose the contingent nature of emerging governance, and enable critical reflection of seemingly self-evident or necessary governance developments (Lövbrand and Stripple, 2011: 188). Such critical reflection may help anticipate how future global environmental governance could avoid the pitfalls of the past (see especially Chapter 10).

Secondly, deconstructive discourse analysis is an *emancipatory* means to make clear the contingent nature of the dominant discourse(s) currently structuring the emergence of governance of a given issue, and to open the way for increased discourse/knowledge diversity. A case in point is the current approach to the global governance of climate change, which has proven to be largely ineffective. As others have argued, "there is a need for more open arguments about the forms of governance and politics – and hence the sorts of knowledge – that best serve the diverse and diverging human projects that proliferate around the world that have a bearing on climate change" (Hulme, 2015: 560, See also Fischer, 2015). Approaching the analysis of ongoing environmental governance development with a post-structural understanding of discourse can help in this regard: By identifying the bounds of the discursive 'blueprints' currently shaping governance development so that existing knowledge 'walls' excluding more diverse types of knowing may begin to be torn down (see also section on 'opening up' governance development below).

Navigating structure and agency

If we acknowledge the structuring power of discourse to shape what sorts of governance can become thinkable and practicable, what does that mean for the agency of political and social actors in global environmental governance? The post-structuralist approach to discourse and governmentality does not, as sometimes posited, deny agency. Rather, it recognises that behaviour is neither dictated structurally nor solely the result of the free will of individuals, but rather a combination of both; that is, agency is decentred, relational, and situated (Dekker et al., 2020: 138).

Situated agency means that social actors engaged in governance development are always negotiating existing discursive (and materialized) structures. Social actors are constituted as subjects and legitimized as speakers by existing structures, but that does not mean they are completely constrained by them. By uncovering and critically assessing the performativity of given discursive structure, we can emancipate ourselves and others to recognize the power/knowledge structures we are reproducing and thus to better navigate the structure(s) we/they operate within.

In addition, conceiving of agency as situated within structure can facilitate alternative understandings of the opportunities and barriers in transformation processes. Although resilient, a given discursive structuration is never fixed or permanent: by choosing to reproduce certain elements of a given structure while neglecting others, social actors may gradually alter the overall construction. This process can be aided by the exposition of the inherently constructed nature of such structures. The Foucauldian approach highlights that discursive structure is "not so much like a steel web as a spider's"; while we may be unable to completely escape its restrictive netting, "we are not so trapped as to be immobilized" (Lipschutz, 2014:

xvi). Exposing the underpinning 'web' of structures within which they operate, and elucidating the shaping it effects it has on how a given debate is being conducted can therefore afford social actors some freedom to expand the discursive conditions of possibility (Keller, 2018b, see also Chapter 6).

A post-structural reconceptualization to the role of agency in global environmental governance development may thus help those who recognize the dominant discursive/ knowledge structures at play to "problematise naturalised and taken for granted classifications, frameworks and ways of working. […] build environmental knowledge collectives where premature closure and consensus are prevented, where space is created for continued questioning and contestation, and where all relevant knowledge holders are able to carve out sufficient space to enact their role[s]" (Turnhout, 2018: 368).

The interplay of discursive and material structures

My approach to analysing governance discussions and development posits that discursive structures can manifest in the form of institutionalised structures (process, practices, and infrastructures) which in turn shape what sorts of discourse/knowledge can be legitimately reproduced in a given setting. Material institutional structures are thus conceived of as being shaped by and shaping discourse in an ongoing, co-constitutive process (cf. Hajer, 2005, Leipold et al., 2019, Stripple and Bulkeley, 2014, Lövbrand and Stripple, 2014).

As I have argued using CE as an example, understanding the co-constitutive dynamics of material and discursive structures can help anticipate challenges and opportunities of global environmental governance in differing institutional settings. I have shown that varying structural 'conditions of possibility' have the power to shape how the same environmental issue is governed differently in various forums, highlighting that neither an exclusive focus on institutional 'hardware' nor on 'discursive' software is sufficient to understand the emergence of governance. Using a framework that brings together the analysis of material and discursive structures can thus help to anticipate, critically reflect upon, and more successfully navigate the emergence of global environmental governance in the Anthropocene.

These insights also contribute to an ongoing debate on the role of discourse in shaping political institutions. Social constructivist institutionalist theories often still prioritize the subjective and ideational agency of actors, rather than integrating the power of discursive and materialized structures themselves into the analysis (e.g. Constructive Institutionalism, Hay, 2006, Discursive Institutionalism, Schmidt 2008). Rather, I follow Post-structural Institutionalists in arguing that discourses shape and constitute processes of institutional resilience and change (Larsson, 2015, 2018, 2020, see also Chapter 9).

A post-structuralist understanding of discursive and material structures as relatively resistant to change suggests that whether and how new environmental issues are governable on the global level will depend on current discursive and material structures in various international forums. This may seem to indicate that governance of novel global environmental problems is unlikely to be innovative – but will rather file into the well-worn (and often perverse) paths established by historically resilient discursive and material structures (see Chapter 10). Post-structuralist theories, however, do not posit that structure is restrictive enough to preclude all change. Rather, they highlight the emancipatory function of elucidating reified discursive and material institutional structures. Thus, mapping the discursive and

material structures which form the 'conditions of possibility' making certain types of environmental governance seem most appropriate within a given forum may enable those engaging in governance development to recognize and critically reflect upon their contingent nature – a necessary first step towards considering novel alternatives (Hajer, 2005).

'Opening up' discursive diversity in global environmental governance development

A structural approach to understanding the structuring role of discourse in governance development highlights the ways in which discursively constituted power/knowledge structures privilege some types of knowledge while marginalizing others. Discursive structures constitute what counts as legitimate governance 'truths' within the debate – what can be said, by whom, with what authority. This insight into the structuring role of discourse highlights that simply bringing more voices into the debate will not necessarily 'open up' the structure of the debate, as new types of knowledge and those reproducing it may continue to be 'outside the discursive bounds of possibility' set by the existing discursive structure of a given environmental governance debate. There is a need to first find the existing bounds of the discursive power/knowledge structures at play in order to begin to contest and expand them. Mapping discursive structures underpinning governance debates can help with this process of resistance and contestation: By assessing what knowledge(s) and truths about governance are influential and predominant; by exploring the respective relationships of knowledge and power, and to subjecting them to criticism with an eye to stepping beyond them and enabling more 'plural' governance development.

But discursive mapping can – and in my opinion should – go beyond critical reflection. Paired with engagement exercises, it can help actively expand the discursive conditions of possibility. Harkening back to a criticism once levelled at my approach (see section 5.6); discourse analysis should not be likened to pulling apart an IKEA table for the simple purpose of understanding its constituent parts. Rather, discourse analysis should be about deconstructing something and showing how it can be put together in different ways – perhaps with additional components and correspondingly expanded functions. In addition to identifying dominant discursive structures and marginalized knowledge types, a post-structuralist approach enables the identification of emerging counter-discourses, as well as highlighting potential synergies between rationalities and speaker positions, thus revealing the basis for possible new (transdisciplinary) discourse coalitions (see also section 11.3).

In particular, I see the potential for discursive mapping approaches to be linked to co-productive, participatory governance development processes. As others have pointed out, such processes, although actively trying to integrate various knowledge types, commonly struggle to overcome power inequalities, especially those related to the discursive authority assigned to scientific expertise vis-à-vis other discourse/knowledge systems. Such participatory processes are often dominated by rational, functional, scientific logics that evoke utilitarian ideas of what is 'the best' solution to a given environmental governance issue. This discursive structure "pressurizes non-elite participants to stay within this scientifically sanctioned rationality" (Turnhout et al., 2020: 16), and thus participatory processes "in practice end up reinforcing and strengthening traditional modes of knowledge production and dissemination, in which scientists are cast as holders of knowledge and other stakeholders as holders of values

or perspectives to be corrected by science, as receivers of scientific expertise, and as co-creators of solutions" (Turnhout et al., 2020: 17).

A recent review of literature on the power dimensions of co-production has highlighted that the key to overcoming these shortcomings is "making power explicit and reflecting on the, often implicit, assumptions and expectations held by participants about each other's roles and responsibilities". This "will be vital to allow for pluralism, create scope to highlight differences and, enable the contestation of interests, views, and knowledge claims" (Turnhout et al., 2020: 17-18).

Co-production academics and practitioners are well aware that different knowledge systems use different methods and styles of reasoning and the boundaries between them can be difficult to be overcome. In particular, the reproduction of conflicting rationalities in participatory governance development processes has been shown to have harmful consequences for the development of joint governance, (Dekker et al., 2020: 138, Turnhout et al., 2010). However, co-production experts emphasise that identifying shared objects, concepts, areas, or problems can serve as boundary objects and points of encounter for the integration of knowledge systems during participatory processes (Matuk et al., 2020: 2), and that "it is key to empower participants to negotiate taken-for-granted assumptions that structure knowledge processes, all must be transparent about their assumptions and expectations, and about the implications of their knowledge choices" (Matuk et al., 2020: 8).

I posit that mapping discourse/knowledge structures to identify governance rationalities, objects, subject and speaker positions being re-produced or 'performed' by participants of a given participatory process can enable the explicit reflection on these elements (cf. Hajer and Uitermark, 2008, Hajer, 2009). Such a mapping exercise could form part of a wider process of 'reflexive questioning' in which participants of the participatory process are encouraged to reflect upon how their interactions are shaped by their discourse/knowledge-based assumptions (Matuk et al., 2020).

Others have pointed out that eliciting rationalities underpinning participatory governance processes can be "the start of openly discussing potential tensions and conflicts and identifying potential synergies. The point of such meaningful engagement is not to win arguments and convince opponents, but to exchange views to allow mutual understanding of other rationalities and the consequent possibility to forge a common ground" (Dekker et al., 2020: 145-6).

Practically, a structural discourse analysis can lay the groundwork for participatory governance development processes by producing maps of privileged and excluded types of discourse/knowledge underpinning a given debate. Such maps could aid both facilitators and participants, showing them the discursive structures they reproduce, which subject/speaker positions they assign or adopt, and which types of knowledge they privilege or exclude. This would allow them to situate themselves within or in opposition to privileged speaker positions and types of knowledge, and to re-evaluate the 'reality inputs' they would feed into deliberations – thus helping to 'open up' environmental governance development processes (Chilvers et al., 2018, Matuk et al., 2020, Turnhout et al., 2020, Dekker et al., 2020, see also Chapter 6).

This final chapter of my thesis has summarized my main empirical findings, critically reflected upon them, and attempted to draw out some broader insights relevant for global

environmental governance. In addition to detailing how my thesis addressed its original research questions, I have discussed how my approach offers a framework for (1) shifting the analytical perspective on the power of discourse in (CE) governance development processes; (2) anticipating and critically reflecting upon how given discursive structures may be making certain types of (CE) governance more/less thinkable and practicable, (3) emancipating those engaging in (CE) governance debates to recognize and (potentially expand the bounds of) the discursive power/knowledge structures they are reproducing, and (4) informing the design of participatory processes to further "open up" discursive diversity in CE and border global environmental governance development processes. As the debate about deliberate anthropogenic interventions into the Earth system further evolves, I believe that continuing to decipher its discursive 'source code' is key to both anticipating governance emergence and emancipating those engaged in the debate to expand the discursive conditions of possibility.

Bibliography

AJANOVIC, A. 2011. Biofuels versus food production: Does biofuels production increase food prices? *Energy,* 36**,** 2070-2076.

ALLEN, M. R. 2015. Short-lived promise? The science and policy of cumulative and short-lived climate pollutants. *Oxford Martin Policy Paper.*

AMELUNG, D. & FUNKE, J. 2015. Laypeople's Risky Decisions in the Climate Change Context: Climate Engineering as a Risk-Defusing Strategy? *Human and Ecological Risk Assessment: An International Journal,* 21**,** 533-559.

ANDERSON, K. 2015. Duality in climate science. *Nature Geoscience,* 8**,** 898-900.

ANDERSON, K. & PETERS, G. 2016. The trouble with negative emissions. *Science,* 354**,** 182-183.

ANKAMAH-YEBOAH, I., XUAN, B. B., HYNES, S. & ARMSTRONG, C. W. 2020. Public Perceptions of Deep-Sea Environment: Evidence From Scotland and Norway. *Frontiers in Marine Science,* 7.

ANSHELM, J. & HANSSON, A. 2014. The Last Chance to Save the Planet? An Analysis of the Geoengineering Advocacy Discourse in the Public Debate. *Environmental Humanities,* 5**,** 101-123.

ARMENI, C. & REDGWELL, C. 2015. International legal and regulatory issues of climate geoengineering governance: rethinking the approach. *Climate Geoengineering Governance Working Paper Series: 021.*

ASAYAMA, S., SUGIYAMA, M. & ISHII, A. 2017. Ambivalent climate of opinions: Tensions and dilemmas in understanding geoengineering experimentation. *Geoforum,* 80**,** 82-92.

ASILOMAR SCIENTIFIC ORGANIZING COMMITTEE 2010. *The Asilomar Conference Recommendations on Principles for Research into Climate Engineering Techniques.* MACCRACKEN, M. (ed.). Washington DC: Climate Institute.

AYKUT, S. C. 2016. Taking a wider view on climate governance: moving beyond the 'iceberg', the 'elephant', and the 'forest'. *WIREs Climate Change,* 7**,** 318-328.

BÄCKSTRAND, K., KAHN, J., KRONSELL, A. & LÖVBRAND, E. 2010. The promise of new modes of environmental governance. *In:* BÄCKSTRAND, K., KAHN, J., KRONSELL, A. & LÖVBRAND, E. (eds.) *Environmental Politics and Deliberative Democracy: Examining the Promise of New Modes of Governance.* Cheltenham: Edward Elgar Publishing.

BÄCKSTRAND, K. & LÖVBRAND, E. 2006. Planting Trees to Mitigate Climate Change: Contested Discourses of Ecological Modernization, Green Governmentality and Civic Environmentalism. *Global Environmental Politics,* 6**,** 50-75.

BÄCKSTRAND, K. & LÖVBRAND, E. 2016. The Road to Paris: Contending Climate Governance Discourses in the Post-Copenhagen Era. *Journal of Environmental Policy & Planning,* 21**,** 519-532.

BÄCKSTRAND, K., MEADOWCROFT, J. & OPPENHEIMER, M. 2011. The politics and policy of carbon capture and storage: Framing an emergent technology. *Global Environmental Change,* 21**,** 275-281.

BAIN, PAUL G., MILFONT, TACIANO L., KASHIMA, Y., BILEWICZ, M., DORON, G., GARÐARSDÓTTIR, RAGNA B., GOUVEIA, VALDINEY V., GUAN, Y., JOHANSSON, L.-O., PASQUALI, C., CORRAL-

VERDUGO, V., ARAGONES, JUAN I., UTSUGI, A., DEMARQUE, C., OTTO, S., PARK, J., SOLAND, M., STEG, L., GONZÁLEZ, R., LEBEDEVA, N., MADSEN, OLE J., WAGNER, C., AKOTIA, CHARITY S., KURZ, T., SAIZ, JOSÉ L., SCHULTZ, P. W., EINARSDÓTTIR, G. & SAVIOLIDIS, N. M. 2016. Co-benefits of addressing climate change can motivate action around the world. *Nature Climate Change,* 6**,** 154-157.

BAKER, S. E. & EDWARDS, R. 2012. *How many qualitative interviews is enough?* National Centre for Research Methods Review Paper. London: Economic and Social Research Council (ECRC) National Centre for Research Methods (NCRM).

BARNETT, M. N. 2005. *Power in global governance,* Cambridge, Cambridge Univ. Press.

BECK, S. & MAHONY, M. 2018. The politics of anticipation: the IPCC and the negative emissions technologies experience. *Global Sustainability,* 1**,** e8.

BELLAMY, R. 2016. A Sociotechnical Framework for Governing Climate Engineering. *Science, Technology, & Human Values,* 41**,** 135-162.

BELLAMY, R. 2018. Incentivize negative emissions responsibly. *Nature Energy,* 3**,** 532-534.

BELLAMY, R., CHILVERS, J. & VAUGHAN, N. E. 2016. Deliberative Mapping of options for tackling climate change: Citizens and specialists 'open up' appraisal of geoengineering. *Public Understanding of Science,* 25**,** 269-286.

BELLAMY, R., CHILVERS, J., VAUGHAN, N. E. & LENTON, T. M. 2012. A review of climate geoengineering appraisals. *WIREs Climate Change,* 3**,** 597-615.

BELLAMY, R. & GEDEN, O. 2019. Govern CO_2 removal from the ground up. *Nature Geoscience,* 12**,** 874-876.

BELLAMY, R. & LEZAUN, J. 2017. Crafting a public for geoengineering. *Public Understanding of Science,* 26**,** 402-417.

BELLAMY, R., LEZAUN, J. & PALMER, J. 2017. Public perceptions of geoengineering research governance: An experimental deliberative approach. *Global Environmental Change,* 45**,** 194-202.

BELLAMY, R., LEZAUN, J. & PALMER, J. 2019. Perceptions of bioenergy with carbon capture and storage in different policy scenarios. *Nature Communications,* 10**,** 743.

BELTER, C. W. & SEIDEL, D. J. 2013. A bibliometric analysis of climate engineering research. *Wiley Interdisciplinary Reviews: Climate Change,* 4**,** 417-427.

BEMELMANS-VIDEC, M. L., RIST, R. C. & VEDUNG, E. O. 2010. *Carrots, sticks, and sermons: Policy instruments and their evaluation,* New Brunswick and London, Transaction Publishers.

BERNSTEIN, S., BETSILL, M., HOFFMANN, M. & PATERSON, M. 2010. A Tale of Two Copenhagens: Carbon Markets and Climate Governance. *Millennium,* 39**,** 161-173.

BERNSTEIN, S. & HOFFMANN, M. 2019. Climate politics, metaphors and the fractal carbon trap. *Nature Climate Change,* 9**,** 919-925.

BETZ, G. & CACEAN, S. 2012. *Ethical Aspects of Climate Engineering,* KIT Scientific Publishing, Karlsruhe.

BIERMANN, F. 2016. Politics for a New Earth: Governing in the "Anthropocene". *In:* NICHOLSON, S. & JINNAH, S. (eds.) *New Earth Politics: Essays from the Anthropocene.* Cambridge & London: MIT Press.

BIERMANN, F. 2021a. It is dangerous to normalize solar geoengineering research. *Nature* 595.

BIERMANN, F. 2021b. Reflections on the NAS Report on Solar Geoengineering Research. *Global Sustainability Governance.* Online: https://www.frankbiermann.org/post/reflections-on-the-nas-report-on-solar-geoengineering-research. Accessed 01.07.2021.

BIERMANN, F. & KALFAGIANNI, A. 2020. Planetary justice: A research framework. *Earth System Governance***,** 100049.

BIERMANN, F. & KIM, R. E. 2020. Architectures of Earth System Governance: Setting the Stage. *In:* BIERMANN, F. & KIM, R. E. (eds.) *Architectures of Earth System Governance: Institutional Complexity and Structural Transformation.* Cambridge: Cambridge University Press.

BIERMANN, F. & LÖVBRAND, E. 2019. Encountering the 'Anthropocene': Setting the Scene. *In:* BIERMANN, F. & LÖVBRAND, E. (eds.) *Anthropocene Encounters: New Directions in Green Political Thinking.* Cambridge & New York: Cambridge University Press.

BIERMANN, F. & MÖLLER, I. 2019. Rich man's solution? Climate engineering discourses and the marginalization of the Global South. *International Environmental Agreements: Politics, Law and Economics,* 19**,** 151-167.

BILLIG, M. 1987. *Arguing and Thinking*, Cambridge, Cambridge University Press.

BLACKSTOCK, J. J. & LOW, S. (eds.) 2018. *Geoengineering our climate? Ethics, politics, and governance.,* London: Earthscan from Routledge.

BLUM, M. & LÖVBRAND, E. 2019. The return of carbon offsetting? The discursive legitimation of new market arrangements in the Paris climate regime. *Earth System Governance,* 2**,** 100028.

BODLE, R. & OBERTHUER, S. 2014. Options and Proposals for the International Governance of Geoengineering. Report prepared on behalf of the Federal Environment Agency (Germany), Berlin.

BOETTCHER, M. 2012. *Climate Engineering Discourse in the United States of America: Cautiously preparing for a Climate Emergency* Master of Arts Master Thesis, University of Heidelberg.

BOETTCHER, M. 2019. Cracking the Code: How discursive structures shape Climate Engineering Research Governance. *Environmental Politics*. 29(5), 890-916.

BOETTCHER, M. 2020. Coming to GRIPs With NETs Discourse: Implications of Discursive Structures for Emerging Governance of Negative Emissions Technologies in the UK. *Frontiers in Climate,* 2(20).

BOETTCHER, M. 2021. A Leap of Green Faith: The Religious Discourse of Socio-Ecological Care as an Earth System Governmentality. *Environmental Policy & Planning*, 24(1), 81-93

BOETTCHER, M. & KIM, R. E. 2022. Arguments and architectures: Discursive and institutional structures shaping global climate engineering governance. *Environmental Science and Policy*, 128, 121-131

BOETTCHER, M. & SCHÄFER, S. 2017. Reflecting upon 10 years of geoengineering research: Introduction to the Crutzen + 10 special issue. *Earth's Future,* 5**,** 266-277.

BOETTCHER, M. & SCHÄFER, S., HONEGGER, M., LOW, S., LAWRENCE, M. G. 2017a Carbon Dioxide Removal. *IASS Fact Sheet,* 2017, 1. Potsdam. IASS.

BOETTCHER, M. & SCHÄFER, S., HONEGGER, M., LOW, S., LAWRENCE, M. G. 2017b Solar Radiation Management. *IASS Fact Sheet,* 2017, 2. Potsdam, IASS.

BOWERMAN, N. H. A., FRAME, D. J., HUNTINGFORD, C., LOWE, J. A., SMITH, S. M. & ALLEN, M. R. 2013. The role of short-lived climate pollutants in meeting temperature goals. *Nature Climate Change,* 3**,** 1021-1024.

BOYD, E., CORBERA, E. & ESTRADA, M. 2008. UNFCCC negotiations (pre-Kyoto to COP-9): what the process says about the politics of CDM-sinks. *International Environmental Agreements: Politics, Law and Economics,* 8**,** 95-112.

BRACMORT, K. & LATTANZIO, E. C. 2013. Geoengineering: Governance and Technology Policy, R4137. Washington, DC.: Congressional Research Service.

BRAND, S. 2009. *Whole earth discipline: an ecopragmatist manifesto,* New York, Viking Press.

BRENT, K. B., WIL AND JEFFREY MCGEE 2019. *Governance of Marine Geoengineering*. Waterloo, Centre of International Governance Innovation, Canada.

BRONDIZIO, E. S., O'BRIEN, K., BAI, X., BIERMANN, F., STEFFEN, W., BERKHOUT, F., CUDENNEC, C., LEMOS, M. C., WOLFE, A., PALMA-OLIVEIRA, J. & CHEN, C.-T. A. 2016. Re-conceptualizing the Anthropocene: A call for collaboration. *Global Environmental Change, 39,* 318-327.

BROWN, N., RAPPERT, B. & WEBSTER, A. (eds.) 2000. *Contested Futures: A Sociology of Prospective Techno-science,* Aldershot, Ashgate.

BUCK, H. J. 2014. Village Science Meets Global Discourse: The Haida Salmon Restoration Corporation's Ocean Iron Fertilization Experiment. *In:* BLACKSTOCK, J. & LOW, S. (eds.) *Geoengineering our Climate? Ethics, Politics, and Governance.* New York, Routledge.

BUCK, H. J. 2016. Rapid scale-up of negative emissions technologies: social barriers and social implications. *Climatic Change, 139,* 155-167.

BUDYKO, M. 1977. Contemporary Climatic Changes. In: *Climatic Changes,* Washington D.C., American Geophysical Union.

BUI, M., ADJIMAN, C. S., BARDOW, A., ANTHONY, E. J., BOSTON, A., BROWN, S., FENNELL, P. S., FUSS, S., GALINDO, A., HACKETT, L. A., HALLETT, J. P., HERZOG, H. J., JACKSON, G., KEMPER, J., KREVOR, S., MAITLAND, G. C., MATUSZEWSKI, M., METCALFE, I. S., PETIT, C., PUXTY, G., REIMER, J., REINER, D. M., RUBIN, E. S., SCOTT, S. A., SHAH, N., SMIT, B., TRUSLER, J. P. M., WEBLEY, P., WILCOX, J. & MAC DOWELL, N. 2018. Carbon capture and storage (CCS): the way forward. *Energy & Environmental Science, 11,* 1062-1176.

BULKELEY, H. & STRIPPLE, J. 2014. Towards a Critical Social Science of Climate Change? *In:* STRIPPLE, J. & BULKELEY, H. (eds.) *Governing the Climate: New Approaches to Rationality, Power & Politics.* New York, Cambridge University Press.

BULKELEY, H., WATSON, M. & HUDSON, R. 2007. Modes of Governing Municipal Waste. *Environment and Planning A: Economy and Space, 39,* 2733-2753.

BURCHELL, G., GORDON, C. & MILLER, P. 1991. *The Foucault Effect: Studies in Governmentality,* Chicago, Chicago University Press.

BUTLER, C., PARKHILL, K. & PIDGEON, N. F. 2013. Deliberating Energy System Transitions in the UK, Transforming the UK Energy System: Public Values, Attitudes and Acceptability. London, UK Energy Research Centre.

CADMAN, T., MARASENI, T., MA, H. O. & LOPEZ-CASERO, F. 2017. Five years of REDD+ governance: The use of market mechanisms as a response to anthropogenic climate change. *Forest Policy and Economics, 79,* 8-16.

CAIRNS, R. 2016. Climates of suspicion: 'chemtrail' conspiracy narratives and the international politics of geoengineering. *Geographical Journal, 182,* 70-84.

CALDEIRA, K., BALA, G. & CAO, L. 2013. The Science of Geoengineering. *Annual Review of Earth and Planetary Sciences, 41,* 231-256.

CALEL, R. 2013. Carbon markets: a historical overview. *WIREs Climate Change, 4,* 107-119.

CAPSTICK, S. B., PIDGEON, N. F., CORNER, A. J., SPENCE, E. M. & PEARSON, P. N. 2016. Public understanding in Great Britain of ocean acidification. *Nature Climate Change, 6,* 763-767.

CARR, W. A. & YUNG, L. 2018. Perceptions of climate engineering in the South Pacific, Sub-Saharan Africa, and North American Arctic. *Climatic Change, 147,* 119-132.

CARTON, W. 2016. *Fictitious Carbon, Fictitious Change? Environmental Implications of the Commodification of Carbon.* Unpublished PhD thesis, Lund University.

CARTON, W. 2019. "Fixing" Climate Change by Mortgaging the Future: Negative Emissions, Spatiotemporal Fixes, and the Political Economy of Delay. *Antipode, 51,* 750-769.

CARTON, W. 2020. Carbon unicorns and fossil futures. Whose emission reduction pathways is the IPCC performing? *In:* SAPINSKI, J., BUCK, H. J. & MALM, A. (eds.) *Has it Come to This? The Promises and Perils of Geoengineering on the Brink.* New Brunswick. Rutgers University Press.

CARTON, W., ASIYANBI, A., BECK, S., BUCK, H. J. & LUND, J. F. 2020. Negative emissions and the long history of carbon removal. *WIREs Climate Change,* 11**,** e671.

CAVIEZEL, C. & REVERMANN, C. 2014. *Climate Engineering. Kann und soll man die Erderwärmung technisch eindämmen?* Endbericht zum TA-Projekt Geoengineering, Berlin, edition sigma.

CBD 1995. *Report of the Second Meeting of the Conference of Parties to the convention on Biological Diversity.* Doc. No. UNEP/CBD/COP/2/19.

CBD 2000. *Decision Adopted by the Conference of the Parties to the Covention on Biological Diversity at its Firth Meeting,* V/6. Ecosystem Approach. Doc. No. UNEP/CBD/COP/5/23.

CBD 2010. *Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting,* X/33. Bio-diversity and climate change. Doc. No. UNEP/CBD/COP/DEC/X/33.

CBD 2016. *Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity,* XIII/14. Climate-related geoengineering. Doc. No. CBD/COP/DEC/XIII/14.

CBD SECRETARIAT 2005. *Handbook of the Convention on Biological Diversity Including its Cartagena Protocol on Biosafety, 3rd Edition,* Montreal, Convention on Bolocical Diversity Secretariat

CBD SECRETARIAT 2011a. *Literature Review on the Potential Impacts of Climate Related Geo-engineering on Biodiversity,* Liason Group Meeting on Climate Related Geo-engineering as it Relates to the Convention on Biological Diversity. Doc. No. lgcrg-eng-01-03-en.

CBD SECRETARIAT 2011b. Report on the Mini-Workshop on Biodiversity and Climate Related Geo-engineering, at the 34th meeting of the Subsidiary Bodies to the United Nations Framework Convention on Climate Change, 10th June, 2011, Doc. No. lgcrg-eng-01-04-en.

CBD SECRETARIAT 2016. Press Release, Secretariat of the Convention on Biological Diversity. Doc. No. pr-2016-12-18-un-bidov-conf-en..

CHHATRE, A., LAKHANPAL, S., LARSON, A. M., NELSON, F., OJHA, H. & RAO, J. 2012. Social safeguards and co-benefits in REDD+: a review of the adjacent possible. *Current Opinion in Environmental Sustainability,* 4**,** 654-660.

CHHETRI, N., CHONG, D., CONCA, K., FALK, R., GILLESPIE, A., GUPTA, A., JINNAH, S., KASHWAN, P., LAHSEN, M., LIGHT, A., MCKINNON, C., THIELE, L. P., VALDIVIA, W., WAPNER, P., MORROW, D., TURKALY, C. & NICHOLSON, S. 2018. *Governing Solar Radiation Management.* Washington, DC, Forum for Climate Engineering Assessment, American University.

CHILVERS, J., PALLETT, H. & HARGREAVES, T. 2018. Ecologies of participation in socio-technical change: The case of energy system transitions. *Energy Research & Social Science,* 42**,** 199-210.

CIPLET, D. & ROBERTS, J. T. 2017. Climate change and the transition to neoliberal environmental governance. *Global Environmental Change,* 46**,** 148-156.

CIPLET, D., ROBERTS, J. T. & KHAN, M. 2015. *Power in a Warming World: The New Global Politics of Climate Change and the Remaking of Environmental Inequality.,* Cambridge, MA, MIT Press.

CLAPP, J. & COHEN, M. J. (eds.) 2009. *The global food crisis.,* Waterloo: Centre for International Governance Innovation and Wilfred Laurier Press.

CLINGERMAN, F. & GARDNER, G. (eds.) 2018. *Playing God: Mutli-faith Repsonses to the Prospect of Climate Engineering,* Highland Park, NJ, Greenfaith.

CLINGERMAN, F. & O'BRIEN, K. J. 2014. Playing God: Why religion belongs in the climate engineering debate. *Bulletin of the Atomic Scientists,* 70**,** 27-37.

CLINGERMAN, F. & O'BRIEN, K. J. (eds.) 2016. *Theological and Ethical Perspectives on Climate Engineering: Calming the Storm,* London, Lexington Books.

CONTY, A. F. 2021. Religion in the Age of the Anthropocene. *Environmental Values,* 30**,** 215-234.

COOKE, S. L. & KIM, S. C. 2019. Exploring the "Evil Twin of Global Warming": Public Understanding of Ocean Acidification in the United States. *Science Communication,* 41**,** 66-89.

CORNER, A., PARKHILL, K., PIDGEON, N. & VAUGHAN, N. E. 2013. Messing with nature? Exploring public perceptions of geoengineering in the UK. *Global Environmental Change,* 23**,** 938-947.

CORNER, A. & PIDGEON, N. 2015. Like artificial trees? The effect of framing by natural analogy on public perceptions of geoengineering. *Climatic Change,* 130**,** 425-438.

COX, E., BOETTCHER, M., SPENCE, E. & BELLAMY, R. 2021. Casting a Wider Net on Ocean NETs. *Frontiers in Climate,* 3.

COX, E. & EDWARDS, N. R. 2019. Beyond carbon pricing: policy levers for negative emissions technologies. *Climate Policy,* 19**,** 1144-1156.

COX, E., SPENCE, E. & PIDGEON, N. 2020a. Incumbency, Trust and the Monsanto Effect: Stakeholder Discourses on Greenhouse Gas Removal. *Environmental Values,* 29**,** 197-220.

COX, E., SPENCE, E. & PIDGEON, N. 2020b. Public perceptions of carbon dioxide removal in the United States and the United Kingdom. *Nature Climate Change,* 10**,** 744-749.

COX, E. M., PIDGEON, N., SPENCE, E. & THOMAS, G. 2018. Blurred Lines: The Ethics and Policy of Greenhouse Gas Removal at Scale. *Frontiers in Environmental Science,* 6.

COX, M. 2012. Diagnosing Institutional Fit: a Formal Perspective. *Ecology and Society,* 17.

CRAIK, N., BLACKSTOCK, J. & HUBERT, A.-M. 2013. Regulating Geoengineering Research through Domestic Environmental Protection Frameworks: Reflections on the Recent Canadian Ocean Fertilization Case. *Carbon & Climate Law Review,* 7**,** 117-124.

CRAWFORD, N. 2004. Understanding discourse: A methods of ethical argument analysis. *Qualitative & Multi-method Research,* 2**,** 22-25.

CRUTZEN, P. J. 2006. Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma? *Climatic Change,* 77**,** 211.

CUDWORTH, E. & HOBDEN, S. 2013. Complexity, ecologism, and posthuman politics. *Review of International Studies,* 39**,** 643-664.

CUMMINGS, C. L., LIN, S. H. & TRUMP, B. D. 2017. Public perceptions of climate geoengineering: a systematic review of the literature. *Climate Research* 73**,** 247-264.

DAGGASH, H. A., HEUBERGER, C. F. & MAC DOWELL, N. 2019. The role and value of negative emissions technologies in decarbonising the UK energy system. *International Journal of Greenhouse Gas Control,* 81**,** 181-198.

DEKKER, L., ARTS, K. & TURNHOUT, E. 2020. From Rationalities to Practices: Understanding Unintended Consequences of CBNRM. *Conservation and Society,* 18**,** 137-147.

DEUDNEY, D. & MENDENHALL, E. 2016. Green Earth: The Emergence of Planetary Civilization. *In:* NICHOLSON, S. & JINNAH, S. (eds.) *New Earth Politics: Essays from The Anthropocene* Cambridge & London, MIT Press.

DIAZ-BONE, R. 2006. Zur Methodologisierung der Foucaultschen Diskursanalyse. *Historical Social Research/ Historische Sozialforschung,* 31**,** 243-274.

DÍAZ, S., DEMISSEW, S., CARABIAS, J., JOLY, C., LONSDALE, M., ASH, N., LARIGAUDERIE, A., ADHIKARI, J. R., ARICO, S., BÁLDI, A., BARTUSKA, A., BASTE, I. A., BILGIN, A., BRONDIZIO, E., CHAN, K. M. A., FIGUEROA, V. E., DURAIAPPAH, A., FISCHER, M., HILL, R., KOETZ, T., LEADLEY,

P., LYVER, P., MACE, G. M., MARTIN-LOPEZ, B., OKUMURA, M., PACHECO, D., PASCUAL, U., PÉREZ, E. S., REYERS, B., ROTH, E., SAITO, O., SCHOLES, R. J., SHARMA, N., TALLIS, H., THAMAN, R., WATSON, R., YAHARA, T., HAMID, Z. A., AKOSIM, C., AL-HAFEDH, Y., ALLAHVERDIYEV, R., AMANKWAH, E., ASAH, S. T., ASFAW, Z., BARTUS, G., BROOKS, L. A., CAILLAUX, J., DALLE, G., DARNAEDI, D., DRIVER, A., ERPUL, G., ESCOBAR-EYZAGUIRRE, P., FAILLER, P., FOUDA, A. M. M., FU, B., GUNDIMEDA, H., HASHIMOTO, S., HOMER, F., LAVOREL, S., LICHTENSTEIN, G., MALA, W. A., MANDIVENYI, W., MATCZAK, P., MBIZVO, C., MEHRDADI, M., METZGER, J. P., MIKISSA, J. B., MOLLER, H., MOONEY, H. A., MUMBY, P., NAGENDRA, H., NESSHOVER, C., OTENG-YEBOAH, A. A., PATAKI, G., ROUÉ, M., RUBIS, J., SCHULTZ, M., SMITH, P., SUMAILA, R., TAKEUCHI, K., THOMAS, S., VERMA, M., YEO-CHANG, Y. & ZLATANOVA, D. 2015. The IPBES Conceptual Framework – connecting nature and people. *Current Opinion in Environmental Sustainability,* 14**,** 1-16.

DIMITROV, R. S. 2010. Inside Copenhagen: The State of Climate Governance. *Global Environmental Politics,* 10**,** 18-24.

DORSCH, M. J. & FLACHSLAND, C. 2017. A Polycentric Approach to Global Climate Governance. *Global Environmental Politics,* 17**,** 45-64.

DOUGHTY, J. 2018. Past forays into SRM field research and implications for future governance. *In:* BLACKSTOCK, J. J. & LOW, S. (eds.) *Geoengineering our climate? Ethics, politics and governance.* London, Earthscan from Routledge.

DÜR, A., BACCINI, L. & ELSIG, M. 2014. The design of international trade agreements: Introducing a new dataset. *The Review of International Organizations,* 9**,** 353-375.

DWYER, J. & BIDWELL, D. 2019. Chains of trust: Energy justice, public engagement, and the first offshore wind farm in the United States. *Energy Research & Social Science,* 47**,** 166-176.

DYKEMA, J. A., KEITH, D. W., ANDERSON, J., G. & WEISENSTEIN, D. 2014. Stratospheric controlled perturbation experiment: a small-scale experiment to improve understanding of the risks of solar geoengineering. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 372**,** 20140059.

ELIASCH, J. 2008. *Climate change: Financing global forests. The Eliash review,* UK The Stationary Office Limted.

ENB 2010. Earth Negotiations Bulletin, Vol. 9 No. 534, Tenth meeting of the Conference of the Parties to the Convention on Biological Diversity: 18-29 October 2010, Published by the International Institute for Sustainable Development (IISD), Doc. No. enb09534e. Online at: http://www.iisd.ca/biodiv/cop10/ Accessed 12.05.2021.

ENB 2019a. Earth Negotiations Bulletin, Vol. 16 No. 145, OECPR-4 Highlights Tuesday, 5 March 2019, Published by the International Institute for Sustainable Development (IISD), Doc. No. enb16145e. Online at: http://enb.iisd.org/unep/oecpr4-unea4/, Accessed 12.05.2021.

ENB 2019b. Earth Negotiations Bulletin, Vol. 16 No. 149, UNEA-4 Highlights Monday, 11 March 2019, Published by the International Institute for Sustainable Development (IISD), Doc. No. enb16149e, Online at: http://enb.iisd.org/unep/oecpr4-unea4/, Accessed 12.05.2021.

ENB 2019c. Earth Negotiations Bulletin, Vol. 16 No. 151, UNEA-4 Highlights Wednesday, 13 March 2019, Published by the International Institute for Sustainable Development (IISD), Doc. No. enb16151e, Online at: http://enb.iisd.org/unep/oecpr4-unea4/Accessed 12.05.2021.

ENB 2019d. Earth Negotiations Bulletin, Vol. 16 No. 153, Summary of the Fourth Session of the United Nations Environment Assembly: 11-15 March 2019, Published by the International Institute for Sustainable Development (IISD), Doc. No. enb16153e, Online at: http://enb.iisd.org/unep/oecpr4-unea4/, Accessed 12.05.2021.

FALKNER, R. 2016. The Paris Agreement and the new logic of international climate politics. *International Affairs,* 92**,** 1107-1125.

FENG, K., DAVIS, S. J., SUN, L. & HUBACEK, K. 2015. Drivers of the US CO2 emissions 1997-2013. *Nature Communications,* 6**,** 7714.

FIORINO, D. J. 1990. Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms. *Science, Technology, & Human Values,* 15**,** 226-243.

FISCHER, F. 2015. Environmental democracy. *In:* LÖVBRAND, K. B. A. E. (ed.) *Research Handbook on Climate Governance.* Cheltenham & Northampton, Edward Elgar Publishing.

FISCHHOFF, B., SLOVIC, P., LICHTENSTEIN, S., READ, S. & COMBS, B. 1978. How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences,* 9**,** 127-152.

FLEGAL, J. A. & GUPTA, A. 2018. Evoking equity as a rationale for solar geoengineering research? Scrutinizing emerging expert visions of equity. *International Environmental Agreements: Politics, Law and Economics,* 18**,** 45-61.

FLEMING, J. R. 2006. The pathological history of weather and climate modification: Three cycles of promise and hype. *Historical Studies in the Physical and Biological Sciences,* 37**,** 3-25.

FLEMING, J. R. 2010. *Fixing the Sky: The Checkered History of Weather and Climate Control*, New York, Columbia University Press.

FLEMING, J. R. 2012. Will Geoengineering Bring Security and Peace? What does History Tell us? *Sicherheit und Frieden (S+F)/Security and Peace,* 30**,** 200-204.

FOLEY, R. W., GUSTON, D. AND SAREWITZ, D. (2018) "", IN (EDS.). (1ST ED.).. HTTPS://DOI.ORG/10.4324/9780203485262 2018. Towards the anticipatory governance of geoengineering. *In:* BLACKSTOCK, J. J. & LOW, S. (eds.) *Geoengineering our Climate?: Ethics, Politics, and Governance* London, London, Earthscan from Routledge.

FOLKE, C., PRITCHARD, L., JR., BERKES, F., COLDING, J., SVEDIN, U., 12. 2007. The Problem of Fit between Ecosystems and Institutions: Ten Years Later. *Ecology and Society* 12**,** 30ff.

FOUCAULT, M. 1969 (2002). *The Archaeology of Knowledge,* London & New York, Routledge.

FOUCAULT, M. 1978. *Dispositive der Macht: über Sexualität, Wissen und Wahrheit,* Berlin, Merve-Verl.

FOUCAULT, M. 1980. *Power/knowledge: Selected Interviews and Other Writings, 1972-1977*, New York, Pantheon Books.

FOUCAULT, M. 2007 [1978]. *Security, Territory, Population: Lectures at the College De France, 1977-78,* New York, Picador.

FOUCAULT, M., DEFERT, D., EWALD, F. & LAGRANGE, J. 1994. *Dits et écrits: 1954-1988,* Paris, Gallimard.

FOUCAULT, M. & GORDON, C. 1980. *Power/knowledge: selected interviews and other writings, 1972-1977,* New York, Pantheon Books.

FREMAUX, A. & BARRY, J. 2019. The "Good Anthropocene" and Green Political Theory: Rethinking Environmentalism, Resisting Eco-modernism. *In:* BIERMANN, F. & LÖVBRAND, E. (eds.) *Anthropocene Encounters: New Directios in Green Political Thinking.* Cambridge & New York, Cambridge University Press.

FRIDAHL, M. & BELLAMY, R. 2018. Multilevel Policy Incentives for BECCS in Sweden. *In:* FRIDAHL, M. (ed.) *Bioenergy with carbon capture and storage: From global potentials to domestic realities.* Brussels, The European Liberal Forum (ELF).

FRUMHOFF, P. C. & STEPHENS, J. C. 2018. Towards legitimacy of the solar geoengineering research enterprise. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 376.

FUENTES-GEORGE, K. 2017. Consensus, Certainty, and Catastrophe: Discourse, Governance, and Ocean Iron Fertilization. *Global Environmental Politics,* 17**,** 125-143.

GALAZ, V., OLSSON, P., HAHN, T., FOLKE, C., SVEDIN, U. 2008. The Problem of Fit between Governance Systems and Environmental Regimes. *In:* YOUNG, O. R., KING, L.A., SCHROEDER, H. (ed.) *Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers.* Cambridge, MIT Press

GANNON, K. E. & HULME, M. 2018. Geoengineering at the "Edge of the World": Exploring perceptions of ocean fertilisation through the Haida Salmon Restoration Corporation. *Geo: Geography and Environment,* 5**,** e00054.

GATTUSO, J.-P., MAGNAN, A. K., BOPP, L., CHEUNG, W. W. L., DUARTE, C. M., HINKEL, J., MCLEOD, E., MICHELI, F., OSCHLIES, A., WILLIAMSON, P., BILLÉ, R., CHALASTANI, V. I., GATES, R. D., IRISSON, J.-O., MIDDELBURG, J. J., PÖRTNER, H.-O. & RAU, G. H. 2018. Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems. *Frontiers in Marine Science,* 5.

GEDEN, O. 2016. The Paris Agreement and the inherent inconsistency of climate policymaking. *WIREs Climate Change,* 7**,** 790-797.

GEDEN, O., PETERS, G. P. & SCOTT, V. 2019. Targeting carbon dioxide removal in the European Union. *Climate Policy,* 19**,** 487-494.

GEDEN, O. & SCHENUIT, F. 2020. Unconventional mitigation: carbon dioxide removal as a new approach in EU climate policy.. *SWP Research Paper, 8/2020.* Berlin: Stiftung Wissenschaft und Politik -SWP- German Institute for International and Security Affairs.

GENUS, A. & STIRLING, A. 2018. Collingridge and the dilemma of control: Towards responsible and accountable innovation. *Research Policy,* 47**,** 61-69.

GERMAN PARLIAMENT 2012. German Federal Government's response to a parliamentary inquiry filed by the parliamentarians René Röspel, Dr. Ernst Dieter Rossmann, Oliver Kaczmarek, et al. and the SPD Faction: Geoengineering/Climate-Engineering,. *G Drucksache 17/10311.*

GESAMP 2019. High level review of a wide range of proposed marine geoengineering techniques. *In:* BOYD, P. W. A. V., C.M.G. (ed.). London, IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UN Environment/ UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.

GIDDENS, A. 1977. *Studies in Social and Political Theory*, Hutchinson.

GLASER, B. G. & STRAUSS, A. L. 1967. *The discovery of grounded theory. Strategies for qualitative research,* New York, de Gruyter.

GORDON, C. 1991. Governmental Rationality: An Introduction. *In:* BURCHELL, G., GORDON, C. & MILLER, P. (eds.) *The Foucult Effect: Studies in Governmentality.* Chicago, University of Chicago Press.

GOUGH, C. & MANDER, S. 2019. Beyond Social Acceptability: Applying Lessons from CCS Social Science to Support Deployment of BECCS. *Current Sustainable/Renewable Energy Reports,* 6**,** 116-123.

GOVERNMENT ACCOUNTABILITY OFFICE 2010. Climate change: A coordinated strategy could focus federal geoengineering research and inform governance efforts, Rep. to the Chairman, Committee on Science and Technology, House of Representatives. GAO-10-903. Washington, DC: US GOA.

GOVERNMENT ACCOUNTABILITY OFFICE 2011. Climate engineering: Technical status, future directions, and potential responses, GAO-11-71. Washington DC: US GOA.

GUEST, G., BUNCE, A. & JOHNSON, L. 2006. How Many Interviews Are Enough?:An Experiment with Data Saturation and Variability. *Field Methods,* 18**,** 59-82.

GUNDERSON, R., STUART, D. & PETERSEN, B. 2019. The Political Economy of Geoengineering as Plan B: Technological Rationality, Moral Hazard, and New Technology. *New Political Economy,* 24**,** 696-715.

GUPTA, A. & MÖLLER, I. 2018. De facto governance: how authoritative assessments construct climate engineering as an object of governance. *Environmental Politics*, 1-22.

GUPTA, A. & MÖLLER, I. 2019. De facto governance: how authoritative assessments construct climate engineering as an object of governance. *Environmental Politics,* 28, 480-501.

GUPTA, A., MÖLLER, I., BIERMANN, F., JINNAH, S., KASHWAN, P., MATHUR, V., MORROW, D. R. & NICHOLSON, S. 2020. Anticipatory governance of solar geoengineering: conflicting visions of the future and their links to governance proposals. *Current opinion in environmental sustainability,* 45, 10-19.

GUPTA, J. 2010. A history of international climate change policy. *WIREs Climate Change,* 1, 636-653.

GUZMAN, A. T. 2005. The Design of International Agreements. *European Journal of International Law,* 16, 579-612.

HABERMAS, J. 1987. *The Theory of Communicative Action, Vol. 2, Life World and System,* Boston, Beacon Press.

HABERMAS, J. 1996. *Between Facts and Norms: Contribution to a Discourse Theory of Law and Democracy,* Cambridge, MIT Press.

HAJER, M. & UITERMARK, J. 2008. Performing Authority: Discusive Politics after the Assassination of Theo van Gough *Public Administration,* 86, 5-19.

HAJER, M. A. 1995. *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process,* Oxford, Oxford University Press.

HAJER, M. A. 2005. Coaltions, Practices, Meaning and Environmental Politics: From Acid Rain to BSE. *In:* TORFING, J. & HOWARD, D. (eds.) *Discourse Threory in European Politics.* Hampshire & New York, Palgrave MacMillan.

HAJER, M. A. 2009. *Authoritative governance: policy-making in the age of mediatization,* Oxford, Oxford University Press.

HALE, B. 2012. The world that would have been: Moral hazard arguments against geoengineering. *In:* PRESTON, C. (ed.) *Reflecting sunlight: the ethics of solar radiation management.* Lanham MD, Rowman and LittleField.

HAMILTON, S. 2018. The measure of all things? The Anthropocene as a global biopolitics of carbon. *European Journal of International Relations,* 24, 33-57.

HANSSON, A. 2011. Colonising the future: the case of CCS. *In:* MARKUSSON, N., SHACKLEY, S. & EVAR, B. (eds.) *The social dynamics of carbon capture and storage.* London, Routledge.

HARDY, C., PHILLIPS, N. & HARLEY, B. 2004. Discourse analysis and content analysis: Two solitudes? *Qualitative & Multi-method Research,* 2, 19-22.

HARNISCH, S., UTHER, S. & BOETTCHER, M. 2015. From 'Go Slow' to 'Gung Ho'? Climate Engineering Discourses in the UK, the US, and Germany. *Global Environmental Politics,* 15, 57-78.

HARVEY, D. 1982. *The limits to capital,* Chicago, University of Chicago Press.

HASSAN, S. S., WILLIAMS, G. A. & JAISWAL, A. K. 2019. Moving towards the second generation of lignocellulosic biorefineries in the EU: Drivers, challenges, and opportunities. *Renewable and Sustainable Energy Reviews,* 101, 590-599.

HASZELDINE, R. S., FLUDE, S., JOHNSON, G. & SCOTT, V. 2018. Negative emissions technologies and carbon capture and storage to achieve the Paris Agreement commitments. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 376, 20160447.

HAWKINS, J. P., O'LEARY, B. C., BASSETT, N., PETERS, H., RAKOWSKI, S., REEVE, G. & ROBERTS, C. M. 2016. Public awareness and attitudes towards marine protection in the United Kingdom. *Marine Pollution Bulletin,* 111, 231-236.

HAY, C. 2006. Constructivist Institutionalism. *In:* R.A.W. RHODES, S. A. B., AND BERT A. ROCKMAN (ed.) *The Oxford Handbook of Political Science.* Oxford, Oxford University Press.

HAY, C. 2011. Ideas and the Construction of Interests. *In:* COX, D. B. A. R. H. (ed.) *Ideas and Politics inSocial Science Research.* New York, Oxford University Press.

HAY, C. 2016. Good in a crisis: the ontological institutionalism of social constructivism. *New Political Economy,* 21**,** 520-535.

HAY, C. 2017. The Interdependence of Intra- and Inter-Subjectivity in Constructivist Institutionalism. *Critical Review,* 29**,** 235-247.

HAYES, D. J. M. 2013. Second-generation biofuels: why they are taking so long. *WIREs Energy and Environment,* 2**,** 304-334.

HEIN, J., GUARIN, A., FROMMÉ, E. & PAUW, P. 2018. Deforestation and the Paris climate agreement: An assessment of REDD+ in the national climate action plans. *Forest Policy and Economics,* 90**,** 7-11.

HELD, D. & ROGER, C. 2018. Three Models of Global Climate Governance: From Kyoto to Paris and Beyond. *Global Policy,* 9**,** 527-537.

HELD, V. 2005. *The Ethics of Care: Personal, Political, and Global,* Oxford, Oxford University Press.

HERRERA, Y. M. & BRAUMOELLER, B. F. Symposium: Discourse and Content Analysis. *Qualitative Methods*, Spring 2004.

HESTER, T. 2018. Legal Pathways to Negative Emissions Technologies and Direct Air Capture of Greenhouse Gases. *Environmental Law Reporter,* 5**,** 10413-10432.

HITZLER, R. & HONER, A. 1997. Einleitung: Hermeneutik in der deutschsprachigen Soziologie heute. *In:* HITZLER, R. & HONER, A. (eds.) *Sozialwissenschaftliche Hermeneutik: Eine Einführung.* Wiesbaden, VS Verlag für Sozialwissenschaften.

HOLZ, F., RICHTER, P. M. & EGGING, R. 2015. A Global Perspective on the Future of Natural Gas: Resources, Trade, and Climate Constraints. *Review of Environmental Economics and Policy,* 9**,** 85-106.

HONEGGER, M. 2019. A battle of paradigms. *Perspectives on the UNEA resolution* Online:https://geoengineering.environment.harvard.edu/blog/perspectives-unea-resolution#MatthiasHonegger. Accessed 21.05.2021.

HONEGGER, M., BURNS, W. & MORROW, D. R. 2021. Is carbon dioxide removal 'mitigation of climate change'? *Review of European, Comparative & International Environmental Law,* 30(3), 327-335.

HONEGGER, M. & REINER, D. 2018. The political economy of negative emissions technologies: consequences for international policy design. *Climate Policy,* 18**,** 306-21.

HOPF, T. 2004. Discourse and Content Analysis: Some Fundamental Incompatibilities. *Qualitative Methods,* Spring 2004**,** 31-33.

HORNRIDGE, A.-K., KELLER, R. & SCHÜNEMANN, W. J. 2018. Introduction: The sociology of knowledge appraoch to discourse in an interdependent world. *In:* HORNRIDGE, A.-K., KELLER, R. & SCHÜNEMANN, W. J. (eds.) *The Sociology of Knowledge Approach to Discourse: Investigating the Politics of Knowledge and Meaning-Making.* London & New York, Routledge.

HORTON, J. B. & KEITH, D. W. 2016. Solar geoengineering and oblications to the global poor. *In:* PRESTON, C. (ed.) *Climate justice and geoengineering: Ethics and policy in the atmosphertic Anthropocene.* London, Rowman & Littlefield.

HORTON, J. B., KEITH, D. W. & HONEGGER, M. 2016. Implications of the Paris Agreement for Carbon Dioxide Removal and Solar Geoengineering. *Policy Brief, Harvard Project on Climate Agreements, Belfer Center,* July 2016.

HORTON, Z. 2017. Going rogue or becoming salmon? Geoengineering narratives in Haida Gwaii. *Cultural Critique,* 97**,** 128-166.

HOWARTH, D. & TORFING, J. 2004. *Discourse Theory in European Politics: Identity, Policy and Governance*, London, Palgrave Macmillan.

HOWARTH, R. W., INGRAFFEA, A. & ENGELDER, T. 2011. Natural gas: Should fracking stop? *Nature,* 477**,** 271-5.

HUBERT, A.-M. 2017. *Revised Code of Conduct for Responsible Geoengineering Research Calgary*, University of Calgary.

HUBERT, A.-M. & REICHWEIN, D. 2015. An exploration of a code of conduct for responsible scientific research involving geoengineering. *IASS Working Paper & InSIS Occasional Paper,* Potsdam & Oxford.

HULME, M. 2010. Problems with making and governing global kinds of knowledge. *Global Environmental Change,* 20**,** 558-564.

HULME, M. 2015. Knowledge pluralism. *In:* LÖVBRAND, K. B. A. E. (ed.) *Research Handbook on Climate Governance.* Cheltenham & Northampton, Edward Elgar Publishing.

HULME, M. & MAHONY, M. 2010. Climate change: What do we know about the IPCC? *Progress in Physical Geography: Earth and Environment,* 34**,** 705-718.

HUNSBERGER, C., BOLWIG, S., CORBERA, E. & CREUTZIG, F. 2014. Livelihood impacts of biofuel crop production: Implications for governance. *Geoforum,* 54**,** 248-260.

HURSTHOUSE, R. 1999. *On Virtue Ethics*, Oxford, Oxford University Publishing.

HUTTUNEN, S. & HILDÉN, M. 2013. Framing the Controversial: Geoengineering in Academic Literature. *Science Communication,* 36**,** 3-29.

HUTTUNEN, S., SKYTÉN, E. & HILDÉN, M. 2014. Emerging policy perspectives on geoengineering: An international comparison. *The Anthropocene Review,* 2**,** 14-32.

IOC, I. O. C. 2010. Ocean fertilization: A scientific summary for policy makers. *In:* UNITED NATIONS EDUCATIONAL, S. A. C. O. & COMMISSION, I. O.

IPCC 2014. Climate Change 2014 Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. *In:* K. PACHAURI, A. L. A. M. (ed.). Geneva, Switzerland, IPCC.

IPCC 2018. Global Warming of 1.5°C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva, IPCC.

IPSOS MORI 2010. Experiment Earth? Report on a Public Dialogue on Geoengineering. Swindon, Natural Environment Research Council.

IRVINE, P. J., KRAVITZ, B., LAWRENCE, M. G. & MURI, H. 2016. An overview of the Earth system science of solar geoengineering. *WIREs Climate Change,* 7**,** 815-833.

JACKSON, R. H. & SØRENSEN, G. 2010. *Introduction to international relations: theories and approaches,* Oxford, Oxford University Press.

JASANOFF, S. (ed.) 2004. *States of Knowledge: The co-production of science and social order,* New York, Routledge.

JASANOFF, S. & KIM, S.-H. 2009. Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea. *Minerva,* 47**,** 119.

JASANOFF, S. & KIM, S.-H. 2015. *Dreamscapes of modernity: sociotechnical imaginaries and the fabrication of power,* Chicago; London, The University of Chicago Press.

JAX, K., CALESTANI, M., CHAN, K. M. A., ESER, U., KEUNE, H., MURACA, B., O'BRIEN, L., POTTHAST, T., VOGET-KLESCHIN, L. & WITTMER, H. 2018. Caring for nature matters: a relational approach for understanding nature's contributions to human well-being. *Current Opinion in Environmental Sustainability,* 35**,** 22-29.

JENKINS, W. 2016. Stewards of Irony: Planetary Stewardship, Climate Engineering and Religous Ethics. *In:* CLINGERMAN, F. & O'BRIEN, K. J. (eds.) *Theological and Ethical Perspectives on Climate Engineering: Calming the Storm.* New York & London, Lexington Books.

JINNAH, S. 2018. Why Govern Climate Engineering? A Preliminary Framework for Demand-Based Governance. *International Studies Review,* 20**,** 272-282.

JINNAH, S., MORROW, D. & NICHOLSON, S. 2021. Splitting Climate Engineering Governance: How Problem Structure Shapes Institutional Design. *Global Policy,* 12**,** 8-19.

JINNAH, S. & NICHOLSON, S. 2019. The hidden politics of climate engineering. *Nature Geoscience,* 12**,** 876-879.

JOBIN, M. & SIEGRIST, M. 2020. Support for the Deployment of Climate Engineering: A Comparison of Ten Different Technologies. *Risk Analysis,* 40**,** 1058-1078.

KANIARU, D. W. 2014. United Nations Environment Assembly: Some Highlights and Challenges. *Environmental Policy and Law,* 44**,** 342-348.

KARLSSON, H., DELAHAYE, T., JOHNSSON, F., KJÄRSTAD, J. & ROOTZ, J. 2017. Immediate deployment opportunities for negative emissions with BECCS: A Swedish case study. Online: https://arxiv.org/abs/1705.07894v1 [physics.soc-ph] Accessed: 21.05.2021.

KEITH, D. W. 2000. GEOENGINEERING THE CLIMATE: History and Prospect. *Annual Review of Energy and the Environment,* 25**,** 245-284.

KEITH, D. W. 2013. *A case for climate engineering,* Cambridge, MA, MIT Press.

KEITH, D. W. 2017. Toward a responsible solar geoengineering research program. *Issues in Science and Technology* 33.

KELLER, D. 2018a. Marine Climate-engineering. *In:* MARKUS, M. S. A. T. (ed.) *Handbook on Marine Environmental Protection: Science, Impacts and Sustainable Management.* Cham: Springer International Publishing.

KELLER, R. 2008. *Wissenssoziologische Diskursanalyse: Grundlage eines Forschungsprogramms* Wiesbaden, VS Verlag für Sozialwissenschaften.

KELLER, R. 2011. *Diskursforschung: Eine Einführung für SozialwissenschaftlerInnen,* Wiesbaden, VS Verlag für Sozialwissenschaften.

KELLER, R. 2018b. The Sociology of Knowledge Approach to Discourse: An Introduction. *In:* KELLER, R., HORNRIDGE, A.-K. & SCHÜNEMANN, W. J. (eds.) *The Sociology of Knowledge Approach to Discourse: Investigating the Politics of Knowledge and Meaning-Making.* London & New York, Routledge.

KELLER, R. & CLARKE, A. E. 2018. Situating SKAD in interpretative inquiry. *In:* KELLER, R., HORNRIDGE, A.-K. & SCHÜNEMANN, W. J. (eds.) *The Sociology of Knowledge Approach to Discourse: Investigating the Politics of Knowledge and Meaning-Making.* London & New York, Routledge.

KELLER, R., HIRSELAND, A., SCHNEIDER, W. & NIEHÖVER, W. (eds.) 2011. *Handbuch Sozialwissenschaftliche Diskursanalyse,* Wiesbaden, Verlag für Sozialwissenschaften.

KELLER, R., HORNRIDGE, A.-K. & SCHÜNEMANN 2018. *The Sociology of Knowledge Approach to Discourse: Investigating the Politics of Knowledge and Meaning-making,* Oxton & New York, Routledge.

KEOHANE, R. O. & VICTOR, D. G. 2011. The Regime Complex for Climate Change. *Perspectives on Politics,* 9**,** 7-23.

KERCHNER, B. 2010a. Juridischer Diskurs und ökonomisches Kalkül: Zu Foucaults Kritik des Rechtsstaat. *In:* SCHULZE, D. G., BERGHAHN, S., WOLF, F.O (ed.) *Rechtsstaat und Demokratie:Transdisziplinäre Analysen zum deutschen und spanischen Weg in die Moderne.* Münster, Westfälisches Dampfboot.

KERCHNER, B. 2011. Kerchner (2011) Vielfalt, Komplexität oder Intersektionalität: Zum Einsatz der Diskurstheorie in der Geschlechterforschung. *Gender Politik Online.*

KERCHNER, B. & SCHNEIDER, S. (eds.) 2006. *Foucault: Diskursanalyse der Politik, Eine Einführung,* Wiesbaden, VS Verlag für Sozialwissenschaften.

KERCHNER, B., SCHNEIDER, SILKE 2010b. Government, Governance, Governmentalität. *Femina Politica: Zeitschrift für feministische Politikwissenschaft,* 19**,** 9-23.

KHAN, M. R. & ROBERTS, J. T. 2013. Adaptation and international climate policy. *WIRes Climate Change,* 4**,** 171-189.

KIM, R. E. & VAN ASSELT, H. 2016. Global Governance: Problem Shifting in the Anthropocene and the Limits of International Law,. *In:* MORGERA, E. & KULOVESI, K. (eds.) *Research Handbook on International Law and Natural Resources.* Cheltenham, Edward Elgar.

KIM, R. E., VAN ASSELT, H., KOTZÉ, L. J., VIJGE, M. J. & BIERMANN, F. 2020. Hierarchization. *In:* BIERMANN, F., KIM, R.E (ed.) *Architectures of Earth System Governance: Institutional Complexity and Structural Transformation.* Cambridge, Cambridge University Press,.

KOEHRSEN, J. 2021. Muslims and Climate Change: How Islam, Muslim Organizations and Religious Leaders influence Climate Change Perceptions and Mitigation Activities. *WIRes Climate Change*.

KOREMENOS, B., LIPSON, C. & SNIDAL, D. 2001. The Rational Design of International Institutions. *International Organization,* 55**,** 761-799.

KRAVITZ, B., ROBOCK, A., BOUCHER, O., SCHMIDT, H., TAYLOR, K. E., STENCHIKOV, G. & SCHULZ, M. 2011. The Geoengineering Model Intercomparison Project (GeoMIP). *Atmospheric Science Letters,* 12**,** 162-167.

KRAVITZ, B., ROBOCK, A., TILMES, S., BOUCHER, O., ENGLISH, J. M., IRVINE, P. J., JONES, A., LAWRENCE, M. G., MACCRACKEN, M., MURI, H., MOORE, J. C., NIEMEIER, U., PHIPPS, S. J., SILLMANN, J., STORELVMO, T., WANG, H. & WATANABE, S. 2015. The Geoengineering Model Intercomparison Project Phase 6 (GeoMIP6): simulation design and preliminary results. *Geosci. Model Dev.,* 8**,** 3379-3392.

KREUTER, J. 2021. *Climate Engineering as an Instance of Politicization: Talking Tomorrow's Technology – Framing Political Choice?,* Cham, Springer International Publishing.

KRÜGER, T. 2017. Conflicts over carbon capture and storage in international climate governance. *Energy Policy,* 100**,** 58-67.

KUCHLER, M. 2014. Sweet dreams (are made of cellulose): Sociotechnical imaginaries of second-generation bioenergy in the global debate. *Ecological Economics,* 107**,** 431-437.

KVALE, S. & BRINKMANN, S. 2008. *InterViews: Learning the craft of qualitative research interviewing,* New Delhi, London, Singapore, Sage.

LAFFEY, M. & WELDES, J. 2004. Methodological Reflections on Discourse Analysis. *Qualitative Methods,* Spring**,** 28-30.

LAL, R. 2020. The role of industry and the private sector in promoting the "4 per 1000" initiative and other negative emission technologies. *Geoderma,* 378**,** 114613.

LARSSON, O. 2018. Advancing Post-Structural Institutionalism: Discourses, Subjects, Power Asymmetries, and Institutional Change. *Critical Review,* 30**,** 325-346.

LARSSON, O. L. 2015. Using Post-Structuralism to Explore The Full Impact of Ideas on Politics. *Critical Review,* 27**,** 174-197.

LARSSON, O. L. 2020. Technocracy, Governmentality, and Post-Structuralism. *Critical Review,* 32**,** 103-123.

LAWRENCE, M. G. & CRUTZEN, P. J. 2017. Was breaking the taboo on research on climate engineering via albedo modification a moral hazard, or a moral imperative? *Earth's Future,* 5**,** 136-143.

LAZARUS, M., TEMPEST, K., KLEVNÄS, P. & KORSBAKKEN, J. I. 2015. *Natural Gas: Guardrails for a Potential Climate Bridge. New Climate Economy contributing paper,* Stockholm, Sweden, and Seattle, WA, Stockholm Environment Institute.

LC 1988. RESOLUTION LDC.30(11): PARTICIPATION OF NON-GOVERNMENTAL INTERNATIONAL ORGANIZATIONS IN MEETINGS OF THE LONDON DUMPING CONVENTION. Doc. No. LDC 11/14.

LC 1996. RESOLUTION LDC.44(14): THE APPLICATION OF A PRECAUTIONARY APPROACH IN ENVI-RONMENTAL PROTECTION WITHIN THE FRAMEWORK OF THE LONDON DUMPING CONVENTION. Doc. No. LDC 14/16.

LC 2007. REPORT OF THE TWENTY-NINTH CONSULTATIVE MEETING AND THE SECOND MEETING OF CONTRACTING PARTIES, 5-9 November 2007, Agenda item 17, Doc. No. LC 29/17.

LC 2008a. CONSIDERATION OF THE REPORT OF THE SCIENTIFIC GROUPS, Action by the governing bodies, Note by the Secretariat, THIRTIETH CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON CONVENTION & THIRD MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL, 27-31 October 2008, Agenda item 3, Doc. No. LC 30/3.

LC 2008b. OCEAN FERTILISATION Report of the Legal and Intersessional Correspondence Group on Ocean Fertilization (LICG) – Breakdown of comments, THIRTIETH CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON CONVENTION & THIRD MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL 27-31 Oc-tober 2008, Agenda item 4, Doc. No. LC 30/INF.2.

LC 2008c. OCEAN FERTILIZATION Report of the Working Group on Ocean Fertilization, THIRTIETH CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON CONVENTION & THIRD MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL 27-31 October 2008, Agenda item 4. Doc. No. LC 30/WP.6.

LC 2008d. OCEAN FERTILIZATION: Report of the Legal and Intersessional Correspondence Group on Ocean Fertilization (LICG), THIRTIETH CONSULTATIVE MEETING OF CON-TRACTING PARTIES TO THE LONDON CONVENTION & THIRD MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL 27-31 October 2008, Agenda item 4. Doc. No. LC 30/4.

LC 2008e. REPORT OF THE THIRTIETH CONSULTATIVE MEETING AND THE THIRD MEET-ING OF CONTRACTING PARTIES, 27-31 October 2008, Agenda item 16, Doc. No. LC 30/16.

LC 2009. REPORT OF THE WORKING GROUP ON OCEAN FERTILIZATION, THIRTY-FIRST CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON CON-VENTION & FOURTH MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL 26 – 30 October 2009, Agenda item 4. Doc. No. LC 31/WP.3.

LC 2010a. OCEAN FERTILIZATION: DEVELOPMENT OF REGULATION ON OCEAN FERTILIZATION, Discussion of an Additional Option to Achieve the Regulation of Legitimate Scientific Research Involving Ocean Fertilization under the London Protocol, Submitted by Canada. THIRTY-SECOND CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON CONVENTION & FIFTH MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL 11-15 October 2010 Agenda item 4.1, Doc. No. LC 32/4/1.

LC 2010b. REPORT OF THE THIRTY-SECOND CONSULTATIVE MEETING AND THE FIFTH MEETING OF CONTRACTING PARTIES. 11-15 October 2010, Agenda item 15, Doc. No. LC 32/15.

LC 2011a. OCEAN FERTILIZATION Report of the Correspondence Group on Ocean Fertilization – Part 2, THIRTY-THIRD CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON

CONVENTION & SIXTH MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL 17-21 October 2011 Agenda item 4, Doc. No. LC 33/4/2..

LC 2011b. OCEAN FERTILIZATION: Report of the 3rd Meeting of the Intersessional Working Group on Ocean Fertilization, THIRTY-THIRD CONSULTATIVE MEETING OF CONTRACT-ING PARTIES TO THE LONDON CONVENTION & SIXTH MEETING OF CON-TRACTING PARTIES TO THE LONDON PROTOCOL 17-21 October 2011 Agenda item 4. Doc. No. LC 33/4.

LC 2013. REPORT OF THE THIRTY-FIFTH CONSULTATIVE MEETING AND THE EIGHTH MEETING OF CONTRACTING PARTIES, 14-18 October 2013, Agenda item 15, Doc. No. LC 35/15.

LC 2019. List of Participants, Doc. No. LC 41/INF.1.

LC/LP 2008. RESOLUTION LC-LP.1(2008) ON THE REGULATION OF OCEAN FERTILIZATION, Doc. No. LC 30/16.

LC/LP 2010. RESOLUTION LC-LP.2(2010) ON THE ASSESSMENT FRAMEWORK FOR SCIENTIFIC RESEARCH IN-VOLVING OCEAN FERTILIZATION, Doc. No. LC 32/15.

LEIPOLD, S., FEINDT, P. H., WINKEL, G. & KELLER, R. 2019. Discourse analysis of environmental policy revisited: traditions, trends, perspectives. *Journal of Environmental Policy & Planning,* 21, 445-463.

LENZI, D. 2018a. The ethics of negative emissions. *Global Sustainability,* 1, e7.

LENZI, D., LAMB, W. F., HILAIRE, J., KOWARSCH, M., MINX, J. C. 2018b. Weigh the ethics of plans to mop up carbon dioxide. *Nature, [Comment],* 561, 303-305.

LÉVI-STRAUSS, C. 1963. *Structural anthropology*. New York, Basic Books

LÉVI-STRAUSS, C. 1980. *Mythos und Bedeutung: fünf Radiovorträge; Gespräche mit Claude Lévi-Strauss,* Frankfurt am Main, Suhrkamp.

LEVI, M. 2015. Fracking and the climate debate. *Democracy,* Summer 2015, No. 37. Online: https://democracyjournal.org/magazine/37/fracking-and-the-climate-debate/Accessed: 12.11.2021.

LIN, A. C. 2013. Does Geoengineering Present a Moral Hazard? *Ecology Law Quarterly,* 40, 673-712.

LINNÉR, B.-O. & WIBECK, V. 2015. Dual high-stake emerging technologies: a review of the climate engineering research literature. *WIREs Climate Change,* 6, 255-268.

LIPSCHUTZ, R. D. 2014. Foreword: Order! Order in the House! *In:* STRIPPLE, J. & BULKELEY, H. (eds.) *Governing the Climate.* New York, Cambridge University Press.

LITFIN, K. T. 1994. *Ozone discourses: science and politics in global environmental cooperation,* New York, Columbia University Press.

LOCKWOOD, T. 2017. Public Outreach Approaches for Carbon Capture and Storage Projects. London, IEA Clean Coal Centre.

LOMAX, G., LENTON, T. M., ADEOSUN, A. & WORKMAN, M. 2015. Investing in negative emissions. *Nature Climate Change,* 5, 498-500.

LÖVBRAND, E., BECK, S., CHILVERS, J., FORSYTH, T., HEDRÉN, J., HULME, M., LIDSKOG, R. & VASILEIADOU, E. 2015. Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene. *Global Environmental Change,* 32, 211-218.

LÖVBRAND, E., MOBJÖRK, M. & SÖDER, R. 2020. The Anthropocene and the geo-political imagination: Re-writing Earth as political space. *Earth System Governance,* 4, 100051.

LÖVBRAND, E., RINDEFJÄLL, T. & NORDQVIST, J. 2009a. Closing the Legitimacy Gap in Global Environmental Governance? Lessons from the Emerging CDM Market. *Global Environmental Politics,* 9, 74-100.

LÖVBRAND, E. & STRIPPLE, J. 2011. Making climate change governable: accounting for carbon as sinks, credits and personal budgets. *Critical Policy Studies,* 5, 187-200.

LÖVBRAND, E. & STRIPPLE, J. 2014. Brining Governmentality to the Study of Global Climate Governance. *In:* STRIPPLE, J. & BULKELEY, H. (eds.) *Governing the Climate: New Approaches to Rationality, Power & Politics.* New York, Cambridge University Press.

LÖVBRAND, E., STRIPPLE, J. & WIMAN, B. 2009b. Earth System governmentality: Reflections on science in the Anthropocene. *Global Environmental Change,* 19, 7-13.

LOW, S. 2021. *Climate Imagineering: Practices and politics of sunlight reflection and carbon removal assessment.* PhD Doctoral Dissertation, Utrecht University

LOW, S. & BOETTCHER, M. 2020. Delaying decarbonization: Climate governmentalities and sociotechnical strategies from Copenhagen to Paris. *Earth System Governance,* 5, 100073.

LOW, S. & BUCK, H. J. 2020. The practice of responsible research and innovation in "climate engineering". *WIREs Climate Change,* 11, e644.

LOW, S. & SCHÄFER, S. 2019. Tools of the trade: practices and politics of researching the future in climate engineering. *Sustainability Science,* 14, 953-962.

LOW, S. & SCHÄFER, S. 2020. Is bio-energy carbon capture and storage (BECCS) feasible? The contested authority of integrated assessment modeling. *Energy Research & Social Science,* 60, 101326.

LP 2013. RESOLUTION LP.4(8) ON THE AMENDMENT TO THE LONDON PROTOCOL TO REGULATE THE PLACEMENT OF MATTER FOR OCEAN FERTILIZATION AND OTHER MARINE GEOENGINEERING ACTIVITIES. [Doc. No. is not available as this resolution is not yet in force].

LUISETTI, T., TURNER, R. K., ANDREWS, J. E., JICKELLS, T. D., KRÖGER, S., DIESING, M., PALTRIGUERA, L., JOHNSON, M. T., PARKER, E. R., BAKKER, D. C. E. & WESTON, K. 2019. Quantifying and valuing carbon flows and stores in coastal and shelf ecosystems in the UK. *Ecosystem Services,* 35, 67-76.

MABON, L. & SHACKLEY, S. 2015. Meeting the Targets or Re-Imagining Society? An Empirical Study into the Ethical Landscape of Carbon Dioxide Capture and Storage in Scotland. *Environmental Values,* 24, 465-482.

MABON, L., SHACKLEY, S. & BOWER-BIR, N. 2014. Perceptions of sub-seabed carbon dioxide storage in Scotland and implications for policy: A qualitative study. *Marine Policy,* 45, 9-15.

MACMARTIN, D. G., CALDEIRA, K. & KEITH, D. W. 2014. Solar geoengineering to limit the rate of temperature change. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 372, 20140134.

MACMARTIN, D. G., KRAVITZ, B., LONG, J. C. S. & RASCH, P. J. 2016. Geoengineering with stratospheric aerosols: What do we not know after a decade of research? *Earth's Future,* 4, 543-548.

MACNAGHTEN, P., DAVIES, S. R. & KEARNES, M. 2015. Understanding Public Responses to Emerging Technologies: A Narrative Approach. *Journal of Environmental Policy & Planning,* 21, 504-518.

MARKUSSON, N. 2013. Tensions in framings of geoengineering: Constitutive diversity and ambivalence. *Climate Geoengineering Governance Working Paper Series: 003.*

MARKUSSON, N., BALTA-OZKAN, N., CHILVERS, J., HEALEY, P., REINER, D. & MCLAREN, D. 2020. Social Science Sequestered. *Frontiers in Climate,* 2.

MARKUSSON, N., DAHL GJEFSEN, M., STEPHENS, J. C. & TYFIELD, D. 2017. The political economy of technical fixes: The (mis)alignment of clean fossil and political regimes. *Energy Research & Social Science,* 23, 1-10.

MARKUSSON, N., GINN, F., SINGH GHALEIGH, N. & SCOTT, V. 2014. 'In case of emergency press here': framing geoengineering as a response to dangerous climate change. *WIREs Climate Change,* 5, 281-290.

MARKUSSON, N., MCLAREN, D. & TYFIELD, D. 2018. Towards a cultural political economy of mitigation deterrence by negative emissions technologies (NETs). *Global Sustainability,* 1, e10.

MATUK, F. A., TURNHOUT, E., FLESKENS, L., DO AMARAL, E. F., HAVERROTH, M. & BEHAGEL, J. H. 2020. Allying knowledge integration and co-production for knowledge legitimacy and usability: The Amazonian SISA policy and the Kaxinawá Indigenous people case. *Environmental Science & Policy,* 112**,** 1-9.

MATZNER, N. & BARBEN, D. 2018. Verantwortungsvoll das Klima manipulieren? Unsicherheit und Verantwortung im Diskurs um Climate Engineering *In:* JANICH, N. & RHEIN, L. (eds.) *Unsicherheit als Herausforderung für die Wissenschaft.* Berlin, Oxford, Peter Lang.

MATZNER, N. & BARBEN, D. 2020. Climate Engineering as a Communication Challenge: Contested Notions of Responsibility Across Expert Arenas of Science and Policy. *Science Communication,* 42**,** 61-89.

MAYRHOFER, J. P. & GUPTA, J. 2016. The science and politics of co-benefits in climate policy. *Environmental Science & Policy,* 57**,** 22-30.

MCDONALD, J., MCGEE, J., BRENT, K. & BURNS, W. 2019. Governing geoengineering research for the Great Barrier Reef. *Climate Policy,* 19**,** 801-811.

MCLAREN, D. 2016. Mitigation deterrence and the "moral hazard" of solar radiation management. *Earth's Future,* 4**,** 596-602.

MCLAREN, D. 2019. A double injustice? *Perspectives on the UNEA resolution* Online:https://geoengineering. environment.harvard.edu/blog/perspectives-unea-resolution#DuncanMcLaren. Accessed: 12.11.2021.

MCLAREN, D. & CORRY, O. 2021. Clash of Geofutures and the Remaking of Planetary Order: Faultlines underlying Conflicts over Geoengineering Governance. *Global Policy,* 12(1), 20-33.

MCLAREN, D. & MARKUSSON, N. 2020. The co-evolution of technological promises, modelling, policies and climate change targets. *Nature Climate Change,* 10**,** 392-397.

MCLAREN, D. P. 2018a. In a broken world: Towards an ethics of repair in the Anthropocene. *The Anthropocene Review,* 5**,** 136-154.

MCLAREN, D. P. 2018b. Whose climate and whose ethics? Conceptions of justice in solar geoengineering modelling. *Energy Research & Social Science,* 44**,** 209-221.

MCLAREN, D. P., TYFIELD, D. P., WILLIS, R., SZERSZYNSKI, B. & MARKUSSON, N. O. 2019. Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions. *Frontiers in Climate,* 1 (4).

MCMAHAN, E. A. & ESTES, D. 2015. The effect of contact with natural environments on positive and negative affect: A meta-analysis. *The Journal of Positive Psychology,* 10**,** 507-519.

MCNABB, D. E. 2010. *Research Methods for Political Science: Quantitative and Qualitative Approaches,* New York, Routledge.

MERT, A. 2019. Democracy in the Anthropocene: A New Scale. *In:* BIERMANN, F. & LÖVBRAND, E. (eds.) *Anthropocene Encounters.* Cambridge & New York, Cambridge University Press.

MICHAELOWA, A., SHISHLOV, I. & BRESCIA, D. 2019. Evolution of international carbon markets: lessons for the Paris Agreement. *WIREs Climate Change,* 10**,** e613.

MILES, E. L., UNDERDAL, A., ANDRESEN, S., WETTESTAD, J., SKJÆRSETH, J.B., CARLIN, E.M. (ed.) 2002. *Environmental Regime Effectiveness: Confronting Theory with Evidence,* Cambridge, MIT Press.

MILLER, C. A. 2004. Climate science and the making of a global political order. *In:* JASANOFF, S. (ed.) *States of knowledge: The co-production of science and the social order.* London, Routledge.

MILLS, S. 2003. *Michel Foucault.* London, Routledge Critical Thinkers.

MITCHELL, R. B. 1994. Regime design matters: intentional oil pollution and treaty compliance. *International Organization,* 48**,** 425-458.

MITCHELL, R. B. 2006. Problem Structure, Institutional Design, and the Relative Effectiveness of International Environmental Agreements. *Global Environmental Politics,* 6**,** 72-89.

MITCHELL, R. B., ANDONOVA, L. B., AXELROD, M., BALSIGER, J., BERNAUER, T., GREEN, J. F., HOLLWAY, J., KIM, R. E. & MORIN, J.-F. 2020. What We Know (and Could Know) About International Environmental Agreements. *Global Environmental Politics,* 20**,** 103-121.

MÖLLER, I. 2020. Political Perspectives on Geoengineering: Navigating Problem Definition and Institutional Fit. *Global Environmental Politics*, 20 (2), 57-82.

MORROW, D. 2017. International Governance of Climate Engineering: A Survey of Reports on Climate Engineering, 2009-2015, *FCEA Working Paper Series,* Washington, DC, FCEA.

MUIDERMAN, K., GUPTA, A., VERVOORT, J. & BIERMANN, F. 2020. Four approaches to anticipatory climate governance: Different conceptions of the future and implications for the present. *WIREs Climate Change,* n/a**,** e673.

MYATT, L. B., SCRIMSHAW, M. D. & LESTER, J. N. 2003. Public perceptions and attitudes towards an established managed realignment scheme: Orplands, Essex, UK. *Journal of Environmental Management,* 68**,** 173-181.

MYHRE, G., FUGLESTVEDT, J. S., BERNTSEN, T. K. & LUND, M. T. 2011. Mitigation of short-lived heating components may lead to unwanted long-term consequences. *Atmospheric Environment,* 45**,** 6103-6106.

NAS, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING & MEDICINE. 1992. *Policy Implications of greenhouse warming: Mitigation, adaptation, and the science base*. Washington DC. The National Academies Press.

NAS, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING & MEDICINE 2018. National Academies Launching New Study on Sunlight-Reflection Research. *Developing a research agenda and research governance approaches for climate-intervention strategies.* Washington DC. The National Academies Press

NAS, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING & MEDICINE 2019. *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda,* Washington, DC, The National Academies Press.

NAS, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING & MEDICINE 2021. *Reflecting Sunlight: Recommendations for Solar Geoengineering Research and Research Governance,* Washington, DC, The National Academies Press.

NRC, NATIONAL RESEARCH COUNCIL 2015a. *Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration,* Washington, DC, The National Academies Press.

NRC, NATIONAL RESEARCH COUNCIL 2015b. *Climate Intervention: Reflecting Sunlight to Cool Earth,* Washington, DC, The National Academies Press.

NAYLOR, R. L., LISKA, A. J., BURKE, M. B., FALCON, W. P., GASKELL, J. C., ROZELLE, S. D. & CASSMAN, K. G. 2007. The Ripple Effect: Biofuels, Food Security, and the Environment. *Environment: Science and Policy for Sustainable Development,* 49**,** 30-43.

NEMET, G. F., CALLAGHAN, M. W., CREUTZIG, F., FUSS, S., HARTMANN, J., HILAIRE, J., LAMB, W. F., MINX, J. C., ROGERS, S. & SMITH, P. 2018. Negative emissions – Part 3: Innovation and upscaling. *Environmental Research Letters,* 13**,** 063003.

NERLICH, B. & JASPAL, R. 2012. Metaphors We Die By? Geoengineering, Metaphors, and the Argument From Catastrophe. *Metaphor and Symbol,* 27**,** 131-147.

NEWELL, P. & PATERSON, M. 2010. *Climate capitalism: global warming and the transformation of the global economy,* Cambridge, Cambridge University Press.

NEWELL, R. G. & RAIMI, D. 2014. Implications of Shale Gas Development for Climate Change. *Environmental Science & Technology,* 48**,** 8360-8368.

NEWIG, J., LENSCHOW, A., CHALLIES, E., COTTA, B. & SCHILLING-VACAFLOR, A. 2020. What is governance in global telecoupling? *Ecology and Society,* 24.

NICHOLSON, S., JINNAH, S. & GILLESPIE, A. 2018. Solar radiation management: a proposal for immediate polycentric governance. *Climate Policy,* 18, 322-334.

NIGHTINGALE, A. J., ERIKSEN, S., TAYLOR, M., FORSYTH, T., PELLING, M., NEWSHAM, A., BOYD, E., BROWN, K., HARVEY, B., JONES, L., BEZNER KERR, R., MEHTA, L., NAESS, L. O., OCKWELL, D., SCOONES, I., TANNER, T. & WHITFIELD, S. 2019. Beyond Technical Fixes: climate solutions and the great derangement. *Climate and Development,* 12, 343-352.

NIKOLERIS, A., STRIPPLE, J. & TENNGART, P. 2019. The 'Anthropocene' in Popular Culture: Narrating Human Agency, Force and Our Place on Earth. *In:* BIERMANN, F. & LÖVBRAND, E. (eds.) *Anthropocene Encounters: New Directions in Green Political Thinking.* Cambridge & New York, Cambridge University Press.

OELS, A. 2005. Rendering climate change governable: From biopower to advanced liberal government? *Journal of Environmental Policy & Planning,* 7, 185-207.

OKEREKE, C., BULKELEY, H. & SCHROEDER, H. 2009. Conceptualizing Climate Governance Beyond the International Regime. *Global Environmental Politics,* 9, 58-78.

OLDFIELD, J. D. 2016. Mikhail Budyko's (1920-2001) contributions to Global Climate Science: from heat balances to climate change and global ecology. *WIREs Climate Change,* 7, 682-692.

OLDHAM, P., SZERSZYNSKI, B., STILGOE, J., BROWN, C., EACOTT, B. & YUILLE, A. 2014. Mapping the landscape of climate engineering. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences,* 372, 20140065.

OLSEN, K. H. 2007. The clean development mechanism's contribution to sustainable development: a review of the literature. *Climatic Change,* 84, 59-73.

OWEN, R., BESSANT, J. R. & HEINTZ, M. 2013. *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society,* Chichester, John Wiley and Sons.

PALMGREN, C. R., MORGAN, M. G., BRUINE DE BRUIN, W. & KEITH, D. W. 2004. Initial Public Perceptions of Deep Geological and Oceanic Disposal of Carbon Dioxide. *Environmental Science & Technology,* 38, 6441-6450.

PARKER, A. & GEDEN, O. 2016. No fudging on geoengineering. *Nature Geoscience,* 9, 859-860.

PARKINSON, C. L. 2010. *Coming Climate Crisis?: Consider the Past, Beware the Big Fix,* Lanham, Rowman & Littlefield Publishers.

PARSON, E. A. & KEITH, D. W. 2013. End the Deadlock on Governance of Geoengineering Research. *Science,* 339, 1278-1279.

PASZTOR, J., HARRISON, N. & IPCC 2021. Introduction to the Special Issue: 'Governing Climate-altering Approaches'. *Global Policy,* 12, 5-7.

PATERSON, M. & P-LABERGE, X. 2018. Political economies of climate change. *WIREs Climate Change,* 9, e506.

PERREZ, F. X. 2020. The Role of the United Nations Environment Assembly in Emerging Issues of International Environmental Law. *Sustainability,* 12, 5680.

PIDGEON, N., PARKHILL, K., CORNER, A. & VAUGHAN, N. 2013. Deliberating stratospheric aerosols for climate geoengineering and the SPICE project. *Nature Climate Change,* 3, 451-457.

PLATT, D., WORKMAN, M. & HALL, S. 2018. A novel approach to assessing the commercial opportunities for greenhouse gas removal technology value chains: Developing the case for a negative emissions credit in the UK. *Journal of Cleaner Production,* 203, 1003-1018.

PORTER, K. E. & HULME, M. 2013. The emergence of the geoengineering debate in the UK print media: a frame analysis. *The Geographical Journal,* 179**,** 342-355.

POTTS, T., PITA, C., O'HIGGINS, T. & MEE, L. 2016. Who cares? European attitudes towards marine and coastal environments. *Marine Policy,* 72**,** 59-66.

PRESTON, C. & CARR, W. 2018. Recognitional Justice, Climate Engineering, and the Care Approach. *Ethics, Policy & Environment,* 21**,** 308-323.

PRINS, G. & RAYNER, S. 2007. Time to ditch Kyoto. *Nature,* 449**,** 973-975.

PSAC. 1965. *Restoring the Quality of Our Environment.* Report of the Environmental Pollution Panel, Presidenty Science Advisory Committee, Washingtion DC, The White House.

PURVIS, T. & HUNT, A. 1993. Discourse, ideology, discourse, ideology, discourse, ideology. *British Journal of Sociology,* 44**,** 473-499.

RAIMI, K. T., MAKI, A., DANA, D. & VANDENBERGH, M. P. 2019. Framing of Geoengineering Affects Support for Climate Change Mitigation. *Environmental Communication,* 13**,** 300-319.

RAYNER, S., HEYWARD, C., KRUGER, T., PIDGEON, N., REDGWELL, C. & SAVULESCU, J. 2013. The Oxford Principles. *Climatic Change,* 121**,** 499-512.

REYNOLDS, J. 2015. A critical examination of the climate engineering moral hazard and risk compensation concern. *The Anthropocene Review,* 2**,** 174-191.

REYNOLDS, J. 2019. *The governance of solar geoengineering: Managing climate change in the Anthropocene,* Cambridge, Cambridge University Press.

RICKE, K. L., MORENO-CRUZ, J. B. & CALDEIRA, K. 2013. Strategic incentives for climate geoengineering coalitions to exclude broad participation. *Environmental Research Letters,* 8**,** 014021.

RICKELS, W. K., G.; DOVERN, J., BETZ, G., BRACHATZEK, N., CACEAN, S., GÜSSOW, K., HEINTZENBERG J., HILLER, S. H., C., LEISNER, T., OSCHLIES, A., PLATT, U., PROELß, A., RENN, O., SCHÄFER, S. AND ZÜRN, M. 2011. Large-Scale Intentional Interventions into the Climate System? Assessing the Climate Engineering Debate. Scoping report conducted on behalf of the German Federal Ministry of Education and Research (BMBF), Kiel, Kiel Earth Institute.

ROBOCK, A. 2014. Stratospheric aerosol geoengineering. *Issues in Environmental Science and Technology* 38.

ROBOCK, A. 2016. Albedo enhancement by stratospheric sulfur injections: More research needed. *Earth's Future,* 4**,** 644-648.

ROBOCK, A., JERCH, K. & BUNZL, M. 2008. 20 reasons why geoengineering may be a bad idea. *Bulletin of the Atomic Scientists,* 64**,** 14-59.

ROCKSTRÖM, J., W. STEFFEN, K. NOONE, Å. PERSSON, F. S. CHAPIN, III, E. LAMBIN, T. M. LENTON, M. SCHEFFER, C. FOLKE, H. SCHELLNHUBER, B. NYKVIST, C. A. DE WIT, T. HUGHES, S. VAN DER LEEUW, H. RODHE, S. SÖRLIN, P. K. SNYDER, R. COSTANZA, U. SVEDIN, M. FALKENMARK, L. KARLBERG, R. W. CORELL, V. J. FABRY, J. HANSEN, B. WALKER, D. LIVERMAN, K. RICHARDSON, P. CRUTZEN, AND J. FOLEY 2009. Planetary boundaries:exploring the safe operating space for humanity. *Ecology and Society* 14**,** 32.

ROLTSON, H. 2006. Caring for Nature: What Science and Economics Can't Teach Us but Religion Can. *Environmental Values,* 15**,** 307-313.

ROSS, K., DAMASSA, T., NORTHROP, E., WASKOW, D., LIGHT, A., FRANSEN, T. & TANKOU, A. 2018. *Strengthening Nationally Determined Contributions to catalyze actions that reduce short-lived climate pollutants.* Working Paper. Washington DC, World Resources Institute and Oxfam.

ROTHE, D. 2020. Governing the End Times? Planet Politics and the Secular Eschatology of the Anthropocene. *Millennium,* 48**,** 143-164.

RØTTERENG, J.-K. S. 2018. The Comparative Politics of Climate Change Mitigation Measures: Who Promotes Carbon Sinks and Why? *Global Environmental Politics,* 18**,** 52-75.

ROYAL SOCIETY 2009. *Geoengineering the climate: science, governance and uncertainty*. London, The Royal Society.

ROYAL SOCIETY AND ROYAL ACADEMY OF ENGINEERING 2018. *Greenhouse Gas Removal*. London, Royal Society and Royal Academy of Engineering.

RUSIN, N. P. & FLIT, L. A. 1960. *Man versus climate,* Moscow, Peace Publishers.

SAUSSURE, F. D. 2006. *Writings in general linguistics,* Oxford, New York, Oxford University Press.

SBSTTA 2012. TECHNICAL AND REGULATORY MATTERS ON GEOENGINEERING IN RELA-TION TO THE CONVENTION ON BIOLOGICAL DIVERSITY, Note by the Executive Secretary, SUBSIDIARY BODY ON SCIENTIFIC, TECHNICAL AND TECHNOLOGI-CAL ADVICE Sixteenth meeting, 30 April-5 May, 2012, Agenda item 7.3, Doc. No. UNEP/CBD/SBSTTA/16/10.

SBSTTA 2015a. CLIMATE-RELATED GEOENGINEERING Note by the Executive Secretary, SUBSIDI-ARY BODY ON SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL ADVICE, Nine-teenth meeting, 2-5 November 2015, Agenda item 4.2, Doc. No. UNEP/CBD/SBSTTA/19/7.

SBSTTA 2015b. REPORT OF THE SUBSIDIARY BODY ON SCIENTIFIC, TECHNICAL AND TECH-NOLOGICAL ADVICE ON ITS NINETEENTH MEETING, Doc. No. UNEP/CBD/SBSTTA/19/10.

SCHÄFER, S., LAWRENCE, M., STELZER, H., BORN, W. & LOW, S. (eds) 2015. *The European Transdisciplinary Assessment of Climate Engineering (EuTRACE): Removing Greenhouse Gases from the Atmosphere and Reflecting Sunlight Away from Earth*. Funded by the European Union's Seventh Framework Programme under Grant Agreement 306993.

SCHENUIT, F., COLVIN, R., FRIDAHL, M., MCMULLIN, B., REISINGER, A., SANCHEZ, D. L., SMITH, S. M., TORVANGER, A., WREFORD, A. & GEDEN, O. 2021. Carbon Dioxide Removal Policy in the Making: Assessing Developments in 9 OECD Cases. *Frontiers in Climate,* 3.

SCHLOSBERG, D. 2007. *Defining Environmental Justice: Theories, Movements, and Nature,* Oxford & New York, Oxford University Press.

SCHMIDT, H., ALTERSKJÆR, K., BOU KARAM, D., BOUCHER, O., JONES, A., KRISTJÁNSSON, J. E., NIEMEIER, U., SCHULZ, M., AAHEIM, A., BENDUHN, F., LAWRENCE, M. & TIMMRECK, C. 2012. Solar irradiance reduction to counteract radiative forcing from a quadrupling of CO2: climate responses simulated by four earth system models. *Earth Syst. Dynam.,* 3**,** 63-78.

SCHMIDT, V. A. 2008. Discursive Institutionalism: The Explanatory Power of Ideas and Discourse. *Annual Review of Political Science,* 11**,** 303-326.

SCHMIDT, V. A. 2010. Taking ideas and discourse seriously: explaining change through discursive institutionalism as the fourth 'new institutionalism'. *European Political Science Review,* 2**,** 1-25.

SCHMIDT, V. A. 2011a. Reconciling Ideas and Institutions through Discursive Institutionalism. *In:* COX., D. B. A. R. H. (ed.) *Ideas and Politics in Social Science Research.* New York, Oxford University Press.

SCHMIDT, V. A. 2011b. Speaking of change: why discourse is key to the dynamics of policy transformation. *Critical Policy Studies,* 5**,** 106-126.

SCHMIDT, V. A. 2017. Theorizing Ideas and Discourse in Political Science: Intersubjectivity, Neo-Institutionalisms, and the Power of Ideas. *Critical Review,* 29**,** 248-263.

SCHNEIDER, L. 2009. Assessing the additionality of CDM projects: practical experiences and lessons learned. *Climate Policy,* 9**,** 242-254.

SCHNEIDER, L. 2019. Fixing the Climate? How Geoengineering Threatens to Undermine the SDGs and Climate Justice. *Development,* 62**,** 29-36.

SCHOLTE, S., VASILEIADOU, E. & PETERSEN, A. C. 2013. Opening up the societal debate on climate engineering: how newspaper frames are changing. *Journal of Integrative Environmental Sciences,* 10**,** 1-16.

SCHRAG, D. P. 2012. Is shale gas good for climate change? *Daedalus* 2**,** 72-80.

SCOTT, V., GILFILLAN, S., MARKUSSON, N., CHALMERS, H. & HASZELDINE, R. S. 2012. Last chance for carbon capture and storage. *Nature Climate Change,* 3**,** 105-111.

SHEARER, C., BISTLINE, J., INMAN, M. & DAVIS, S. J. 2014. The effect of natural gas supply on US renewable energy and CO 2 emissions. *Environmental Research Letters,* 9**,** 094008.

SHINDELL, D., BORGFORD-PARNELL, N., BRAUER, M., HAINES, A., KUYLENSTIERNA, J. C. I., LEONARD, S. A., RAMANATHAN, V., RAVISHANKARA, A., AMANN, M. & SRIVASTAVA, L. 2017. A climate policy pathway for near- and long-term benefits. *Science,* 356**,** 493-494.

SHINDELL, D., KUYLENSTIERNA, J. C. I., VIGNATI, E., VAN DINGENEN, R., AMANN, M., KLIMONT, Z., ANENBERG, S. C., MULLER, N., JANSSENS-MAENHOUT, G., RAES, F., SCHWARTZ, J., FALUVEGI, G., POZZOLI, L., KUPIAINEN, K., HÖGLUND-ISAKSSON, L., EMBERSON, L., STREETS, D., RAMANATHAN, V., HICKS, K., OANH, N. T. K., MILLY, G., WILLIAMS, M., DEMKINE, V. & FOWLER, D. 2012. Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security. *Science,* 335**,** 183-189.

SHOEMAKER, J. K., SCHRAG, D. P., MOLINA, M. J. & RAMANATHAN, V. 2013. What Role for Short-Lived Climate Pollutants in Mitigation Policy? *Science,* 342**,** 1323-1324.

SIKKA, T. 2012. A critical discourse analysis of geoengineering advocacy. *Critical Discourse Studies,* 9**,** 163-175.

SILLMANN, J., LENTON, T. M., LEVERMANN, A., OTT, K., HULME, M., BENDUHN, F. & HORTON, J. B. 2015. Climate emergencies do not justify engineering the climate. *Nature Climate Change,* 5**,** 290-292.

SILVER, J., ACTON, L., CAMPBELL, L. & GRAY, N. 2020. How a Global Ocean Treaty Could Protect Biodiversity in the High Seas. The Conversation. Online: http://theconversation.com/how-a-global-ocean-treatycould-protect-biodiversity-in-the-high-seas-139552. Accessed 07.07.2021).

SLOVIC, P. 1987. Perception of risk. *Science,* 236**,** 280-285.

SMITH, W. & WAGNER, G. 2018. Stratospheric aerosol injection tactics and costs in the first 15 years of deployment. *Environmental Research Letters,* 13**,** 124001.

SOVACOOL, B. K. 2021. Reckless or righteous? Reviewing the sociotechnical benefits and risks of climate change geoengineering. *Energy Strategy Reviews,* 35**,** 100656.

SPENCE, E., PIDGEON, N. & PEARSON, P. 2018. UK public perceptions of Ocean Acidification – The importance of place and environmental identity. *Marine Policy,* 97**,** 287-293.

SRIVASTAVA, S. & MEHTA, L. 2017. *The Social Life of Mangroves – Resource Complexes and Contestations on the Industrial Coastline of Kutch, India* STEPS CentreWorking Paper. Falmer, Institute for Development Studies, University of Sussex.

STEFFEN, W., RICHARDSON, K., ROCKSTRÖM, J., SCHELLNHUBER, H. J., DUBE, O. P., DUTREUIL, S., LENTON, T. M. & LUBCHENCO, J. 2020. The emergence and evolution of Earth System Science. *Nature Reviews Earth & Environment,* 1**,** 54-63.

STIELIKE, L. 2017. *Entwicklung durch Migration: Eine postkoloniale Dispositivanalyse am Beispiel Kamerun-Deutschland,* Bielefeld, Transcript Verlag.

STILGOE, J. 2015. *Experiment Earth: Responsible innovation in geoengineering,* London & NewYork, Eathscan from Routledge.

STILGOE, J., OWEN, R. & MACNAGHTEN, P. 2013. Developing a framework for responsible innovation. *Research Policy,* 42.

STIRLING, A. 2007. "Opening Up" and "Closing Down": Power, Participation, and Pluralism in the Social Appraisal of Technology. *Science, Technology, & Human Values,* 33**,** 262-294.

STOKKE, O. S. 1998. Beyond Dumping? The Effectiveness of the London Convention. *Yearbook of International Cooperation on Environment and Development* 39-49.

STRIPPLE, J. & BULKELEY, H. (eds.) 2014. *Governing the Climate: New Approaches to Rationality, Power and Politics,* Cambridge: Cambridge University Press.

STRONG, A., CULLEN, J. & CHISHOLM, S. 2015. Ocean fertilization: science, policy, and commerce. *Oceanography* 22**,** 236-261.

SURPRISE, K. 2018. Preempting the Second Contradiction: Solar Geoengineering as Spatiotemporal Fix. *Annals of the American Association of Geographers,* 108**,** 1228-1244.

SURPRISE, K. 2019. Stratospheric imperialism: Liberalism, (eco)modernization, and ideologies of solar geoengineering research *Environment and Planning E: Nature and Space.* 3(1),141-163.

SURPRISE, K. 2020. Geopolitical ecology of solar geoengineering: from a 'logic of multilateralism' to logics of militarization. *Journal of Political Ecology,* 27**,** 213-235.

TERDIMAN, R. 1985. *Discourse/Counter-Discourse The Theory and Practice of Symbolic Resistance in Nineteenth-Century France*, Ithaca and Londin, Cornell University Press.

THE GUARDIAN 2016. UN climate science chief: It's not too late to avoid dangerous temperature rise. Online: https://www.theguardian.com/environment/2016/may/11/un-climate-change-hoesung-lee-global-warming-interview Accessed 12.11.2021

TILMAN, D., SOCOLOW, R., FOLEY, J. A., HILL, J., LARSON, E., LYND, L., PACALA, S., REILLY, J., SEARCHINGER, T., SOMERVILLE, C. & WILLIAMS, R. 2009. Beneficial Biofuels – The Food, Energy, and Environment Trilemma. *Science,* 325**,** 270-271.

TIROSH-SAMUELSON, H. 2018. Redemptive Activism: Judaism, Climate Change, and Climate Engineering. *In:* CLINGERMAN, F. & GARDNER, G. (eds.) *Playing God: Mutli-faith Repsonses to the Prospect of Climate Engineering.* Highland Park, NJ, GreenFaith.

TORFING, J. 1999. *New Theories of Discourse: Laclau, Mouffe and Zizek,* Oxford, Blackwell Publishers.

TOUR, J. M., KITTRELL, C. & COLVIN, V. L. 2010. Green carbon as a bridge to renewable energy. *Nature Materials,* 9**,** 871-874.

TRONTO, J. 2015. Democratic caring and global care responsibilities. *In:* TULA BRANNELLY, L. W., AND NICKI WARD (ed.) *Ethics of Care: Critical advances in international perspective.* Oxford, Oxford University Press.

TURNHOUT, E. 2018. The Politics of Environmental Knowledge. *Conservation and Society,* 16**,** 363-371.

TURNHOUT, E., METZE, T., WYBORN, C., KLENK, N. & LOUDER, E. 2020. The politics of co-production: participation, power, and transformation. *Current Opinion in Environmental Sustainability,* 42**,** 15-21.

TURNHOUT, E., SKUTSCH, M. M. & DE KONING, J. 2015. Carbon accounting. *In:* LÖVBRAND, E. & BÄCKSTRAND, K. (ed.) *Research Handbook on Climate Governance.* Cheltenham & Northampton, Edward Elgar Publishing.

TURNHOUT, E., VAN BOMMEL, S. & AARTS, N. 2010. How participation creates citizens: participatory governance as performative practice. *Ecology and Society,* 15**,** 26.

UHRQVIST, O. & LÖVBRAND, E. 2014. Rendering global change problematic: the constitutive effects of Earth System research in the IGBP and the IHDP. *Environmental Politics,* 23**,** 339-356.

UK GOVERNMENT 2013. The government's view on geo-engineering research.

UNEA 2016. Rules of Procedure of the United Nations Environment Assembly of the Unit-ed Nations Environment Programme. Doc. No. UNEP/EA.3/3..

UNEA 2019. Resolution for consideration at the 4th United Nations Environment Assembly: Geoengineering and its governance. Submitted by: Switzerland. Supported by: Burkina Faso, Federated States of Micronesia, Georgia, Liechtenstein, Mali, Mexico, Montenegro, Niger, Republic of Korea, and Senegal. Revised Version: 25.02.2019. Online: https://geoengineering.environment.harvard.edu/files/sgrp/files/draft_unea_resolution.pdf Accessed: 13.05.2021

UNEA. 2021. *United Nations Environment Assembly* [Online]. Available: https://www.unep.org/environmentassembly/[Accessed 11.05.2021].

UNEP-EA 2019. Proceedings of the UNEA at its Fourth Session, 11-15 March 2019. Doc. No. UNEP/EA.4/2.

UNEP/WMO 2011. Integrated assessment of black carbon and tropospheric ozone. Report, United Nations Environment Programme and World Metrorological Organization. Online: https://www.ccacoalition.org/en/resources/integrated-assessment-black-carbon-and-tropospheric-ozone Accessed: 12.11.2021.

UNGA 2012. The Future We Want. Doc. No. A/RES/66/288.

UNGA 2013. Report of the Governing Council of the United Nations Environment Programme on its twelfth special session and on the implementation of section IV.C, entitled "Environmental pillar in the context of sus-tainable development", of the outcome document of the United Nations Conference on Sustainable Development. Doc. No. A/RES/67/213.

UNITED KINGDOM HOUSE OF COMMONS. 2010. United Kingdom House of Commons, Science and Technology Committee: The Regulation of Geoengineering. London, U. K., The Stationary Office.

UNITED STATES HOUSE OF REPRESENTATIVES 2009. United States House of Representatives Committee on Science and Technology Geoengineering I: Assessing the Implications of Large-Scale Climate Intervention. Washington, DC, US Government Printing Office Serial No. 111-66,.

UNITED STATES HOUSE OF REPRESENTATIVES 2010a. United States House of Representatives Committee on Science and Technology Geoengineering II: The Science and Engineering Challenges,. Washington, DC, US Government Printing Office Serial No. 111-66, HR.

UNITED STATES HOUSE OF REPRESENTATIVES 2010b. United States House of Representatives Committee on Science and Technology Geoengineering III: Domestic and International Research Governance. Washington, DC, US Government Printing Office Serial No. 111-66, HR.

UNRUH, G. C. 2000. Understanding carbon lock-in. *Energy Policy,* 28**,** 817-830.

URRY, J. 2014. The Problem of Energy. *Theory, Culture & Society,* 31**,** 3-20.

UTHER, S. 2014. *Diskurse des Climate Engineering: Argumente, Akteure und Koalitionen in Deutschland und Großbritannien,* Wiesbaden, Springer VS.

VALDIVIA, M., GALAN, J. L., LAFFARGA, J. & RAMOS, J. L. 2016. Biofuels 2020: Biorefineries based on lignocellulosic materials. *Microb Biotechnol,* 9**,** 585-94.

VERLAAN, P. 2013. London Convention and London Protocol. *The International Journal of Marine and Coastal Law,* 28**,** 729-736.

VICTOR, D. G. 2008. On the regulation of geoengineering. *Oxford Review of Economic Policy,* 24**,** 322-336.

VICTOR, D. G., MORGAN, M. G., APT, J., STEINBRUNER, J. & RICKE, K. L. 2013. The truth about geoengineering: Science fiction and science fact. *Foreign Affairs,* 92**,** 1-8.

VICTOR, D. G., ZAELKE, D. & RAMANATHAN, V. 2015. Soot and short-lived pollutants provide political opportunity. *Nature Climate Change,* 5**,** 796-798.

VIRGOE, J. 2009. International governance of a possible geoengineering intervention to combat climate change. *Climatic Change,* 95**,** 103-119.

WALLER, L., RAYNER, T., CHILVERS, J., GOUGH, C. A., LORENZONI, I., JORDAN, A. & VAUGHAN, N. 2020. Contested framings of greenhouse gas removal and its feasibility: Social and political dimensions. *WIREs Climate Change,* 11**,** e649.

WAXMAN, A. R., KHOMAINI, A., LEIBOWICZ, B. D. & OLMSTEAD, S. M. 2020. Emissions in the stream: estimating the greenhouse gas impacts of an oil and gas boom. *Environmental Research Letters,* 15**,** 014004.

WEINBERG, A. M. 1966. Can Technology Replace Social Engineering? *Bulletin of the Atomic Scientists,* 22**,** 4-8.

WELDES, J. & SACO, D. 1996. Making State Action Possible: The United States and the Discursive Construction of 'The Cuban Problem', 1960-1994. *Millennium,* 25**,** 361-395.

WENDT, A. 1998. On Constitution and Causation in International Relations. *Review of International Studies,* 24**,** 101-117.

WEST, S., HAIDER, L. J., MASTERSON, V., ENQVIST, J. P., SVEDIN, U. & TENGÖ, M. 2018. Stewardship, care and relational values. *Current Opinion in Environmental Sustainability,* 35**,** 30-38.

WIBECK, V., HANSSON, A., ANSHELM, J., ASAYAMA, S., DILLING, L., FEETHAM, P. M., HAUSER, R., ISHII, A. & SUGIYAMA, M. 2017. Making sense of climate engineering: a focus group study of lay publics in four countries. *Climatic Change,* 145**,** 1-14.

WIGLEY, T. M. L. 2006. A Combined Mitigation/Geoengineering Approach to Climate Stabilization. *Science,* 314**,** 452-454.

WILCOX, J., PSARRAS, P. C. & LIGUORI, S. 2017. Assessment of reasonable opportunities for direct air capture. *Environmental Research Letters,* 12**,** 065001.

WILLIAMS, L., MACNAGHTEN, P., DAVIES, R. & CURTIS, S. 2017. Framing 'fracking': Exploring public perceptions of hydraulic fracturing in the United Kingdom. *Public Understanding of Science,* 26**,** 89-104.

WILLOUGHBY, H. E., JORGENSEN, D. P., BLACK, R. A. & ROSENTHAL, S. L. 1985. Project STORMFURY: A Scientific Chronicle 1962-1983. *Bulletin of the American Meteorological Society,* 66**,** 505-514.

WINICKOFF, D. E., FLEGAL, J. A. & ASRAT, A. 2015. Engaging the Global South on climate engineering research. *Nature Climate Change,* 5**,** 627-634.

WOLSKE, K. S., RAIMI, K. T., CAMPBELL-ARVAI, V. & HART, P. S. 2019. Public support for carbon dioxide removal strategies: the role of tampering with nature perceptions. *Climatic Change,* 152**,** 345-361.

YEO, A., LEGARD, R., KEEGAN, J., WARD, K., MCNAUGHTON NICHOLLS, C. & LEWIS, J. 2013. In-depth Interviews. *In:* RITCHIE, J., LEWIS, J., MCNAUGHTON NICHOLLS, C. & ORMSTON, R. (eds.) *Qualitative ResearchPractice: A Guide for Social Science Students and Researchers.* Los Angeles, London, New Dehli, Singapore. Sage.

YOUNG, M. I. 1996. Democracy and Difference: Contesting the Boundaries of the Political. *In:* BENHABIB, S. (ed.) *Communication and the other: beyond deliberative democracy.* Princeton, NJ, Princeton University Press.

YOUNG, O. R. 2002. *The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale,* Cambridge, MIT Press.

YOUNG, O. R., KING, L. A. & SCHROEDER, H. 2008. *Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers*, Cambridge, MIT Press.

YOUNG, O. R. & ZÜRN, M. 2006. The International Regimes Database: Designing and Using a Sophisticated Tool for Institutional Analysis. *Global Environmental Politics,* 6**,** 121-143.

Samenvatting

Het klimaat verandert snel en de oorzaken zijn antropogeen – door de uitstoot van kooldioxide in de atmosfeer wijzigt de mensheid al tientallen jaren onbedoeld het mondiale klimaat, waardoor de wereld op weg is naar een gevaarlijke opwarming, een stijging van de zeespiegel en verstoorde neerslagpatronen. De vraag hoe de mensheid deze mondiale uitdaging zal aangaan, is een centraal thema geworden in wetenschappelijke, politieke en maatschappelijke debatten over de toekomst van het klimaat. Zullen we erin slagen de wereldeconomie snel genoeg koolstofvrij te maken om de ergste gevolgen van de klimaatverandering te voorkomen? Of zullen we misschien gedwongen zijn ons aan te passen aan een leven in een aanzienlijk warmere wereld, waarbij de steden van vandaag moeten worden verplaatst om te ontsnappen aan de stijging van de zeespiegel en grote delen van de wereld niet langer in staat zijn voedsel te produceren? Naast mitigatie en adaptatie als belangrijke strategieën om de toekomst van het klimaat te sturen, is er nu een derde manier in opkomst om op de klimaatverandering te reageren: Het idee om doelbewust in te grijpen in het mondiale klimaatsysteem, vaak 'klimaatengineering' (CE) genoemd. De heterogene reeks voorstellen die onder deze overkoepelende term vallen, zijn gericht op het actief verwijderen van kooldioxide uit de atmosfeer (bekend als kooldioxideverwijdering [CDR], negatieve-emissietechnologieën [NET's] of broeikasgasverwijdering [GGR]) of op het verminderen van de hoeveelheid zonnestraling die de atmosfeer binnenkomt en erin wordt gevangen, door de reflecterende eigenschappen van de stratosfeer, wolken en andere oppervlakken te wijzigen.

Terwijl sommigen aanvoeren dat bepaalde vormen van klimaatengineering een essentieel onderdeel zullen vormen van de toekomstige klimaatresponsstrategieën en dat daarom een faciliterende governance nodig is om de ontwikkeling van de technologieën op responsieve wijze te stimuleren, benadrukken anderen de noodzaak van een restrictieve governance om te anticiperen op de potentiële milieu- en sociaal-politieke risico's van onderzoek, ontwikkeling, demonstratie en ontplooiing (RDD&D) van CE en deze te beperken. Het besef groeit dat de jure governance van onderzoek en ontwikkeling van sommige typen CE de komende jaren nodig zal zijn, en dat de facto governance al vorm krijgt door de discoursen en praktijken van CE-onderzoek en -beoordeling (Gupta en Möller, 2019). Er wordt steeds meer aandacht besteed aan de soorten wetenschappelijke en maatschappelijke kennis die vorm geven aan de manier waarop het idee CE en de governance daarvan tot stand komen.

In deze dissertatie, die een bijdrage levert aan deze groeiende literatuurpoel, wordt de brede vraag gesteld hoe de discursieve constructie van klimaatengineering-governance plaatsvindt in de wetenschap, de industrie, het maatschappelijk middenveld en de politiek.

Geleid door deze vraag, benader ik de uitdaging van CE governance vanuit een post-structuralistisch discourstheoretisch perspectief dat benadrukt dat, aangezien discours

de broncode is waarmee betwiste toekomsten worden geschreven, het ,kraken van de discursieve code' die ten grondslag ligt aan het debat over CE governance kan helpen om te anticiperen op en kritisch na te denken over het ontstaan van toekomstige bestuurspraktijken en infrastructuren. Uitgaande van het inzicht dat er een performatief verband bestaat tussen discursieve structuren en de ontwikkeling van governance, gebruik ik het concept van governmentality als een heuristische lens om de discursieve structuren in kaart te brengen die ten grondslag liggen aan verschillende gebieden van het debat over CE-governance, waarbij ik laat zien hoe ze ,discursieve blauwdrukken' kunnen vormen voor opkomende klimaatengineering-governance.

Dit proefschrift is ingedeeld in drie delen. Deel I bevat een algemene inleiding op het onderwerp klimaatengineering als een governance-uitdaging (Hoofdstuk 2). In hoofdstuk 2.1 wordt de historische ontwikkeling van het debat over CE-governance gedetailleerd beschreven en wordt een overzicht gegeven van enkele van de centrale kwesties die de huidige discussies over CE en de governance daarvan structureren, waarbij wordt aangetoond dat het CE-debat wordt gekenmerkt door een oriëntatie op speculatieve toekomsten die fundamenteel bepaalt hoe CE de collectieve verbeelding van wetenschappers, beleidsmakers en het publiek binnendringt (Hoofdstuk 2.2 & 2.3).

Hoofdstuk 3 beschrijft de sociaal constructivistische en poststructuralistische grondslagen van mijn theoretisch kader en geeft een samenvatting van de analytische concepten die ik voor mijn analyses gebruik.

Hoofdstuk 4 presenteert mijn methodologische aanpak, met een schets van mijn onderzoeksopzet en onderzoeksdeelvragen, mijn op interviews gebaseerde empirische dataverzamelingsproces, en hoe ik de iteratieve data-codering en discursieve structurele mapping analyses in elke empirische casestudy heb uitgevoerd.

Deel II presenteert vervolgens de vier empirische casestudies en twee interpretatieve reviews die de kern van dit proefschrift vormen:

Hoofdstuk 5 presenteert de analyse van een reeks interviews met deskundigen uit de wetenschap/beleidswereld in de VS, het VK en Duitsland over een voorgestelde gedragscode voor klimaattechnologisch onderzoek. De analyse illustreert hoe – door vorm te geven aan wat wordt gedefinieerd als het (de) object(en) van bestuur, waarom bestuur noodzakelijk wordt geacht, en wie de bevoegdheid krijgt om te besturen – de onderliggende discursieve structuur binnen de wetenschap/politiek in deze drie landen vorm kan geven aan het ontstaan van polycentrische structuren gericht op het vergroten van democratische legitimiteit in CE-onderzoeksbestuur (Cracking the Code).

Hoofdstuk 6 presenteert de analyse van een reeks interviews met Britse vertegenwoordigers uit de industrie/beleidswereld over wat zij als geschikte governance-instrumenten voor NET's beschouwen. Het artikel laat zien dat strategische en utilitaire kennis en sociale actoren binnen deze sfeer van het Britse debat over de governance van NET's worden bevoorrecht,

en benadrukt manieren waarop discursieve mapping een belangrijke emancipatoire rol kan spelen bij het ‚openstellen' van governance-ontwikkelingsprocessen voor bredere kennistypen (Coming to GRIPs with NETs Discourse).

Hoofdstuk 7 geeft een gedetailleerde analyse van een reeks interviews met religieuze leiders en geleerden uit het transnationale maatschappelijke middenveld om kritisch te bespreken hoe het religieuze discours over de rol van de mensheid in en haar verantwoordelijkheid voor de natuur vorm kan geven aan de opkomst van klimaatengineering-governance in het bijzonder, en aan de herconceptualisering van socio-ecologisch bestuur van het aardsysteem in het algemeen (A Leap of Green Faith?).

Hoofdstuk 8 laat zien hoe het heroverwegen van het discours als structuur verbindingen mogelijk maakt met andere structurele benaderingen van de analyse van de ontwikkeling van mondiaal milieubeheer. Het hoofdstuk brengt neo-institutionalistische en post-structuralistische perspectieven samen in een innovatief kader om te onderzoeken hoe het bestuur van klimaatengineering vorm krijgt door discursieve en institutionele structuren in drie internationale fora: de Conventie van Londen en het bijbehorende protocol; de Conventie over Biologische Diversiteit; en de Milieuvergadering van de Verenigde Naties (Arguments and Architectures).

Hoofdstuk 9 biedt een conceptuele verkenning van de manieren waarop verschillende soorten discours vorm kunnen geven aan het opkomende bestuur van op de oceaan gebaseerde negatieve emissietechnieken. In combinatie met benaderingen voor aanvaardbaarheid door het publiek en beleidsbeoordeling laat de analyse zien dat alleen al het idee van oceaan-NET's waarschijnlijk de weg vrijmaakt voor een heel nieuw scala aan betwiste bestuurlijke toekomstbeelden (Casting a wider net on ocean NETs).

Hoofdstuk 10 zoomt uit om te onderzoeken hoe meta-governalities vorm kunnen geven aan een langere en bredere boog van klimaatgovernance. De analyse maakt gebruik van een regeringslens om te wijzen op gemeenschappelijke trends in de manier waarop een schijnbaar ongelijksoortige reeks klimaatresponsstrategieën tussen 2005-2015 is ontstaan, geëvolueerd en in werking is getreden (Uitstel van decarbonisatie).

Deel III geeft vervolgens een samenvatting van de overkoepelende empirische en theoretische conclusies van elk hoofdstuk en van het proefschrift als geheel, en biedt een vooruitblik op verder onderzoek.

Supplementary material

Interviewee Nr.	Affiliation
01	Government department, UK
02	Academia/policy advisor, USA
03	Parliament, UK
04	Academia/policy advisor, USA
05	Civil society/policy advisor, Germany
06	Civil society/policy advisor, USA
07	Government department, USA
08	Academia/policy advisor UK
09	Academia/policy advisor, USA
10	Civil society/policy advisor, USA
11	Civil society, USA
12	Former government department, USA
13	Government department, Germany
14	Former government department, USA
15	Former government department, USA
16	Civil society, USA
17	Civil society, Germany
18	Academia/policy advisor, Germany
19	Academia/policy advisor UK
20	Civil society, USA
21	Academia/policy advisor, USA
22	Former government department, USA

Supplementary Table 1: List of interviewees (Chapter 5)

Speaker position	Demand rationale	Governance roles	Social actors
Principled gatekeeper	Normative	Ensuring accountability in the development of governance	Civil society representatives
		Pushing issues onto the governance agenda	
		Facilitating communication	
		Representing the rights and interests of the under-represented	
Responsible information provider	Functional	Providing objective information to decision-makers to inform the development of problem-specific governance mechanisms	Scientists
		Explaining or demonstrating the scientific grounds for the need for governance of a particular activity	
		Providing ongoing input into the decision-making process to inform the iterative design of adaptive governance for emerging technologies	
		Producing evidence of the effectiveness of specific governance mechanisms	
Strategic controller	Strategic	Developing leverage to constrain (undesirable) research activity and prevent conflict	Political decision-makers
		Providing robust authorization for desirable/useful research activities	
		Engaging in long-term strategic societal and environmental planning to inform governance goals	
Self-benefit-maximizer	Outside boundaries of authoritative discursive space	Generating profit through research and technology development (negative)	Nebulous others – industrial actors?
		Close-holding information gained from research in an attempt to maintain competitiveness (negative)	
		Incentivizing profitable (but not always useful) research (negative)	

Supplementary Table 2: Speaker positions available in the structure of the CE research governance debate and their associated demand rationales & roles (Chapter 5)

Background/Expertise	Code
Industrial strategy	I1
Climate change policy	I2
Forestry	I3
Rural affairs	I4
Industrial strategy	I5
Science & technology policy	I6
Parliament	I7
Industrial strategy	I8
Industrial strategy	I9
Parliament	I10
Parliament	I11
Technology innovation	I12
Industrial strategy	I13
Industrial policy	I14
Local government	I15
Local government	I16
Parliament	I17
Industrial strategy	I18
Climate change innovation	I19
Transportation	I20
Farming	I21
Industrial policy	I22
Entrepreneurial Investment	I23
Environmental research policy	I24
Technology development	I25

Supplementary Table 3: List of interviewees (Chapter 6)

Country	Religion	Code
Nepal	Buddhist	BU1
USA	Christian	CH2
USA	Christian	CH3
USA	Christian	CH4
UK	Christian	CH5
UK	Hindu	HI6
USA	Hindu	HI7
USA	Jewish	JE8
Sweden	Christian	CH9
USA	Christian	CH10
USA	Christian	CH11
Turkey	Muslim	MU12
Indonesia	Muslim	MU13
Indonesia	Muslim	MU14
USA	Muslim	MU15
Chile	Christian	CH16
Belgium	Christian	CH17
South Africa	Christian	CH18
Germany	Christian	CH19
USA	New Pagan	PA20

Supplementary Table 4: List of interviewees (Chapter 7)

	Discursive structure	Description	Example
Objects (what)	A *narrow, bounded* governance object was discursively constituted	Ocean fertilization as one specific type of 'placement activity' with the potential to cause harm to the marine environment (external differentiation). Placement of matter for a purpose other than the mere disposal thereof, subject to (scientific) assessment to ensure its benefits outweigh the potential harm, is constituted as 'legitimate scientific research' (internal differentiation)	At the 29th Consultative Meeting/2nd Meeting of Contracting Parties it was noted that, following consideration of several submissions relating to large-scale iron fertilization of the oceans to sequester CO2, the Scientific Groups, at their joint session in June 2007, had developed a "Statement of Concern", taking the view that knowledge about the effectiveness and potential environmental impacts of ocean iron fertilization currently was insufficient to justify large-scale operations and that this could have negative impacts on the marine environment and human health (LC 2008d: LC 30/4)
			The London Convention and the London Protocol should continue to work towards providing a global, transparent and effective control and regulatory mechanism for ocean fertilization and other activities that fall within the scope of the London Convention and the London Protocol and have the potential to cause harm to the marine environment (LP 2013: LP.4(8))
			In order to provide for legitimate scientific research, such research should be regarded as placement of matter for a purpose other than the mere disposal thereof under Article III.1(b)(ii) of the London Convention and Article 1.4.2.2 of the London Protocol (LC/LP 2008: LC30/16)
			By creating a new permitting regime to control ocean fertilization research, the debate over whether this activity is best considered as dumping or placement, outlined in paragraph 10.4, can be avoided. To date, this debate has revolved around whether ocean fertilization research should be permitted, which is only possible under the current dumping controls, or subjected to "voluntary" controls under the existing placement regime. By creating a permitting authority for ocean fertilization research as a placement activity, a binding permit requirement is created without having to interpret ocean fertilization research as dumping (LC 2010a: LC32/4/1)

Supplementary Table 5: LC-LP discursive structures (Chapter 8)

	Discursive structure	Description	Example
Rationales (why)	Rationales for governance were *utilitarian*, balancing between the potential *benefits and risks* of OF activities.	Governance to make sure that OF (research) activities have maximal benefits (knowledge gain) and minimal harmful (environmental) effects	The Scientific Groups considered it, as a minimum, premature to assess the likelihood of any scenario achieving the stated purpose of carbon export as a climate mitigation strategy and they indicated implicit support for continued research provided it does not adversely affect the marine environment. The importance of continuing fundamental research was also noted by some parties and it has been suggested that criteria be established for assessment of research projects (LC 2008d: LC30/4)
			This Assessment Framework guides Parties as to how proposals they receive for ocean fertilization research should be assessed and provides criteria for an initial assessment of such proposals and detailed steps for completion of an environmental assessment, including risk management and monitoring (LC 2010b:LC 32/15)
			Any specific framework developed for placement activities requires consideration of the following aspects: The details of the specific proposal, including its purpose and characteristics; A clear justification that the proposal is a placement activity with a description of the anticipated benefits and risks; Means to maximize any anticipated benefits and minimize disbenefits; [...]. (LC 2011b: LC 33/4)
			The provisions of the permit shall ensure, as far as practicable, that environmental disturbance and detriment are minimized, and the benefits maximized (LC 2011b: LC 33/4)
			This option will require use of the AF [assessment framework] which will make monitoring mandatory and enable data on observed effects and benefits to be collected centrally and shared to ensure that future research has maximal benefits and is conducted to minimize negative effects on the marine environment (LC 2011a: LC 33/4/2)
Modes (how)	Case-by-case expert *assessment* to restrict/permit activities		Scientific research proposals should be assessed on a case by case basis using an assessment framework developed under the London Protocol and Convention (LC 2008c: LC 30/WP.6)
			Legitimate scientific research should be defined as those proposals that have been assessed and found acceptable under the assessment framework (LC 2008c: LC 30/WP.6)
			Scientific research proposals should be assessed on a case-by-case basis using an assessment framework to be developed by the Scientific Groups under the Convention and the Protocol, and the assessment framework should include, inter alia, tools for determining whether the proposed activity is contrary to the aims of the Convention and the Protocol (LC 2009 LC 31/WP.3).
			Some delegations were of the view that there was a need to develop a "generic placement assessment framework", designed for Contracting Parties to evaluate proposed placement activities and which could be the basis for the development of specific placement guidance, analogous to the "Generic Guidelines" and the "Specific Guidelines" developed for assessment of wastes eligible for dumping under the London Convention and Protocol (LC 2011b: LC 33/4)

Supplementary Table 5: LC-LP discursive structures (Chapter 8)

	Discursive structure	Description	Example
Speakers (who)	Legitimate *'Knowledge Producer'* speaker position afforded to scientific and legal experts	Scientists and legal experts assigned authority as (independent) knowledge producers, tasked with provision of advice to inform the decisions of Contracting Parties.	The Meeting established a Legal and Technical Working Group to prepare comprehensive advice on this issue (LC 2007; LC 29/17)
			The governing bodies established a legal intersessional correspondence group and agreed the following process of future work between this body and the Scientific Groups in 2008: 1 the Legal Intersessional Correspondence Group (LICG) should develop a checklist of legal issues that need to be addressed relevant to whether, and how, the legal framework of the London Convention and Protocol applies to key scenarios on ocean fertilizations and this work should be completed in time for discussion by the Scientific Groups in May 2008;2 the Scientific Groups should, at their May 2008 session, respond to those questions requiring technical input including what would be contrary to the aims of the Convention/Protocol;3 after the Scientific Groups meeting in May 2008, the LICG should take the technical information from the Scientific Groups meeting report to finalize answers to the legal questions; and a LICG lead-country would summarize the legal views in a document for the next joint session of the governing bodies, recognizing that completion on some aspects would be dependent on the availability of sufficient information from the Scientific Groups (LC 2007; LC 29/17)
			Endorse the Group's recommendation that technical/scientific expertise is included in delegations when the issue of ocean fertilization is discussed further at this session (LC 2008a: LC 30/3)
			Where respondents considered the act to be dumping, it was generally not seen to be captured by Annex 1 (which allows the dumping of certain wastes or other matters with a permit) unless the iron could be classified as an "inert, inorganic geological material". Guidance on this was requested from the Scientific Groups, who responded, and specifically noted, that it should not be considered as 'inert, inorganic geological material' (LC 2008d:: LC 30/4).
			The governing bodies requested the Scientific Groups to prepare a document, for the information of all Contracting Parties, summarizing the current state of knowledge on ocean fertilization, relevant to assessing impacts on the marine environment (LC 2008e: LC 30/16)
			The Meeting noted that Germany believes that the establishment of an independent international expert group is necessary which should have two tasks: 1) to provide an independent scientific statement concerning the state of scientific knowledge before a decision is taken whether a specific activity is listed in annex 4 according to the proposal as outlined in LC 35/4; and 2) to scientifically review applications for permissions (LC 2013: LC 35/15).
			After the Scientific Group has assessed the waste and its composition, a legal consideration of authorising the activity could follow (LC 2008c:LC 30/INF.2.)
			Before forming a view on whether ocean fertilisation constitutes pollution, Australia considers that the opinions of the Scientific Group should be sought on whether ocean fertilisation may have one or more of the deleterious effects listed in the definition of pollution (LC 2008c:LC 30/INF.2.)

Supplementary Table 5: LC-LP discursive structures (Chapter 8)

	Discursive structure	Description	Example
Objects (what)	A singular, but *broad, unspecific* governance object discursively constituted.	All CE techniques that *may* affect biodiversity and associated socio-ecological systems	An interim definition of geo-engineering includes any technologies that deliberately reduce solar insolation or increase carbon sequestration from the atmosphere on a large scale that may affect biodiversity (CBD Secretariat 2011a: lgcrg-eng-01-03-en)
			The technical study indicates that the deployment of some geoengineering techniques, if feasible and effective, could reduce the magnitude of climate change and its impacts on biodiversity. At the same time, most geoengineering techniques are associated with unintended impacts on biodiversity, particularly when deployed at a climatically-significant scale, together with significant risks and uncertainties (SBSTTA 2012: SBSTTA/16/10)
			[T]he impacts of geoengineering on the drivers of biodiversity loss, including the potential decrease in the climate change driver from effective geoengineering techniques, changes in other drivers, including land-use change, that are inevitably associated with geoengineering approaches (SBSTTA 2015a: SBSTTA/19/7)
Rationales (why)	*Precautionary* rationales emphasising the *potential impacts* of CE, and the need for more diverse information to assess them.	Governance to protect biodiversity against the *potential impacts* of CE on biodiversity and socio-ecological systems by *preventing* such activities from taking place. Governance to facilitate transdisciplinary research and knowledge integration to holistically assess the *potential impacts* of CE on biodiversity and associated social, economic and cultural systems.	On geo-engineering, the COP invites parties and governments, according to national circumstances and priorities, to ensure, in line with decision IX/16 C on ocean fertilization, in the absence of a science-based, global, transparent and effective control and regulatory mechanism for geo-engineering, and in accordance with the precautionary approach and CBD Article 14, that no climate change-related geo-engineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify them and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts (ENB 2010: enb09534e)
			The lack of understanding of risks as a result of reliance upon models and limited observations makes it difficult to evaluate the full spectrum of potential impacts of climate-related geo-engineering on biodiversity, especially when considering complex systems such as the reliance of some ecosystems on monsoons. [...] climate-related geo-engineering is relatively un-studied and, therefore, should continue to be managed within the framework of the precautionary principle/approach (CBD Secretariat 2011b: lgcrg-eng-01-04-en)
			The COP reiterated the importance of the precautionary approach in relation to climate-related geoengineering. [...] and the need for more research and knowledge-sharing in order to better understand the impacts of climate-related geoengineering (CBD Secretariat 2016: pr-2016-12-18-un-bidov-conf-en)

Supplementary Table 6: CBD discursive structures (Chapter 8)

	Discursive structure	Description	Example
Modes (how)	*Coercive, centralized, global* governance mode discursively constituted as practicable.	Global, transparent and effective *control and regulatory* mechanisms to *prevent potentially* harmful CE activities from taking place.	[…] proposed inserting language on the urgent need for a global transparent regulatory framework on geo-engineering (ENB 2010: enb09534e)
			Informal exchanges also continued on a possible moratorium on geo-engineering, with conjecture surrounding the possible fate of one of the conditions for lifting the moratorium, namely the setting up of a global regulatory framework (ENB 2010: enb09534e)
			The current regulatory mechanisms that could apply to climate-related geoengineering relevant to the Convention do not constitute a framework for geoengineering as a whole that meets the criteria of being science-based, global, transparent and effective (SBSTTA 2012: SBSTTA/16/10)
Speakers (who)	Legitimate *'Knowledge Producer'* speaker positions afforded to both scientific non-scientific actors	*Life scientists, indigenous peoples and local communities (IPLCs)* all produce knowledge relevant for making decisions on CE governance.	[The COP] recognizes the importance of taking into account sciences for life and the knowledge, experience and perspectives of indigenous peoples and local communities when addressing climate-related geoengineering and protecting biodiversity (SBSTTA 2015b: SBSTTA/19/10)
			It is necessary for decision makers and scientists to understand the wider multidisciplinary concerns expressed by indigenous peoples, to root their geoengineering proposals within this broader framework and to set aside part of their investigation to understanding how to incorporate a holistic approach into their work (SBSTTA 2012: SBSTTA/16/10)
			[…] the prediction and assessment of potential harms to biological diversity by geoengineering proposals should include local criteria and indicators, and should fully involve the relevant indigenous and local communities (SBSTTA 2012: SBSTTA/16/10)

Supplementary Table 6: CBD discursive structures (Chapter 8)

	Discursive structure	Description	Example
Objects (what)	Governance object formation disputed, broad vs. narrow. CE as a whole vs. only certain types of CE to be governed	Governance to address CE as a whole, alongside mitigation and adaptation under an overarching 'climate response strategies' label. All types of CE defined as a unified governance object due to their inherently risky nature.	They were definitely seeing this as a thing, geoengineering or climate engineering, as a thing, which was summarized by the risky nature of it more than by its potential contribution to dealing with climate (Interviewee A1) There are different factions who are either emphasizing "we need to govern this as an emerging risk issue", while others are saying "we need to govern this as a uncertain climate action avenue". (Interviewee A1) The EU on the other hand seemed comfortable to see CDR and SRM in one proposal, while doubling down on the sentiment that all of 'geoengineering' required extreme caution, that its risks raised 'grave concerns' and introducing reference to the precautionary principle (Honegger 2019)
		Governance to address SRM & CDR separately because their respective states of development, their risks and political implications are vastly different. Lumping CE approaches for governance purposes could inhibit freedom to develop/deploy CDR	Mindful of the varying definitions of geoengineering and the general distinction of technologies in solar radiation management and carbon dioxide removal, and taking into account their varying state of development with respect to science, their application, and potential risks (UNEA 2019) The US made it clear early on that they saw the lumping of these very different categories into one as fundamentally problematic. It had good reasons to believe that the resolution as well as the ensuing mandate to UNEP would have tended to address both under a premise of restriction rather than enablement – at a point in time where the US is perhaps the leading country in terms of incentivising CDR implementation (Honegger 2019)

Supplementary Table 7: UNEA discursive structures (Chapter 8)

	Discursive structure	Description	Example
Rationales (why)	Discursive rationales for/against governance were split. Enable some types to help achieve (political) climate goals, restrict others to reduce (political/environmental risk).	Governance of CE at the global level to ensure precautionary control and oversight Governance to mitigate potential for global risks/adverse impacts of CE on environment and sustainable development. Governance of CE to make sure the topic is considered, build the capacity of international actors to deal with the issue. '. Governance to establish (lack of) relationship of CE to mitigation in climate policy. Governing CE at UNEA would infringe into the political realm of climate change, politicizing CE. Governance of CE on the global level would create undue restrictions on national climate/research policy. Governance not needed through UNEA as CE it is already being addressed in other international forums (CBD, LC/LP, IPCC). As there is not yet a scientific consensus on CE, it is too early to be having international governance discussions.	Bolivia regretted that the precautionary principle had not been sufficiently recognized in relation to this issue (ENB 2019c: enb16l5e) Bolivia and some European countries pushed for changes in its preamble, adding a reference the precautionary principle and further emphasizing a 2010 decision by the Convention on Biological Diversity (CBD) parties (Reynolds 2019) Deeply concerned about the potential global risks and adverse impacts of geoengineering on environment and sustainable development, and noting the lack of multilateral control and oversight (UNEA 2019) Several reports suggested that certain geotechnologies [sic] could pose a risk of severe environmental impacts, so more information was needed to enable Member States to have an informed discussion on the issue (UNEP-EA 2019: UNEP-EA.4/2) Thee majority feared that pursuit of geoengineering options could undermine mitigation, and supported text that restated the primacy of emissions reductions. The minority opposed such text, claiming that carbon removal could be a direct substitute for emissions cuts (McLaren 2019) Some delegates cautioned the negotiations were veering into the difficult political domain of climate change, while others said discussions on geoengineering and climate change are unavoidably intertwined (ENB 2019a: enb16l45e) The opponents called the resolution premature, and criticised it for threatening inappropriate restrictions, especially on carbon removal approaches (McLaren 2019) Several delegates raised concerns about the objective of the resolution,[...] They warned against, among others, potential duplication of work as the topic is already under consideration in other fora, including the Intergovernmental Panel on Climate Change (IPCC) (ENB 2019d: enb16l53e) Delegates also debated which existing governance bodies should be referred to in the text, and whether a discussion on governance was appropriate, considering the still-embryonic scientific consensus on the nature and scope of geoengineering technologies (ENB 2019a: enb16l45e)

Supplementary Table 7: UNEA discursive structures (Chapter 8)

	Discursive structure	Description	Example
Modes (how)	Centralized, expert-led, mode conflicted with a participatory/consultation based mode, a and with decentralized mode	Governance options put together by a group of experts, presented to UNEP Secretariat, as basis of policy recommendations for parties.	Call for proposals of and select participants for an Ad Hoc Independent Expert Group to advise the Executive Director on the development of the abovementioned assessment (UNEA 2019)
			The other things that were attached to that as well were definitely a sort of broader participatory sense of how governance should be achieved and this would require much wider consultation with affected populations. [...] I was actually quite pleased to hear the EU joining in with this sort of language, about other forms of knowledge, different knowledges rather than the core scientific modelling narrative of the ... that we see the IPCC in particular (Interviewee A2)
		Governance informed by existing international principles/laws & prior decisions in other fora.	Among other proposed amendments, a developed country supported new language referring to the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 degrees (ENB 2019 a: enb16145e)
			On geoengineering, delegates began to work through a heavily bracketed operative paragraph requesting UNEP to work in collaboration with other stakeholders, such as relevant UN and intergovernmental bodies, to prepare a report on the "state of play and potential gaps'" in the field (ENB 2019b: enb16149e)
			There was a lot of emphasis from the Bolivians and several others of, in a sense, preserving what we have agreed, seeing the CBD as a forum where a lot of this had been agreed in terms of the precautionary stance and that the informal moratoria type view of geoengineering (Interviewee A2)
		Governance discussions/decisions with full participation of civil society & affected parties.	For it to be a legitimate discussion on geoengineering governance, it must be based on multilateral, transparent and accountable deliberations, in which all governments can freely participate in a democratic manner, open to public scrutiny and with the full participation of civil society organisations, Indigenous Peoples and social movements. It must be free from corporate influence, respectful of existing international laws and decisions, based on the precautionary principle [...] (HBF-ETC 2019)
		Governance discussions/decisions transparent to outsiders.	The EU's support of the proposal was, however, lukewarm as it might not have felt ready to address CDR and SRM head on at the multilateral level, for lack of internal clarity: CDR is silently built into the EUs 2050 long-term strategy, while at a political level clashes with the EUs climate policy paradigm (Honegger 2019)
		Governance discussions/decisions not influenced by corporate interests.	[T]he US in particular did already have at least one policy in place that was specifically looking to advance carbon removal as part of the mitigation ensemble. The previous administration, Obama's administration, had adopted a long-term climate strategy which involved explicitly removals as part of the plan. And so pursuing the first steps towards global governance on climate engineering or geoengineering [...], suggested a more hesitant approach or a more blocking approach, which would be contradictory to the US' already existing policies (Interviewee A1)
		Governance decentralized through national policy	

Supplementary Table 7: UNEA discursive structures (Chapter 8)

	Discursive structure	Description	Example
Speakers (who)	Legitimate *Knowledge Producer* speaker position afforded to diverse social actors: Expert/ scientific vs. local/ traditional.	Governance decisions to be made based on expert/ scientific consensus on risks/benefits of CE.	Countries disagreed on which stakeholders should be mentioned and how, as well as on whether such an expert report should be commissioned (ENB 2019b: enb16149e) Many representatives expressed regret that, due to the opposition of some Member States, no agreement had been reached at the current session on the draft resolution on geoengineering and its governance, which would have requested UNEP to collect information and prepare a factual report on the risks, potential and governance challenges of geoengineering technologies, in line with its mandate of keeping Member States apprised of emerging environmental issues (UNEP-EA 2019: UNEP-EA.4/2) According to a regular stakeholder in attendance this week, "there has been a shift against acceptance of civil society in recent years" among Member States (ENB 2019a: enb16145e) Ensure that the Ad Hoc Expert Group represents the knowledge, interests and views of those potentially most affected by geoengineering, including Indigenous Peoples, Women, Youth and civil society. Ensure that the Ad Hoc Expert Group is free of conflicts of interest, such as fossil fuel industry interests, investors or stakeholders in geoengineering companies or researchers with patents on geoengineering or other conflicting commercial interests, by establishing a robust Conflict of Interest policy (HBF-ETC 2019) At the UNEA many countries supported a Swiss resolution – levelled at the UN's top environmental body – intended to build knowledge – not just about the climatic implications of geoengineering, but about its potential social, environmental, economic, political and technical implications and side-effects (McLaren 2019)
		Governance decisions to take into consideration the knowledge, interests and views of those potentially most affected by CE, i.e., indigenous, traditional knowledge. Governance based on a broad assessment of environmental and social concerns, not solely on scientific & economic assessment.	A representative of Asia Indigenous Peoples Pact made a statement on behalf of the major groups and stakeholders except business and industry. He noted with regret the abandonment of proposed resolutions on deforestation, agricultural supply chains and the strengthening of geoengineering governance and the dilution of other resolutions, which would mean, inter alia, a lack concerted action on and resources for implementation. Major groups intended to enhance their engagement in work programmes with the inclusion of indigenous traditional knowledge and practices (UNEP-EA 2019: UNEP-EA.4/2) I think where that then echoed into the negotiators positions, was in a sense of precaution that, "actually, this is why we want this thing to go ahead. We want to have an independent – but rooted in broad environmental and social concern – assessment of these technologies" (Interviewee A2)

Supplementary Table 7: UNEA discursive structures (Chapter 8)

Curriculum Vitae

Professional Experience

Research Associate, German Institute for International and Security Affairs (SWP), Berlin	2021 –
Research Associate, Institute for Advanced Sustainability Studies, Potsdam	2015-2021
Research Analyst & Workshop Facilitator, Foresight Intelligence, Berlin	2014-2015
Research & Teaching Assistant, Ruprecht-Karls-Universität, Heidelberg	2010-2012
Docent & Faculty Coordinator, F&U Academy, Heidelberg	2008-2012

Science Management

Steering Committee Co-Chair, Climate Engineering Conference Series, IASS Potsdam	2018 –
Steering Committee Member, Climate Engineering Conference Series, IASS Potsdam	2015-2017
Conference Coordinator, Climate Engineering Symposium, Marsilius-Kolleg, Heidelberg	2012
Co-Coordinator, Sociology of Knowledge Approach to Discourse (SKAD) Network	2020 –
Review Editor, Frontiers in Climate: Negative Emission Technologies	2021

Education

PhD Candidate, Copernicus Institute for Sustainable Development, Utrecht University	2018-2021
Master of Arts, Political Science & Government, Ruprecht-Karls-Universität Heidelberg	2010-2012
Alumni Prize for Highest Ranked PolSci Graduate, Ruprecht-Karls-Universität Heidelberg	2012
Bachelor of Arts, Political Science & Government, Ruprecht-Karls-Universität Heidelberg	2007-2010

Publications

Peer reviewed

Boettcher, M. and Kim, R. (2022): Arguments and architectures: Discursive and institutional structures shaping global climate engineering governance. *Environmental Science and Policy* https://doi.org/10.1016/j.envsci.2021.11.015

Boettcher, M. (2021): A leap of Green faith: the religious discourse of Socio-Ecological Care as an Earth system governmentality. *Journal of Environmental Policy and Planning.* https://doi.org/10.1080/1523908X.2021.1956310

Boettcher, M., Brent, K., Buck, H.J., Low, S., McLaren, D. and Mengis, N. (2021): Navigating potential hype and opportunity in governing marine carbon removal, *Frontiers in Climate,* https://www.frontiersin.org/articles/10.3389/fclim.2021.664456/full

Cox, E., **Boettcher, M.**, Spence, E. & Bellamy, R. (2021): Casting a wider net on ocean NETs, *Frontiers in Climate,* https://doi.org/10.3389/fclim.2021.576294

Boettcher, M. (2020) Coming to GRIPs with NETs Discourse: Implications of discursive structures for emerging governance of Negative Emissions Technologies in the UK, *Frontiers in Climate*, 2 (20), https://doi.org/10.3389/fclim.2020.595685

Low, S. & Boettcher, M. (2020) Delaying decarbonization: Climate governmentalities and sociotechnical strategies from Copenhagen to Paris, *Earth System Governance*, 5, https://doi.org/10.1016/j.esg.2020.100073

Boettcher, M. (2019): Cracking the code. How discursive structures shape climate engineering research governance. *Environmental Politics* http://doi.org/10.1080/09644016.2019.1670987

Boettcher, M., & Schäfer, S. (2017). Reflecting upon 10 Years of Geoengineering Research: Introduction to the Crutzen + 10 Special Issue. *Earth's Future*, 5(3), 266-277. https://doi.org/10.1002/2016EF000521

Harnisch, S.; Uther, S. & Boettcher, M. (2015): From 'go-slow' to 'gung-ho'? Comparing Climate Engineering discourses in the UK, the US and Germany. *Global Environmental Politics*, 15 (2), https://doi.org/10.1162/GLEP_a_00298

Special issues

Boettcher, M., & Schäfer, S. (Eds.) (2016): Crutzen +10: Reflecting upon 10 years of geoengineering research [Special Issue]. *Earth's Future*, 4 (12), https://agupubs.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)2328-4277.GEOENGIN1

Chapters

Boettcher, M. (2015): Erfahrungsbericht zum Thema Diskursanalyse (Research using discourse analysis methodology), In: *Methodologie, Methoden, Forschungsdesign: Ein Lehrbuch für fortgeschrittene Studierende der Politikwissenschaft,* edited by Achim Hildebrandt, Sebastian Jäckle, Frieder Wolf, & Andreas Heindl. Wiesbaden, Springer VS.

Assessments & Reports

GESAMP (2019): High level review of a wide range of proposed marine geoengineering techniques. (Boyd, P.W. and Vivian, C.M.G., eds.) Contributors: Boettcher, M., Chai, F., Cullen, J., Goeschl, T., Lampitt, R., Lenton, A., Oschlies, A., Rau, G., Rickaby, Ricke, R., Wanninkhof, R. UN Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. Rep. Stud. GESAMP No. 98.

Boettcher, M., Schäfer, S., Low, S., Parker, A. (2018): Climate Engineering Conference 2017: Critical Global Discussions. Conference Report, (IASS Report), Potsdam: Institute for Advanced Sustainability Studies (IASS) DOI: https://doi.org/10.2312/iass.2018.003

Boettcher, M., Schäfer, S., Honegger, M., Low, S., Lawrence, M. G. (2017): Carbon Dioxide Removal. – IASS Fact Sheet, 2017, 1.DOI: http://doi.org/10.2312/iass.2017.017

Boettcher, M., Parker, A., Schäfer, S., Honegger, M., Low, S., Lawrence, M. G. (2017): Solar Radiation Management. – IASS Fact Sheet, 2017, 2.DOI: http://doi.org/10.2312/iass.2017.018

Boettcher, M.; Flegal, J. (2016): 2nd meeting Academic Working Group on the International Governance of Climate Engineering: Meeting Report, New York, Washington D.C.: Forum for Climate Engineering Assessment American University (FCEA); American Univ.

Boettcher, M.; Gabriel, J., & Low, S. (2016): Solar Radiation Management: Foresight for Governance. Project Report. – IASS Working Paper, April 2016. DOI: http://doi.org/10.2312/iass.2016.007

Boettcher, M.; Gabriel, J & Harnisch, S. (2015): Scenarios on Stratospheric Albedo Modification in 2013, *DFG SPP 1689 Scenario Workshop Report*, Hamburg 22-24 March, 2015. Available at: http://www.youblisher.com/p/1216991- Miranda-Boettcher-M-A-Johannes-Gabriel-Dr-Sebastian-Harnisch-Prof-Dr/

Boettcher. M. (2015): Climate Engineering Research Symposium Blog, *DFG SPP 1689 Current State and Future Perspectives: Climate Engineering Research Symposium,* Berlin 7-10 July, 2015. Available at: http://www.spp-climate-engineering.de/Symposium_Blog.html

Matzner, N. & **Boettcher, M**. (2013): Bridging the gaps – Summer Schools on Climate Engineering. *EASST Review; European Association for the Study of Science & Technology*, 32 (1).

Boettcher, M. & Kettner, S. (2010): Governing Climate Engineering – A Transdisciplinary Summer School. *Marsilius Kolleg, Ruprecht-Karls-Universität Heidelberg,* September 2010.

Selected reviews

Global Environmental Change, Environmental Politics, Technological Forecasting & Social Change, International Studies Quarterly, Frontiers in Climate, Cambridge University Press, ETH Zurich Research Commission, NCAR Early Career Faculty Innovator Program (ECI)

Selected presentations

Invited talks

2021   **A leap of green faith:** The religious discourse of socio-ecological care as an earth system governmentality, Earth System Governance in turbulent times: prospects for political and behavioural responses**,** Earth System Governance Conference, Slovak University of Technology, Bratislava, Slovakia & Online.

2021   **Arguments and Architectures:** Discursive and institutional structures shaping international decisions on climate engineering governance**,** Earth System Governance in turbulent times: prospects for political and behavioural responses**,** Earth System Governance Conference, Slovak University of Technology, Bratislava, Slovakia & Online.

2019   **Mapping CE Governance Demand Rationales – Who, how and to what end?** Climate Engineering: Opportunities and Challenges for Responsible Research and Anticipatory Governance: Conference of the DFG Priority Programme on Climate Engineering (SPP 1689), Museum of Natural History, Berlin, Germany.

2019   **Cracking the Climate Engineering Governance Code:** How discursive structures can inform the anticipatory development of a Code of Conduct for Climate Engineering Research, Public lecture, Australian-German Climate & Energy College, University of Melbourne, Australia.

2019   **The discursive construction of climate engineering between science, society and politics.** Symposium on Discourse Theoretical Approaches to Politics, Society, Communication and Media, DESIRE (the Centre for the study of Democracy, Signification and Resistance), Vrije Universiteit, Brussels, Belgium.

2018   **Transformative Transdisciplinarity:** Walking the Line between Academia and Advocacy. International Relations Department Colloquium Lecture Series, Institute for Political Science, Heidelberg University, Germany.

Chaired panels

2019	**Towards a deliberative science-policy interface?** Conference on Ethics & Values in Assessments: Divergent values in sustainability assessments: love them, leave them, or change them? Mercator Research Institute on Global Commons and Climate Change "Seminarschiff", Berlin, Germany.

2019	**Future issues for climate engineering assessment and governance:** Climate Engineering: Opportunities and Challenges for Responsible Research and Anticipatory Governance: Conference of the DFG Priority Programme on Climate Engineering (SPP 1689), Museum of Natural History, Berlin, Germany.

2018	**Die Zukunft des Climate Engineerings:** „Heidelberger Brücke" Symposium, Heidelberg Center for the Environment (HCE), Heidelberg, Germany.

2017	**Campfire Session on a Code of Conduct for Geoengineering Research:** Mapping the expert discourse on a Code of Conduct for climate engineering research, Climate Engineering Conference 2017 (CEC17), Berlin.

Teaching experience

Lecturer

Social Science Perspectives on Climate Engineering: Block Seminar as part of the MA module "Interdisciplinary Introduction to Environmental Sciences", Fern Universität Hagen, Germany, Summer Semester 2019.

The Climate Engineering Governance Challenge: Guest Lecture at the University of Potsdam as part of the MA course "Atmospheric Science in the Anthropocene", University of Potsdam, Germany, Winter Semester 2018/19.

The Climate Engineering Governance Challenge: Guest Lecture at the University of Potsdam as part of the MA course "Atmospheric Science in the Anthropocene", University of Potsdam, Germany, Winter Semester 2017/18.

Teaching Assistance

Introduction to International Relations: BA Lecture, Department of Political Science and Government, Ruprecht-Karls-Universität Heidelberg, Winter Semesters 2010-2012.

Qualitative Methods in Political Science: MA Seminar, Department of Political Science and Government. Ruprecht-Karls-Universität Heidelberg, Summer Semester 2012.

German Developmental Policy: A textbook project. MA Seminar, Department of Political Science and Government, Ruprecht-Karls-Universität Heidelberg, Summer Semester 2012.

State-Building and Conflict in Sub-Saharan Africa: MA Seminar, Department of Political Science and Government, Ruprecht-Karls-Universität Heidelberg, Summer Semester 2011.

Plan B for the Planet? Climate Change, International Climate Policy and the option of Climate Engineering: Interdisciplinary MA Seminar, Department of Political Science and Government, Ruprecht-Karls-Universität Heidelberg, in collaboration with Heidelberg Center for the Environment (HCE). Winter Semester 2010/11.

Other teaching experience

2008-2012 **Docent & Faculty Coordinator** at F&U Academy, private vocational education institute. Courses taught included: Commercial Correspondence, Translation (German-English), American, British and Australian Cultural Studies.

Fellowships

2021 **Research Fellow**, Earth System Governance Project Research Alliance, Future Earth, Utrecht University, Netherlands (Ongoing).

2019 **Visiting Scholar**, Australian-German Climate and Energy College, University of Melbourne, Australia (February).

2018 **Oxford Martin Visiting Fellow**, Institute for Science, Innovation and Society, University of Oxford, United Kingdom (October-December).

Memberships

2016 – **GESAMP Working Group 41: Ocean Interventions for Climate Mitigation** (previously Marine Geoengineering). Assessment group member, report contributor.

2017-2019 **Carnegie Climate (Geoengineering) Governance Initiative**. Academic Advisor.

2017-2019 **Institute for Advanced Sustainability Studies**. PhD Representative.

2008-2012 **Student Council of the Department of Political Science and Government**, Ruprecht-Karls-Universität Heidelberg, Active Member.

Additional training

Mentoring Plus Training Program for Female PhD Candidates, Potsdam Graduate School, University of Potsdam, February 2019-February 2020.

Discourse Theoretical Approaches to Politics, Society, Communication and Media – PhD Masterclass, Vrije Universiteit Brussel, 2 February, 2019

How to Write a Competitive EU Proposal – Brandenburg EU Competence Network Workshop, Potsdam University of Applied Sciences, 21 November, 2019

Foucauldian Discourse Analysis – Berliner Methodentreffen Qualitative Forschung, Freie Universität Berlin, 27-28 July, 2018.

Sociology of Knowledge Approach to Discourse (SKAD) – Berliner Methodentreffen Qualitative Forschung, Freie Universität Berlin, 27-28 July, 2018.

Sociology of Knowledge Approach to Discourse (SKAD) – Autumn School, University of Augsburg, 11-12 November, 2018.

Network Analysis – European Consortium for Political Research (ECPR) Summer School in Methods and Techniques – Central European University, Budapest 27 July-12 August 2017

Qualitative Expert Interviews – European Consortium for Political Research (ECPR) Summer School in Methods and Techniques – Central European University, Budapest 27 July-12 August 2017

Professional Training Program on Facilitation and Participatory Leadership – Art of Hosting, European Forum Alpbach, 17-20 August 2016.

Languages

English (Native speaker)	**Spanish** (Working proficiency)
German (Native speaker equivalent)	**Indonesian** (Basic proficiency)

Acknowledgments

And so now all that remains is the final – and perhaps most important – section of this thesis. So many people were directly and indirectly involved in what has been a long and challenging process – you know who you all are – but given that many of you have struggled through 200+ pages already, I will try to keep my appreciation short and to the point:

Many thanks to Prof. Frank Biermann and Dr. Rak Kim for their invaluable support and advice during my time as a PhD candidate at Copernicus Institute of Sustainable Development at Utrecht University. I am also immensely grateful to Prof. Mark Lawrence at the Institute for Advanced Sustainability Studies – not only for providing the financial means that made this thesis possible, but also for always having an open door and an open mind.

My heartfelt gratitude goes out to Prof. Sebastian Harnisch, for introducing me to the topic of CE in 2009, and for constantly pushing me to challenge myself throughout my BA and MA studies at Heidelberg University. But for an unexpected twist of funding-fate, he would no doubt have shepherd me to my PhD-title much earlier.

Thank you to the Marsilius Kolleg CE-crew for introducing me to the wild and wonderful world of interdisciplinary research – above all Stephanie Uther (now Renforth), who was a wonderful sparring partner in my early days of discourse-analysis crime.

To all those who I laughed and learned with at the various Climate Engineering Summer Schools; even if we have since become 'real' academics – let's never forget the serious silliness of those days.

Thank you to Johannes Gabriel, for reminding me that there are always a multitude of plausible futures. Thank you to Clare Heyward for 'academically adopting' me when I needed it most.

To all the iterations of the 109h office crew – but especially Andy Parker and Matthias Honegger – thank you for all the sh%#ty coffee, horrible music, and great laughs.

To my family – thank you for supporting my life choices, even if you weren't quite sure where they would take me.

And finally, Sean – as usual, I can't improve upon your choice of words. If I had only met you today, I would do it all again.

In addition to mitigation and adaptation as strategies for governing climate futures, a third way of responding to climate change is now emerging: Intentional intervention into the global climate, often termed 'climate engineering' (CE). There is a growing awareness that formal governance of some types of CE is going to be needed in the coming years, and that informal governance is already being shaped by the discourses and practices of CE research and assessment. Increased attention is being paid to the types of scientific and societal discourses shaping the emergence of CE governance. Contributing to this literature, this thesis asks how the discursive construction of CE governance is taking place in science, industry, civil society, and politics. The project emphasises that, as discourse is the source code with which contested futures are written, 'cracking the discursive code' underpinning the CE governance debate can help critically anticipate the emergence of future governance practices and infrastructures. In this vein, the thesis peruses several interrelated aims: (1) Exploring a framework for shifting the analytical perspective on the role of discourse in (CE) governance development processes; (2) Anticipating and critically reflecting upon how given discursive structures may be making certain types of CE governance more/less thinkable and practicable, (3) emancipating those engaging in the CE governance debate to recognize and expand the bounds of the discursive structures they are reproducing, and (4) informing the design of participatory processes to further "open up" discursive diversity in CE governance development.