LUND UNIVERSITY

From Show Pony to Working Horse

Reimagining Carbon Capture and Storage for Just Climate Change Mitigation

Lefstad, Lina

2026

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
Lefstad, L. (2026). *From Show Pony to Working Horse: Reimagining Carbon Capture and Storage for Just Climate Change Mitigation*. [Doctoral Thesis (compilation), LUCSUS (Lund University Centre for Sustainability Studies)]. Lund University Centre for Sustainability Studies (LUCSUS).

Total number of authors:
1

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

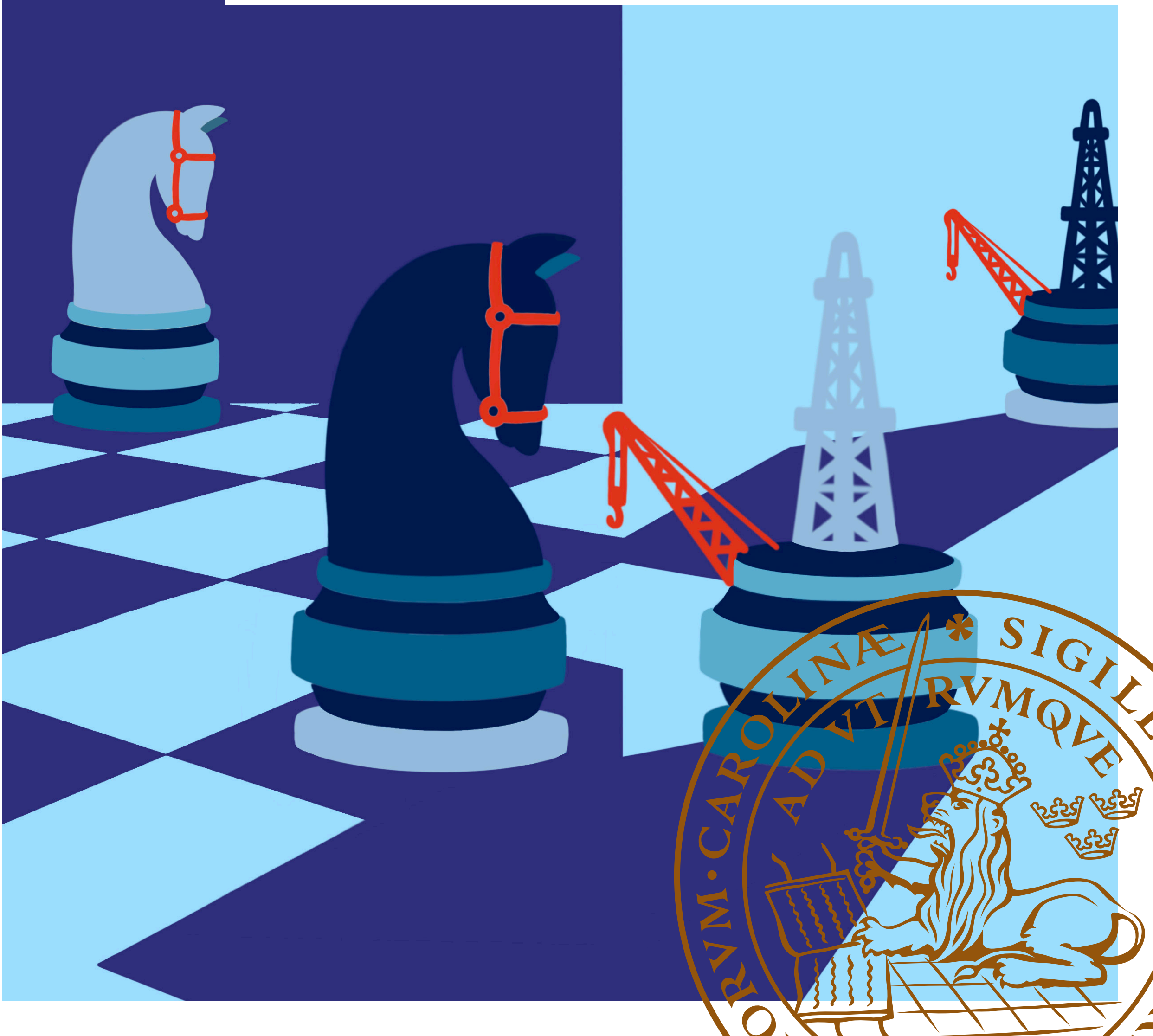
Download date: 06. Jun. 2026

From Show Pony to Working Horse

Reimagining Carbon Capture and Storage for Just Climate Change Mitigation

LINA LEFSTAD

LUCSUS | FACULTY OF SOCIAL SCIENCES | LUND UNIVERSITY



From Show Pony to Working Horse

Reimagining Carbon Capture and Storage for Just Climate Change Mitigation

Carbon Capture and Storage (CCS) is a long-discussed technology, but it has struggled to scale. Its journey so far, the "show pony" phase, has proven technical feasibility, captured policy attention and secured a place for CCS in binding net-zero strategies. But for CCS to now deliver meaningful climate mitigation, the focus must shift from proving what can be done to governing how it's done.

In this thesis, I analyse policy frameworks in Norway and the European Union and find that the current market-driven approach is structurally misaligned with both the technology's material realities and the climate justice principles enshrined in the Paris Agreement. This governance model, I argue, depoliticises our choices for decarbonisation, entrusts the fossil fuel industry with a gatekeeper role, and has so far failed to deliver on either scale or equity. To break this impasse, I propose a reimagined path forward: shifting from treating CCS as a market commodity to stewarding it as a public good. In this thesis I offer a constructive and timely compass for turning CCS from a "show pony" into the "working horse" that just climate mitigation demands.

LINA LEFSTAD is an interdisciplinary social scientist focussing on justice in climate change mitigation. She has a background in ecological economics and international management.

Printed by Media-Tryck, Lund 2026 NORDIC SWAN ECOLABEL 3041 0903

LUND UNIVERSITY

LUCSUS
Faculty of Social Sciences

ISBN: 978-91-8104-858-2

From Show Pony to Working Horse

Reimagining Carbon Capture and Storage for Just Climate Change Mitigation

Lina Lefstad

DOCTORAL DISSERTATION

Doctoral dissertation for the degree of Doctor of Philosophy (PhD) at the Faculty of Social Science at Lund University to be publicly defended on 13th of May 2026 at 10.15 in Ostrom, Josephson, 5 Biskopsgatan, Lund

Faculty opponent
Professor Oluf Langhelle, University of Stavanger

Organization: LUND UNIVERSITY

Document name: Doctoral Dissertation

Date of issue: 2026-05-13

Author(s): Lina Lefstad

Sponsoring organization: LUCSUS

Title and subtitle: From Show Pony to Working Horse: Reimagining Carbon Capture and Storage for Just Climate Change Mitigation

Abstract:

This thesis examines the governance of Carbon Capture and Storage (CCS) technology in its current phase of policy-driven deployment within European climate policy. Positioned in the gap between established critique of CCS and its newly central role in binding net-zero strategies, my research adopts a critical-pragmatic stance to acknowledge that CCS is a contentious technology embodying risks of carbon lock-in and mitigation deterrence, while simultaneously recognising its political inevitability for decarbonising hard-to-abate sectors within the post-Paris Agreement context. My research aim is to offer a constructive critique of CCS governance by asking how deployment can be aligned with climate justice principles. I employ three theoretical lenses; the concept of imaginaries diagnoses the dominant vision driving CCS policy, revealing a “techno-market” imaginary that frames CCS as an inevitable, cost-efficient market commodity. A cosmopolitan climate justice framework, grounded in the equity principles of the United Nations Framework Convention on Climate Change and the Paris Agreement provides the moral compass to evaluate this imaginary. Finally, a political economy of decarbonisation-lens analyses the governance structures, specifically the roles of state and market, that enact this vision. Through a multi-method qualitative approach including systematic literature reviews, comparative policy analysis and expert interviews, this research analyses the Norwegian and European Union policy architecture. The findings demonstrate that the current dominant governance model, predicated on the techno-economic imaginary, is structurally misaligned with CCS’s material realities and ethical imperatives. This manifests in three core trends, namely through depoliticisation of the need for CCS, a gatekeeper problem with incumbent industry and lastly, how the market has so far failed to scale. In response, I argue for a conscious re-imagining of CCS governance through a shift from a market-commodity to a public-good model. In conclusion, this research contributes a timely, justice-centred framework for governing a contentious but important technology. The findings suggest CCS has successfully completed its phase as a “show pony” by proving technical feasibility and securing political mandate. For it to now become an effective “working horse” for decarbonisation, its governance must be reoriented around public stewardship and cosmopolitan justice principles, moving beyond a sole market logic to ensure just and effective large-scale deployment.

Key words: Climate Change Mitigation, Climate Justice, Carbon Capture and Storage (CCS), Imaginaries.

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language English

Number of pages: 194

ISSN and key title:

ISBN: 978-91-8104-858-2 (print)

978-91-8104-859-9 (electronic)

Recipient’s notes

Price

Security classification

I, the undersigned, being the copyright owner of the abstract of the above-mentioned dissertation, hereby grant to all reference sources permission to publish and disseminate the abstract of the above-mentioned dissertation.

Signature

Date 2026-03-24

From Show Pony to Working Horse

Reimagining Carbon Capture and Storage for Just Climate Change Mitigation

Lina Lefstad

LUND UNIVERSITY

Copyright

Pages 1-117 © 2026 Lina Lefstad, https://orcid.org/0000-0002-1148-8641 (licensed under CC BY 4.0)
Paper 1 © 2024 The authors. Published by Energy Research and Social Science (licensed under CC BY 4.0).
Paper 2 © 2025 The authors. Published by Climate Policy (licensed under CC BY 4.0).
Paper 3 © 2025 The author. Published by Carbon Management (licensed under CC BY-NC 4.0)
Paper 4 © 2026 The authors (Manuscript unpublished)

Cover image by Nicola Parfitt

Published by:
Lund University Centre for Sustainability Studies
Faculty of Social Science
Lund University
Lund 2026

ISBN 978-91-8104-858-2 (print)
ISBN 978-91-8104-859-9 (electronic)

Printed in Sweden by Media-Tryck, Lund University,
Lund, 2026

Nordic Swan Ecolabel
Printed matter 3041 0903

Media-Tryck is a Nordic Swan Ecolabel certified provider of printed material. Read more about our environmental work at www.mediatryck.lu.se

MADE IN SWEDEN

Til Pappa, Arild (1966-2016)

Whose faith in me I try to live up to

Table of Contents

Abstract

This thesis examines the governance of Carbon Capture and Storage (CCS) technology in its current phase of policy-driven deployment within European climate policy. Positioned in the gap between established critique of CCS and its newly central role in binding net-zero strategies, my research adopts a critical-pragmatic stance to acknowledge that CCS is a contentious technology embodying risks of carbon lock-in and mitigation deterrence, while simultaneously recognising its political inevitability for decarbonising hard-to-abate sectors within the post-Paris Agreement context. My research aim is to offer a constructive critique of CCS governance by asking how deployment can be aligned with climate justice principles.

I employ three theoretical lenses; the concept of imaginaries diagnoses the dominant vision driving CCS policy, revealing a "techno-market" imaginary that frames CCS as an inevitable, cost-efficient market commodity. A cosmopolitan climate justice framework, grounded in the equity principles of the United Nations Framework Convention on Climate Change and the Paris Agreement, provides the moral compass to evaluate this imaginary. Finally, a political economy of decarbonisation-lens analyses the governance structures, specifically the roles of state and market, that enact this vision. Through a multi-method qualitative approach including systematic literature reviews, comparative policy analysis and expert interviews, this research analyses the Norwegian and European Union policy architecture. The findings demonstrate that the current dominant governance model, predicated on the techno-economic imaginary, is structurally misaligned with CCS's material realities and ethical imperatives. This manifests in three core trends, namely through depoliticisation of the need for CCS, a gatekeeper problem with incumbent industry and lastly, how the market has so far failed to scale. In response, I argue for a conscious re-imagining of CCS governance through a shift from a market-commodity to a public-good model. In conclusion, this research contributes a timely, justice-centred framework for governing a contentious but important technology. The findings suggest CCS has successfully completed its phase as a "show pony" by proving technical feasibility and securing political mandate. For it to now become an effective "working horse" for decarbonisation, its governance must be reoriented around public stewardship and cosmopolitan justice principles, moving beyond a sole market logic to ensure just and effective large-scale deployment.

Sammendrag

Denne avhandlingen undersøker styringen av karbonfangst- og lagringsteknologi (CCS) i den nåværende fasen av politikkdrevet utrulling innen europeisk klimapolitikk. Jeg plasserer min forskning i gapet mellom etablert kritikk av CCS og dens nye, sentrale rolle i bindende netto-null-strategier. Jeg inntar en kritisk-pragmatisk holdning som erkjenner at CCS er en omstridt teknologi, med risiko for karboninnlåsning og at den kan virke som sovepute for utslippskutt. Samtidig anerkjenner jeg dens politiske uunngåelighet for å dekarbonisere sektorer som er vanskelige å omstille i konteksten etter Parisavtalen. Hovedmålet med forskningen er å gå fra å kritisere CCS som en spekulativ idé til konstruktivt å undersøke styringen av den, og spørre hvordan implementeringen kan tilpasses prinsippene for klimarettferdighet.

Jeg bruker et tverrfaglig rammeverk som syntetiserer tre teoretiske perspektiver: Begrepet «imaginære» [fra engelsk «imaginaries»] diagnostiserer den dominerende visjonen som driver CCS-politikken, og avdekker et teknologisk-økonomisk-imaginær som rammer inn CCS som en uunngåelig, kostnadseffektiv markedsvare. Et kosmopolitisk rammeverk for klimarettferdighet, basert på rettferdighetsprinsippene i FNs klimakonvensjon og Parisavtalen, gir det moralske kompasset for å evaluere dette imaginæret. Til slutt analyserer en politisk økonomi av dekarbonisering styringsstrukturene, spesielt statens og markedets roller, som gjennomfører denne visjonen. Gjennom en kvalitativ flermetodisk tilnærming, inkludert systematiske litteraturgjennomganger, komparativ politikkanalyse og ekspertintervjuer, analyserer denne forskningen den norske og europeiske unions politiske arkitektur.

Funnene viser at den nåværende dominerende styringsmodellen, basert på det teknisk-økonomiske imaginæret, er strukturelt i misforhold til CCS' materielle realiteter og etiske imperativer. Dette manifesterer seg i tre hovedtrender: for det første gjennom en depolitisering av behovet for CCS, for det andre et portvakt-problem knyttet til den etablerte industrien, og til slutt gjennom hvordan markedet så langt har mislyktes i å skalere teknologien. Som svar på dette argumenterer jeg for en bevisst nytenkning av CCS-styringen gjennom en overgang fra en markedsvare- til en offentlig gode-modell. Konklusjonen er at denne forskningen bidrar med et tidsriktig, rettferdighetsorientert rammeverk for styring av en omstridt, men viktig teknologi. Funnene tyder på at CCS har fullført sin fase som utstillingsponni ved å bevise teknisk gjennomførbarhet og sikre et politisk mandat. For at det nå skal bli en effektiv arbeidshest for dekarbonisering, må styringen omorienteres til offentlige forvaltningsprinsipper og kosmopolitiske rettferdighetsprinsipper, og gå utover en ren økonomisk markedslogikk for å sikre rettferdig og effektiv storskala utrulling.

Acknowledgements

I am in a debt of gratitude to all the people who have crossed my path on this PhD adventure. There have been endless discussions, conversations, questions asked and answered, some hard and some easier, and all influencing my work, or ability to do it, in one way or another… It has been a great experience.

First of all, I must thank my team of supervisors. Henner, for always being available for "a question" and support on and off topic, you made me believe I could do it! Wim, for showing me what thorough, critical research is. Bregje, for your critical problem-solving skills and dependability. At times it was hard to put the three of you together, but to be able to "pick the brains" of three quite different, but excellent, scholars that I look up to has been a privilege. Thank you also to my three discussant who so kindly discussed my work at first-, mid-term and final seminars: Alexandra, Max and Nils. It was an honour!

Thank you to the supportive and fun environment at LUCSUS. A deepfelt gratitude to my wonderful PhD colleagues, past and present. You have put the bar high and showed the way, or we have figured it out together. You have shown me so much generosity and kindness, and I graduate with the honour of having gained dear friends. Another benefit of doing one's PhD at a place like LUCSUS is the privilege of having so many experts under one roof, so one can simply go and knock on some doors to discuss specific problems and questions. Thank you so much for sharing your expertise with me.

I have also benefitted greatly from being a member of the Empower Futures PhD school - Thank you for creating an intellectually and socially stimulating space which I now get to be an alumnus of. I also did no less than three "visiting researcher" stays – with Alina and Etienne & co. at the Department of Political Science at the University of Vienna, with Jeroen and Maarten & co. at the Urban Futures Studio at the University of Utrecht, and lastly with Lars, Sid and Tor-Håkon & co. at Fridtjof Nansen Institute in Oslo. I am deeply grateful to you all for opening your doors to me, for taking time to engage in stimulating conversations and helping me with my research in such nuanced and engaging ways. Each stay was a privilege that I would do again in a heartbeat if I had the opportunity.

Thank you to my dear friends and beloved family for your endless support and belief in me. You are the best! Thank you Miffy, Valentina and Pellemax, without you I wouldn't be who I am.

Last but not least, thank you dear Dr. Schulz, my love Felix. Supervisor, personal chef, mental support, cheerleader, stable cleaner, copy editor, reviewer, discussant … The list goes on and thank you does not quite cut it. Without you I would never have started in the first place.

List of Papers

Paper 1

Lefstad, L., Allesson, J., Busch, H. and Carton, C. (2024). Burying Problems? A systematic literature review of carbon capture and storage imaginaries in Scandinavia. *Energy Research and Social Science*. 113. https://doi.org/10.1016/j.erss.2024.103564

Paper 2

Lefstad L. and Rubiana Rivadeneira, N. (2025). From the Rainforest to the Fjords: Examining equity in carbon capture and storage policy. *Climate Policy.* 1-15. https://doi.org/10.1080/14693062.2025.2451644

Paper 3

Lefstad, L. (2025). Between Speed and Safeguards: Evaluating equity in the EU's Carbon Capture and Storage Policy Landscape. *Carbon Management*. 16(1). https://doi.org/10.1080/17583004.2025.2564723

Paper 4

Lefstad, L., Schulz, F. and Busch, H. (202?). Beyond Market Fixing: the role of the state in CCS Deployment. *Submitted manuscript.*

Author's contribution to the papers

Paper 1

The idea was developed in collaboration between all authors. LL and JA undertook data collection. LL, JA and HB undertook analysis with input from WC. LL and HB wrote the first draft of the manuscript with input from JA. LL refined and revised the manuscript with input from WC.

Paper 2

LL and NR contributed equally to the design, data collection, analysis and writing of the manuscript.

Paper 3

LL is sole author, having developed the idea, undertaken data collection, data analysis, writing and editing.

Paper 4

LL developed the idea, undertook data collection and data analysis, and wrote the first draft of the manuscript. FS and HB refined and revised the manuscript in collaboration with LL.

Additional Papers

Lefstad, L. and Paavola, J. (2023). The evolution of climate justice claims in global climate change negotiations under the UNFCCC. *Critical Policy Studies.* 18(3). https://doi.org/10.1080/19460171.2023.2235405

Faber, L., Busch, H. and **Lefstad, L.** (2025). A Trojan horse for climate policy: Assessing carbon lock-ins through the Carbon Capture and Storage-Hydrogen-Nexus in Europe. *Energy Research and Social Science.* 120. https://doi.org/10.1016/j.erss.2024.103881

Föcker, J., Busch, H. and **Lefstad, L**. (202?). Bridging the Knowledge Gap? Understanding the Role of Knowledge Brokers in the Science-Policy Interface around Bioenergy with Carbon Capture and Storage in Sweden. *Under 2nd round of review in Energy, Sustainability and Society.*

Abbreviations

CBDR	Common But Differentiated Responsibilities
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
EOR	Enhanced Oil Recovery
IAM	Integrated Assessment Model
IEA	International Energy Agency
IEAGHG	International Energy Agency Greenhouse Gas R&D Programme
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

“We are on the brink of an irreversible climate disaster. This is a global emergency beyond any doubt”. With these sobering words, Ripple et al. (2024, p. 812) begin their special report on the state of the climate. Despite uncountable warnings, global CO_2 emissions, the primary driver of climate change, are still increasing (UNEP, 2025; Ripple et al., 2024; Welsby et al., 2021). As reaching Net Zero by 2050 is now law in the European Union, an urgent role is carved out for rapid decarbonisation. This makes climate change mitigation one of, if not the, most important tasks of our lifetime. And as such, the central concern of my thesis.

Climate change mitigation refers to the reduction of emissions of greenhouse gases (IPCC, 2014), specifically by preventing anthropogenic emissions from entering the atmosphere (Boucher et al., 2014). Global climate change mitigation strategies are increasingly reliant on aspirational technological solutions (IPCC, 2022; IEA, 2025). Among these, Carbon Capture and Storage (CCS) has emerged as a central mitigation technology. But even though CCS has been recognised and defined as a climate change mitigation tool for more than twenty years (See for example the report on the topic, IPCC, 2005), interest in its development has come in waves (Anker, 2018; Narita, 2012). Following the global signing of the Paris Agreement, where countries agree to limit global warming to 2°C and to strive to stay below 1.5°C, a new wave of interest in CCS can be seen (Wettestad et al., 2024).

The promise of CCS technology is significant: it is presented as a means to enable the decarbonisation of heavy industries and potentially reverse atmospheric carbon accumulation by enabling certain Carbon Dioxide Removal (CDR) applications. However, this promise stands in contrast to the technology’s history. CCS has been the subject of intense critique for decades and seen as a “technological fix” (Weinberg, 1972), in other words, as a shortcut that risks perpetuating unequal and exploitative fossil fuel systems and delaying an energy transition from fossil fuels to renewables (Markusson et al., 2017, 2018). This critique is underscored by a persistent implementation gap. Historically, over 80% of projects have failed to materialise due to high up-front investment as well as operational costs (Abdulla et al., 2021), leaving global operational capacity at a mere 4% of what is required by 2030 to meet critical net-zero pathways (IEA, 2025; Kazlou et al., 2024).

If all plans from the first major waves of CCS projects had been realised, operational capacity would be almost seven times higher than it is today (Kazlou et al., 2024).

Despite the historical inability to scaling, the political landscape following the Paris Agreement and the IPCC's 1.5°C report has established CCS as a non-negotiable component of official net-zero strategies for a growing group of governments and industries (Sovacool et al., 2024). This signifies a new, third policy phase of European CCS development: moving beyond first-of-a-kind pilot projects in Phase 1 in the 1990s and (largely) failed fossil power-projects in Phase 2 in the early-mid 2000s, into a post-Paris era in Phase 3. Phase 3 is characterised by policy-driven rollout focused on hard-to-abate industries within binding net-zero frameworks, particularly in Europe, but is still largely limited to pilot projects (Coleman & Taylor, 2024; Global CCS Institute, 2024; Sovacool et al., 2024). This new empirical reality creates an urgent task to move from criticising the idea of CCS to critically interrogating and shaping its governance (Buck, 2021).

The new CCS policy context in Europe includes the European Green New Deal and the European Climate Law which legally mandates net-zero emissions, as well as the Climate Plans of various countries and organisations. Combined, these create a new regulatory drive for climate change mitigation in general (Böhringer, 2013; Crespy & Munta, 2023; Dupont et al., 2024), increasing pressure on emitters to decarbonise (Dupont et al., 2024) and communicating a clear political will for decarbonisation which has not previously been present (Kern et al., 2016; Scott et al., 2013). In parallel, the number of prospective CCS projects has grown more than 50% since 2022 (Global CCS Institute, 2025). This unprecedented growth in intentions, driven at least partly by its framing as a cost-efficient mitigation tool within models like those of the IPCC (Rubiano Rivadeneira & Carton, 2022), is occurring alongside a well-documented catalogue of socio-technical risks and justice concerns across its technological chain, from local pollution and toxic waste at the capture stage to under-studied safety hazards of transport and systemic bottlenecks in storage (Brandl et al., 2021; Cuéllar-Franca & Azapagic, 2015; Lane et al., 2021). This disconnect between the aim for a rapid deployment of CCS and its complex socio-ethical dimensions is mirrored in the divided academic literature.

Scholarly work on CCS has traditionally fallen into two broad streams. The first stream has provided essential insights into the techno-economic feasibility of CCS. This literature is essential to understanding the physical parameters of the technology, and spans far-reaching fields including chemistry, petroleum engineering, geology and economics. Here, calculations to estimate costs, the energy penalty, model capture rates and the durability of storage as well as mapping storage capacity and develop risk methodologies have contributed to a understanding for how CCS works from a technical and economic perspective (see for instance Allinson et al., 2014; Damen et al., 2006; Davidson et al., 2017; Kearns et al., 2017; Kloo et al., 2024; Pawar et al., 2015; Siirila-Woodburn et al., 2017; Vasudevan et al., 2016; Zhang et al., 2022; Zheng et al., 2023). This literature has treated the technology predominantly as a neutral tool (Abdulla et al., 2021; Martin-

Roberts et al., 2021; Wang et al., 2021), sidestepping important questions like "why?", "for whom?" and "to what end?" (Buck, 2021; Morrow, 2021).

In contrast, a critical social science stream has provided important analysis of systemic risks, including mitigation deterrence, carbon lock-in and the moral dilemma of the fossil fuel industry's central role (See for instance Arlota & Costa, 2021; Grubert & Sawyer, 2023; Grubert & Talati, 2024; Huber, 2023; Lenzi et al., 2023; Markusson et al., 2011, 2017; McLaren, 2012; Sovacool et al., 2022). This has been key for understanding the underlying complexities that have been sidelined in the technical literature, for example in relation to how CCS being seen as a "technical fix" essentially defers a legitimacy crisis for fossil interests (Markusson et al., 2017). This directly connects with the critiques of mitigation deterrence, where the prospect of future CCS deployment risks delaying more radical emission reductions in the present (Anderson & Peters, 2016), with some going as far as calling investments in CCS "irresponsible" (Stephens, 2014). Yet, this stream of literature tends to fail to grasp the political reality: CCS is no longer merely a contested model output or a speculative option (Beck et al., 2021; Van Beek et al., 2022); it has become an integral part of European climate politics and seems unlikely to disappear anytime soon. This, in turn, places the governance of CCS deployment as indispensable to mitigating the issues raised by the critical social science literature.

The task of governing CCS deployment is not only a technical or economic challenge. Climate change is a preeminent justice issue, considering how those who have contributed the least to its onset are often the most vulnerable to its consequences and may have the least opportunities to act (Adger et al., 2001; Sultana, 2022). In response, the global climate regime has codified key equity principles, namely common but differentiated responsibilities, protection of the vulnerable and the right to sustainable development, to guide mitigation action (IPCC, 2014; Klinsky et al., 2017). Yet, as CCS transitions from idea to policy reality, it risks being governed through a narrow imaginary that prioritises cost-efficiency (Rubiano Rivadeneira & Carton, 2022). Such an approach lacks the capacity to account for the equitable distribution of benefits and burdens or the risk of exacerbating existing inequalities. To assess whether the current CCS rollout represents a just contribution to mitigation, its governance must be evaluated against the justice principles to which the global community has committed.

This thesis is situated in this gap between the established critical perspectives on CCS and its newly urgent, political roll-out. I adopt a critical yet pragmatic stance on CCS. Critically, I acknowledge that it embodies the risk of perpetuating carbon-intensive systems (Faber et al., 2025; Carton, 2019; Markusson et al., 2011). Pragmatically, its central role in post-Paris policy reflects the broader, material reality of persistent fossil fuel dependency and insufficient emission cuts (Ripple et al., 2024). Consequently, in certain hard-to-abate sectors, CCS may be the mitigation option of last resort (E3G & Bellona, 2023). This critical pragmatic position enables a systematic, empirical investigation into the justice outcomes of CCS as it is actively governed within the novel post-Paris policy context. A clear research gap exists here. While the more technical literature has provided tools and knowledge for the deployment of CCS, it lacks the lens to evaluate whether this deployment aligns with principles of climate justice like responsibility, capacity and protecting the vulnerable (Klinsky et al., 2017) – principles which were reaffirmed in the Paris Agreement but which have received less focus than the temperature limit-goal (Lefstad & Paavola, 2023). Given that the climate crisis is as much an ethical challenge as a technical one (Shue, 2018), integrating justice perspectives is important. This is the critical gap this thesis aims to contribute to by offering a constructive critique of CCS governance. Here I ask how justice principles can be operationalised within the political imaginaries and governance structures now shaping CCS deployment, to bridge the divide between the critical social science analysis and the technicalities of implementation within a constrained set of political possibilities.

Theory and Methods

To do this, I use the concept of imaginaries (Jasanoff & Kim, 2013) to diagnose the dominant "techno-market" imaginary driving policy and a cosmopolitan climate justice framework as the critical lens for evaluating the moral direction of CCS deployment. I adopt a cosmopolitan conception of climate justice, which posits that our obligations to uphold human rights and ensure fairness extend globally, in direct response to the transboundary and unjust nature of the climate crisis (Caney, 2001; Sultana, 2022). I build this framework on established equity principles adopted by the UNFCCC and Paris Agreement, namely responsibility, capacity (and ability to act), the right to sustainable development and the imperative to protect the most vulnerable (IPCC, 2014; Klinsky et al., 2017). In essence, equity aims to provide the necessary tools for people to thrive within a given system/situation, while justice questions the system/situation itself (Cook & Hegtvedt, 1983). This synthesis allows me to move beyond separate critiques to examine the political economy of CCS deployment by analysing both the narrower equity implications as to CCS's impacts as well as the broader justice implications of the CCS system within the political economy of decarbonisation. I will expand on these theories in the Theoretical Framework chapter. The theoretical frameworks are grounded within a critical realist philosophy of science. The method used to analyse data has primarily been thematic analysis, with more detail provided about critical realism, methods and approach in the chapter on Research Design.

Research Aim and Questions

My research aim is to offer a constructive critique of CCS governance. I use systematic literature review, policy document analysis, participant observation and semi-structured expert interviews to empirically investigate the justice implications of current CCS governance and propose alternative, justice-aligned principles for its deployment. Three interconnected research questions guide my inquiry:

1. How is CCS currently imagined and governed, and what are the justice implications of this dominant pathway?
2. Why are the tensions between the current deployment of CCS and the achievement of climate justice goals so persistent?
3. How can CCS deployment feasibly be aligned with climate justice objectives?

The first research question establishes a foundational understanding of how CCS is currently imagined and governed and diagnosing what the current problem is. To answer this question, I map the dominant imaginaries of CCS and analyse the justice implications of the governance models they produce. Building on the analysis resulting from Q1, the second research question essentially identifies and analyses why the current imaginary of CCS deployment is problematic. Here, I critically examine the specific tensions and contradictions between the market-led deployment model and the requirements of climate justice. The final research question turns my view forward and asks how the lack of just CCS deployment can be addressed. By answering this question, I derive suggestions for governance principles to overcome the problem identified in questions 1 and 2 and thereby outline the conditions under which CCS could align with climate justice principles.

Findings

This thesis is structured in two contextual halves, reflecting the evolving focus of the project. Papers 1 and 2 provide a deep-dive into the Norwegian context, a pioneer and symbolic “first mover”, analysing its domestic imaginaries and its strategic framing of CCS as a technology for export. Papers 3 and 4 shift the lens to the European Union, analysing the supra-national policy architecture that will ultimately impact the scale and justice of deployment across the continent. Table 1 below provides a summary of which papers contribute to which research question. The central argument is that the dominant governance model, predicated on a techno-economic imaginary that frames CCS as a cost-efficient market commodity, is structurally misaligned with the technology’s material realities and ethical imperatives, as I show in Papers 1-4 and go into depth in the Synthesis of Findings.

My findings demonstrate how this model depoliticises fundamental choices about climate change mitigation, entrusts the fossil fuel industry with a gatekeeper role and fails to deliver the necessary scale and safeguard equitable outcomes. In response, I derive the conditions for an alternative pathway. I argue that aligning CCS with climate justice requires a re-imagining of the technology, shifting from a market-commodity to a public-good model stewarded by a public coordinator tasked with strategic planning, de-risking investment, and ensuring access is allocated based on climate value rather than ability to pay, which I elaborate on in the Path Forward chapter.

Table 1, explaining which question(s) each paper contributes to

Research Question	**Paper**			
	1	2	3	4
How is CCS currently imagined and governed, and what are the justice implications of this dominant pathway?	X	X		
Why are the tensions between the current deployment of CCS and the achievement of climate justice goals so persistent?		X	X	X
What governance principles and state roles are necessary to align CCS deployment with climate justice objectives?			X	X

The contribution of this research lies in the constructive critique of CCS deployment within a new, empirical context. I move from conceptualising justice risks to empirically investigating their manifestation within the novel and urgent policy context of European deployment. By integrating critical perspectives, this thesis contributes a constructive, justice-centred framework for a contentious technology of the net-zero transition. I seek to not act as a blanket opponent or naïve supporter, but as a critical friend to CCS deployment, providing the moral compass and governance principles needed to navigate the journey from pilot-projects in Phase 3 to a just and effective Phase 4 of large-scale deployment.

Thesis outline

This Kappa is structured as follows: To provide a background context, the Background chapter provides a technical and historical overview of CCS. Following on, the Theoretical Framework chapter presents the theoretical framework, introducing the trinity of imaginaries, climate justice and the political economy of markets and the state in decarbonisation with CCS. Then comes the chapter on Research Design, which introduces the methodology, detailing the critical realist philosophy this research is grounded in, the multi-method approach chosen to answer the aforementioned research questions and ethical considerations important to the work. The Synthesis of Findings chapter comes next, bringing together the results of the four papers to answer the core research questions, organised around three common themes; depoliticisation, the gatekeeper problem and how the CCS market fails on scale and justice. The Way Forward chapter follows on, presenting a proposed path forward including a discussion of the thesis' contributions, reflections on limitations and suggested avenues for future research, before the Conclusion chapter draws it all to a close.

Background

Before I delve into a detailed explanation of CCS technology's supply chain components and history, I believe it is important to highlight the broader CCS context and my own research approach within this context.

CCS is a contested technology among social science researchers, with some calling for abandoning the "irresponsible" investments in it (e.g. (Stephens, 2014)). This is due in large part to how the technology can be used to enable the avoidance of stranded fossil fuel assets by decarbonising their utilisation (Clark & Herzog, 2014) and its close relationship to the fossil fuel industry (Narita, 2012). I want to acknowledge the paradox inherent to CCS, in that it is a technology conceived to mitigate climate change yet is predicated on the continued creation of CO_2 emissions for CCS technology to have emissions to capture. This carries inherent risks of carbon lock-in and the perpetuation of fossil fuel infrastructure (Faber et al., 2025; Markusson et al., 2012). From a normative standpoint focused on preventative action and rapid energy transition, the preferred pathway would minimise these dependencies and aim not to deploy CCS at all, since ideally, we should not have any CO_2 to capture.

But the current political reality, where we have achieved insufficient emissions reductions even though we are a decade into the Paris Agreement (Ripple et al., 2024), has positioned CCS as one increasingly important component of net-zero strategies (Bacilieri et al., 2024; Davidson et al., 2017). I appreciate the perspective of these critical studies and understand that we need to chisel out a *limited* role for CCS.

The critical scholarly task I aim to undertake, therefore, is to interrogate the desirability of how CCS deployment is unfolding and what a just outcome for CCS would look like, one that would avoid the risks highlighted by the above perspectives. How can this technology contribute towards meaningful climate change mitigation? To operationalise this, my research is guided by frameworks for assessing "useful" CCS, exemplified by methodologies such as the E3G's and Bellona's "CCS Ladder" (2023) for *where* the technology can be deployed (note that my research focuses on *how* to deploy it). Their approach employs a multi-criteria analysis, which evaluates 1) competition from alternative technologies; is there an alternative, soon or currently available, low-carbon technology that could produce the same good/material without CCS but achieve climate neutrality and decarbonisation? 2) To what extent can CCS reduce *overall* emissions, both on a system-dimension and for a single plant if employed in that particular case? 3) How techno-economically feasible is carbon capture in that sector/for that particular plant, including infrastructure needs and system costs? As in, is it likely to be politically and economically possible to get it done? And 4), what is the source of the CO_2? Is there risk of fossil fuel lock-in or other negative impacts? This ladder then prioritises applications where CCS delivers the greatest climate value, such as in abating process emissions from hard-to-abate industries, while deprioritising those where it risks delaying the direct electrification and decarbonisation of sectors, like its application in power generation (E3G & Bellona, 2023). Pisciotta et al. for example, following the same methodology, define cement, lime and ammonia as the top priority application of CCS in the US (2024).

In sum, this framework underscores that the strategic goal is to limit the need for CCS wherever possible, while directing the limited resources, infrastructure and political capital towards applications where it can contribute the highest climate value towards a net-zero transition. This approach to CCS is the approach I apply. To make the need for such an approach clear, in this chapter I will outline the technical basics of CCS technology and its value chain, followed by its contested historical evolution in climate policy and an understanding of where we are today. I round up this section with an introduction to the academic debates on CCS deployment, which will also touch deeper on the technology's risks. The purpose of this chapter is to set the foundation for my analysis to enable me to later analyse (justice) risks in the current deployment model. But first, I turn to the technical basics.

Carbon Capture and Storage

Carbon Capture and Storage (CCS) is a chain of different technologies enabling the capture, transport and underground storage of CO_2. It can be applied to decarbonise fossil fuelled power stations and industrial processes, or to facilitate the permanent geological storage of some Carbon Dioxide Removal (CDR) technologies (IPCC, 2014, 2018, 2022). In the following I will focus on CCS, not CDR, but the challenges and risks that will be introduced later in this chapter may apply across (parts of) both emissions reductions and emissions removal technological chains including Bioenergy with CCS (BECCS) and Direct Air Capture (DACCS).

CO_2 Capture

The first step in the CCS-chain is to capture the CO_2. There are three main ways for technical CO_2 capture: post-combustion, pre-combustion, or oxyfuel (Cuéllar-

Franca & Azapagic, 2015; Markusson et al., 2011). Pre-combustion sees more concentrated CO_2 input into the capture process and is more efficient than post-combustion, but all processes have high capital costs and significant energy requirements as CO_2 capture requires specialized infrastructure (Finney et al., 2019; Shirdel et al., 2022). Current operations achieve capture rates between 5-75 per cent, a huge range depending on composition of flue-gas and which technology is applied, with higher capture-rates in for example coal-facilities due to a higher concentration of CO_2 in the emission stream (Bacilieri et al., 2023). While capture-rates above 90 per cent are deemed feasible in models and have been achieved in some pilot projects, there is a trade-off between costs and efficiency (Brandl et al., 2021) as higher capture-rates, preferable for climate change mitigation, increase costs due to the energy penalty incurred (Abdulla et al., 2021; Cuéllar-Franca & Azapagic, 2015; Rochelle, 2021).

CO_2 Transport

After capture, the CO_2 is transported to a dedicated geological storage-site via truck, train, ship or pipeline. Pressurized pipelines are estimated to be the most cost-efficient option considering the large volumes of CO_2 requiring transport (Mahgerefteh et al., 2008; Span et al., 2020), but carry large up-front investment costs as well as questions of land-ownership, NIMBYism, and in the context of Europe could span Member State' jurisdictions which increases complexity in terms of responsibility and maintenance (Span et al., 2020).

CO_2 Storage

CO_2 storage is the last step in the CCS-chain and, perhaps, the most crucial one. The geological storage of CO_2 would ensure it is kept out of the atmosphere permanently – the requirement for CCS to contribute to emissions reductions (and removal), aligned with a climate change mitigation agenda. The most suitable storage sites are put forth as underground, depleted hydrocarbon reservoirs (e.g. empty oil and gas fields) or saline aquifers (Lane et al., 2021). Especially depleted hydrocarbon reservoirs have a number of advantages in terms of their use as CO_2 storage, as they have a proven capability of sealing hydrocarbons in place over million-year time frames and their properties, i.e. size and pressure-capacities, are well known (Paluszny et al., 2020). In addition, support-infrastructure is most likely already existing nearby since old hydrocarbon extraction-assets have the potential to be repurposed, which might make these more a more cost-efficient option (Lane et al., 2021). While most focus has been given to offshore storage sites simply because they are further away from communities and pose less threat in the event a leak or mishap should occur (Aminu et al., 2017), possible onshore storage locations have been identified across Europe and beyond. Onshore storage would make CCS more economically accessible also to landlocked countries but carries significant political risk especially related to NIMBYism (Allinson et al., 2014; Gidden et al., 2025).

Early History

With this broad understanding of each step of the CCS technology chain in mind, I now turn to a brief historical overview; this is important to understand the depth of the fossil fuel industry's embeddedness in CCS technology. Carbon capture technology was first put in use for enhanced oil recovery (EOR) in Texas, USA, in 1972. EOR is a practice where CO_2 is captured during natural gas-processing and reinjected in the underground oil or gas reservoir to increase the pressure in an effort to extract more oil and/or gas (Robertson & Mousavian, 2023). EOR is the most common use of captured CO_2 to date as it provides a viable commercial opportunity to overcome the large financial costs of building and operating carbon capture technology, and has contributed important learnings including the creation of a vast CO_2 pipeline-network in the US which transports some 30MtCO_2 annually (Middleton et al., 2015). Whether or not EOR can be considered a climate change mitigation technology is currently an ongoing debate e.g. under the Carbon Management Strategy proposed for the UNFCCC, as this would depend on whether the injected CO_2 is permanently stored or not. In European climate policy, the storage of captured CO_2 must be permanent (EU CCS Directive, 2009), which likely disqualifies EOR.

The expansion of carbon capture technology to carbon capture *and storage* technology happened in the 1990s when interest grew based on its potential to avoid large amounts of stranded fossil fuel assets while reducing emissions (Anker, 2018; Narita, 2012). But more knowledge was needed to understand how this could work, and so the IPCC was asked to author a special report on CCS to assess the "scientific, technical, environmental, economic and social aspects of capture and storage of CO_2" (IPCC, 2005). This report placed CCS among other climate change mitigation tools as a technology that can provide cost-efficient flexibility for reducing emissions, and also mentions BECCS as a potential use of the technology in a way that can allow for net negative emissions (IPCC, 2005). While the 2005 IPCC-report aimed to lay out the state-of-knowledge on CCS to date, a plethora of knowledge gaps were also highlighted, such as how long CO_2 would need to be stored, an issue linked to stabilization pathways and intergenerational justice aspects, as well as the financial risks involved. CCS has been at the receiving end of increasing focus in IPCC Assessment Reports ever since (IPCC, 2014, 2018, 2022).

The first CCS project

The learnings from EOR-utilized CO_2 capture enabled, directly or indirectly, 26 large-scale CCS facilities to be developed globally between 1972 and 2021 which captured and stored (or at least injected) 300MtCO_2 in this timeframe (Loria & Bright, 2021). Today, some 77 operational facilities exist (Global CCS Institute, 2025). To some scholars this "demonstrate[s] that the technology has successfully been deployed to scale" (Loira and Bright, 2021, p.1), yet a significant share of current operational facilities still relates to EOR (Global CCS Institute, 2025).

The first facilities dedicated solely for storage can be found in Norway (Loria & Bright, 2021; Martin-Roberts et al., 2021). CCS emerged as a serious policy and technological pursuit in Norway following from the 1991 introduction of a Norwegian carbon tax (Markusson et al., 2017), which helped kick off domestic CCS development. To avoid this carbon tax, Statoil (Norway's state-owned oil company, now renamed as Equinor) developed "*Sleipner"*, the worlds´ first CO_2 *storage*-project, in 1996 (Loira and Bright, 2022). This was the first step to show that CCS could be a climate change mitigation technology and CCS became Norway´s most ambitious domestic climate policy as it was seen as an opportunity to "harmonize petroleum exports with ambitious [climate] commitments" (Røttereng, 2018, p216). Sleipner has stored approximately 1MtCO_2 per year between 1996-2022 from offshore processing of natural gas (Norsk Petroleum, 2021). A second dedicated CCS project, *Snøhvit,* which successfully stored separated CO_2 from gas extraction under the North Sea, was implemented in 2008 (Norsk Petroleum, 2021). For a long time these two Norwegian projects were "hailed as role models in international debate and in research communities" (Buhr & Hansson, 2011, p. 3), for their operational function and the dedicated policy and state support that these projects had received. The need to reconcile climate and energy goals related to a large oil and gas industry have been recognized as the main reasons for such strong policy support for CCS in Norway (Tjernshaugen, 2011). CCS is broadly seen as part of an important, national project, heavily grounded in national conditions (Buhr & Hansson, 2011; Ishii & Langhelle, 2011), and highlights the important role that Norway has played in this context.

The period between the commencement of these first CCS projects in the 1990s and today is a period full of global "first-of-a-kind" projects that have demonstrated a host of different capture, monitoring and injection technologies (Ma et al., 2022). Still, the post-2009 period has been largely characterised by failed projects (Abdullah et al., 2021) mainly due to the huge costs involved for CCS deployment combined with lack of sufficient CO_2 prices and incentives to deploy the technology in a period of great financial turmoil following the global financial crisis (Markusson et al., 2017). Interest in the technology did not die out completely, however. The Paris Agreement marked a significant shift, with interest in CCS now reaching an all-time high (Global CCS Institute, 2025).

CCS in Norway today

My research started off with a focus on Norway. As discussed above, the country has been considered a “role model” for CCS deployment in research, technical knowledge as well as policy development, and CCS has been a politically attractive compromise in Norway since the 1990s (Anker, 2018; Ishii & Langhelle, 2011; Røttereng, 2018; Tjernshaugen, 2011). CCS technology allowed the state to continue benefiting from fossil fuels while simultaneously decreasing carbon emissions (Tønnessen, 2021). For a long time, Sleipner and Snøhvit were the only operational CCS projects in Europe, and Norway the “north star” in terms of CCS policy (Ishii & Langhelle, 2011); in Paper 2 I conduct a more detailed analysis of the Norwegian CCS policy framework, but in brief, the legal foundation for CCS in Norway is the EU’s 2009 CCS Directive, transposed into national law through several regulations (Arbeids- og sosialdepartementet, 2020; Klima- og miljødepartementet, 2004; Olje- og energidepartementet, 2014). Taken together, these legal instruments reveal a governance model primarily concerned with allocating property rights and managing environmental risk.

Due to growing interest in CCS post-Paris and after concluding in 2016 that it is “technically feasible to realize a flexible CCS chain in Norway” (Meld st. 33 (2019-2020), p.27), the Norwegian government in 2020 launched Longship, the world’s first full-scale CCS chain to demonstrate to the world that full-chain CCS is possible (as previous efforts have been *project* based, lacking the full-chain knowledge (Ma et al., 2022)). Longship consists of three sub-projects: two first-of-a-kind capture-projects and a transport and storage project called Northern Lights, and has largely been successful in reaching their goals (Fortum, 2025, Tønnesen, 2021; Gassnova, n.d.). Longship in particular and CCS in general has been one of the technologies the Norwegian government has invested in to help contribute to non-quota covered emissions and technology transfer (Klima- og Miljødepartementet, 2021). Despite not being an EU member, Norway is fully integrated in the EU ETS and approx. half of its emissions are quota-covered.

Even though Norway is among the global leaders in CCS development both in policy and physical deployment (Wetterstad et al., 2024), as well as being the owner of the worlds’ largest sovereign wealth fund, the cost challenge in CCS development is present even here. The current EU ETS CO_2 price does not provide sufficient incentives to develop and implement CCS, “in part due to high investment costs, low income potential in the short term and high risk”, meaning it is necessary for “countries to contribute to the development of CCS to achieve faster dissemination and deployment” (Ministry of Petroleum and Energy, 2020, p. 8). State funding has hence been put forward as an important factor in making the technology cost-effective (Abdulla et al., 2021). For Longship, the main aim is to both help develop the technology as well as to reduce its costs to make it marketable. Longship has an estimated price-tag of approx. NOK 28 billion, of which the Norwegian state will cover at least NOK 18 billion (Olje- og Energidepartementet, 2020). Licensing of CO_2 storage-exploration has started and the first exploitation license granted (Det Kongelige Olje- og Energydepartement, 2023; Ringstad, 2024). If all sites are deemed suitable for storage, the Norwegian Continental Shelf is expected to have an injection capacity of upwards of 37MtCO_2 per year by 2030 (Ringstad, 2024).

CCS in the European Union

A key turning point in my research occurred while analysing Norwegian policy documents for Paper 2. Norway is positioning itself as a European storage hub and has signed several MOUs which could enable e.g. Germany, Belgium, France, the Netherlands and Sweden to store their CO_2 emissions in Norwegian North Sea storage-sites. My findings revealed that Norway's Longship project is framed primarily as an international climate contribution and technology effort, rather than a direct means for short-term domestic emissions cuts (Klima- og Miljødepartement, 2021; Olje- og energidepartementet, 2020). The Norwegian government aims to act as a "market maker" (IEA, 2022, p. 46), facilitating a cost-effective solution aligned with the Paris Agreement. This means that Norway is primarily focusing on developing storage for European costumers, since there are not enough catchment sites in Norway (Wettestad et al., 2024). For my research to understand just *outcomes*, I then needed to broaden my focus beyond domestic Norway to encompass the most likely clients of Norwegian CCS technology, namely the EU. The EU's regulatory framework for CCS is built upon the binding European Climate Law (2021), which mandates 55% overall emissions reductions by 2030 and climate neutrality by 2050.

While Norway's CCS policy framework has been established based on the pre-existing petroleum regulation, the EU's framework has largely been created in the years following the Paris Agreement. I analyse this in more depth in Paper 3, but in brief, the foundational legal instrument is the 2009 CCS directive, which governs the safe geological storage of CO_2. This is the Directive that was also implemented in Norway, which shows the close relationship between these two jurisdictions on CCS-matters. This framework has since been expanded, with important additions including the Net-Zero Industry Act (NZIA) which designates CCS as a strategic net-zero technology and targets 50 MtCO_2 stored annually by 2030, expanding to capture some 280 MtCO_2 by 2040 and around 450 MtCO_2 by 2050 (European Commission, 2024b). The Industrial Carbon Management Strategy (2024) outlines the EU's plan to create an integrated cross-border CO_2 transport and storage network, with the explicit goal of establishing a "single market for CO_2" by 2040 (European Commission, 2024). This market-driven approach is further supported by the Clean Industrial Deal (2025), which links CCS development to the EU's industrial competitiveness agenda. Together, these policies position the state as a facilitator or "market maker" to enable CCS development in the EU. A key change from pre-Paris CCS discussions is that in post-Paris CCS policy frameworks in the EU, CCS is strategically directed towards hard-to-abate industries – not fossil fuel energy generation.

Global CCS Deployment

Globally, CCS is currently experiencing unprecedented policy momentum. All CCS projects globally in development, construction and operation combined would scale up to 450MtCO_2 captured and stored per year, a more than 50% increase in ambition since 2022 and a ten-fold increase from current capacity (Global CCS Institute, 2025). The rapid scale-up of CCS is at least partly a result of countries´ need to increase their Nationally Determined Contributions to the Paris Agreement (Global CCS Institute, 2024), as CCS is generally considered, by many policy and decision-makers, an essential technology for cost-efficient climate change mitigation (Scott et al., 2013; Sovacool et al., 2024). Today, overall global capacity is at a mere 40MtCO_2/year, and this number includes enhanced oil recovery operations (Kazlou et al., 2024). The Net Zero Emissions by 2050 Scenario by the IEA puts forth a scale-up of CO_2 storage to 1GtCO_2/year by 2030 and over 6Gt per year by 2050 (IEA, 2023). But if all current global CCS projects in planning and operation are realised, they can realise half of the 2030 capacity, which highlights the immense need for scaling to make a meaningful mitigation contribution. The ambitious, global policy drive is advancing in parallel to an increasingly well-documented catalogue of environmental, health and safety risks across the entire CCS chain. Next, I turn to the central debates in the academic literature.

CCS Deployment Risks

The deployment of CCS presents a suite of environmental, health and safety risks across its entire capture, transport and storage chain, which, if ungoverned, can directly translate into distributive and procedural justice concerns for affected communities. For a more thorough overview please see Paper 3, summarised here in brief. Starting with capture, some CO_2 capture technologies require the use of chemicals that can cause air pollution and generate toxic waste (Brandl et al., 2021). A life-cycle assessment reveals that power plants equipped with CCS can have higher environmental impacts than those without, though the global warming potential of a plant with CCS is lower compared to without (Cuéllar-Franca & Azapagic, 2015). A critical issue is the energy penalty (Rochelle, 2024), where the significant energy demands of the capture process can lead to increased consumption of the energy source of the plant – and if this is coal or gas, more coal and gas are needed to maintain the same output.

Transport of CO_2 produces other distinct risks. Transport is primarily considered with pipelines or ships, where the main safety risk related to pipeline-storage is leakage. High concentrations of CO_2 are asphyxiant and toxic, posing a hazard to human and non-human life (Connolly & Cusco, 2007; IPCC, 2005). While technically feasible, significant uncertainties remain in accurately predicting leakage rates and the dispersion distance of escaped CO_2 gas, making it difficult to assess the full scope of the risk (Span et al., 2020). Overall, transport risks remain under-studied, as literature has primarily focused on cost-optimisation over comprehensive risk assessment (Bjerketvedt et al., 2020), though it is a topic at the receiving end of growing attention.

The last stage, the geological storage of CO_2, carries its own set of systemic and intergenerational risks. While global theoretical storage capacity is vast, estimated up to 50,000Gt CO_2 (Kearns et al., 2017), the assumption that storage is a "done deal" is challenged by technical, economic and geopolitical bottlenecks (Fuss et al., 2014; Hansson et al., 2022; Lane et al., 2021). A primary constraint is not just the total volume, but the industrial accessibility and injection rate capacity of storage sites. Injecting CO_2 too quickly can exceed critical pressure levels which may compromise the integrity of the geological formation (Petersen et al., 2022; Rahman et al., 2022). This injection-bottleneck is a major limitation for the pace and scale of CCS deployment (Lane et al., 2021). Geographically, storage is often concentrated in regions with a historic fossil fuel industry, which creates a distributive justice risk and a dependency on oil and gas sector knowledge and infrastructure. Operationally, risks include leakage, induced seismicity and for onshore storage, groundwater contamination (Celia et al., 2015; Zoback & Gorelick, 2012). These storage challenges are often marginalised in discourse, with risks framed as manageable through technology (Hansson et al., 2022; Tadjer & Bratvold, 2021). There is now a growing recognition that CO_2 storage sites are a limited good, with the main bottleneck being injection capacity rather than storage capacity (Gidden et al., 2025).

Due to the tendency to over-promise but under-deliver at higher costs than initially estimated (Robertson and Mousavian, 2023), many CCS projects fail to reach operational stage (Abdullah et al., 2022). As a result of the lack of CCS up-scaling despite industrial hype-ups and government funding, a growing body of literature has raised a number of equity and justice concerns with the implementation of CCS in the context of climate mitigation (Corry & Riesch, 2012; Gough & Mander, 2019; McLaren, 2012). These concerns can generally be grouped into three main critiques; performativity, required scale and use of resources. Firstly, critique has been raised about the potential impacts that the overreliance of CCS in climate scenarios could have in decision-making. The overoptimistic expectation of future CCS in general, but BECCS in particular, in climate mitigation pathway models could reduce the willingness to invest in and implement other measures for decarbonisation, like renewable energy (Hansson, 2012; Weber, 2018). There are also risks that CCS technology will be used to extend the lifetimes of fossil infrastructure (Carton, 2019; Faber et al., 2025). From a justice perspective, this performative function raises questions about intergenerational equity since future generations may be burdened with both continued emissions as well as the unproven promise of their later capture. Secondly, the required scale of CCS raises distributive justice concerns related to the needed infrastructure footprint if CCS would need to be deployed at massive scale, concomitantly with the question of whether CCS can be deployed rapidly enough to contribute to near-term mitigation targets (Kazlou et al., 2024). Finally, concerns about the use of both financial and material resources implicate procedural and recognitional justice. Substantial public subsidies are required for CCS demonstration and deployment which represent opportunity costs and raises questions about who participates in these allocation decisions. Moreover, while CCS can reduce CO_2 emissions, it may simultaneously increase other air pollutants like fine particulate matter or toxic ammonia emissions (Fendt et al., 2023) as just explored, which would have localised health impacts. Intersecting risks, technical uncertainties and distributional consequences form the core of the academic debate about the viability and desirability of CCS.

Navigating the Academic Discourse

The academic discourse on CCS has evolved from early technical optimism, which to some extent remains today, citing the above risks as "technical" and something that can be overcome with monitoring, into a deeply contested field where critical social science research has systematically challenged the assumptions, viability and socio-political implications of the technology. Literature on CCS reveals a landscape where critical scholars have identified fundamental risks that the more optimistic, techno-economic assessments often overlook, minimise, or perhaps has not got the epistemological bandwidth within the respective fields to engage with.

Proponents of CCS often frame the technology as a necessary and viable component of decarbonisation portfolios. From this perspective, the technical principles of capture and storage are considered proven, often exemplified by decades of experience in natural gas processing and EOR (Robertson & Mousavian, 2023). The primary barrier to deployment is diagnosed as economic, stemming from "policy uncertainty and limited public support" (Hansson, 2011, p.84), rather than as a result of technical flaws. This view is reinforced by analyses suggesting that EOR, which creates a revenue stream for the captured CO_2, faces fewer barriers to deployment (Robertson & Mousavian, 2023). However, even within this more optimistic framing, warnings emerge about the financial and technical risks of using CCS to extend the life of fossil-fuel power plants (Wang et al., 2021).

Beyond the purely technical focus and now recognising the risks associated with the close interconnection between CCS and the fossil fuel industry, a growing body of research has turned to investigating the public acceptance of the technology (L′Orange Seigo et al., 2014). It is recognised that lack of public acceptance could deter politicians' willingness to implement policies that would support and encourage CCS deployment (Fridahl & Lehtveer, 2018), creating a vicious cycle where policy inaction and policy uncertainty reinforce one another (Bäckstrand et al., 2011). Early acceptance research revealed that public perception is not primarily driven by knowledge deficits but by deeper socio-political factors, and that the strongest predictor of acceptance is the perception of benefits. However, for CCS, this is intrinsically linked to the continued use of fossil fuels, which many view as an unsustainable "end-of-pipe" solution that may displace investments in renewable alternatives (L'Orange Seigo et al., 2014). Notably, in Paper 1, we found that a lot of the public acceptance research in Scandinavia focused on how to increase public acceptance rather than necessarily trying to change CCS' deployment to align better with public values (Lefstad et al., 2024). This connects to a core tension identified by Bäckstrand et al. (2011), in that CCS's economic and technical appeal lies in its compatibility with current energy (and industrial) systems, but that this connection is also the main source of significant public concern.

A direct response to navigating this tension can be seen in the pragmatic position applied by some policy-oriented organisations, which seek to steer deployment towards its most effective applications. For example, as mentioned above, European think-tanks like Bellona and E3G (2023) acknowledge CCS as a useful mitigation tool, but also point out that deployment in the wrong sectors, especially fossil fuel energy or sectors where alternative ways of decarbonising exist, could risk delaying climate action. As explained at the beginning of this chapter, they argue that the "climate value", i.e. where CCS could contribute the most to decarbonisation, is highest in hard-to-abate industrial sectors with significant point-source process emissions like cement and chemicals, and lowest in the power sector where renewable alternatives are readily available. This assessment hinges on factors like the risk of fossil fuel lock-in, lifecycle emission reductions and technological feasibility (E3G & Bellona, 2023). This perspective highlights that the governance of deployment, i.e. the where and how CCS is applied, is critical to its climate value as the wrong deployment could lead to a delay in climate change mitigation (Carton, 2019; Markusson et al., 2011).

There is a substantial body of critical social science research which argues that the technological CCS assessments often overlook or minimize fundamental systemic risks. The primary critique has been the risk of carbon lock-in and mitigation deterrence. Carbon lock-in refers to the inertia in the energy system where investments create a path dependence that prevent or delay the transition away from fossil fuels (Unruh, 2000), and mitigation deterrence refers to the risk that the promises of a technological climate intervention, such as CCS or negative emission technologies, will lead to delayed or reduced efforts to reduce emissions (without these often controversial, sometimes unproven or at least not yet scaled-up technologies) (Markusson et al., 2018). Early critiques positioned CCS as a "technical fix", something that promises to solve the CO_2 problem without disrupting the fossil fuel energy system. The idea of CCS created "images of an add-on solution, with the promise to leave existing elements of the system unchanged" (Markusson et al., 2012; Markusson & Haszeldine, 2009, p. 4627). This promise, critics argue, functions as a "defensive spatio-temporal fix" (Markusson et al., 2017; 2018), deferring a legitimacy crisis for fossil interests by offering a future technological solution. "Technical fixes" imply "a use of the power of technology to solve problems that are nontechnical in nature" (Markusson et al., 2017, p.1) and are often referred to as cheap shortcuts (in negative terms), since they essentially try to sidestep the difficulties of solving problems by influencing peoples motivations and behaviours directly (Markusson et al., 2017; Weinberg, 1967). This has been recognised as a moral hazard, where the mere prospect of large-scale CCS deployment may deter or delay the urgent, radical and systemic change that would be required for climate change mitigation (Anderson et al., 2020; Lenzi et al., 2023). The high historical failure rate of CCS projects (Wang et al., 2021) deepens this concern.

Closely linked is the political economy of CCS, which questions why, despite its prominence in climate models, its deployment has repeatedly stalled. Research shows that the huge costs associated with CCS deployment cannot be understood in isolation, but is closely intertwined with the complex interplay between state and market (Kern et al., 2016). As previously pointed out, CCS is a capital-intensive, high-risk enterprise with limited revenue potential in the absence of strong and stable policy incentives (Kern et al., 2016; Scott et al., 2013). This has created a situation where progress "hinges on the political will to make it happen" (Scott et al., 2013, p.108). But this will is often undermined by economic austerity, competing low carbon/decarbonisation options and the lobbying power of incumbent industries, especially the fossil fuel industry (Kerns et al., 2016). The fossil fuel industry is not a neutral actor here, as it is the one industry with the most entanglement with CCS: it possesses the essential knowledge, infrastructure and regulatory experience to deploy it (Lane et al., 2023).

These macro-level critiques of lock-in, mitigation deterrence and a problematic political economy translate into quite concrete justice and equity risks at multiple levels. Following Schlosbergs (2012) distinctions, a range of potential harms may stem from CCS deployment *(these are developed in more depth in Paper 3)*. CCS deployment risks would be unevenly distributed from increased local pollution due to the energy penalty of capture processes (Cuéllar-Franca and Azapagic, 2015; Sovacool et al., 2022) to the siting of pipelines and storage reservoirs that might impact vulnerable communities – as well as concerns that CCS deployment could lead to higher energy costs and fuel poverty (Sovacool et al., 2024). Procedural justice entails meaningful participation in decision-making and free, prior and informed consent for affected communities. This may be lacking in CCS processes as the central role of corporations and technocratic governance marginalises public voices (McLaren, 2012; Sovacool et al., 2022). The framing of CCS as an unavoidable technical solution can fail to recognise the concerns, values and knowledge of local communities and others historically marginalised by the fossil fuel economy (Socavool et al., 2022), leading to recognitional injustice. Finally, the long-term liability for stored CO_2 and the risk of leakage, however large or small, create a burden of monitoring and a potential harm for future generations (Sovacool et al., 2022). In Europe today, the focus has shifted from fossil-fueled power plants to "hard-to-abate" industrial sectors like cement and steel (Langhelle et al., 2024; Sovacool et al., 2024) which could indicate a recognition of the moral hazard issue linked with the fossil fuel industry, but some of these other justice concerns still persist.

Bridging the Critical and the Pragmatic

In this thesis, I recognise the importance of these critical perspectives and acknowledge that the critical literature has established that CCS is a socio-technical system with potential political, economic and ethical perils. A key gap, however, remains between the conceptual and discursive identification of these justice risks, and the empirical investigation of how they are now materialising, as a new political context has emerged in Europe. The EU's Green New Deal, Net Zero Industrial Act and the Climate Law now create a novel decarbonisation policy framework in the EU (Dupont et al., 2024). My research attempts to address this gap, starting from the critical premise of the concerns raised in the literature and moving the inquiry forward empirically: If, as a matter of pragmatic climate policy, CCS is being actively promoted and deployed in the European context, then the critical task becomes to rigorously investigate what specific justice risks are emerging in practice, and how governance frameworks are attempting to mitigate them. In doing this, I build on the critical literature by providing empirical grounding to its central claims and by evaluating the capacity of current governance structures to prevent the very injustices scholars have identified. Next, I turn to the theoretical framework that helps me on this endeavour.

Theoretical Framework

This thesis is anchored in the field of sustainability studies. While a multitude of different definitions of sustainability exist, I follow Spangenberg (2011, p. 275) and define sustainability as “a normative ethically justified utopia, describing a state of economy, society and environment considered optimal”. This definition entails a concern for equity and distribution, as well as the need to meet both environmental and social challenges simultaneously (Costanza et al., 1997), which aligns with this thesis’ aim of contributing towards the achievement of climate justice principles. This entails an explicit recognition of the limits to nature but equally the recognition of social floor requirements (O’Neill et al., 2018), which I understand through the equity principles of the UNFCCC. Jerneck et al. posit that the aim of sustainability studies is to foster coherent interdisciplinary research across natural and social sciences, by understanding the natural sciences with perspectives grounded in justice, power, politics, and critical research (2011). Applying this perspective to CCS is important to direct its use towards achieving just outcomes since the technicalities of CCS is grounded in the natural sciences of geology, chemistry, engineering and so forth – but how to govern it has so far only received limited attention from justice concerns.

In my thesis, I use three interrelated theories which I will introduce according to the order they are applied. First, the concept of “imaginaries” serves as the foundational lens for my research. Imaginaries are politically charged visions of the future that legitimize certain worlds and actions while discrediting others. This concept enables me to understand the objective of my PhD research, what my PhD is actually trying to solve, as imaginaries has helped me understand the dominant vision of CCS deployment and as a result, the problem with or lack of just CCS. As the sufficiently scaled deployment of CCS technologies to meet climate targets largely remains a future task, imaginaries was a central concept in Paper 1 which allowed me to situate these future goals into the present.

Imaginaries shape outcomes, and a goal of this research is to contribute to achieving *just* outcomes, introducing the second concept in this thesis. Justice is the concept which has shaped my overall research question as well as the angle I have taken in papers 2-4. As CCS-research has yet to look at the “how” of its deployment (Buck, 2021), this lens provides an important perspective that has hitherto been missing in literature. In this chapter I first try to introduce justice and establish the baseline for what climate justice would entail, based on the equity principles that dominate the

UNFCCC approach to climate change. These were also the baseline for the analysis conducted in Paper 2 and where a more detailed account of this baseline can be found. But justice is a contested topic. After introducing the climate justice principles, I show why that is by broadening out and delving into the dominant philosophies of justice that we can find in Western literature. I do this to better create the tools to understand why the cosmopolitan justice I apply has not yet guided CCS deployment, as there are many different connotations and understandings of what justice entails.

The last theoretical lens guiding this PhD thesis developed in an abductive way from the research and data collection process rather than as a pre-determined feature. I draw from the political economy of decarbonisation, specifically looking at market-centric climate policy, due to the centrality of the cost-efficiency paradigm in discussions of CCS deployment. Perceptions of justice are also key here, since the desired outcome, namely cost efficiency in climate change mitigation, will impact the mechanisms deployed to get to the desired end. It was important to incorporate this perspective due to the dominant role of the imaginary of cost efficiency which drove CCS technology into the climate change mitigation-toolbox in the first place, as well as the interlinkage of the political and economic context in CCS deployment.

In short, then, imaginaries are used to create the map and to understand where the desired end-goal for CCS is located. Theories of (climate) justice provide the moral and philosophical compass to (i) evaluative criteria, (ii) to assess the map created by imaginaries and (iii) to identify factors that influence or determine which paths are either problematic or desirable. The literature on political economy provides the analytical tools to understand the structures of the proposed governance frameworks, explaining the mechanisms that enable or prohibit the reaching of the goal. I now turn to each concept, starting with imaginaries.

Imaginaries

"Sustainability" is perhaps the "grandest imaginary of our time" (Beck et al., 2021, p. 143). The imagination can open or close doors to the perception of a future state's feasibility, possibility and desirability. Imaginaries are closely linked to how institutions and economic activity is organized, structured and conceived (Levy & Spicer, 2013). This means that while generative, imaginaries can also circumscribe the realm of the possible.

The social imagination is often deeply embedded within, and shaped by, the institutions and rules that govern social life (Castoriadis, 1997; Marcuse & Kellner, 2007). These rules include social norms, learned values and perceptions of justice – a concept I will return to in the following sub-chapter. This potential for constraint is powerfully illustrated by Marcuse's "one-dimensional man" (1967), who loses the ability to conceive of alternatives as society reinforces change that aligns only with prevailing institutions and parameters. But if the future can only be imagined along the paths of the past, how is one to deal with unprecedented problems like climate change? Here, I use the concept of imaginaries to interrogate the problem space of CCS, basically to understand its parameters, foundations and broader implications.

A brief introduction to the concept

Imagination can be understood as "a way of seeing, sensing, thinking and dreaming", which creates the conditions for material and political interventions (Yusoff & Gabrys, 2011, p. 1). The capacity to "imagine" is essential because if we are to deal with the future, we have to do so through the imagination (Kahn & Wiener, 1967). But this is not a neutral process - it is deeply political. For instance, the IPCC's projection of pathways to sustainable futures serves to open up or close down the "horizon of action", that is the perceived expected, feasible and realistic path(s) forward (Beck et al., 2021, p. 143). The imagination is thus stimulated to privilege certain visions as more realistic and desirable than others, a process driven by agenda-setting and the strategic promotion of specific imaginaries over others (Beck et al., 2021). This ability to legitimize certain worlds while discrediting others is what makes imagining a powerful political tool (Levy and Spicer, 2013). This power was recognized early on, from Kant's definition of it as "*the power to make be that which "realiter" is not*" (in Castoriadis, 1994, p322). As early as in Ancient Greece, Socrates and Plato mention power in their definitions of imagination (Castoriadis, 1994). Ultimately, the depth, quality and complexity of our collective imagination not only shape our perception of a problem but also actively determine which solutions are deemed possible and which tools are made available to address it (Yusoff and Gabrys, 2011).

While imagination begins with individuals or groups, its true social power is realized when these visions coalesce into social imaginaries. A foundational definition is offered by Jasanoff and Kim (2013, p. 190), who describe imaginaries as "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects". This definition implies a dialectical relationship where individual imaginations feed the collective imaginary, which in turn shapes individual perceptions, underpinned by the making of social life. This concept of constitutive imaginaries is further elaborated by Lee and LiPuma (2002), who identify the three core social imaginaries that underpin Western modernity: the public sphere (the domain of public opinion), the citizen state (the relationship between individuals and governance), and the market. These are not separate entities but interdependent collective agents that mutually constitute one another (Lee and LiPuma, 2002). Built on historical structures and past choices, these three imaginaries together generate a powerful, shared understanding of how social life *ought* to be organized (Calhoun, 2002). In this thesis, acknowledging this triad in the context of CCS governance demonstrates how the hegemony of the market imaginary structurally limits the potential of the citizen state, which motivated the integration of the political economy of decarbonisation, to which I will return later in this chapter.

The theoretical power of the concept of imaginaries lies in their ability to bridge wide-ranging fields such as sociology, philosophy, science and technology studies, sustainability and economics. This interdisciplinary reach underscores the usefulness of the concept for engaging in discussions about desirable futures (Hajer & Pelzer, 2018; Jasanoff & Kim, 2013; Mendoza et al., 2017; Wright et al., 2013). This is especially evident in debates on climate change, where divergent visions of the future have been conceptualized as “climate imaginaries”, defined as “shared socio-semiotic systems that structure a field around a set of shared understandings of the climate” (Levy and Spicer, 2013, p.1). These different, oftentimes competing visions of what climate change entails for our societies are propelled by distinct value regimes (Prainsack, 2022). These value regimes are the deeply embedded political-economic and cultural arrangements that systematically (re)produce specific values within institutions, actor groups, and governance mechanisms (Levy and Spicer, 2013). Next, I turn to the imaginaries of CCS, where specific value regimes are at play.

Imaginaries of CCS

Having established the theoretical contours of imaginaries as normative, value-laden projects that structure what we think of as feasible futures, this framework can be applied to unpack CCS. As with other climate imaginaries, visions of CCS are not neutral but are driven by competing value regimes (Levy & Spicer, 2013; Oomen et al., 2022). In the European context, scholarly analysis reveals a dominant “techno-market” imaginary which frames decarbonisation tools that rely on technology primarily through a lens of cost-efficiency and market logic (Levy and Spicer, 2013). This imaginary, seeking the cheapest path to mitigation with minimal systemic disruption (Rubiano Rivadeneira & Carton, 2022), effectively dominates the “corridors” of perceived feasible climate action (Beck & Oomen, 2021). A key consequence of this framing is that it inherently sidelines deeper political and ethical questions concerning fossil fuel accountability, risk distribution and considerations of equity (Beck & Oomen, 2021; Rubiano Rivadeneira & Carton, 2022; Van Beek et al., 2022). The power and specificity of such imaginaries are best understood when they become embedded in concrete national projects and public discourses (Kim and Jasanoff, 2015), illustrated by the divergent social meanings CCS has acquired across different countries.

“Last chance for carbon capture and storage” was the assessment of a Nature paper from 2013 (Scott et al., 2013), which exemplifies the long and evolving history of imaginaries that have portrayed, contested and reinvented CCS through its many highs and lows over its lifetime (Tønnesen, 2011). As I write this in 2026, CCS deployment overcame the 2013-dip and has reached an all-time high within a post-Paris political landscape (Global CCS Institute, 2025). This is precisely the period in which imaginaries have "become even more important as climate politics is no longer about raising awareness but about shaping the sustainability transition itself" (Hajer and Pelzer, 2018, p.222). The technology's shifting social meaning, from "last chance" to, in some contexts, a mainstream climate tool, is nationally grounded and politically contingent, as illustrated by contrasts across Europe. In Poland, the imaginary of coal has been "fused" with national development, with CCS framed as part of a modern, clean technological future essential to the nation's economy as linked to coal (Kuchler & Bridge, 2018, p. 144). But in neighbouring Germany, by contrast, CCS technology is discussed "with much reluctance", often framed as a moral hazard that distracts from present reductions or as a high-risk "waste disposal" technology due to fears of leakage and seismic activity (Otto et al., 2021, p. 7). This negative narrative is however changing quite rapidly, illustrated by a CO_2 transport and storage law being implemented in late 2025 and the exploration of CCS as common interest projects between Norway and Germany (Faber et al., 2025). A comparative study of media framing in Norway and Sweden further illustrates how the nationally specific imaginaries shape CCS's social interpretation (Buhr & Hansson, 2011). In Norway, CCS is embedded in a national project narrative, with the state assuming responsibility and the media conveying pride and legitimacy which frames benefits as CO_2-free domestic power, technology exports and an enhanced international reputation. In Sweden, where no such hegemonic national project exists, media discourse rather question "whether CCS should be considered a sustainable pathway at all" (Buhr & Hansson, 2011, p. 344).

Marzban and Karimi's more recent work has provided a structured, scenario-based methodology for analysing competing CCS imaginaries (2026). Their work demonstrates how thinking about the future can systematically unpack the value regimes (Levy & Spicer, 2013) embedded in different pathways, showing that the debate over CCS is fundamentally a debate over desired social futures. Their work confirms that CCS futures are not uniform, and propose four scenarios presented as political tools to raise awareness of diverse, plausible pathways of CCS development: the first is seamless deployment aligned with techno-optimism with steady innovation, helped by political support and public acceptance which allows CCS to develop as a mainstream mitigation tool within existing economic and governance frameworks. The second is obstacle-ridden implementation where CCS advances slowly due to public scepticism, political caution and economic hurdles. The third is stagnation, where CCS is socially delegitimized, seen as a harmful distraction or a form of greenwashing, ultimately abandoned in favour of renewable energy and efficiency. The fourth and final pathway is the negative emissions boom, an imaginary of transformative integration where CCS, BECCS and DACCS are propelled by bottom-up support, strong policy and funding into a new carbon management regime (Marzban & Karimi, 2026). Each of these imaginaries encodes different values, such as economic continuity versus more community-led transformation, which underscores the political struggle over which values dominate in the decarbonisation agenda (Beck et al., 2021; Levy & Spicer, 2013).

This body of work underscores that imaginaries are performative. They are "techniques of futuring" that make specific pathways appear feasible and desirable, as "the public imagination is infused with visions of future environmental catastrophe and social inequality – as well as visions advocating for and assessing specific technologies" (Oomen et al., 2022, p. 254). In this view, "the future is real in so far as social actors produce representations of the future which have an effect on others' actions in the present" (Tutton, 2017, p.483). The absence of powerful, desirable counter-visions, as Prainsack (2022) argues, can itself explain the persistence of contested socio-technical regimes. This stresses the central role that values and social understandings play in imaginaries, as what one imaginary might put forth as "efficient" another might call "unjust". Thus, to critically evaluate an imaginary like the cost-efficient deployment of CCS, it is important to explicitly engage with theories of justice. It is to these frameworks, which provide the principles to assess outcomes, identify harms and articulate alternatives in my work, that I turn in the following sub-chapter. I will start by introducing the justice compass that directs this research, namely climate justice.

Justice Conceptualizations

Climate justice fundamentally seeks to address the core inequity of climate change: that contributions to its onset are profoundly unequal and that the capacity to deal with its impacts is unequally distributed, culminating in a situation where those who have done the least to cause the problem are often the most vulnerable to its consequences (Adger et al., 2001; Islam & Winkel, 2017). This posits climate change as a preeminent justice issue that can be defined as "fundamentally about paying attention to how climate change impacts people differently, unevenly and disproportionately, as well as redressing the resultant injustices in fair and equitable ways" (Sultana, 2022, p. 118). Climate justice is made particularly complicated since the activities that constitute the wrong, such as the burning of fossil fuels, "are not wrong per se, such as genocide or slavery, but are only wrongful when done excessively" (Meyer & Roser, 2010, p. 230).

In global climate governance, calls for greater equality, equity, access and allocation of rights and responsibilities under the UNFCCC have a long and contested history (Caney, 2014; Pickering et al., 2012; Shue, 1999, 2018). The formal codification of these key equity principles for just climate change mitigation (and adaptation) comes from the cosmopolitan-aspirational framework of the UNFCCC and the Paris

Agreement, instruments shaped by Northern diplomatic and legal traditions (Okereke, 2008; Ciplet & Roberts, 2017). However, their substantive ethical force, particularly the demands for equity, historical responsibility and the right to development, stems from decades of advocacy, scholarship and protest from the Global South and global climate justice activist movements, supported by some key Northern countries and diplomats (Okereke, 2008). These justice principles are therefore a hybrid, contested consensus, providing a yardstick against which to measure climate policy.

The cosmopolitan principles are aiming for a "globally fair distribution of benefits and burdens" (Biermann & Kalfagianni, 2020, p. 3), notably, in a way that "ensure global benefits at the lowest possible cost" (UNFCCC, 1992). While the notion of cost-efficiency is central in UNFCCC principles, it is enshrined alongside foundational concepts like equity, the right to sustainable development, common but differentiated responsibilities (CBDR) and respective capabilities, and protecting the most vulnerable (IPCC, 2014; Kantikar et al., 2018; UNFCCC, 1992). CBDR is a cornerstone of the UNFCCC. It acknowledges a shared global duty while insisting that responsibilities need to be differentiated based on historical contributions and current capacity, essentially placing the weight of leadership on developed nations (Klinsky et al., 2017). Scholars also highlight the importance of protecting the worlds' vulnerable (Klinsky et al., 2017; Okereke & Coventry, 2016). These foundational principles were later reaffirmed by the Paris Agreement's call to achieve climate goals "on the basis of equity" and in "the context of sustainable development and efforts to eradicate poverty" (2015). Notably, the IPCC's Fifth Assessment Report (Synthesis Report) (2014) also formalized a combination of equity principles in a dedicated chapter on "Foundations of decision-making about climate change", to serve the basis for discussions on "equitable burden sharing in a climate regime" (p.76). Essentially, this means that principles of climate equity have been formalised in the global climate governance structure (Lefstad & Paavola, 2023).

The perhaps most contested equity principle is the one referring to the right to sustainable development. For this analysis, sustainable development is understood as a process that meets human needs within planetary boundaries, as emphasized by ecological economists, while actively pursuing intra- and inter-generational equity (Costanza et al., 1997; Daly, 1992). The definition I use is the one put forth by the Brundtland report, where "(s)ustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future" (WCED, 1987, p. 39). This is a contested political project, since the meaning of sustainable development is shaped by core tensions between growth and limits, competing interpretations of equity, as well as between instrumental and intrinsic valuations of nature (Daly & Farley, 2011). Asara et al. situate sustainable development as the dominant paradigm that emerged in the late 1980s with the goal of harmonising economic growth, social welfare and environmental protection

(Asara et al., 2015). In their analysis, sustainable development, in its mainstream interpretation, is problematised as a depoliticised framework that leaves the imperative for economic growth unchallenged. Critics renders it a form of weak sustainability, a technocratic concept that facilitates consensus but fails to integrate the deep and deliberate transformation required to address the intertwined crises of ecology (in my context, climate change) and inequality (Asara et al., 2015). In the Brundtland-report itself, it is stated that "[a]t a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils and the living beings" (WCED, 1987, p. 43). But while the meaning of sustainable development is deeply contested, oscillating between a transformative project for equity and a depoliticized frame for continued growth (Anker, 2018; Asara et al., 2015), its status as a foundational, consensual objective of international climate governance is unambiguous. It is among the principles to which states have committed to in the Paris Agreement and, consequently, the benchmark against which the fairness of any mitigation tool, including CCS, can be evaluated.

This cosmopolitan conception of climate justice, grounded in the global equity principles of the UNFCCC, provides the moral compass for my analysis of CCS. Equity concerns the fair allocation of resources and opportunities, recognizing that individuals and groups start from different circumstances and may require differentiated support to achieve comparable outcomes (Cook & Hegtvedt, 1983). It is fundamentally about meeting people where they are. Justice, however, operates at a deeper, structural level; it addresses the systemic and root causes of inequality, including institutionalised power imbalances and discriminatory practices, seeking to create a fair society (Dooley et al., 2021; Klinsky et al., 2017). In essence, equity aims to provide the necessary tools for people to thrive within a given system/situation, while justice questions and works to reform the system/situation itself (Cook and Hegtvedt, 1983). The above understanding of climate equity may be the norm in global climate policy, but it does not stem from a unison global conception of *justice.* The very emergence of CCS as a prominent mitigation tool was predicated on a rather different ethical foundation, rooted in competing philosophical traditions of justice that prioritize economic efficiency over equitable distribution.

From Map to Compass and the Necessity of Choice

If imaginaries provide the map for possible futures, justice acts as the compass to evaluate their moral direction. Once established, imaginaries embed specific values and are thus inherently normative. Yet as Sandel (1982, p. 176) observes, "the values and relations we have are a product of choice". There is no universal, objective moral order to distinguish right from wrong. Instead, we must navigate a landscape of competing conceptions of justice. This section introduces major

Western philosophical traditions that underpin these conceptions, providing the theoretical tools to critically assess the values encoded in imaginaries like those driving CCS.

In the next sections I will shortly introduce the main Western theories of justice, to provide a background into definitions and understandings of justice and how these translate into political arrangements. Where above I introduced the climate *equity* principles that direct global climate change governance, those equity principles are interpreted according to various *justice* conceptions. This breaking-down of what justice is has been helpful for me to understand where and how CCS plays into climate justice and how questions of justice are currently being governed. As my research is situated in the Global North, I place my focus on Western conceptions. I want to note that there are a plethora of justice conceptions out there, and that this simplified list is by no means exhaustive and should not be seen to diminish the reality of the plurality of justice understandings across the world, but they do broadly cover the justice conceptions that can be found in global climate change governance policies and treaties (Biermann & Kalfagianni, 2020; Lefstad & Paavola, 2023; Sterba, 1980), which are relevant to this research.

Recognizing that Climate Justice is One of Several Understandings

The integration of CCS into the climate change mitigation toolbox exemplifies how a specific conception of justice becomes embedded in policy. CCS gained prominence through the Integrated Assessment Models (IAMs) used by the IPCC, a methodology designed to identify cost-optimized pathways to mitigation (Rubiano Rivadeneira & Carton, 2022). This choice, to search for the most cost-optimized approach to climate action, is itself a value judgement which indicates that economic efficiency is prioritized over other parameters, such as equity or restorative justice[1]. This choice can be traced to deeper philosophical traditions that have shaped Western thought since the Enlightenment. To understand the conflict between the cosmopolitan climate justice compass I adopt and the logic driving CCS, it is important to understand these root traditions.

Justice is a multi-dimensional concept, debated across several intersecting planes. Scholars often distinguish between its key dimensions, such as distributive justice, which concerns the fair allocation of benefits and burdens; procedural justice, which concerns the fairness of decision-making processes; and recognitional justice, concerning the respect for diverse identities, cultures and experiences of different (groups of) people (Schlosberg, 2012, 2004; Fraser, 2012). The implications of these in CCS applications have already been shortly introduced in the previous chapter,

[1] *I want to make it clear that the IPCC put forth in e.g. their 5th Assessment Report that also social and ethical valuation-methods are available, in addition to economic ones, to assist decision-making (IPCC, 2014), but indeed economic optimization is the primary method in IAMs.*

but the important thing to note is that different principles and understandings of justice can be applied *within* these dimensions.

The overview that follows focuses on the underlying philosophical foundations of justice - the core ethical premises about what makes a society fair (Sen, 2002). These three dominant traditions provide the normative foundations that generate and justify specific positions on distribution, procedure and recognition, and rationalise the prioritisation of certain principles over others. Broadly, the choices that direct our actions and thoughts on justice are deduced from three main traditions: maximising welfare (utilitarianism), respecting freedom (libertarianism), and promoting virtue (virtue ethics). Each offers a different answer to the fundamental question of what do we owe each other in a just society (Sandel, 2010). The following overview of justice conceptions navigates a complex philosophical landscape. I distinguish between the underlying ethical traditions that inform theories of justice, and the more political theories that apply them to governance. The climate justice framework outlined above is an example of a political theory built upon a virtue-ethical foundation. For instance, the philosophical commitment to treating individuals as ends-in-themselves, a virtue-based ethic, provides the foundation for political theories like cosmopolitanism which dominate the discourse in the UNFCCC (Lefstad & Paavola, 2023). Similarly, liberal egalitarianism through e.g. Rawls can be seen as a political application of these virtue-based ethics within the context of a nation-state. The following synthesis will first outline the three core philosophical traditions of utilitarianism, libertarianism and virtue ethics, before also briefly noting their key manifestations in political and climate governance discourse. The following table synthesises the key features of these traditions.

Table 2: Core principles of key philosophical traditions

Philosophical Tradition	Core Principle	Role of the State	View on Redistribution	Subjects of Justice
Utilitarianism	Maximize overall welfare/ happiness	To maximize the total utility of its citizens	Justifiable if it leads to a net increase in overall welfare	The collective population whose happiness is being aggregated
Libertarianism	Maximize individual liberty and respect for private property rights	A minimal state to enforce contracts & protect against force, theft, fraud	A violation of individual rights, unjust by default	The individual, a self-owning agent
Virtue Ethics*:*	Cultivate moral character and treat individuals as ends-in-themselves	To create conditions that respect human dignity and autonomy	Justified if it upholds the duty to respect persons and ensure fairness	All individual human beings worthy of respect

Utilitarianism: Justice as maximizing welfare

Maximising welfare, or utilitarianism, works according to the greatest happiness principle where just outcomes is about weighing costs and benefits. Essentially, consequences are calculated and the right thing to do is whatever will produce the best outcome overall, all things considered (Sandel, 2013). Utilitarianism was an idea initially developed by Jeremy Bentham in the 1780s. Bentham was an established Enlightenment thinker, and his main contribution was bringing *rationality* to politics and ethics - the idea that preferences can be weighed and calculated (Okereke, 2008). This weighing can be executed through cost-benefit analysis, where costs and benefits are compared in monetary terms, and can be executed by the state, as the role of the state from a utilitarian perspective is typically to maximize the utility (happiness) of its citizens (Okereke, 2008; Sandel, 1982, 2013).

Weighing preferences against each other with the goal of maximizing overall happiness created an idea that justice and morals can be calculated without normative judgement: calculations can be based on more “reasonable” “*scientific means*” for optimising overall happiness (Sandel, 1982; Sterba, 1980). The omission of normative or subjective elements from moral questions about right and wrong formed the basis of contemporary science and may have trickled down into contemporary ideas of justice and equity being normative issues that should not be discussed in scientific climate change fora (Pickering et al., 2012). This idea of maximising individual happiness was the initial idea leading to our modern market societies and welfare states, but it comes with one major limitation: lack of consideration of *individual* rights, since the goal is to maximise *overall* levels of happiness (Sandel, 2013). To understand it simply, the question directing thinking in this tradition would be “what action will create the best overall outcome for most, all things considered”.

Libertarianism: Justice as respecting freedom

In almost direct opposition to utilitarianism, individual rights are the main tenet of a libertarian perspective of justice. This is a popular conception broadly developed by philosophers, political theorists and economists like John Locke, Friedrich Hayek and Robert Nozick, where *liberty* is considered the ultimate moral ideal (Sterba, 1980). Here, human freedom is the objective of highest value. Libertarians believe that everyone has a fundamental right to do whatever they want with the things they own, including themselves, as long as they also respect other people´s rights to do the same(Sandel, 1982, 2013). Justice for libertarians means people are free to pursue their own interests without coercion, which makes its proponents more concerned with processes than outcomes. As long as the processes are just, the outcomes are by default also just (Sandel, 2013). Here, all people are equal before the law with inherent rights to life, liberty and property, so any individual person is a legitimate subject of justice (Boettke et al., 2017).

In its most extreme application, justice from a libertarian perspective depends on two requirements: did an individual legally and legitimately obtain the resources he or she used to gain their property? And did the distribution happen in a free market exchange? This means that if a person became a billionaire from selling stolen goods, this would be unjust and thus require remedy (Sandel, 2008). However, as long as the processes were lawful, the outcomes are perceived as just and thus not to be disrupted (Sterba, 1980). "Social justice is blind because it remains forever cut off from the wisdom of the market" (Mirowski, 2013, p.63), in other words, the state should not interfere in trying to create "just outcomes" since the market will know best. This focus on processes leads to a very specific view of the role of the state. Only a minimal state would be morally right here, whose only legitimate role is to protect against force, theft and fraud, and to enforce contracts (Nozick, 1980). Redistributive policies are considered a violation of human rights and are as such considered unjust by default, since each individual is entitled to whatever they own as long as the ownership came about voluntarily and through transfer from another legitimate owner (Nozick, 1980). Redistribution through e.g. taxation is argued to lead to inefficiencies that would harm economic growth, which would harm overall welfare. Here, policies for justice are policies that create economic opportunities for all, such as lowering taxes and reducing barriers to free markets (Friedman, 1980; Hayek, 1980). As a result, the only legitimate mechanisms for justice are economic free-market-based ones that create new or enhanced economic opportunities (Okereke, 2008). Libertarian mechanisms have become a common approach in global climate change negotiations, meaning climate action is often marketised (Ciplet & Roberts, 2017; Lefstad & Paavola, 2023; Okereke, 2008). I will return to this in the section on political economy.

Egalitarianism: Justice as promoting virtue and fairness

The third and last major philosophy, virtue-based justice, focuses on the moral character of the actor and offers a fundamental alternative to utilitarian and libertarian views. As the oldest theory of justice in Western literature, originating in ancient Greek philosophy, it posits justice as a human virtue grounded in our intrinsic ability to reason and distinguish right from wrong (Fraser, 2010a; Sterba, 1980). Immanuel Kant modernized this perspective by arguing that morality is not about maximising happiness or respecting liberty alone, but about respecting people as an end itself. He developed virtue-based ethics in direct response to utilitarianism, contesting that rights become vulnerable when rested on calculations of what produces the greatest happiness. For Kant, desired outcomes – for example an overall increase of happiness, is an insufficient condition for justice (Sandel, 2010). Instead, what is morally just depends on the motive, not the outcome. Justice requires us to uphold human rights of all people simply because they are "humans capable of reason and therefore worthy of respect" (Sandel, 2010, p. 91). This justice based on duty and moral law forms the philosophical foundation for modern human rights (Humphreys, 2009), and informs two contemporary important political theories of justice: liberal egalitarianism and cosmopolitanism.

Liberal egalitarianism

Liberal egalitarianism is a conception of justice developed in contrast to libertarianism, broadly stemming from John Rawls´ attempt to combine freedom with social equality (Sterba, 1980). It applies a Kantian respect for persons within the context of the nation-state. Here, justice is viewed as fairness, realized through just political and social institutions that ensure equal political, economic and cultural opportunity (Rawls, 1971, 1980). Unlike libertarianism, liberal egalitarianism is concerned with both just processes and equitable outcomes. Rawls' famous two principles of justice state that each person is to have "equal right to the most extensive basic liberty compatible with a similar liberty for others", and that "social and economic inequalities are to be arranged so that they are both a) reasonably expected to be to everyone´s advantage and b) attached to positions and offices open to all under conditions of fair equality of opportunity" (Rawls, 1980, p. 52). Subjects of justice are members of a society with a shared public culture and political system, usually a nation state (Biermann & Kalfagianni, 2020). The role of the state and the mechanisms for achieving justice rests on social contract theory and the design of social and economic policy to benefit the least well off to achieve good lives, but it is not the role of the state to dictate what such a good life entails (Okereke, 2008; Rawls, 1971).

Cosmopolitanism

As previously established, cosmopolitanism globalizes the core tenets of liberal egalitarianism, applying the Kantian principle that all individuals are ends in themselves to the entire global populace. A conception commonly found in international climate governance (Lefstad & Paavola, 2023), cosmopolitanism argues that justice requires that "persons of equal ability and motivation have equal opportunities to attain an equal number of positions of a commensurate standard of living" (Biermann & Kalfagianni, 2020, p.5; Caney, 2001). Subjects of justice are not just individuals within a nation-state, but subjects in a global society based on interdependence through e.g. trade. This view holds that distribution of national resources is entirely arbitrary, e.g. that Norway or Saudi Arabia have oil while Sweden does not, which is a matter of chance, and as such not based on merit. Therefore, the mechanisms for justice for cosmopolitans are based on global redistribution to benefit the poorest people, to equalize opportunities across the globe.

Revisiting the tensions in CCS deployment

Under the climate regime of the UNFCCC, a gap emerges between these agreed cosmopolitan principles of what justice is understood to be and the mechanisms deployed to enact them. Here, subjects of justice are global citizens and principles of justice are based on fair distribution and human rights, stemming from virtue-based ethics and cosmopolitan justice traditions (Biermann and Kalfagianni, 2021). But in the mechanisms deployed to enact justice a divergence in these ethical traditions becomes clear, as utilitarian and libertarian imaginaries of justice dominate. Market-based mechanisms prioritising cost-efficiency, aligning with a libertarian worldview, often override distributive justice concerns in final agreements, including in the Paris Agreement (Lefstad & Paavola, 2023). Of course, the UNFCCC should not be viewed as holding a global coherent justice view, as some nations e.g. frequently advocate for liberal-egalitarian mechanisms that prioritise benefitting their own citizens over for example a more cosmopolitan interpretation that would benefit all global citizens (Fraser, 2010b; Lefstad & Paavola, 2023; Shue, 2018). Cost-efficiency and dealing with climate change in a way that "ensure global benefits at the lowest possible cost" are clearly embedded in the UNFCCC principles too (UNFCCC, 1992). But what is important to note here is that by being signatories to the UNFCCC and Paris Agreement, it is not *only* cost-efficiency that is supposed to drive mitigation. Cost-efficiency can be one of the principles that guide action, side by side with the others identified here. Problems arise when cost-efficiency is the only or the dominating principle taken into account.

This tension between principle, what we understand justice to be, and mechanism, what we do to correct injustices or make equity happen, is reflected within climate governance. Some have suggested to sideline equity overall for fear that it will complicate negotiations and undermine collective action (Keohane, 2016; Pickering et al., 2012). This view posits equity as a dangerous distraction in a post-Paris world. However, as Pickering et al. (2012) argue, research on equity is not a distraction but an essential precondition for effective, legitimate and durable climate action. Klinsky et al. (2017) put forth four key reasons for this: First, an obligation to human wellbeing demands that we account for the differential impacts of policies on the most vulnerable. Second, understandings of justice and equity are essential to rigorous political analysis, as equity claims are central to the formation of coalitions and negotiation dynamics. Third, equity is not inherently in tension with climate action - perceptions of fairness are important for building the reciprocity and legitimacy needed for long-term cooperation. Fourth and finally, and perhaps most importantly, we cannot meaningfully understand the trade-offs of different policy pathways without an equity lens that reveals who wins and who loses within this particular system.

From this, it is possible to derive several conclusions for the objectives of this PhD thesis. I draw an understanding that a just outcome for CCS deployment cannot be evaluated through a techno-market imaginary alone, since this imaginary does not have the capacity to consider just outcomes in the cosmopolitan sense. The cosmopolitan sense is important in this thesis because it is the one mainly directing the UNFCCC (Lefstad & Paavola, 2023) and the one I personally find to be the most appropriate due to its focus on outcomes, not in the utilitarian cost-benefit sense but in the sense that all humans are inherently worthy. That means that I must assess just CCS deployment against the established equity principles of the climate regime that focuses on outcomes, namely responsibility, capacity to act, the right to sustainable development and to protect the most vulnerable without perpetuating existing inequalities (IPCC, 2014; Kanbur & Shue, 2018; Klinsky et al., 2017; Shue, 2014; Sultana, 2022), because my goal is to contribute to climate change mitigation.

A core concern I explore in my work is whether the market-based mechanisms might sideline deeper questions of equity, accountability and even possibilities for transformative change, in favour of mitigating climate change to the extent possible without disrupting the socio-economic status quo. The theoretical framework is missing one last part to be able to look at this more comprehensively. I now turn from the ends of justice, having established the principles we need to achieve for CCS deployment to be just, to the means of governance, to examine the role of the state and of the market in deployment of CCS as climate policy.

A Political Economy of Decarbonisation

> The Paris Agreement, by comparison of what it could have been, is a miracle. By comparison of what it should have been, is a disaster.
>
> (Ciplet & Roberts, 2017)

In this section I outline the neoliberal ideology that is shaping contemporary climate governance. My aim is to explain its core tenets, implications and logic, as this ideology provides the essential context for understanding the current governance approach to CCS in the post-Paris era. A important development is how a neoliberal turn was taken in the mechanisms proposed to achieve the Paris Agreement (Ciplet & Roberts, 2017; Lefstad & Paavola, 2023). In practice, this means that the Paris Agreement "is largely indicative of a process of marketization" (Ciplet and Roberts, p.153), where the focus for climate change mitigation has become one on how to effectively leverage the private sector to act. In short, "the private sector has emerged as the primary mechanism for spurring mitigation (…) action" (ibid).

To analyse CCS governance is to analyse the interaction of states and markets, a core concern of political economy, literally defined as the interaction of "states" and "markets" (Kaczmarczyk, 2021; Kern et al., 2016; Paul & Amawi, 2013). Where economics is understood as "the laws of the marketplace" and politics as "the processes that generate government policy" (Paul and Amawi, 2013, p2). This acknowledgement of the centrality of politics makes the study of the interaction of states and markets inherently a study of justice: “From abstract philosophy down to the most mundane of public policies, one way of life is chosen over another, and one set of values placed above its rivals” (Paul and Amawi, 2013, p8). This interaction is critical for CCS, as its development and deployment are wholly contingent on policy support to create a viable business case (Kern et al., 2016). Therefore, CCS cannot be separated from its political-economic context. This context is dominantly shaped by neoliberal, market-centric ideology (Lohmann, 2012), briefly explained below.

Neoliberal Ideology in Climate Governance

The key ideology characterizing global environmental governance and climate change policy in general is neoliberalism (Ciplet & Roberts, 2017; Clapp & Dauvergne, 2011; Okereke, 2008). Neoliberalism can be described as “a politically guided intensification of market rule” (Brenner et al., 2010, p.184). Ciplet and Roberts characterise neoliberal environmentalism by four main processes; “1) the prominence of libertarian ideals of justice, 2) marketisation (where market mechanisms and private sector engagement are viewed as the most effective and efficient forms of governance), 3) governance by disclosure (where the primary obstacle to sustainability are “imperfect information” and regulatory structures that inhibit innovation), and 4) exclusivity (where multilateral decision-making is shifted from consensus to minilateralism)” (2017, p.150). As the first process was already unpacked in the previous sub-section, and the fourth is more applicable on global governance level in e.g. the UNFCCC and in COP processes (Okereke, 2008; Lefstad and Paavola, 2023) rather than on Norwegian/European level, I will unpack and explain the second and third process of neoliberalism in this sub-section.

As “neoliberalism” is a contested term with diverse interpretations (Mirowski, 2013), I will focus on the “umbrella context” relevant to CCS policy. Neoliberalism, in essence, is a political-economic ideology that asserts the superiority of market mechanisms and private enterprise in organizing society and solving public problems. In brief, it promotes “an approach to solving environmental problems through privatization, commercialization and commodification of natural resources” (Bakker, 2005). A common understanding is that economic growth and high per capita incomes are key to welfare and sustainable development (Clapp & Dauvergne, 2011), which are pursued through widespread markets and private property rights secured by the state (Hodgson, 2015). A commonality among growth-based ideologies, including neoliberalism, is the idea that with economic growth, “all boats will rise”, thanks in large part to entrepreneurship and innovation through modern science and new technology. Important to note is that neoliberalism has “never been implemented uniformly”, and it faces resistance and critique (Ciplet & Roberts, 2017, p. 149).

Philosophical and Historical Foundations

The neoliberal ideology is underpinned by the libertarian and utilitarian philosophical traditions dominant in the global North, which support a political-economic order based on profit-oriented private property (Jessop, 2012) and which established the foundations for neoliberal climate governance (Okereke, 2008). "Ideology" is defined in the Cambridge dictionary as a "set of beliefs or principles, especially one on which a political system, party, or organization is based". As a formal political project, neoliberalism was advanced after the Second World War by thinkers like Friedrich Hayek and Milton Friedman (Mirowski, 2013). The neoliberal project started from the point that the good society they are seeking must be constructed. Its public discourse champions a "weak" state to enable a "free" market, however, a central paradox key to this analysis is that neoliberalism in practice requires a strong state to construct and guarantee the conditions for that market (Bonefeld, 2015; Jessop, 2012; Mirowski, 2013).

The argument is that only a strong state can set the rules and regulations needed to ensure fair and orderly market competition, thereby producing a stable market society. A weak state is "the Achilles heel of a free economy [read: a free market]: unable to defend itself from the preying social interests", "succumbing to the attacks of pressure groups, monopolies and unionized workers" (Bonefeld, 2015, p. 20). The weak state allows these interests to govern through it, unable to set limits and rules. A strong state is required to protect and restrain competition and establish and police rules and regulations, so freedom is not misused (Bonefeld, 2015). The state then is essential to decide the rules of the game and to enforce these rules, to then facilitate the operation of the invisible, all-seeing and all-knowing hand of the market: The market, through price, knows everything worth knowing (Hayek, 1980), so the state should actively create the conditions for the market to function to its full capacity (Bonefeld, 2015; Hodgson, 2015; Mirowski, 2013). This market "can seemingly always provide solutions to problems caused by the market in the first place" (Mirowksi, 2013, p.64). In response to the climate crisis, it is therefore best, in the neoliberal view, "to enlist the strong state to allow the market to find its own way to the ultimate solution" since "the final arbiter of truth is the market" (ibid, p.338). The state's core role is to actively create the framework from within which the market can function to its full capacity (Bonefeld, 2015; Mirowski, 2013).

Success, here, is determined by having a functioning market system where economic agents respond to price signals in a "civilized and self-responsible manner" (Bonefeld, 2015, p.19). This places a lot of responsibility on governments, as failures in the market can be considered political failures where the governments failed either in creating the necessary conditions to market freedom or in restraining competition, restraining greed, implementing the right rules or regulations or laws, etc. In other words, it is commonly accepted (even if not always publicly acknowledged) that "markets require rules" and active governing (Mirowski, 2013; S. K. Vogel, 2023, p. 320).

"State" and "Market"

Given the centrality of the state-market relationship, it is necessary to define these terms. This is no easy task, as "the state is undeniably a messy concept" (Mann, 1984, p. 187). According to Mann, the state contains four main elements: 1) "a differentiated set of institutions and personnel, embodying 2) centrality in the sense that political relations radiate outwards from a centre to conver c) a territorially demarcated area over which it exercises d) a monopoly of authorative binding rule-making" (ibid, p.188). As such, I understand the state as a functional authority able to implement rules, laws and regulations, driven by a political agenda, and as for the case of Europe, headed by democratically elected parties and leaders.

A market, meanwhile, is understood as an arena where buyers and sellers engage in "voluntary exchange where both parties to an exchange expect benefits" (Hodgson, 2015, p. 10). This builds on libertarian philosophy placing heavy ideological weight on "free markets", though we know that this freedom is necessarily governed by a strong state framework (Mazzucato, 2013; Mirowski, 2013). The neoliberal ideal is a "perfect" market characterized by many buyers and sellers, comparable products, complete information, no entry costs, and where supply and demand determine prices (Vogel, Steven K., 2018). A critical piece for a perfect market is competition, which can help limit unearned "rents"; the income or returns above market value which could otherwise distort the market functioning. Extending these definitions, one could understand the "state" as representing the public sphere and the "market" as representing the private sphere, a distinction I maintain throughout this thesis. Of course, this is a simplified understanding. The market and the state cannot be entirely separated (Hanieh, 2024) as they weave into each other in various ways, for example through (part- or majority-) state-owned companies. Equinor is a perfect example as the Norwegian state owns 67 per cent. Nevertheless, I see the state and market still valid as separate categories as they perform different functions and as such are separable. And, alas, for this market to function perfectly, rules must be in place, ultimately defined and enforced by the state.

A debate on "Marketcraft" and the Purpose of Governance

As established in the preceding sections, the neoliberal view paradoxically requires a strong state to construct, regulate and police the "free" market framework within which private actors can operate and compete. This prescribed role is predominantly that of a "market fixer", where the state's task is to correct for "market failures" (Mirowski, 2013). These would be situations where the idealized conditions of a perfect market, with perfect competition, information and no externalities, breaks down, in turn leading to inefficient outcomes (Vogel, 2018). Examples of failures include the lack of competition in natural monopolies, the undersupply of public goods, and the negative externalities of pollution, where the social cost of an activity is not reflected in its market price. The state's intervention is thus legitimised as a necessary correction to restore efficient market function (Mazzucato, 2013). This corrective, minimalist role is the endpoint of the neoliberal logic, where the (strong) state enables and fixes the market but does not steer it, for example towards specific public goals, since the market knows best what needs to be done.

Aligned with this minimalist view of the state is a role chiselled out by the demands of private capital, where the state, as required, takes on the role as a "de-risking" agent (Collington, 2025; Scholvin et al., 2025; Vezzoni, 2024). In de-risking, the state plays a role in absorbing financial risk in high-risk, capital-intensive projects with uncertain futures (Mazzucato, 2013; Collington, 2025) – characteristics that fit the description of CCS technology. The goal is essentially to summon the state to assume the risk of failure through various alternative means, including subsidies, loan guarantees and financial buffers, in order to transfer potential losses onto the public budget to essentially encourage private capital to invest (Hunt & Tilsted, 2024; Vezzoni, 2024). This creates a form of private-public partnership where the state facilitates, regulates and de-risks development, while private actors finance, manage and profit from them (Mazzucato, 2013; Vezzoni, 2024). Critics argue that this "de-risking state" risks lacking an independent, strategic vision, potentially prioritizing profitable asset creation over equitable public outcomes, and making deployment contingent on return (Grubert & Talati, 2024; Vezzoni, 2024). Furthermore, this form of de-risking where the state only finances without reaping any (financial) rewards from their risk-taking is not sustainable long-term (Mazzucato, 2013).

This traditional view of the state invites a critical question. If the state is already so deeply involved in crafting the rules of the market, what should those rules aim to achieve, and in whose interests (S. K. Vogel, 2023, p. 321)? A growing body of scholarship is challenging the narrow "market fixer", which extends into the "de-risker" conception, and argues for a more purposive and strategic role for the state. Scholars like Steven Vogel and Mariana Mazzucato do not dispute that markets require rules, but they do dispute the passive and corrective purpose assigned to the state in traditional (neoliberal) economic theory. It is their belief that markets can be directed, designed to achieve equitable outcomes and to deliver critical public goods. A public good would be a commodity or a service that is provided without profit to all members of a society. According to Vogel, "we can craft governance to empower markets, and to direct them towards the public good" (2018, p. 150).

Similarly, Mazzucato's concept of the "entrepreneurial state" challenges the view of the state as merely that of a "market fixer". In this orthodox view, state intervention is justified only in the case of market failure, as identified above. These failures can take two forms: 1) to correct structural inefficiencies like monopolies or oligopolies that distort competition and reduce public welfare, and 2) to address situations where the social return on investment exceeds the private return on investment. This second rationale is critical for technologies with public-good characteristics or high initial risks and refers to when the broad societal benefits of an innovation are large, but the financial profits are uncertain, distant or difficult for a private firm to capture, and as a result the market will systematically underinvest. The state steps in to fill this "investment gap", by e.g. subsidising or funding the activity to align private incentives with the public good, after which it ideally retreats (Mazzucato, 2013; Mirowski, 2013).

Mazzucato's work moves beyond this corrective, gap-filling paradigm, making the case for the "entrepreneurial state": a state which can and must realize big, visionary projects, where the state is a proactive visionary, investor and market-shaper (2013). Entrepreneurship can be understood as a person/group who is willing and able to convert a new idea or invention into a successful innovation – and that this innovation goes beyond being just a new business and instead creates a new product, process, or even a whole new market (Schumpeter, 1947; Mazzucato, 2013). She demonstrates that in past missions and technological breakthroughs, from NASA's "man on the moon" to the internet, the state acted not just as a market fixer but took on the active role of providing visionary, long-term and high-risk investment. The state actively created and shaped entirely new technological landscapes and markets, providing the strategic direction and more patient capital that the risk-averse private sector lacked (Mazzucato, 2013; Schumpeter, 1947). This was necessary because firms are structurally incentivised to prioritize financial gain, and to only invest if short- or at least medium-term returns can be guaranteed (J. Hinton, 2020). The state, on the other hand, has more funds than most firms, is not legally required to have a fast return on profit, and does not have investors chasing them demanding high returns (Mazzucato, 2013).

My research engages with these perspectives to highlight a central tension: while neoliberal governance prefers market-centric tools, effective and just deployment of complex technologies like CCS, for the goal of mitigating climate change, might demand a more directive, entrepreneurial and strategically crafted state role, as exemplified by the lack of scaling up of CCS infrastructure (Abdulla et al., 2021; Martin-Roberts et al., 2021). I will explore this point further in the synthesis of findings section. First, let's turn to how market-centric climate policy is actually applied.

From Ideology to Political Economy: Market-Centric Climate Policy

In the context of climate change governance, mitigation responses have been dominantly shaped by market-centric climate policy (Ciplet & Roberts, 2017; Okereke, 2008). In this context, the state's primary role is to create and regulate markets that incentivize decarbonization (Lohmann, 2012). This approach uses economic mechanisms to incorporate the cost of emitting CO2 into market decisions (Calel et al., 2025; Lohmann, 2008; Stavins, 2003), theoretically allowing "any desired level of pollution cleanup to be realized at the lowest overall cost to society" (Stavins, 2003, p.259).

For clarity, it is useful to contrast market-based instruments with the alternative of command-and-control regulations. This approach, dominant in environmental policy until the 1990s/early 2000s, relies on direct governmental mandates to achieve environmental goals, such as setting emission limits, mandating specific pollution control technologies, or banning certain substances. While effective in many cases, such regulations are critiqued within mainstream economics for being inflexible and economically inefficient (Stavins, 2003). By imposing the same reduction requirements on all firms regardless of their abatement costs, command-and-control approaches fail to harness the cost-revealing mechanism of the market – goes the argument. They force companies to comply irrespective of expense, potentially imposing higher total costs on society than a market-based system where firms can trade permits or choose the cheapest way to meet an overall cap (Bretter & Schulz, 2024; Stavins, 2003).

Neoliberal proponents argue that command-and-control regulations rely on a state with incomplete information instead of the all-knowing market (Hayek, 1980) in where and how decarbonisation can be done in the most cost-efficient manner. Market-based instruments, instead of force, use financial incentives (or penalties) to incentivise (or disincentivise) a targeted action (Stavins, 2003). The basic idea is to incorporate a price-signal into specific actions, goods and/or services to make cleaner alternatives more economically competitive or to make it more economically competitive to reduce emissions compared to emitting them, and by design leave it up to private companies, through the market, to decide the cheapest way to do it. Market-based instruments rely on the profit motive, the imperative for businesses to prioritize financial gain (J. Hinton, 2020; J. B. Hinton & Cornell, 2022), and the aim is to align the corporate profit-making motive with decarbonisation targets to create "win-win" situations for both shareholders and the climate (Lohmann, 2012).

A key strategy is marketisation: "the presence of market rationalities and practices" (Anttonen & Meagher, 2013, p. 18), often by creating new markets. The EU Emissions Trading Scheme (EU ETS) is a prime example, as it essentially created a market in the rights to pollute (Calel et al., 2025). In short, the EU ETS sets an overall limit on the total amount of GHG emissions allowed to be emitted by the covered sectors (a limit that is lowered annually) and then lets companies trade emission allowances, creating a carbon price to incentivize decarbonization. The idea, in theory, is that the carbon price internalises the externality of emissions by making every ton of CO_2 emitted have a cost equal to the market price of an allowance. The effectiveness of these instruments, however, is contingent on design and enforcement. Prices must be high enough to change behaviour. The EU ETS price has historically been too low to incentivize costly options like CCS, though recent price increases (reaching €84/tCO_2 in December 2025) are beginning to narrow the gap to CCS cost estimates (€75 to €250/tCO_2)(Lockwood, 2024).

Thus, even though market-based instruments dominate as the most cost-efficient approach to decarbonization (arguably) (Bretter & Schulz, 2025), their effectiveness is repeatedly challenged due to often inefficient tax and price-levels (Calel et al., 2025). Profit-seeking firms are structurally incentivized to avoid investments without short- or medium-term returns (Hinton, 2020), particularly where alternatives, such as continued pollution in the absence of a sufficiently high CO_2 price, remain cheaper. Furthermore, these approaches remain vulnerable to fundamental market failures such as lack of perfect competition or information (Shahar, 2017; Mosca, 2008; Perman et al., 2003).

A critical market failure relevant to CCS is the natural monopoly characteristics present in parts of its value chain. Natural monopolies arise in sectors like railroads and electricity grids, where characteristics of high fixed costs and economies of scale prevail, making it economically inefficient to have multiple competitors (Mosca, 2008; Roessler, 2019). Such conditions historically prompt direct state intervention through e.g. state ownership or regulated private monopolies, because standard market competition and neoliberal preferences for competitive tendering are ill-suited since competition for the market cannot overcome the core inefficiencies of operations in a natural monopoly (Roessler, 2019; Stilwell, 2011)(Gomez-Ibanez, 2016). The characteristics of natural monopolies that apply to CCS are the vast, privately owned and/or operated high-cost infrastructure networks, geographically specific storage sites, combined with how transport and storage infrastructure can only transport and store a certain amount of CO_2 at any one time due to limited capacity of pipelines/other transport methods, but also for maintaining storage integrity (Lane et al., 2021). These suggest the presence of market failures from natural monopolistic characteristics, at least for parts of the CCS value chain.

CCS Governance: A critical Juncture of State and Market

The dominant imagined deployment strategy for CCS technology has, to date, been a market-centric one, reliant on private actors and supported by significant state funding (Abdulla et al., 2021; Kern et al., 2016; Subraveti et al., 2023). Yet, the market-centric attempt at deployment has so far failed to deliver CCS technology at any meaningful scale, as exemplified by the 4% capacity-rate, globally, of what would put us on-track with IEA's Net Zero by 2050-goal for 2030 (IEA, 2024). This might be explained by how CCS technology-deployment presents a compound challenge for governance since it not only involves infrastructure with natural monopoly characteristics due to being a high-risk, capital-intensive and geographically bound technology, but it also lacks a clear market since, simply, the

EU ETS price is too low (Aune et al., 2022; Calel et al., 2025; Kern et al., 2016; Oei & Mendelevitch, 2016). This dual nature could trigger two distinct rationales for state involvement within the paradigm of current market-centric deployment. First there is the classic regulatory role to manage natural monopoly inefficiencies as mentioned above (Roessler, 2019; Mosca, 2008). Second is the role chiselled out by the demands of private capital, where the state takes on the role as the "de-risking" agent (Collington, 2025; Scholvin et al., 2025; Vezzoni, 2024). Later chapters will subject this context to critique grounded in climate justice principles, arguing that a framework merely aimed at cost-efficient decarbonisation is insufficient if it fails to address fundamental questions of equity and justice in the governance of climate solutions, and especially so if it fails to deploy the technology at the needed scale.

Synthesis of Theoretical Framework

The approach I have developed here provides the lens through which I analyse CCS technology by exploring the gap between its cost-efficient imaginary and the demands of climate justice.

To sum up, I first employ the concept of imaginaries to reveal how the dominant imaginary legitimises CCS by providing a techno-economic roadmap for its deployment. The problem is that this "techno-economic" imaginary sidelines ethical considerations. To overcome this, I introduce a critical climate justice lens, to be able to evaluate this roadmap against the moral compass directed by equity, responsibility and protecting the vulnerable. Here, I highlight the contradictions between the critical climate justice discourse and utilitarian and libertarian principles of market-centric climate policy. Lastly, I bring in a political economy approach to analyse the current CCS governance framework. The ideal, to align with the ethically justified "utopia" that is sustainability, is to link effectiveness and justice in CCS deployment to achieve just climate change mitigation.

What emerges is a framework that ask, as mentioned on page 19: how is CCS currently imagined and governed, and what are the justice implications of this? Why are there tensions between the current deployment model and achievement of climate justice goals, and how can CCS deployment feasibly be aligned with climate justice objectives? Next, I turn to the research design to explain how I went about answering these questions.

Research Design

This chapter outlines the philosophical and methodological approach developed and applied to address the research gap and answer my research questions. My research is grounded in critical realism, a philosophy that acknowledges an objective reality (including e.g. the physical constraints of CCS as well as the real-world impacts of (in)justice) while understanding that our knowledge is always socially mediated. This sets a foundation that justifies an approach which takes technical and economic analyses seriously, though not as neutral truths. Rather, as socially situated claims that I can then integrate with a political and ethical inquiry. This leads to my methodological choices, characterised by a qualitative synthesis of existing interdisciplinary research, expert interviews, participant observation and policy analysis through thematic analysis.

Where I differ from previous critical social science literature is in my aim to move beyond and between the separate assessments, the critical and the more techno-economic, in the new post-Paris political context, to generate an empirically grounded understanding of how CCS can be governed to achieve just outcomes. I do this by deliberately centring justice to challenge the more dominant economic narratives. My goal is not to produce another paper that says, “forget CCS” and also not another one arguing for why it is needed, but rather, to recognise the implementation pressures from many different angles and work towards just outcomes. The following sections of this chapter detail the critical realist philosophical foundation and the thematic analysis methodology, followed by an overview of the research evolvement, including a brief explanation of my “case”, before turning to the data collection methods and finally my positionality, ethical considerations and limitations.

Critical Realism

The multi-dimensional and interdisciplinary nature of CCS deployment, which spans technical, geological, chemical, social, economic and political spheres, necessitates a philosophical framework that can accommodate this complexity. Critical realism recognizes that, ontologically, there exists an objective reality independent of humans (Benton & Craib, 2001) and epistemologically, sees facts as embedded and context-dependent (Buch-Hansen & Nesterova, 2021). This embeddedness is analysed through a stratified view of reality, often described as three overlapping domains (Bhaskar, 1978). These are 1) the “real”: the domain of underlying structures, mechanisms and potentials - it includes everything and whatever exists, whether it is natural, social, empirical or not, including worldviews; 2) the “actual”: the domain where these mechanisms are activated, generating events that occur whether observed or not, including systems and structures; and 3) the “empirical”: the subset of the actual that we directly observe and/or experience.

The development of CCS technology and the concomitant imaginaries can be mapped onto these domains. In the real one, the potential for CCS is found: the laws of thermodynamics, the geological structures, the IPCC pathways and government plans – and of particular relevance to my research, the imaginaries, values and justice perceptions that create the CCS context. In the actual domain, these potentials are activated: pilot projects are built, policy frameworks are discussed and designed, political and economic structures have influence. Finally, in the empirical domain, observations and experiences about this can be made, e.g. through industry actors’ deployment of CO_2 capture technology and dealings with CCS policy.

The critical realist ontology brings into focus the interconnection between nature and humans (Benton & Craib, 2001; Buch-Hansen & Nesterova, 2021; Spash, 2012, 2020). This understanding entails an embeddedness that recognizes the laws of physics, viewing the economy as embedded within society, which itself is embedded within the biophysical environment (Benton & Craib, 2001; Spash, 2012). This understanding of knowledge provides the room for me to draw from many diverse fields in my research, which crosses natural and social science as well as economics, into a coherent, yet context-dependent, “whole” to understand justice implications along the value chain of CCS technology deployment.

A core task of this research is to use empirical data, including policy documents, expert accounts or other, to uncover the structures and mechanisms that determine the trajectory of CCS. Epistemologically, critical realism is committed to science oriented towards the common good and emancipatory social change (Benton and Craib, 2001). It is “a core task of the social sciences to deliver social critique while envisioning a better world” (Buch-Hansen and Nesterova, 2021, p2). This involves uncovering the causal mechanisms that explain why things are the way they are, with the goal of informing praxis to improve them (Spash, 2012). Because knowledge is understood as context-dependent, abductive inquiry is a central methodological approach here (Vincent & O’Mahoney, 2018). Abduction involves iteratively moving between empirical observation, theory and literature to build plausible explanations for observed phenomena. Throughout my research papers and this Kappa, I have engaged in this iterative process to develop and refine my understanding of the mechanisms that shape CCS deployment.

Research Evolvement

I have not adhered to a rigid, pre-defined plan in my thesis. Instead, my research has evolved through a focus on diagnosing the problem, mirroring the critical realist task of moving from the empirical to the actual and ultimately to the real. This flexibility was necessary to properly diagnose the complex and often polarized problem space of CCS and to allow my research to be responsive to the emerging findings. The evolution of my research approach shows how each paper's findings generated new questions that compelled me to re-engage with theory and seek new empirical data, to progressively refine my understanding of the underlying structures shaping CCS deployment from national to supra-national imaginaries of the political economy of decarbonisation.

It started with a systematic literature review for paper 1. This review identified the dominant socio-technical imaginaries of CCS in Scandinavia since the Paris Agreement and provided the foundational understanding of the imaginaries driving the technology development that grounds my research. A key finding was the prominence of Norway, not just as a technical first-mover but concomitantly as the discursive/political and policy driver of the technology. Furthermore, considering the fossil fuel context of the technology's history and Norway's role as a fossil fuel benefactor, this made Norway an interesting exploratory case to understand the foundational imaginaries at play.

Drilling deeper, Paper 2 took on an explanatory approach by analysing Norwegian policy to understand how these imaginaries translate into governance. A key discovery was Norway's explicit framing of CCS as a technology for international transfer, not just or even primarily for domestic decarbonisation, in "Klimaloven", the Norwegian Climate Law (2021). This made me question the case of my research, as initially I thought the core focus would be on Norway - as I introduced in the background section, Norway has long been the "model" other countries look to for CCS development and an influential actor both for technological development as well as politically and in the policy sphere. But seeing the focus grounded in technological transfer creates a context where Norway is seen as the example for other petrostates while their CCS strategy essentially exports both the technology and its associated justice dilemmas to some extent. This led to Paper 2 becoming a two-case comparative study: comparing Brazilian and Norwegian policy documents and legislation on CCS in the context of the countries' climate and energy plans and how this relates to the equity principles guiding the UNFCCC. Note that in this kappa, I only draw on the findings from the Norwegian case.

As I am interested in contributing towards just outcomes, learning that Norway might not be the primary user of the technology inspired me to look at who then this could be, which shifted my focus from Norway as a self-contained case to Norway as more of a linchpin in a wider European system. Here, the European Union became an important focus due to e.g. how EU countries are the ones who have signed memorandums of understandings for the Norwegian CO_2 storage space and in turn became the main actor to deploy the technology. Importantly, Norway concomitantly develops capture projects in the Longship project, but the point is that the policy innovation and integration has moved to the EU level - and so my focus moved with it, since I am interested in understanding parameters for just deployment. Thus, Paper 3 aimed to understand two different things: first, does the EU policy framework understand and manage the risks associated with CCS deployment? And secondly, what exactly are these risks? For this paper I decided to do a cross-disciplinary systematic literature review to understand the environmental and social impacts across the entire CCS chain, to then be able to better understand whether the technology can contribute towards just outcomes in the current way it is being imagined and implemented in the EU's policy framework for CCS.

Lastly, Paper 4 then aimed to identify the constraints placed on the current imaginary of CCS deployment and look for ways that just outcomes can be reached by learning from CCS policy experts, policy makers, policy advisors and industry actors. Here, I wanted to understand the bottlenecks to deployment as experienced by the actors tasked with CCS deployment and draw out implied solutions to these bottlenecks from the answers they provide. I attended industry and policy-oriented workshops, seminars and conferences, and sought out the more "critical" voices in Brussels as interview participants to fill in the gaps. With this paper I aimed to delve deeper into the mechanisms at play in the real domain.

Consequently, the relevance and applicability of the findings generated in this thesis are contextual. Papers 1 and 2 are analyses of and for the Norwegian context, examining its domestic imaginaries, policy frameworks and its envisioned role as a technology exporter. The findings and justice implications discussed in these papers are primarily relevant for understanding and critiquing the trajectory of CCS in Norway and similar fossil-fuel based economies. In contrast, Papers 3 and 4 shift the analytical lens to the EU level. Their findings speak to supra-national policy architecture, governance challenges and strategic imaginaries shaping CCS deployment across EU member states. This is an important delineation since while Norway acts as a pioneering node within the broader European system, the political, regulatory and justice frameworks analysed in the latter half of the thesis are specific to the EU's unique multi-level governance structure but still relevant in other market-based climate policy jurisdictions.

Data Collection

Grounded in a critical realist philosophy and an abductive approach, the data collection for this thesis has been an iterative process of engaging with empirical data to uncover the underlying structures and mechanisms shaping CCS deployment. This abductive process involved gathering data from multiple sources to develop a nuanced understanding of the problem of CCS deployment. Each paper draws on distinct methods and data, with an overview provided in Table 3 for the approach taken per paper. A more detailed methodology can be found in each paper.

Paper 1

I started with a systematic literature review for Paper 1. This study covered 58 peer-reviewed research articles. Here, the aim was to map the empirical domain of expressed beliefs and assumptions, i.e. imaginaries, through a systematic literature search in Web of Science.

Paper 2

Paper 2 is a two-case comparative study, comparing Brazilian and Norwegian policy documents and legislation on CCS in the context of the countries' climate and energy plans. For Norway, I analysed 24 policy documents, legislations and regulations, several which were more than 200 pages long, to cover the full Norwegian policy landscape on CCS in the context of climate change mitigation, energy and industrial decarbonisation.

Paper 3

Paper 3 is a mixed-methods study, combining a cross-disciplinary systematic literature review on environmental and social impacts from CCS deployment with a comprehensive policy analysis, analysing the whole EU CCS framework. A deductive thematic analysis was used here, drawing out the main themes or categories of potential impacts from the data. This included 54 peer-reviewed research articles, as well as the most up-to-date IEAGHG R&D program reports to present the industry best standard of knowledge, and the five policy documents and legislations that currently make up the EU CCS policy framework (These are the CCS Directive, the TEN-E Regulation, the Industrial Carbon Management Strategy, the Net Zero Industrial Deal Act and the Clean Industrial Deal) against the backdrop of the European Green Deal.

Paper 4

Paper 4 entailed 13 semi-structured expert interviews (the interview guide can be found in Appendix I) and participant observations at 18 industry-related workshops and conferences, both in-person and online. The workshops and conferences ranged in length from one hour to two days and formed the majority of the data, where the interviews were mainly used to ask clarifying or deeper questions, sometimes with individuals who had presented or been a panellist at the conferences or workshops.

This multi-method approach ensures that my research does not rely on one single "slice" of data, but rather combines the analysis of texts, expert interviews and observation. By relying on different data for each paper I have attempted to provide a triangulation of findings to establish credibility and reduce potential biases that could come forth if I relied on fewer data sources (Bowen, 2009; Gorup, 2019). Furthermore, three out of four papers rely on document analysis, where I, the researcher, have no manner of influence on the raw data; these documents were readily available, and anyone could have read them. Only in the final paper did my presence in the field, through attending the workshops/conferences and conducting interviews, start to potentially impact the behaviours of the participants. By triangulating these findings and data sources I have aimed to develop a more complete picture to counter threats to trustworthiness based on researcher or respondent bias (Bowen, 2009; Gorup, 2019).

Table 3: Overview of data and method per paper, noting the primary jurisdictional focus of analysis (NO for Norway, EU for European Union).

Paper	Data	Method
Burying Problems? A systematic literature review of carbon capture and storage imaginaries in Scandinavia	Peer-reviewed, academic literature (*n=58)*	Systematic literature review
From the Rainforest to the Fjords: Examining equity in carbon capture and storage policy	Policy documents, legislations and regulations (*n=24/Norway, n=22/Brazil). NO*	Comparative two-country case study
Between Speed and Safeguards: Evaluating equity in the EU's Carbon Capture and Storage Policy Landscape	Peer-reviewed, academic literature (*n=54)* Policy documents (*n=5). EU*	Systematic literature review Thematic document analysis
Beyond Market Fixing: The role of the state in efficient and effective CCS Deployment	Expert interviews (*n=13)* Participant observation at industry and policy events (*n=18). EU*	Thematic Analysis

Thematic Analysis

A common methodology across my articles has been thematic analysis. Ahmed et al. explain the main goal of thematic analysis as one that identifies and interprets patterns and themes in data (2025), making it a theoretically flexible method that focuses on meaning, context and interpretation drawn from data (Byrne, 2022; Nowell et al., 2017). Within a critical realist framework, thematic analysis serves as a tool for abductive inquiry as the flexibility in the method enables the back-and-forth inference required. The knowledge produced from thematic analysis is not a positivist discovery of neutral facts waiting in the data, but a context-dependent, interpretive explanation of the social phenomena observed (T. Clark et al., 2021). The 'themes' are my own conceptualization of the salient patterns and mechanisms (in the critical realist sense) that explain the data. Replicability is not the goal here, since the focus lies on credibility and explanatory power: my aim is to understand better the current processes that determine just application of CCS technology, and to do that I need to understand the contents of the policy documents that are implementing the technology. My justice-centric focus acted as a guide in this process, where it oriented my attention towards patterns related to equity and justice. These patterns would naturally be less visible, if at all, to a researcher with another guide, for instance technical feasibility. The resulting findings are thus a theoretically informed interpretation that seeks to explain how and why certain narratives, omissions or contradictions exist in the CCS policy landscape, moving from the empirical in the documents and participant observations towards the actual and real in the underlying structures, i.e. imaginaries and political structures.

But what is a theme? Braun and Clarke put forth that a theme is a category of interest identified by the individual(s) doing the analysis. The theme relates to the research focus, builds on codes identified in transcripts and/or field notes, and essentially provides the researcher the basis for a theoretical understanding of their data (Braun & Clarke, 2006; Byrne, 2022). Themes are identified in the data by looking for repetitions, through typologies relevant to e.g. that particular field (which is how I learned that "leakage" from a geologists' perspective means that the CO_2 travelled outside the identified storage space – not that it leaked out and up into the atmosphere, as is commonly interpreted outside that field), metaphors and analogies (here a very good example is the "chicken-and-egg problem" which has come to gain a common understanding among most CCS actors), similarities and differences (Ryan & Bernard, 2003). "Repetition" is probably one of the most common ways, both within and across data sources, for identifying themes (T. Clark et al., 2021), but Bazeley (2013) argues that just because a code is repeated so many times that it becomes a theme is not enough. The themes that are identified need to also be relevant to the research being conducted, and it is up to the researcher to explain how and why the themes are significant, whether they relate to other literature and what their implications are (Bazeley, 2013).

Hence, I followed the below approach to thematic analysis, based mainly on Braun and Clarke (2006) and Byrne et al. (2022). The steps were not strictly followed in a linear sequence as an iterative process proved to be more helpful to ensure that important insights were not missed or drowned in overwhelm. Importantly, this also includes the writing step, which I attempted to do throughout. In any case, the steps to thematic analysis are as follows:

1. Familiarization with the Data: I started by reading parts of the material to become familiar with the content. This initial review helped identify preliminary ideas, patterns and meanings, and allowed for the recognition of any potential biases and assumptions within the data.
2. Generating initial codes: I then coded all the material to develop an understanding of the data. While systematic identification of codes was important, care was taken to avoid overcoding and inconsistency. For co-authored papers, codes were checked and discussed collaboratively to ensure consistency (Papers 1 and 2).
3. Searching for themes: Codes were elaborated into themes by looking for common elements and broader patterns to move beyond mere coding. It was important for me to reflect on how the theoretical framework influenced theme identification. For example, in Paper 4, some recurring themes were later dropped as they were not relevant to the specific research question (Bazeley, 2013).
4. Reviewing themes: Themes were reviewed to ensure each was coherent and consistent across the dataset (Ahmed et al., 2025). This involved revisiting the coded data and reflecting on the thematic structure to balance detail with over-refinement. Higher-order themes were evaluated and named, and sub-themes were identified where necessary, especially for instance for in Paper 2 where the higher-order themes were predetermined.
5. Defining and naming themes: Each theme was clearly defined and named. Possible links and connections between the themes were examined to finalize the thematic structure.
6. Producing the paper: The insights were written up, weaving the analytical process and findings into a coherent narrative.

All papers followed these steps to some extent, but differed most significantly in whether the themes were pre-determined or emergent. For paper 2, for example, the goal was to compare CCS policy to the equity principles in the UNFCCC. Consequently, those equity principles served as the pre-determined higher-order themes under which the data was coded. The analysis involved applying codes to these themes, identifying sub-themes and comparing similarities and differences across the two cases.

For Paper 3s and 4, however, the themes emerged from the data, guided by the justice-centric focus. In Paper 3, the research question concerned understanding negative impacts across the CCS technology chain. The communicated concerns from the literature for each technological step were coded; these codes were then grouped to form sub-themes. These sub-themes were subsequently organised into higher-order themes, namely health, storage and socio-economic equity, based on where the concerns were most relevant. The second methodological step was a policy analysis to examine whether these identified concerns were reflected in EU policy documents.

Lastly, for Paper 4, data from interviews and participant observation were treated equally, coded without assigning greater weight to one source over another, and used to develop emergent themes. In reporting the findings, however, the data sources were presented separately to highlight differences. This approach was taken largely to contrast the more critical perspectives of interview participants compared to those of the industry and policy actors that were observed. Here, too, the themes emerged from the data, focused on bottlenecks and opportunities to CCS deployment.

Positionality

My research is guided by a personal position that aligns with the action-oriented drive of sustainability studies, namely the goal of contributing to a "normative ethically justified utopia" (Spangenberg, 2011, p.275). Here, the "normative" prescribes how society ought to be; the ethical justification refers to how the proposed society is grounded in a specific theory of justice; and the utopia involves conceiving what this "good life" is. I have chosen this approach and this field of studies because it aligns with my own drive to contribute to just climate change mitigation because I believe this is the right thing to do.

It was important to me to integrate a justice lens in my research. Having a background in International Business Management I know how easy it is to simplify (complex) decisions to a number at the bottom of an Excel-document. I wanted to counter this by asserting that mitigating climate change is more than an economic problem; to be truly sustainable, climate action must also maintain critical social and environmental features (Gowdy, 2000, p. 28). Sometimes, that means that monetary returns may need to come secondary to social and environmental ones, to secure societal well-being and reduce inequality (Dietz and O´Neill, 2013). My goal is to unveil exploitative and unfair outcomes in a solutions-seeking manner. I have adopted a theoretical stance that enables me to act as a "critical friend" to CCS deployment, which is neither an uncritical advocate nor a blanket opponent, to promote constructive engagement across disciplines. This was motivated during a formative experience early in my research: At an "interdisciplinary" workshop on Iceland, where I was the only social scientist, a geologist asked me whether I was "for or against CCS". This question expressed a common assumption of dualism, and to some extent polarization, between the natural scientists who tend to lean "for" versus the social scientists who tend to lean "against". My answer - "it depends", has defined my approach. But this position also requires constant reflexivity; the balancing of an "insider's understanding" versus the outsider's critical distance and being careful that my analysis would not unconsciously adopt the dominant framings of the field. The justice and sustainability of CCS depend on the how, but to understand the how, interdisciplinary collaboration is important.

My Norwegian citizenship, language skills and cultural understanding perhaps enabled a more nuanced interpretation of the political debates and tacit assumptions within Norwegian CCS discourse, beyond the practicalities of being able to read policy documents and legal bills in Norwegian. I have also personally benefitted from, but also paid the price for a close connection with the fossil fuel industry, in that my late father worked in offshore oil both in Norway and abroad. This probably makes me more sympathetic to fossil fuel workers' fate, and resistant to pulling them all under one comb to complain about "the" fossil fuel industry's opposition to climate change mitigation, since I know that there are individuals there, too, that are positive to climate action, as is naturally also shown in literature (Halttunen et al., 2022). Lastly, I think it is important to state that I do wish CCS technology was not necessary at all – in the sense that I wish we were way ahead on our global course of climate action than where we are. I am wary of advocating for a technology that, if safeguards and limitations to its use are not implemented, could be used to expand the life of the fossil fuel industry, which needs to be transitioned away from as soon as possible as a key step to stop worsening the climate crisis (Narita, 2012; Ripple et al., 2024). I want it to be clear that my support of CCS technology hinges unquestionably on the nuance of how it is used. This multi-faceted positionality requires an ontological and epistemological framework that can handle nuance, complexity and context-dependent knowledge, which I have explained in this chapter on research design.

Ethical considerations

I declare no conflict of interest. I followed the good research practice guidelines of the Swedish Research Council (2024), which means that the research design was developed to ensure methodological rigour and ethical integrity. Paper 4 was subject to ethical review due to the possibility for revealing sensitive personal information in the interviews in relation to political opinions (as climate change could be argued to be considered a political issue), and the research plan developed to ensure ethical conduct was followed. This included a data management plan and ensuring prior informed consent to both conduct the respective interviews as well as to record them. All research data are stored in compliance with data protection regulations. The analysis and reporting of findings have been conducted with a commitment to honesty, transparency and accountability. Lastly, I have done my best to ensure proper citation of all sources and be clear about the research's boundaries and limitations.

Tools and Technologies

I acknowledge the use of AI large language models, specifically OpenAI's ChatGPT and DeepSeek's DeepSeek Chat, for proof reading and copy-editing parts of this thesis. I wrote my own text and used AI to improve the clarity of my writing, i.e. to edit and polish my language and as a conversational partner to brainstorm the logical flow of my arguments (For example, I would paste an excerpt of text I wrote and ask the AI what it understood the main argument of said text to be. This was done to ensure I communicate clearly what I wanted to communicate). It is important to underline that all ideas, theoretical frameworks, analytical conclusions and final interpretations are my own and all content used in this research were sourced and verified by me. Every piece of text the AI edited was critically reviewed and rewritten by me to ensure it reflected my intended meaning. In line with principles of academic integrity, I consider the AI a tool that helped me as a language editor and thinking aid, but the intellectual substance and accountability for this work are my own.

Limitations

My research has taken a particular look at CCS deployment through social science literature covering imaginaries, cosmopolitan climate justice and a critical approach to decarbonisation based on neoliberal market mechanisms, and is, as a natural result, limited to this perspective. A key limitation of this research concerns the scope of its empirical engagement with justice. While the thesis has rigorously analysed policy frameworks, expert interviews, industry perspectives and imaginaries, I have not done direct ethnographic fieldwork or participatory methods with communities that might in the future be directly affected by CCS infrastructure. As a consequence of this, my findings speak of the principles of justice and equity as they are encoded in governance systems rather than the lived experiences of injustice or inequity at the local level. This means I can identify the risk of distributive injustice near a capture plant or in the context of access to storage sites, but I am not able to document the nuanced, on-the-ground perception of that risk. Therefore, the "how" that is implicitly implied in my research question is addressed by critically analysing and proposing a reconfiguration of current governance frameworks to pre-empt and mitigate these risks based on cosmopolitan justice principles. This constitutes a critical and necessary step towards just outcomes, but future research should include to centre community voices to test and refine the principles proposed here.

Synthesis of Findings

The preceding chapters have presented the context, theoretical framework and research design of my thesis. In this chapter, I synthesize the findings from my papers to build the argument that CCS deployment is faltering on both effectiveness and justice grounds because it is trapped within a dominant techno-economic imaginary. This imaginary frames CCS as an inevitable, cost-optimising market solution despite lacking the required profit margin to make it appealing for private industry, while it systematically depoliticises decision-making and sets up fossil fuel incumbents as gatekeepers to CCS deployment.

I define this techno-economic imaginary by its collectively held vision that frames complex socio-political challenges in CCS policy and implementation as primarily technical and economic problems, presenting a specific and value-laden pathway as an objective and inevitable necessity (Paper 1). It operates by depoliticising and technifying decision-making, which shuts down debate about alternative futures that do not involve CCS (Papers 1 and 2). Concomitantly, the imaginary reduces moral questions of responsibility and equity to technical calculations of cost-efficiency. Framing CCS as a cost-effective mitigation tool masks the distributive justice question of who should pay for decarbonisation and who gets to use the infrastructure, substituting the "polluter pays" principle with a "polluter who can pay" approach, putting forth instead an inevitability of profit and cost-efficiency as the dominant criteria. This imaginary in essence depoliticises normative choices to make them seem like they are not choices at all, but rather rational, science-based and market-driven inevitabilities, entirely in line with a utilitarian approach.

It is perhaps unsurprising that this governance model is faltering, since there are several inconsistencies inherent to its imaginary. My work makes a contribution by identifying three inherent tensions within this imaginary to explain its failing trajectory. To present this argument, the structure of this chapter is aligned with the progression of my research questions. Each core tension I analyse corresponds to a step in building the overall argument, moving from diagnosing the problem to proposing a path forward. The first section, Depoliticisation, establishes the foundational problem identified. Here, I show how CCS is currently imagined and governed, answering SQ1: "How is CCS currently imagined and governed, and what are the justice implications of this dominant pathway?", detailing how justice and ethical considerations key to the Paris Agreement are marginalised in the current, dominant CCS imaginary.

The two following sections delve into the primary tensions that make the current pathway unsustainable. The section The Gatekeeper Problem outlines the tension created when entrusting the fossil fuel industry with building a transition technology, followed by the section on Why CCS Markets Fail on Scale and Justice which directly analyses the mismatch between the dominating neoliberal market logic and the public-good characteristics of CCS. Together, these sections answer the 2nd research question, why primary tensions between the current deployment and the achievement of climate justice goals are so persistent, and explain why the current deployment approach is faltering. Finally, the following chapter culminates in a synthesis of governance principles and state roles to answer my final question: "How can CCS deployment feasibly be aligned with climate justice objectives?", proposing a first suggestion for how to overcome the identified challenges.

Depoliticisation

"Cut emissions, not development"
Norwegian Climate Plan, 2022

The dominant vision of CCS is captured in statements framing it as an inevitable necessity, something we show in Paper 1. But this imaginary has hidden the politics of CCS deployment behind a techno-economic veil, which has turned ethical and political questions into technical and economic ones instead.

Mechanisms of Depoliticisation

My analysis across Papers 1 and 2 maps the mechanisms of depoliticisation, showing how scientific authority and economic framing work in tandem to obscure political choice. Depoliticisation, as defined by Flinders and Buller, refers to a governing strategy where political actors move decision-making away from the direct, visible sphere of elected politics and traditional accountability mechanisms (2006). It is not about the removal of politics, but about the concealment or displacement of decision-making. This is done by framing choices as technical, neutral or inevitable, often by moving them to the private sphere through marketisation (Flinders & Buller, 2006), as CCS exemplifies.

The depoliticisation of CCS deployment is operationalised through several key mechanisms, but first and foremost through "scientific authority", as demonstrated in Paper 1. Here, we found that the dominant imaginary relies on appeals to scientific bodies and authorities like the IPCC, the scientific body advising the UNFCCC, and the International Energy Agency to frame CCS as an indisputable and necessary climate solution. This appeal is used by governments in e.g. national climate plans as well as by industry actors and in public-private partnership communications (see e.g. (Klima- og Miljødepartement, 2021; Nordic Energy Research, 2021; OED, 2020). Paper 1 focused on the scientific literature through a systematic literature review. The technocratic language found in this context depoliticises the choice to pursue CCS by presenting it not as the value-laden political decision it is, but rather as a rational and science-based inevitability. This rational and science-based inevitability concomitantly sidelines debates about alternative futures.

Notably, this appeal to scientific authority for CCS is sometimes taken out of context. The IPCC WGIII's 6th assessment report found that deployment of bioenergy with carbon capture and storage (BECCS) and carbon dioxide removal (CDR) technologies "to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 or GHG emissions are to be achieved" (IPCC, 2022), which refers to removals, not necessarily CCS for emissions reductions. This narrative of necessity originates from the cost-optimization based modelling of Integrated Assessment Models (IAMs), which are structured to identify the least-cost pathways to climate targets (Forster et al., 2020; Rubiano Rivadeneira & Carton, 2022). This process is an example of rule-based depoliticisation, where complex political and ethical choices about the future are reduced to a technically-driven economic rule, i.e. cost-optimisation (Flinders & Buller, 2006). The prominence of CCS and BECCS increased when findings suggested their inclusion could reduce the total cost of meeting the Paris Agreements 2°C goal by approx. $22 trillion USD through 2100 (Davidson et al., 2017). Consequently, the cost-efficiency lens of IAMs has shaped the broader policy discourse and framed CCS as a cost-optimising necessity (Paper 1, van Beek et al., 2022; Forester et al., 2020).

The explicit aim of the dominant imaginary of CCS, identified in Paper 1, is achieving "massive emission cuts without transitioning the economy" (Røttereng, 2018), i.e. the imaginary we call "Greening the Industrial Regime". This framing depoliticises the roll-out of CCS by presenting the preservation of incumbent industrial and fossil interests as a neutral, common-sense goal, rather than a political choice that prioritises certain actors and sidelines alternative or more systemic change. This directly aligns with what Felli (2015) identifies as the core function of neoliberal depoliticisation, which is to ensure that environmental management does not raise political questions about what is produced, by whom and for whom, to protect existing structures of investment and production. If CCS is then not deployed, it functions as a powerful form of mitigation deterrence which is discursively delaying more radical action by creating an imaginary of systemic change as unnecessary.

In Paper 2, I moved on to analyse Norwegian policy documents to understand better how CCS is currently governed. Interestingly, Norway indirectly frames CCS as a tool that can "monetize climate action" and ensure "cost-efficient mitigation". This economic framing reduces the moral question of responsibility for emissions into a technical question of what the cheapest solution is. This utilitarian cost-benefit logic is operationalised in policy and justified under a sustainable development framing, exemplified by Norway's motto for the Longship CCS project that reads "cut emissions, not development", elegantly framing the concept of "sustainable development", one of the four climate justice principles applied in the UNFCCC, as a predominantly economic endeavour. This effectively sidelines the other climate justice principles and is consistent with broader literature criticising the inherent ambiguity of sustainable development, a concept that is malleable enough to support both weak and strong sustainability frameworks (Gowdy, 2000; Okereke, 2008; Spash, 2021). Considering that CCS embodies principles like green growth and the literal technological substitution of natural carbon cycles, it logically becomes a candidate for the weak sustainability interpretation.

These trends observed in Norwegian policy could to some extent be followed into EU policy. While the EU has established a comprehensive CCS governance framework and placed this within its broader climate and industrial policy, this framework itself enacts a form of depoliticisation. It does this by compartmentalising and fragmenting the questions of "why" and "how" of CCS deployment by breaking it down into isolated, manageable technical problems that obscure the cumulative impacts and risks of this deployment. On the one hand, this fragmentation creates an illusion of less complexity and makes CCS deployment appear more manageable, which might make deployment more attractive, but on the other hand it concomitantly obscures the cumulative socio-ecological impacts explored in Paper 3. This can be seen as a form of institutional depoliticisation, where the disaggregation of a complex political issue into isolated technical sub-problems is managed by delegated governance structures, moving the overall coordination and systemic knowledge away from democratic oversight (Flinders & Buller, 2006; Flinders & Wood, 2015). I argue that this depoliticising fragmentation, combined with the omnibus of speedy/deregulation for EU projects of common interest (among which are several CCS projects), creates a blind spot in that both the ultimate control regarding course of action and the CCS-system knowledge reside with the companies themselves. There is no political or public managerial entity overseeing the complex technological chain. But a key positive development came at the end of 2025 (post publication of Paper 3) with the renewal of the EU Innovation Fund by implementing the "Do No Significant Harm"-principle, which essentially is a stronger reference to environmental impacts which I highlighted in Paper 3 as missing from EU CCS policy infrastructure. If anything, this shows the timeliness of this research in the current context of policy development, and that there is still room to change the course of CCS rollout in the EU.

Justice Implications

A inconsistency lies at the heart of this depoliticising project: While the implementation of CCS policy is guided by a techno-economic paradigm, its justification often relies on the authority of the UNFCCC and the Paris Agreement, as seen above in relation to the "Scientific authority"-imaginary. The key here is that these regimes apply cosmopolitan climate justice principles (Lefstad & Paavola, 2023). Even though elements of cost-efficiency are present in the principles that guide action, e.g. in the UNFCCC's founding text (1992), the point is that action is not meant to be guided by cost efficiency only. The "techno-economic" imaginary depoliticises and reframes ethical questions as technical and inevitable questions of market efficiency and economic prioritisation, while it concomitantly relies on and obscures the justice concerns central to its claims of legitimacy.

The consequences of this depoliticisation are significant for the pursuit of just climate outcomes. Depoliticisation logic is acutely evident in climate policy, where market instruments are designed to implement the authority of market logic over democratically elected political decision-making (Felli, 2015). This can lead to a situation where "the social deliberation surrounding a political issue gradually erodes to the extent that it effectively becomes depoliticised in the sense that the existence of choices concerning that issue are no longer debated" (Harder, 1996, p. 42), a tendency we find in Paper 1. Perhaps the most concerning aspect of depoliticisation in this context is that by framing CCS as this comprehensive technical solution, the techno-economic imaginary actively limits the future by framing out alternative pathways (Paper 1).

The need for societal discussions about reducing consumption, planning within a carbon budget or transitioning away from certain industrial activities that might not be needed anymore (Brad et al., 2025), is marginalised since the climate crisis has been successfully framed as a simple problem of a CO_2 imbalance - with CCS technology as the suitable partial solution. By channelling debate through the technical frameworks of IAMs and the rhetorical frame of cost-efficiency, the political system is structured to prevent the question of alternative socio-ecological futures from gaining access to the decision-making arena (Felli, 2015; Prainsack, 2022). The injustice is not just a lack of discussion but a systematically engineered foreclosure of democratic debate. While the lack of debate to e.g. discuss avoid options in the broader emissions reductions discussion is pressing (Brad et al., 2025), at least in the EU, the EU Innovation Fund is only applicable to energy-intensive industries, renewable energy generation, energy storage, CCUS and Net-Zero mobility, buildings and technology manufacturing – voiding fossil power generation (EuroAccess, 2024). This means that the EU is hereby showing policy awareness of at least some justice risks inherent in the techno-economic imaginary linked to carbon lock-in and mitigation deterrence. This limiting of CCS funding applicability is more aligned with the principle of equitable need and climate value as communicated by the CCS Ladder (E3G & Bellona, 2023) than it would be if funding was also open to fossil fuel applications.

More broadly, at the core of the depoliticisation of CCS is a philosophical crash between paradigms. The current CCS approach is underpinned by a combination of libertarian and utilitarian justice principles. Libertarianism is focused on market-based processes, which are seen as inherently fair because they rest on the protection of property rights and the principle that individual effort and innovation should be rewarded. The moral appeal lies in the idea that in a well-functioning market, hard work leads to measurable reward and voluntary exchange benefits all parties, so its focus is on the justice of the process itself and not on redesigning specific outcomes (Boettke et al., 2017). Utilitarianism, on the other hand, does focus on outcomes: by calculating the right thing to do based on whatever will produce the best outcome overall (Sandel, 2008), which in the case of climate policy has become imagined to mean whatever outcome will be most cost-efficient based on IAM cost-optimisation (van Beek et al., 2022; Rubiano Rivadeneira & Carton, 2023). These two together then create a market-based cost-efficiency paradigm which is structurally incompatible with the cosmopolitan principles of climate justice that focus on outcomes as global equity, universal human rights and shared responsibility. This can be viewed as an outcome of strategic depoliticisation, in that the tools (IAMs and cost-optimisation) are designed to substitute political and ethical judgment in preference to technical and economic calculations (Flinders and Buller, 2006). This process renders cosmopolitan principles of equity, historical responsibility and need "non-decidable", i.e. that they are not included in the formal process of decision-making within the governing framework (Felli, 2015). This creates an internal inconsistency at the core of CCS' rollout due to the techno-economic imaginary's appeal to the scientific authority of the IPCC and to meeting the Paris Agreement, the latter which embeds exactly these cosmopolitan climate justice principles, but these climate justice principles do not fit within the utilitarian and libertarian paradigm under which CCS is currently imagined and governed because the cost-efficiency paradigm trumps other equity concerns. I find that the current market-centric framework depoliticises the rollout of CCS by design, with a few exceptions like the EU's exclusion of fossil power plants from CCS innovation funding, creating a system that provides little conceptual or procedural space for climate justice principles to be enacted. Even though fossil power plants are excluded from EU Innovation Funding, the next section outlines how the fossil fuel industry nevertheless have a central role in CCS deployment.

The Gatekeeper Problem

The development of CCS is structurally dependent on the fossil fuel industry, a dependency that is also wired into its governance. A key finding in my research is how the techno-economic imaginary structurally embeds a "gatekeeper" problem, where the fossil fuel industry, the industry with the greatest historical responsibility for the climate crisis, is positioned to control the infrastructure of one of its proposed solutions.

Mechanisms of Gatekeeping

This structural incumbency is a feature of the current governance model that is achieved through legislative alignment and control of existing infrastructure, with the foundational policies for CCS explicitly modelled on fossil fuel-extraction governance frameworks in both the EU and Norway. As Paper 2 highlights, Norway's CCS legislation is "deeply inspired by the Petroleum Act" (p.7), and the fossil industry's know-how is consistently framed as a "clear advantage" and a "natural candidate to lead" (p.9). Other examples include how storage sites are licensed with the same systems as have been used for decades for licensing of oil and gas fields – meaning if you are an oil and/or gas extractor, you have a competitive advantage over those without this experience to navigate the complex bureaucracy to obtaining exploration and exploitation-rights to CO_2 storage fields.

The legislative incumbency goes further, as the projects in Norway as well as the EU's emerging storage hubs are all led by major fossil fuel companies (Papers 2 and 3). This grants these actors a more de-facto "gatekeeper" role over the transport and storage of CO_2, which are segments in the CCS value chain with natural monopoly characteristics. A well-established oil and gas industry is put forth as a "pre-requisite" for storage development, which would ideally take advantage of existing infrastructure, geological know-how (Lane et al., 2021), and policy and legislative expertise (Paper 2). This deep dependency creates a critical vulnerability in that the way CCS deployment is contingent on continued interest and investment from the fossil fuel industry. Should this interest wane, e.g. due to shifting corporate priorities, low profitability or any other reason, the planned deployment may collapse as no other actors possess the concentrated capital, subsurface expertise and regulatory familiarity to serve as immediate substitutes. But this governance model also has several other potential flaws.

While policies like the storage obligation in the EU's Net Zero Industry Act represents a tentative step towards enforcing the polluter pays principle, a loophole remains. There are no mechanisms yet present to prevent the fossil fuel company that is developing a specific storage site from using all the storage capacity they develop for their own emissions, i.e. there are no mechanisms in place that regulate how the storage site can be used. One might argue that emissions would still be reduced and the same amount of CO_2 would still be stored, but this brings us back to the question of the climate value of the CCS technology deployed to each particular industrial process (E3G and Bellona, 2023): The climate value of CCS is not the same for every installation or industry. CCS applied to e.g. reducing emissions from fossil energy has much lower climate value and increases the energy penalty of the capture process significantly more than if CCS is applied to cement, where a higher percentage of the flue-gas is CO_2. Cement is considered a hard-to-abate industry with higher climate value of CCS application (Paper 3). Consequently, if the fossil fuel industry uses scarce CO_2 storage capacity mainly for its own emissions, it will be harder to decarbonise hard-to-abate industries as they will have less storage available to them. Critical access questions also extend to applications of CCS-based CDR activities, which may be important in the latter half of this century (IPCC, 2022).

The combination of this gatekeeper role and the natural monopoly characteristics of CO_2 storage creates a risk of unfair price-setting and restricted access. There are currently no mechanisms to cap the cost of utilizing CO_2 storage, but the current structure invites concern about the fossil fuel industry controlling the infrastructure as it will have both the incentive and the market power to set prices that maximize their own returns within the limits of what the market is willing to pay. Without regulatory safeguards, such as transparent cost-reporting or price controls as advocated for by some policymakers and industry actors (Paper 4), storage costs could be prohibitively high. This would effectively price out less profitable but perhaps more important hard-to-abate industries and turn the storage network into a bottleneck for private profit rather than a public good for climate change mitigation efforts.

The incumbent interest is to maintain high returns from core business activities (Newell, 2021), yet CCS, at best, represents an avoided cost with no significant profit margin (Paper 4) unless you are the monopoly owner of a storage site. This raises a question of whether the current governance framework for CCS is a self-defeating prophecy? A singular focus on cost is misaligned with CCS deployment and represents the need to discuss and plan decarbonization according to lowest external cumulative impacts and highest climate value.

Justice Implications

There are significant justice implications to the gatekeeper problem. First of all, the current deployment structure creates a moral dilemma where the primary contributors to the climate crisis are positioned to potentially profit from its solution, if it is successfully implemented. This creates a double-dividend: first from the sale of fossil fuels and then from the public funding and infrastructure control associated with CCS (Lenzi, 2021; Mintz-Woo & Lane, 2021). In essence, even though CCS is currently not profitable (Papers 2-4), the governance model is set up in a way that if it *becomes* profitable, this profit will go into the hands of the actors operating the technology, the fossil fuel industry, as I explain in Paper 3. This directly subverts the "polluter pays" principle and instead creates a system where the historical and continued polluters can become paid solution-providers.

This inversion of responsibility is embedded in the political project for CCS through the creation of a market for the technology. As shown in Papers 1 and 2 and evident in both Norwegian and EU policy frameworks, governments are pursuing CCS with the dual recognition that it requires substantial public funding to initiate but is then intended to become a competitive and self-sustaining market that can drive future deployment without state support. However, this market-creation model with its focus on competition risks undermining the system it seeks to build. Funding mechanisms like the EU's Innovation Fund, which is awarded based on effectiveness of greenhouse gas emissions avoidance, degree of innovation, project maturity, replicability and cost efficiency (EuroAccess, 2024), are often granted to the most resourceful actors (Paper 4). This not only risks "grandfathering" incumbents (Kartha et al., 2018) into the new system but can also foster a fragmented, project-by-project approach. For a technology that requires synchronised capture, transport and storage, this is quite a flaw since if multiple links in a single value chain must compete for the same funding independently, the failure of just one (e.g. capture without transport) could collapse the whole chain. Consequently, the strategic need for a synchronised system is at odds with a competitive funding model that grants support to individual actors. Norway countered this risk with the Longship pilot project by granting funding to the full-chain project (Paper 2), and Denmark is an example of an EU country which is also considering full-chain proposals as favourable when granting funding (Paper 4). These approaches acknowledge that for CCS to succeed, coordination must sometimes be prioritised over pure competition, but the current dominant model still reinforces the gatekeeper position of incumbent, resource-rich actors.

The industry promotes a narrative that justifies their privileged position. The debate I observed for Paper 4 showed how fossil fuel actors present themselves as mere service providers. Following this logic, the actual pollution takes place closer to the end-product and is thus the responsibility of the end-user, and would (at least partially) obliviate the fossil fuel industry from the historical interpretation of the polluter pays-principle as it would move to a "consumer pays" approach. This "consumer pays" narrative challenges the view that CCS is prohibitively expensive. An argument is emerging in literature that builds on the "consumer pays", where recent studies suggest that when the cost of CCS is distributed across the final product, for example as part of the construction cost of a bridge where CCS was used in cement production, the resulting price increase for the consumer is minimal (Roussanaly et al., 2025; Subraveti et al., 2023). This narrative could help build traction for CCS deployment if developers can operationalise the sharing of costs in that way. At the same time, this reframing of costs opens a deeper debate about responsibility and climate accountability: if the polluter should pay, who is the polluter? Is it the producer, and if so, at which stage in the value chain, or is it the final consumer (Kantikar et al., 2024)? This question of accountability is central to climate justice questions, as the prevailing method of calculating emissions at the national level is based on territorial production which might create a dual injustice by unfairly assigning emission burdens to producer nations while enabling wealthy consumer nations to externalise costs (Muttitt and Kartha, 2020), a point we exemplify in Paper 2. The legal landscape is beginning to engage with this complexity, as exemplified by the 2025 ruling by the EU Human Rights Court which stated that Norway must assess the Scope 3 emissions (the emissions from the actual burning of extracted oil and gas, not previously assessed as most is exported) in environmental impact assessments and climate impact for new fossil fuel projects (Cunningham, 2025). This formally links producer responsibility to downstream emissions and could incentivise the cost-distribution calculations that make CCS viable.

The gatekeeper-problem presents policymakers with an ethical and strategic dilemma. It places control over a key climate solution in the hands of an industry with a well-documented history of funding climate disinformation and opposing climate action (Franta, 2022; Herranen, 2023; Kinol et al., 2025; Roberts et al., 2025), creating the possibility for a conflict of interest. Yet, the current model's deep structural dependency suggests that without this industry's involvement, large-scale CCS deployment may not materialise at all.

Why CCS Markets Fail on Scale and Justice

"If it ain't profitable, it ain't doable"
Industry Conference Participant

In the third and final theme of findings, I present a critique of the prevailing market-centric model of CCS deployment, where I argue that the failure to deploy CCS is a logical and direct outcome of applying neoliberal governance to a technology with the material characteristics of CCS. To understand this model's logics and shortcomings, I first shortly recall the neoliberal ideology that shapes contemporary climate governance, introduced in the theoretical framework: Neoliberal ideology asserts the superiority of market mechanisms and private enterprise in solving problems, including public problems like climate change. In practice, it means climate policy largely becomes a process of "marketisation", where the state's primary role is to create and regulate markets, such as with carbon pricing through the EU ETS, which incentivize private sector-led decarbonisation (Ciplet & Roberts, 2017; Lohmann, 2012). Marketisation is, as we saw above, a central strategy in depoliticisation since it removes the need for public debate on decision-making (Felli, 2015). This model is intrinsically ill-suited to manage a technology with the complex characteristics of CCS, as demonstrated by the failures to achieve both scale and justice as I argue in this thesis. The logic is succinctly captured by an industry expert at a conference: “If it ain’t profitable, it ain’t doable”. This profit motive creates a contradiction in that it renders rapid, large-scale deployment of CCS contingent on a profitable business case – that does not yet exist.

Mechanisms of the Market-logic Undermining Scale

At the heart of CCS policy stands a rather stark contradiction. As Papers 1 and 2 show, there is widespread acknowledgement that CCS requires “massive mobilization of public/private partnerships” and “large-scale public funding” – whilst the technology is simultaneously framed as a “cost-efficient market solution” (Quotes from Paper 1). This sets up a deployment model where the state socialises the risks and costs, coming in to de-risk investments and develop a market through policy incentives and regulation, creating a system where if there is any profit then private actors are positioned to capture it. Even though the private actors have also entered their CCS endeavours with substantial capital, which they want returned since “we are looking for returns, we are not a philanthropic organisation” (Quote from an industry conference, Paper 4), nevertheless the state in question has usually invested significantly more and might not see any financial returns on these investments (Mazzucato, 2013). This division of labour is a political-economic choice that embodies the neoliberal preference for market-led solutions, where the state sets the decarbonisation target and the rules of the game, but the “doing” is delegated to the market (Lohmann, 2008; Mazzucato, 2013).

The point is that this model has until now failed to deliver the required scale of CCS deployment, achieving only a small fraction of the capacity needed for net-zero targets by 2030 and 2050 (IEA, 2024). CCS looks hard to come by at the necessary scale to meet net-zero and the Paris Agreement emission reductions targets at least until either the CO_2 price overtakes the CCS price or governments are ready with massive, continuous subsidies (Kern et al., 2016; Scott et al., 2013) for as long as CCS deployment is driven by a profit motive. This flaw stems, at least in part, from a narrow “market fixer” and “de-risker” role applied to the state. Intervention is only justified to correct “market failures” and otherwise the state should preferably leave the market alone to do what it does best, namely, to achieve efficient and optimal outcomes (Mirowski, 2013). But the material characteristics of CCS as a high-risk, capital-intensive technology, which also is lacking a pre-existing market (Kern et al., 2016), and its successful deployment would furthermore benefit the public beyond what the private sector would be able to capture as everyone, globally, would gain a safer living environment from the mitigation of climate change. On top, add the natural monopolistic characteristics for storage and transport infrastructure, as identified in Paper 3. These conditions combined are building a case for the state to take a more active role (Mazzucato, 2013; Vogel, 2018).

Yet, in the case of Norway, the state made their involvement in the first full-chain CCS pilot-project, Longship, perfectly clear; from the get-go it was communicated that the state would provide funding for phase 1 of the Longship project, which ran until 2025. The state had identified 6 goals with the Longship project: to demonstrate whole chain CCS at acceptable costs, show that CCS is possible and safe, establish transport and storage infrastructure, contribute to CCS cost, prove the technology, and help create a CO_2 market (Wettestad et al., 2024). In short, the goal of the state was purely to demonstrate that full-chain CCS is possible. That means for phase 2 and beyond, Longship and CCS in general is expected to rely on the market, which the government has helped fund and set up. But, as I discuss in Paper 4, the market is still not profitable. Longship might still be successful since the CO_2 storage capacity of Phase 2 is more or less sold out for the next 10 years according to their website and since the state was the main funder of the capital costs (Wettestad et al., 2024). But what happens next? And is this enough to develop a bigger market with more actors? It seems that the state of Norway has stopped just before the last step of sustained, strategic direction, which it has in common with the EU which also falls short of taking that visionary role with clear directionality that Mazzucato proposes (2013).

The current market model has so far not only failed to deploy CCS technology to the scale that would be needed for timely meeting the Paris Agreement (Kazlou et al., 2024) but has also in a sense marketized justice by turning what could be considered a moral obligation into a commodity. This commodification stems from the prevailing policy imaginary that frames CO_2 storage as a market good, risking a system of "luxury" decarbonisation where storage is allocated to the highest bidder rather than according to climate justice principles (Shue, 1999, 2018, 2019), as argued in Paper 3. A justice- and climate value aligned approach would instead ask who most urgently need storage and allocate this scarce resource to plan for equitable outcomes. However, the EU's vision of a "single market for CO_2", despite aiming to operate with "fair, open and non-discriminatory conditions", ultimately allocates this public good on the ability to pay as current policies do not make judgements on the CO_2 source to qualify for storage. While this aligns with libertarian, process-focused principles of justice, it risks allowing sectors with deeper pockets to outbid those sectors that are hardest to abate. Consequently, as I argue in Paper 3, CCS may be deployed where it is most profitable and not where it is most morally urgent and has the most climate value.

The Current Role of the State

In this current model the state has a very specific role, namely to de-risk the technology to create the conditions for profitability for private actors. This embodies the “de-risking state” role, where the state absorbs financial risk to encourage private investment, but potentially lacking an independent, strategic vision (Collington, 2015; Mazzucato, 2013). This is especially the case in the EU[2], which is constrained by institutional commitments to neoliberalism (Beckert, 2020; Jessop, 2002). These constraints include policies towards “technology neutralism”, meaning that the EU should not “pick winners” among technologies but rather let different decarbonisation technologies compete in the market, creating market-oriented steering mechanisms where essentially the EU steers towards the net-zero goal through climate policy, but does not tell member states what to do, as my findings from Papers 3 and 4 show and which align with previous literature (Collington, 2025; Dupont et al., 2024; Hunt & Tilsted, 2024; Jessop, 2002).

This constrained, de-risking role of what governing bodies should do has a direct and critical implication, in general, in that it does not connect the provision of public support to the enforcement or realisation of public good conditions (Mazzucato, 2013). In particular, it means the state assumes risk to make CCS investable, but its neoliberal institutional framework stops it from attaching strong, strategic obligations to that support to ensure that it serves the broader public good. If there are no strong obligations or conditions to ensure the public support given to CCS companies serves the public good – i.e., decarbonisation of hard-to-abate industries with the highest climate value, then this arrangement would not only be unfair but also undermine the effectiveness of CCS as a climate tool. Without such conditions, the technology might then be deployed where it is most profitable and most convenient for private actors, for example on concentrated industrial clusters with high-purity CO_2 streams such as coal and gas to liquids (for example for gasoline, diesel and jet fuel conversion) and natural gas processing, which is significantly cheaper compared to capture from low-purity streams like pulp and paper, cement and iron or steel (5-6$/t CO_2 captured vs 50-75$/t CO2 captured at 90% capture rate, respectively (Hughes & Zoelle, 2023)). This would be the predictable outcome of a system that funds technology up to market-readiness but does not direct its use. Though as shown in Paper 3, the EU has placed some limitations on where EU CCS funding can be used, which excludes e.g. natural gas facilities, but these limitations have not been placed on who can obtain CO_2 storage space. The Norwegian Longship project has sold out its storage capacity for Phase 1, but they have not presented conditions for only selling storage space to hard-to-abate sectors or otherwise. Such potential for misallocation of storage space would mean CCS fails to address the emissions that have been identified as having the highest climate value for CCS deployment (E3G & Bellona, 2023), a implication that could also extend into the CDR-realm in that the growing need for CDR might suffer from lack of available CO_2 storage space or also be priced out.

[2] Recognising that the EU is not ”a” state but a supranational state entity

Justice Implications

The justice implications of this market-centric model are systemic and severe, rooted in the political-economy ideology that structures it. As introduced in the theoretical framework, the analysis of states and markets is inherently a study of justice, as it involves choosing “one way of life over another, and one set of values placed above its rivals” (Paul & Amawi, 2013, p.8). This is an ethical choice that reflects a clash between competing philosophical traditions of justice as introduced in the sub section on justice in the theory chapter. The hegemonic “market imaginary” (Jasanoff and Kim, 2013; Lee and LiPuma, 2002) that underpins CCS policy, a core element of neoliberal environmental governance (Ciplet & Roberts, 2017), structurally subordinates the “citizen-state” imaginary responsible for ensuring public welfare and equity (Lee and LiPuma, 2002). This reflects the broader trajectory of climate governance noted by scholars, as while the Paris Agreement includes cosmopolitan justice principles, its mechanisms took a more “neoliberal turn”, becoming “largely indicative of a process of marketization” (Ciplet & Roberts, 2017, p.153). This divergence between cosmopolitan ends and market-centric means creates the core justice dilemma for CCS.

The market model operationalizes a specific and quite narrow conception of justice. By treating CO_2 storage as a commodity to be traded on a “single market for CO_2”, it prioritizes a combination of libertarian and utilitarian justice. The focus on process (a “free” market) and cost-efficiency embodies libertarian ideals that centre market freedom and utilitarian calculations that maximize overall welfare (Okereke, 2008; Sandel, 2010). This is the logical endpoint of Bakker’s (2005) definition of neoliberal environmentalism as solving problems “through privatization, commercialization and commodification of natural resources”. What happens then is that the polluter pays principle rather becomes a pay-to-pollute system, if adhered to, which when applied to CO_2 storage sets up a system where more wealthy polluters can secure a limited public good (Grubert & Talati, 2024), while sectors with higher climate value on the CCS ladder could be priced out. This privileges “ability to pay” over principles of need, a key principle under the Paris Agreement, and could lead to a direct distributive justice failure. As already mentioned, the risk is “luxury” decarbonisation (Shue, 2019), where CCS is deployed for profitable emissions in sectors with alternatives, hijacking scarce storage from “necessary” emissions in hard-to-abate industries aligned with climate value and the CCS ladder. This marketisation of a moral obligation aligns with a core neoliberal tenet. As Mirowski observes, under this logic, “social justice is blind because it remains forever cut off from the wisdom of the market” (Mirowski, 2013, p.63). The outcome is a system where profit dictates decarbonisation access.

This flawed allocation stems directly from the state’s prescribed role within the neoliberal framework. The state acts as a “market fixer” and “de-risker”, creating the conditions for a market but refusing to pick winners or direct outcomes based on a strategic vision for the public good (Mazzucato, 2013; Collington, 2025, and discussed above), enforcing the rules of a libertarian process but abdicating the cosmopolitan principles signed on to in the Paris Agreement to ensure equitable outcomes. To correct this would require governance aligned with a cosmopolitan compass. One approach could be to align storage access with a tool like the CCS Ladder (E3G and Bellona, 2023), which would prioritise storage for high climate value installations and enable plan for equitable allocation from the outset. This would represent a move from "market fixing" to what Vogel calls "marketcraft" (2018), in essence actively crafting governance to direct markets toward public goals and just outcomes.

However, implications of the market-based model for justice extend beyond the point of flawed allocation and into the threat of non-deployment. As Ciplet and Roberts ask, "can neoliberal governance be effective and equitable?" (2017, p.154). My findings suggest it may fail on both. The primary barrier to scaling this technology is considered to be economic, i.e. the absence of a profitable business case. For-profit firms, compelled by a financial gain imperative (Hinton, 2020), face high upfront costs, long payback periods and profit uncertainty in CCS endeavours, but are nevertheless considered the main actors, in partnership with the state, to deploy CCS. This embodies the paradox of the neoliberal state, in that it must be strong enough to construct and de-risk the market but is ideologically prohibited from steering it toward specific (just) outcomes (Bonefeld, 2015; Mirowski, 2013).

From a business perspective, CCS deployment does not create a new product or a new business model, meaning CCS would not be necessary was it not for e.g. a climate law dictating a certain amount of emissions reductions by X year. At best, CCS represents an avoided cost if carbon prices surpass the cost of CCS deployment. This creates a structural reliance on high carbon prices or continuous subsidies to achieve viability, and this dependency subjects the pace and scale of a critical climate solution to the volatile logic of profitability and private investment cycles. The market, in the neoliberal view, is trusted to "find its own way to the ultimate solution", as "the final arbiter of truth is the market" (Mirowski, 2013, p.338). Yet, this faith is misplaced for a technology that exhibits classic market failures including high social returns and natural monopoly characteristics, which the market alone appears structurally incapable of resolving at the required pace for Paris Agreement compliance.

The consequence is a dangerously slow rate of deployment. While research on feasible deployment-rates for CCS put forth that CCS could reach 0.37GtCO_2 by 2030 if the failure of projects is halved, which would be lower than required for the 1.5°C pathway but on track or even succeeding the need for the 2°C pathway. Staying on the 2°C track would require that in "2030-2040 CCS accelerates at least as fast as wind power did in the 2000s, and that after 2040, it grows faster than nuclear power did in the 1970s to 1980s" (Kazlou et al., 2024, p.1047). This is quite a task for a technology that still lacks profitability. This risk of failure to deploy at the necessary speed and scale constitutes a profound intergenerational justice issue as it places an increasingly greater burden of emissions reduction and the escalating costs of climate adaptation onto future generations. In essence, the market-centric model for CCS governance, shaped by neoliberal ideology, is holding the technology's potential hostage. The profit logic does not appear able to summon the necessary speed or equity, which is building the case for reimagining the state's role from a passive market enabler to that of a more active, entrepreneurial and justice-driven market crafter.

Framing a New Imaginary for the Way Forward

The previous sections diagnosed a governance model dominated by a techno-economic imaginary which sidelines the climate justice principles of the Paris Agreement. The techno-economic imaginary with its mechanisms of depoliticisation, structural incumbency and market logic is not aligned with the material realities and ethical imperatives of CCS, since a) it lacks structures to take just outcomes into account and b) the CCS business model has so far not been strong enough to warrant scaling up for private industry. I argue that the path forward requires a re-imagining of CCS governance, since the goal as established earlier is to deploy the technology at a scale meaningful for just climate change mitigation. This necessitates a process of strategic repoliticisation to deliberatively reverse the depoliticisation strategies identified by Flinders and Buller (2006) and Felli (2015). This would entail moving decisions back from technical bodies to democratic oversight and replacing narrow cost-efficiency calculations with broader public deliberation about values and trade-offs. Here I draw primarily on the empirical findings of Papers 3 and 4 and posit a suggestion for a path forward aimed at achieving two simultaneous goals: 1) to break the current impasse in CCS deployment, and 2) to align CCS deployment with climate justice objectives. This re-imagining is a first step to resonate with Ciplet and Roberts' vision of a non-neoliberal governance model, which would be "mandatory based on ideals of fairness" (2017, p.155), and answers Felli's (2015) call to make foundational political questions explicitly decidable and central to climate governance.

A Public Coordinator for CCS Deployment

The current governance model entrenches depoliticisation through institutional delegation to market actors (Flinders & Buller, 2006). Institutional repoliticisation is required to invert the neoliberal logic, where instead of insulating deployment choices from political accountability to protect investor freedom, the mandate would be to explicitly subject the choices of which emissions are captured, from whom and for whose benefit to democratic oversight and justice-based criteria.

As discussed above, in Paper 2 and in literature (e.g. Lane et al., 2021), the fossil fuel industry is naturally placed to lead CCS deployment because of their know-how of the regulations, infrastructure and the underground where CO_2 is to be stored. However, the fossil fuel industry is currently not planning to decrease production of fossil fuels – in Norway, for example, fossil fuel extraction is imagined to continue for a long time yet (Klima- og Miljødepartement, 2023). This may create an incentive to use CCS to decarbonise ongoing fossil fuel power operations rather than prioritising its application for harder-to-abate sectors. As the industry is also positioned as the default market provider, this conflict of interest warrants placing the coordination and organisation of the CCS chain in a separate, public entity. A public coordinator could be put in place to oversee and manage the CCS chain.

The public CCS network coordinator could function as a central, state-mandated coordinator. This model acknowledges a key lesson from the history of technological development, in that the development and deployment of big scale, complex technologies, such as nuclear power - that also require planning over long time-scales and have a vulnerability from public acceptance, "resulted from direct management by national governments through programmes lasting several decades" (Scott et al., 2013, p.110). Similarly, a public coordinator for CCS would act as the counterparty for emitters, transporters and storage operators and directly solves both the "chicken-and-egg" problem as well as the cross-chain (investment) risks. It can do that by aggregating demand, planning infrastructure and buffering cumulative, systemic risks that individual actors do not have the structures to identify or manage themselves, and as such could simultaneously generate public trust. The "chicken-and-egg" problem can be explained as those with a suitable hard-to-abate industrial plant are reluctant to invest in capture technology to retrofit their plant if storage space cannot be guaranteed, and likewise those developing transport and storage infrastructure are reluctant to do this without knowing that they will have captured CO_2 to transport and store. This is a key concern expressed by most actors involved in CCS development and is explored in Paper 4. A central coordinator would be more able to take a birds-eye view on deployment beyond singular projects to link storage providers with emitters and ensure compliance with all applicable regulations, as well as take steps to limit negative cumulative impacts across and beyond the chain. A key limitation identified in Paper 3 is the fragmentation in EU CCS policy in that it is project based and not full chain-based, and while the EU Innovation Fund has since implemented more stringent "Do No Significant Harm" rules (European Commission, 2025b) the cumulative oversight remains missing.

Industry actors themselves have called for a central coordinator for the CCS value chain to overcome the uncertainty and de-risking needs that currently paralyse investment (Paper 4). Two EU policy frameworks, the TEN-E Regulation and the "Projects of Common Interest", are stepping-stones but as of yet based on individual proposals and not wider coordination. The key difference I propose here is to mandate that this coordinator operates not as a neutral market facilitator, which would perpetuate depoliticisation by rule and cost-optimisation, but as a vehicle for the active political realisation of cosmopolitan climate justice principles. Its role would be to make these principles "decidable" (Felli, 2015) by creating the administrative and procedural mechanisms to implement them, essentially replacing the rule of cost-efficiency with rules of equity and need. By being explicitly tasked with this as a mission, the public coordinator would be taking steps towards filling the visualisation-role proposed for an entrepreneurial state (Mazzucato, 2013) and "marketcrafting" (Vogel, 2018). In theory, there is no limit to how far the coordinators' role could go. It may even be extended to operating or even owning transport infrastructure and storage sites, the segments in the CCS value chain with natural monopoly characteristics, and coordinating public funding as it would ensure that one entity is responsible for the full technology chain, thus increasing stability and planning-capacity of both public and private actors. This could make investment by private capital more appealing and as such help scale CCS at speed while concomitantly maintaining safeguards.

The set-up of such a coordinator could draw inspiration from the Norwegian "*Gassnova"*. Gassnova started as a subsidiary organisation under the Ministry for Petroleum and Energy in 2005 before being established in 2007 as an official state-owned company (Wettestad et al., 2024). It has since played an important coordinating role for Norwegian CCS endeavours. In the context of the Longship project, Gassnova was the primary initiator, coordinator and driver (Wettestad et al., 2024). This reflects a broader national Norwegian imaginary where CCS is framed as a core responsibility of the state, embedded in a project narrative that generates public legitimacy (Buhr and Hansson, 2011). Within this frame, the claimed benefits of CCS including technology exports and, in the past, CO_2-free domestic power, are to some extent understood as public goods that justify and sustain state leadership (Buhr and Hansson, 2011). Gassnova initiated talks to engage private industry, delivered feasibility studies and coordinated the efforts that then became the successful Longship project (Gassnova, N.D.).

Reorganising and expanding the task of a Gassnova-like organisation might help CCS deployment go from the current Phase 3 with pilot projects towards a Phase 4 of larger-scale deployment since it would enable cooperation, rather than competition, across the value chain. The current approach where companies across different sections in the CCS chain, e.g. one storage developer and one capture project, often compete for the same public funds (European Commission, 2025a), is a bottleneck for CCS deployment. The capture project needs the storage developer and vice versa, but what may happen is that only one of the projects receives public funding. The current set up in EU funding creates competition between projects that would benefit from cooperation. CCS projects could have a positive interdependence where if one project achieves their goal, another project would also be positively affected. The projects in a CCS value chain are not independent of each other and should be treated as interdependent for more effective deployment, cooperation (Deutsch, 1973), and ultimately meeting of climate goals. The lack of coordination in relation to EU industrial policy was acknowledged in the so-called "Draghi Report" (European Commission, 2024a), but the public coordinator may enable this cooperation.

To fulfil this de-risking and coordinating function effectively, the coordinator must have a clear mandate to operationalise and deploy CCS for just climate change mitigation. This mandate is critical because it orients the fundamental purpose of the coordinating body. As McCulloch and Ridley-Duff (2019) argue, the key importance to achieving social missions is for the organisation to have a purpose and a mandate to achieve that purpose. Unlike a for-profit entity, which by nature must prioritise generating financial return for shareholders and will feel pressure to choose a profitable outcome over a just one when those paths diverge, a not-for-profit or public body exists mainly to fulfil a mission (Hinton, 2020; Robinson, 2023). This structural difference makes it easier to pursue climate justice as decisions can be guided by mission and values rather than the "bottom line" (Brower & Shrader, 2000). A public CCS coordinator could therefore accept lower rates of return (e.g. 2-3% versus the 8-12% expected by private capital (Paper 4)), making technically and socially preferable projects more feasible. As Hall and Millo demonstrate in their analysis of social return on investment, the value of a public enterprise is not captured by its profitability (or lack thereof) alone (2018). Rather, its contribution lies in the broader social, environmental and strategic goods it delivers, which in the case of CCS refers to climate change mitigation and the realisation of climate justice principles. By reframing CCS from a "money making machine" to a form of "waste management" for the public good (Paper 4), a mission-oriented, not-for-profit approach could provide the necessary foundation for building climate justice into the fabric of deployment.

A mission-oriented, not-for-profit approach taken by the CCS coordinator moves toward a governance model that would "incorporate logics of legitimacy not reductive to managerial quantified and market-based measures, but be built with procedural justice" (Ciplet and Roberts, 2017, p.155). Research would need to look in more depth into how this coordinator should be organised, who should control it, how it should be set up; a subsidiary per region or country, with the overarching coordination happening at an aggregate level, for example? What rate of transport and storage capacity makes sense to reserve for higher climate value emissions versus be competitively available? In any case, it must have a mandate to work towards the Paris Agreement emission reduction in general, and equity principles in particular e.g. where access is naturally limited.

Prioritising Climate Value over Profit

Another core task for a reimagined CCS deployment model and a distinct function of the public coordinator is to resolve the question of allocation. I identified this as a bottleneck to just deployment in Paper 3, because of the combination of the fossil fuel industry holding the gatekeeper-role and the natural monopoly characteristics of CO_2 transport and storage infrastructure. This, I argue, can lead to unfair price-setting and/or lack of access to the storage sites by hard-to-abate industries where CCS-use is identified to have high(er) climate value in comparison to e.g. CCS on fossil fuel power stations (Paper 3). This need for access will also extend, increasingly, to negative emission-storage from BECCS, DACCS, etc., towards the latter half of this century if we continue to exceed the Paris Agreement temperature limits (IPCC, 2022). The market-centric model has demonstrably failed to deliver scale, and a market-driven approach to storage access might disadvantage sectors with higher climate value if they are economically disadvantaged in comparison to those with lower climate value – as briefly discussed above, the cost of CO_2 capture is higher if the CO_2 concentration in the fluegas is lower, since more energy will be needed to clean the fluegas to the same 90% (Hughes and Zoelle, 2023). The fluegases with the higher CO_2 concentration include coal and gas to liquids – low CCS climate value sectors, in comparison with low purity fluegases in e.g. pulp and paper (for BECCS) and cement, which would be high climate value sectors (E3G & Bellona, 2023; Hughes & Zoelle, 2023). To what extent 100% capture rates are desirable depends on the increased energy penalty and the source of energy input, which needs to be considered at each individual installation.

Unlike a market model that would allocate based on ability to pay, risking a system of luxury decarbonisation (Shue, 2019), a justice-oriented framework must ensure that allocation of access to critical infrastructure with natural monopoly characteristics is based on climate value calculations. Transcending this logic requires replacing market allocation with justice-based prioritisation, an approach that would help "privilege distributive and non-libertarian ideals of justice", a key element of the non-neoliberal model (Ciplet and Roberts, 2017, p.155). A public coordinator, as proposed above, would be the entity mandated to implement this principle. While this may not be applicable in Phase 3 as the focus there should be on building up of capacity, the public coordinator I envision must have a climate justice and climate value mandate where the aim is to operationalise and deploy CCS technology for climate change mitigation for Phase 4 or as soon as demand exceeds supply.

One important step is to improve, nationally contextualise and implement tools like the CCS Ladder into regulation to ensure that CO_2 transport and storage, which have naturally limited accessibility because there are only so many $MtCO_2$ that can run through the infrastructure per day/month/year, is reserved on a climate-value basis. This includes first of all for hard-to-abate industries with no (currently) viable alternatives, which later on makes space for CO_2 from CDR activities according to the growing need from this sector (Wettestad et al., 2024). Any *excess* capacity (which could arise for example from the need to keep injection pressure stable (Lane et al., 2021)) could be sold to the highest bidder in the market to help fund and build out infrastructure capacity and ensure a steady injection stream into the storage site, making the most effective use of the infrastructure. Operationally, the revenues from more profitable parts of the chain that could still be subject to competition can be used by the coordinator to subsidise access for less profitable but essential industries and regions, which can prevent a situation where only the wealthiest actors can afford to decarbonise. This pools resources and risks to ensure that the costs of decarbonisation are distributed according to capacity to act and pay, which are key equity principles in the UNFCCC. By separating the logic of allocation from pure market dynamics, this approach seeks to ensure CCS is deployed where it is most morally urgent and has the most climate value.

The Broader Context

The governance challenges for CCS identified in this thesis are not isolated. They interact with other interrelated global challenges, including a geopolitical tension emerging where climate action, framed as a matter of survival for humanity (Calvin et al., 2023; UNSDG, 2023), clashes with economic and energy security interests. Nations like Qatar and the USA are challenging EU's climate measures and human rights laws (Halabi, 2025), the two key things I have tried to highlight as critical steps in the right direction towards just climate change mitigation. This underscores how decarbonisation pathways are contested terrains where short-term competitiveness trumps the cooperative, long-term focus needed for climate governance. The need for cooperation is so important that it even received its own Sustainable Development Goal; goal 17, "Partnership for the goals" (UNSDG, 2023). The accelerating physical reality of the climate crisis, as detailed by the IEA's most recent, sobering scenarios where all three exceed 1.5°C warming by 2030 (International Energy Agency, 2025), creates an urgent imperative for rapid, large-scale deployment of all available mitigation tools, including CCS and the CDR technologies it enables. But this urgency exists in tension with the prevailing global, and European, climate governance paradigm that privileges market-based, competitive approaches over the coordinated, mission-oriented state leadership that history shows is necessary for mobilising complex technological systems at pace and scale (Ciplet & Roberts, 2017; Mazzucato, 2013; M. Schreurs, 2024; Scott et al., 2013).

This need for strategic coordination extends to the alternatives to CCS as well. On the CCS Ladder, the first question is: are there alternatives? For fossil power generation, renewable electricity is the most obvious one. But the scale-up of renewables and electrification itself faces geopolitical and material constraints, including a fragile supply chain for critical minerals (Schreurs, 2024, 2023). China dominates with 70% of the global capacity on critical minerals, with an additional layer of complexity added as most of these are subject to export controls (International Energy Agency, 2025). CCS technology needs to be seen as one component in a complex net-zero portfolio, as decisions need to be taken in ways that combine climate action, geopolitical considerations and energy security and sufficiency (Vogel et al., 2021). It is important that (climate) justice principles do not get lost in this equation, which highlights the critical role for a public coordinator with a climate justice mandate.

Consequently, my proposal to shift from a market-commodity to a public-good model, steered by a public coordinator, is a proposal aimed towards achieving just and effective CCS. But this has implications that go beyond European industrial policy since it speaks directly to the core question of how societies organise to tackle crises. The proposed model of a public coordinator, tasked with strategic planning, de-risking investment and ensuring equitable access based on climate value, offers a proposal for a way to transcend the "chicken-and-egg" paralysis that plagues CCS but probably also other networked and capital-intensive climate infrastructures. By foregrounding climate justice and the need for strategic direction, this framework aligns with the cooperative spirit of SDG 17 and provides a counter-narrative to other competitive imaginaries of the net-zero transition.

Limitations

This research has several important limitations. First, my empirical scope is deliberately focused on the EU and Norwegian contexts, and as such the findings are not readily generalisable to regions with different political economies of energy and climate governance even if the cosmopolitan climate justice framework would still apply in countries that are Paris Agreement signatories. Secondly, the methodological reliance on policy documents, literature reviews, expert interviews and participant observations, which provided a clear understanding of what the problem is understood to be in these contexts and how the governance structure of CCS functions, does not capture the lived experiences or justice perceptions of communities living with the direct impact of CCS infrastructure. These lived experiences are, however, not readily available as CCS is not yet deployed at large scale. Furthermore, some of the concepts in this justice framework, especially "*sustainable development"*, is subject to vast critique due to its ambivalent definition. This is hence another limitation of this research as I have not engaged with this critique and instead used the "Our common future" definition given in this text. The cosmopolitan justice framework has furthermore, naturally, shaped my interpretation of the data. Another justice lens would have shed a different light and brought other issues to the fore, for instance sovereignty over land use for CO_2 storage or the Sami peoples' opposition to the build-out of wind parks in Northern Norway as a result of Equinor's opposition to building out CCS at Melkøya. These have not fallen within the scope of my research but not for lack of relevance. Lastly, my research captures a specific moment in "Phase 3" of CCS development. This context is rapidly evolving, especially in relation to geopolitics and energy security crises with resulting policy shifts. I nevertheless hope the climate justice lens applied here maintains relevance for as long as climate action is needed.

Future Research

A core focus of this thesis has been to explore whether the way CCS is currently rolled out in Europe is aligned with climate justice principles. One aspect of just roll-out relates to where the technology is applied and that this should primarily be in hard-to-abate industries. Here, the attempt to define who or what *qualifies* as hard-to-abate in the context of CCS has not been in focus and I have instead used E3G and Bellona's CCS Ladder to understand the methodology of where CCS can contribute (the most) climate value. Helping to refine and establish a peer-reviewed "CCS Ladder" or similar tool for European deployment would hence be an important future research task.

Furthermore, new actors are beginning to shape the governance landscape and warrant scholarly attention. Specialised start-ups in capture technology and new entrants in the transport segment, for instance, as well as AI developments, may challenge incumbent dominance or introduce new governance dynamics that I have not analysed here. Future research should examine whether and how emerging actors and trends might alter the political economy of CCS deployment and whether they could serve as vehicles for more just outcomes.

The geographical scope of my research also invites extension. China has become the region with the most rapid growth in CCS deployment (Global CCS Institute, 2025), yet its political system and governance logic differ markedly from the European context analysed here. While policy models naturally cannot be directly transplanted, there may nevertheless be valuable lessons to be learned from China's approach to scaling the technology. Comparative research may identify governance principles that transcend political systems and could contribute to more effective and equitable deployment globally.

In this thesis, I have referred to the "fossil fuel industry" as one actor and highlighted that if the fossil fuel industry loses interest in CCS, then the know-how they bring might not be readily available for CCS deployment. This approach made sense for the purpose and context of my research, but as Nawaz et al. point out, the knowledge of the fossil fuel industry is embodied in the *workers* of the fossil fuel industry

(2024). Future research should investigate how to utilise the expert knowledge these workers have. This could possibly be extended into exploring whether CCS could enable a just transition of fossil fuel industry-workers (Halttunen et al., 2022; Swennenhuis et al., 2020) to becoming CCS workers.

Naturally, the public coordinator model proposed in this thesis opens multiple avenues for further inquiry. While I have argued for its potential to align CCS with climate justice principles and scale deployment, the specific legal, financial and political mechanisms required for its establishment remain to be specified. Future research could explore how such an entity would be designed, what powers it would need, how it would be held accountable and what institutional barriers might impede or help its realisation in different national contexts.

Finally, the question of cost-sharing and emission responsibility warrants mention. This thesis has touched upon the distributive implications of allocating CCS costs and the unresolved question of whether responsibility lies with producers or consumers, particularly in relation to Scope 3 emissions. Recent legal developments like the 2025 ruling by the EU Human Rights Court on scope 3 assessments in Norway suggest this is an evolving area. Future research should examine how evolving legal norms around supply chain responsibility might reshape the political economy of CCS and whether new accountability mechanisms could help operationalise the polluter pays principle in ways that current governance models do not.

Conclusion

This thesis began by recognising that Carbon Capture and Storage (CCS) has moved from being a speculative and contested tool on the periphery of climate change mitigation discussions to having a central role in official Net Zero strategies. The signing of the Paris Agreement and the subsequent binding climate laws in Europe have created a new, urgent reality in that CCS is now a matter of "how", no longer "if". My research is situated in the gap between the established, critical perspectives on CCS and this newly urgent, policy-driven rollout. Adopting the stance of a critical friend to CCS deployment, I have not asked whether CCS should exist but rather how its deployment can be governed to align with the climate justice principles embedded in the agreements that now mandate decarbonisation.

This inquiry has been guided by a set of frameworks. The concept of imaginaries has helped me diagnose the dominant vision behind the perceived need for CCS in the first place, cosmopolitan climate justice has enabled the evaluation of its moral direction, and lastly the political economy of decarbonisation set the framework to analyse the governance structures that bring this imaginary to life. Through an analysis of Norwegian and European Union policy architecture, this theoretical trinity has shown how the current dominant pathway for CCS is governed by a techno-economic imaginary that frames the technology primarily as a cost-efficient market commodity. This imaginary of CCS, I have argued, operates by depoliticising fundamental choices about our industrial future, entrusting the fossil fuel industry with a gatekeeper role and constructing market models that have so far failed to deliver the necessary scale or safeguard equitable outcomes. In essence, the current governance model has produced what can be understood as the *CCS Show Pony*.

A show pony's purpose is to perform. The CCS Show Pony has performed in policy arenas and model scenarios, become a way for industry to demonstrate their commitment to a Net Zero world and showing technical feasibility, with projects like Sleipner and Longship proving that capture and storage could work. Its prominence in IPCC reports and Integrated Assessment Models showcased its theoretical cost-efficiency, arguing for and cementing its place in climate change mitigation portfolios. And this performance has been important; it has spurred political will, secured a place for CCS in critical legislations like the EU's Net Zero Industry Act and mobilised an expert ecosystem of researchers, engineers and policymakers. To extend the metaphor, the CCS Show Pony has won the show.

Decades of research, trial and error have proven that the technology is worthy of our attention, because it can capture, transport and store CO_2 emissions safely in geological formations, preventing their release into the atmosphere. But the show pony, even if it has been a successful show pony, is not built for the plough. The show pony requires very specific conditions to show off its (limited) talent.

My findings indicate that CCS must now transition from being a show pony to becoming a working horse to pull the plough. The performance phase of the show pony has largely been achieved in proving feasibility, securing political buy-in, setting up policy frameworks and the beginning of support structures. What now needs to happen is deployment at scale, but this is a task of unglamorous work; planning interconnected infrastructure, managing scarce storage resources justly, mitigating cumulative environmental risks, ensuring costs and benefits are borne fairly, etc. This is work for a dependable, purposeful and justice-oriented governance system that won't turn its hooves up if the profit margin drops too low. The current market-commodity model with its reliance on profitability and competitive bidding is ill-suited to this task. As my research shows, it creates a "chicken-and-egg" bottleneck that leaves strategic planning to the mercy of private investors. If it gets deployed at all, we risk allocating scarce storage to the highest bidders rather than to the emissions with the highest climate value, which down the line could impede the deployment of negative emissions technologies whose implementation will be extremely important to return from climatic overshoot.

To make CCS an effective working horse for climate mitigation, we need to consciously shift from treating CCS as a market commodity to stewarding it as a public good. My proposed reimagined path forward suggests a governance framework to take the technology from the current Phase 3 (where Phase 1 was first-of-a-kind projects, Phase 2 largely characterised by applying it to the wrong projects, i.e. fossil power installations, and now Phase 3 is the post-Paris hard-to-abate application but still very small scale) to large-scale, targeted, Phase 4 deployment. Phase 3 scaling up could already be supported by and benefit from elements of this new imaginary. The first step is to create a public coordinator where the state evolves from its current role as a passive "de-risker" of private investment to becoming an active coordinator, which may extend to owning the segments of the CCS chain with natural monopoly characteristics. This body would be tasked with planning the integrated CO_2 transport and storage networks, aggregating demand, buffering cross-chain investment risks, solving coordination failures, providing certainty to investors and communities and in general holding the reins of the system. The second step is to allocate storage space (or injection capacity, to be accurate) by climate value, where the public coordinator operates within an explicit climate justice mandate. This means allocating access to the infrastructure with characteristics of natural monopolies not by ability to pay but by applying tools like the CCS Ladder to ensure that capacity is prioritised for hard-to-abate industrial process emissions before being allocated to sectors with alternative decarbonisation pathways. The just deployment mandate can be implemented when demand starts to exceed availability, creating a tiered implementation of the suggestions presented here.

I am making this argument in a spirit of appreciation. The CCS Show Pony has played an important role: it has captured our imagination, demonstrated potential and now brought the global CCS industry to this point where government feasibility studies are starting to point in a positive direction. It is important to honour this contribution while simultaneously recognising that the task now at hand is different, requiring the resilience of the working horse to put in the heavy grinding labour for larger-scale decarbonisation. In this thesis I have sought to provide the constructive principles for this next phase. By diagnosing the justice deficits of the dominant imaginary and proposing an alternative anchored in public stewardship and cosmopolitan justice, I have attempted to contribute a moral governance compass for CCS in Phase 4. Phase 4 should be the phase of just, scaled and targeted deployment. The climate crisis is a serious threat to the quality of life as we know it and we need every tool we have, but used with purpose that goes beyond private profitmaking. And if deployed in the right way, CCS will have a part to play.

References

Abdulla, A., Hanna, R., Schell, K. R., Babacan, O., & Victor, D. G. (2021). Explaining successful and failed investments in U.S. carbon capture and storage using empirical and expert assessments. *Environmental Research Letters*, *16*(1), 014036. https://doi.org/10.1088/1748-9326/abd19e

Adger, W. N., Benjaminsen, T. A., Brown, K., & Svarstad, H. (2001). Advancing a Political Ecology of Global Environmental Discourses. *Development and Change*, *32*(4), 681–715. https://doi.org/10.1111/1467-7660.00222

Ahmed, S. K., Mohammed, R. A., Nashwan, A. J., Ibrahim, R. H., Abdalla, A. Q., M. Ameen, B. M., & Khdhir, R. M. (2025). Using thematic analysis in qualitative research. *Journal of Medicine, Surgery, and Public Health*, *6*, 100198. https://doi.org/10.1016/j.glmedi.2025.100198

Allinson, W. G. . G., Cinar, Y. ., Neal, P. R. . R., Kaldi, J. ., & Paterson, L. . (2014). CO2-Storage Capacity—Combining Geology, Engineering and Economics. *SPE Economics & Management*, *6*(01), 15–27. https://doi.org/10.2118/133804-PA

Aminu, M. D., Nabavi, S. A., Rochelle, C. A., & Manovic, V. (2017). A review of developments in carbon dioxide storage. *Applied Energy*, *208*, 1389–1419. https://doi.org/10.1016/j.apenergy.2017.09.015

Anderson, K., Broderick, J. F., & Stoddard, I. (2020). A factor of two: How the mitigation plans of 'climate progressive' nations fall far short of Paris-compliant pathways. *Climate Policy*, *20*(10), 1290–1304. https://doi.org/10.1080/14693062.2020.1728209

Anker, P. (2018). A pioneer country? A history of Norwegian climate politics. *Climatic Change*, *151*(1), 29–41. https://doi.org/10.1007/s10584-016-1653-x

Anttonen, & Meagher. (2013). Mapping Marketisation: Concepts and Goals. In *Marketisation in Nordic eldercare: A research report on legislation, oversight, extent and consequences* (pp. 13–21). Department of Social Work, Stockholm University.

Arbeids- og sosialdepartementet. (2020). *Forskrift om sikkerhet og arbeidsmiljø ved transport og injeksjon av CO2 på kontinentalsokkelen*. https://lovdata.no/static/lovtidend/ltavd1/2020/sf-20200225-0186.pdf

Arlota, C., & Costa, H. K. D. M. (2021). Climate change, Carbon Capture and Storage (CCS), energy transition, and justice: Where we are now, and where are (should be) we headed? In *Carbon Capture and Storage in International Energy Policy and Law* (pp. 385–393). Elsevier. https://doi.org/10.1016/B978-0-323-85250-0.00019-0

Asara, V., Otero, I., Demaria, F., & Corbera, E. (2015). Socially sustainable degrowth as a social–ecological transformation: Repoliticizing sustainability. *Sustainability Science*, *10*(3), 375–384. https://doi.org/10.1007/s11625-015-0321-9

Aune, F. R., Gaure, S., Golombek, R., Greaker, M., Kittelsen, S. A. C., & Ma, L. (2022). Promoting CCS in Europe: A Case for Green Strategic Trade Policy? *The Energy Journal*, *43*(6), 71–102. https://doi.org/10.5547/01956574.43.6.faun

Bacilieri, A., Black, R., & Way, R. (2023). *Assessing the relative costs of high-CCS and low-CCS pathways to 1.5 degrees*. Oxford University. https://www.smithschool.ox.ac.uk/sites/default/files/2023-12/Assessing-the-relative-costs-of-high-CCS-and-low-CCS-pathways-to-1-5-degrees.pdf

Bäckstrand, K., Meadowcroft, J., & Oppenheimer, M. (2011). The politics and policy of carbon capture and storage: Framing an emergent technology. *Global Environmental Change*, *21*(2), 275–281. https://doi.org/10.1016/j.gloenvcha.2011.03.008

Beck, S., Jasanoff, S., Stirling, A., & Polzin, C. (2021). The governance of sociotechnical transformations to sustainability. *Current Opinion in Environmental Sustainability*, *49*, 143–152. https://doi.org/10.1016/j.cosust.2021.04.010

Beck, S., & Oomen, J. (2021). Imagining the corridor of climate mitigation – What is at stake in IPCC's politics of anticipation? *Environmental Science & Policy*, *123*, 169–178. https://doi.org/10.1016/j.envsci.2021.05.011

Beckert, J. (2020). The exhausted futures of neoliberalism: From promissory legitimacy to social anomy. *Journal of Cultural Economy*, *13*(3), 318–330. https://doi.org/10.1080/17530350.2019.1574867

Benton, T., & Craib, I. (2001). *Philosophy of social science: The philosophical foundations of social though*. Palgrave.

Biermann, F., & Kalfagianni, A. (2020). Planetary justice: A research framework. *Earth System Governance*, *6*, 100049. https://doi.org/10.1016/j.esg.2020.100049

Bjerketvedt, V. S., Tomasgard, A., & Roussanaly, S. (2020). Optimal design and cost of ship-based CO2 transport under uncertainties and fluctuations. *International Journal of Greenhouse Gas Control*, *103*, 103190. https://doi.org/10.1016/j.ijggc.2020.103190

Boettke, P. J., Coyne, C. J., & Storr, V. H. (Eds.). (2017). *Interdisciplinary studies of the market order: New applications of market process theory*. Rowman & Littlefield International.

Böhringer, C. (2013). *Two Decades of European Climate Policy:* (21).

Bonefeld, W. (2015). Crisis, Free Economy and Strong State: On Ordoliberalism. *European Review of International Studies*, *2*(3), 16–26. https://doi.org/10.3224/eris.v2i3.23445

Boucher, O., Forster, P. M., Gruber, N., Ha-Duong, M., Lawrence, M. G., Lenton, T. M., Maas, A., & Vaughan, N. E. (2014). Rethinking climate engineering categorization in the context of climate change mitigation and adaptation. *WIREs Climate Change*, *5*(1), 23–35. https://doi.org/10.1002/wcc.261

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, *9*(2), 27–40. https://doi.org/10.3316/QRJ0902027

Brad, A., Schneider, E., Dorninger, C., Haas, W., Hirt, C., Wiedenhofer, D., & Gingrich, S. (2025). *Existing demand-side climate change mitigation policies neglect avoid options*. In Review. https://doi.org/10.21203/rs.3.rs-5998199/v1

Brandl, P., Bui, M., Hallett, J. P., & Mac Dowell, N. (2021). Beyond 90% capture: Possible, but at what cost? *International Journal of Greenhouse Gas Control*, *105*, 103239. https://doi.org/10.1016/j.ijggc.2020.103239

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bretter, C., & Schulz, F. (2024). Public support for decarbonization policies in the UK: Exploring regional variations and policy instruments. *Climate Policy*, *24*(1), 117–137. https://doi.org/10.1080/14693062.2023.2273302

Brower, H. H., & Shrader, C. B. (2000). Moral Reasoning and Ethical Climate: Not-for-Profit vs. For-Profit Boards of Directors. *Journal of Business Ethics*, *26*(2), 147–167. https://doi.org/10.1023/A:1006150115975

Buch-Hansen, H., & Nesterova, I. (2021). Towards a science of deep transformations: Initiating a dialogue between degrowth and critical realism. *Ecological Economics*, *190*, 107188. https://doi.org/10.1016/j.ecolecon.2021.107188

Buck, H. J. (2021). Social science for the next decade of carbon capture and storage. *The Electricity Journal*, *34*(7), 107003. https://doi.org/10.1016/j.tej.2021.107003

Buhr, K., & Hansson, A. (2011). Capturing the stories of corporations: A comparison of media debates on carbon capture and storage in Norway and Sweden. *Global Environmental Change*, *21*(2), 336–345. https://doi.org/10.1016/j.gloenvcha.2011.01.021

Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, *56*(3), 1391–1412. https://doi.org/10.1007/s11135-021-01182-y

Calel, R., Dechezleprêtre, A., & Venmans, F. (2025). Policing carbon markets. *Climate Policy*, 1–19. https://doi.org/10.1080/14693062.2025.2464699

Calhoun, C. (2002). Imagining Solidarity: Cosmopolitanism, Constitutional Patriotism, and the Public Sphere. *Public Culture*, *14*(1), 147–171. https://doi.org/10.1215/08992363-14-1-147

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W. L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., … Péan, C. (with Lee, H.). (2023). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland.* (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Caney, S. (2001). International Distributive Justice. *Political Studies*, *49*, 974–997. https://doi.org/doi.org/10.1111/1467-9248.00351

Caney, S. (2014). Two Kinds of Climate Justice: Avoiding Harm and Sharing Burdens. *Journal of Political Philosophy*, *22*(2), 125–149. https://doi.org/10.1111/jopp.12030

Carton, W. (2019). "Fixing" Climate Change by Mortgaging the Future: Negative Emissions, Spatiotemporal Fixes, and the Political Economy of Delay. *Antipode*, *51*(3), 750–769. https://doi.org/10.1111/anti.12532

Castoriadis, C. (1997). *The Castoriadis reader*. Blackwell Publishers.

Celia, M. A., Bachu, S., Nordbotten, J. M., & Bandilla, K. W. (2015). Status of CO $_2$ storage in deep saline aquifers with emphasis on modeling approaches and practical simulations: STATUS OF CO $_2$ STORAGE IN DEEP SALINE AQUIFERS. *Water Resources Research*, *51*(9), 6846–6892. https://doi.org/10.1002/2015WR017609

Ciplet, D., & Roberts, J. T. (2017). Climate change and the transition to neoliberal environmental governance. *Global Environmental Change*, *46*, 148–156. https://doi.org/10.1016/j.gloenvcha.2017.09.003

Clapp, J., & Dauvergne, P. (2011). Peril or Prosperity? Mapping Worldviews of Global Environmental Change. In *Paths to a Green World* (pp. 1–18). The MIT Press. https://doi.org/10.7551/mitpress/5265.003.0005

Clark, T., Foster, L., Sloan, L., & Bryman, A. (2021). *Bryman's Social Research Methods* (6th ed.). Oxford University Press.

Clark, V. R., & Herzog, H. J. (2014). Can "stranded" Fossil Fuel Reserves Drive CCS Deployment? *Energy Procedia*, *63*, 7261–7271. https://doi.org/10.1016/j.egypro.2014.11.762

Coleman, J. W., & Taylor, C. (2024). *Carbon Capture and Storage: The Key to a Net-Zero Economy*. SSRN. https://doi.org/10.2139/ssrn.4876707

Collington, R. (2025). The limits to derisked decarbonization: State capacity unevenness in domestic green transition strategies. *Review of International Political Economy*, 1–24. https://doi.org/10.1080/09692290.2025.2505785

Connolly, S., & Cusco, L. (2007). *HAZARDS FROM HIGH PRESSURE CARBON DIOXIDE RELEASES DURING CARBON DIOXIDE SEQUESTRATION PROCESSES*. (153).

Cook, K. S., & Hegtvedt, K. A. (1983). Distributive Justice, Equity, and Equality. *Annual Review of Sociology*, *9*(1), 217–241. https://doi.org/10.1146/annurev.so.09.080183.001245

Corry & Riesch. (2012). Beyond "for or against": Environmental NGO-evaluations of CCS as a climate change solution. In *Social Dynamics of Carbon Capture and Storage* (pp. 91–109). Routledge.

Costanza, R., Cumberland, J., Daly, H., Goodland, R., & Norgaard, R. (1997). *An Introduction to Ecological Economics*.

Crespy, A., & Munta, M. (2023). Lost in transition? Social justice and the politics of the EU green transition. *Transfer: European Review of Labour and Research*, *29*(2), 235–251. https://doi.org/10.1177/10242589231173072

Cuéllar-Franca, R. M., & Azapagic, A. (2015). Carbon capture, storage and utilisation technologies: A critical analysis and comparison of their life cycle environmental impacts. *Journal of CO2 Utilization*, *9*, 82–102. https://doi.org/10.1016/j.jcou.2014.12.001

Cunningham. (2025, November 14). European Court says Norway must fully account for oil and gas emissions. *Gas Outlook*. https://gasoutlook.com/analysis/european-court-says-norway-must-fully-account-for-oil-and-gas-emissions/#:~:text=The%20European%20Court%20of%20Human%20Rights%20technically%20ruled%20in%20favour,ruling%20makes%20a%20procedural%20argument.

Daly, H. E. (1992). Allocation, distribution, and scale: Towards an economics that is efficient, just, and sustainable. *Ecological Economics*, *6*(3), 185–193. https://doi.org/10.1016/0921-8009(92)90024-M

Damen, K., Faaij, A., & Turkenburg, W. (2006). Health, Safety and Environmental Risks of Underground Co2 Storage – Overview of Mechanisms and Current Knowledge. *Climatic Change*, *74*(1–3), 289–318. https://doi.org/10.1007/s10584-005-0425-9

Davidson, C. L., Dahowski, R. T., McJeon, H. C., Clarke, L. E., Iyer, G. C., & Muratori, M. (2017). The Value of CCS under Current Policy Scenarios: NDCs and Beyond. *Energy Procedia*, *114*, 7521–7527. https://doi.org/10.1016/j.egypro.2017.03.1885

Det Kongelige Olje- og Energydepartement. (2023, June 28). *Godkjenning av nye prosjekter på norsk sokkel* [Pressemelding]. regjeringen.no. Regjeringen.no. https://www.regjeringen.no/no/aktuelt/godkjenning-av-nye-prosjekter-pa-norsk-sokkel/id2987131/

Deutsch, M. (1973). Cooperation and Competition. In P. T. Coleman (Ed.), *Conflict, Interdependence, and Justice* (pp. 23–40). Springer New York. https://doi.org/10.1007/978-1-4419-9994-8_2

Dooley, K., Holz, C., Kartha, S., Klinsky, S., Roberts, J. T., Shue, H., Winkler, H., Athanasiou, T., Caney, S., Cripps, E., Dubash, N. K., Hall, G., Harris, P. G., Lahn, B., Moellendorf, D., Müller, B., Sagar, A., & Singer, P. (2021). Ethical choices behind quantifications of fair contributions under the Paris Agreement. *Nature Climate Change*, *11*(4), 300–305. https://doi.org/10.1038/s41558-021-01015-8

Dupont, C., Moore, B., Boasson, E. L., Gravey, V., Jordan, A., Kivimaa, P., Kulovesi, K., Kuzemko, C., Oberthür, S., Panchuk, D., Rosamond, J., Torney, D., Tosun, J., & Von Homeyer, I. (2024). Three decades of EU climate policy: Racing toward climate neutrality? *WIREs Climate Change*, *15*(1), e863. https://doi.org/10.1002/wcc.863

E3G, & Bellona. (2023, July 5). *Carbon capture and storage ladder*. E3G. https://www.e3g.org/publications/carbon-capture-and-storage-ladder/

EuroAccess. (2024). *Innovation Fund 2024: Net-Zero Technologies*. European Commission, Strasbourg. https://www.euro-access.eu/en/calls/1721/Innovation-Fund-2024-Net-Zero-Technologies--General-decarbonisation--Medium-Scale-Projects

European Commission (Ed.). (2024a). *The future of European competitiveness: Part A: A competitiveness strategy for Europe*. Publications Office. https://doi.org/10.2872/1823372

European Commission. (2024b). *The Net-Zero Industry Act Explained*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en

European Commission. (2025a). Competitive bidding [European Commission]. *Competitive Bidding, a Tool for Funding Innovative Low-Carbon Technologies under the Innovation Fund*. https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/competitive-bidding_en

European Commission. (2025b). What is the Innovation Fund? [European Commission]. *Energy, Climate Change, Environment*. https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/what-innovation-fund_en#what-is-being-funded-and-how

Faber, L., Busch, H., & Lefstad, L. (2025). A Trojan horse for climate policy: Assessing carbon lock-ins through the Carbon Capture and Storage-Hydrogen-Nexus in Europe. *Energy Research & Social Science*, *120*, 103881. https://doi.org/10.1016/j.erss.2024.103881

Felli, R. (2015). Environment, not planning: The neoliberal depoliticisation of environmental policy by means of emissions trading. *Environmental Politics*, *24*(5), 641–660. https://doi.org/10.1080/09644016.2015.1051323

Finney, K. N., Akram, M., Diego, M. E., Yang, X., & Pourkashanian, M. (2019). Carbon capture technologies. In *Bioenergy with Carbon Capture and Storage* (pp. 15–45). Elsevier. https://doi.org/10.1016/B978-0-12-816229-3.00002-8

Flinders, M., & Buller, J. (2006). Depoliticisation: Principles, Tactics and Tools. *British Politics*, *1*(3), 293–318. https://doi.org/10.1057/palgrave.bp.4200016

Flinders, M., & Wood, M. (Eds.). (2015). *Tracing the political: Depoliticisation, governance and the state*. Policy Press.

Forster, J., Vaughan, N. E., Gough, C., Lorenzoni, I., & Chilvers, J. (2020). Mapping feasibilities of greenhouse gas removal: Key issues, gaps and opening up assessments. *Global Environmental Change*, *63*, 102073. https://doi.org/10.1016/j.gloenvcha.2020.102073

Franta, B. (2022). Weaponizing economics: Big Oil, economic consultants, and climate policy delay. *Environmental Politics*, *31*(4), 555–575. https://doi.org/10.1080/09644016.2021.1947636

Fraser. (2010a). *Scales of Justice*. Columbia University Press.

Fraser, N. (2010b). Who Counts? Dilemmas of Justice in a Postwestphalian World. *Antipode*, *41*, 281–297. https://doi.org/10.1111/j.1467-8330.2009.00726.x

Fridahl, M., & Lehtveer, M. (2018). Bioenergy with carbon capture and storage (BECCS): Global potential, investment preferences, and deployment barriers. *Energy Research & Social Science*, *42*, 155–165. https://doi.org/10.1016/j.erss.2018.03.019

Friedman, M. (Ed.). (1980). The Distribution of Income. In *Justice: Alternative political perspectives* (1st ed., pp. 140–148). Wadsworth Pub. Co.

Fuss, S., Canadell, J. G., Peters, G. P., Tavoni, M., Andrew, R. M., Ciais, P., Jackson, R. B., Jones, C. D., Kraxner, F., Nakicenovic, N., Le Quéré, C., Raupach, M. R., Sharifi, A., Smith, P., & Yamagata, Y. (2014). Betting on negative emissions. *Nature Climate Change*, *4*(10), 850–853. https://doi.org/10.1038/nclimate2392

Gidden, M. J., Joshi, S., Armitage, J. J., Christ, A.-B., Boettcher, M., Brutschin, E., Köberle, A. C., Riahi, K., Schellnhuber, H. J., Schleussner, C.-F., & Rogelj, J. (2025). A prudent planetary limit for geologic carbon storage. *Nature*, *645*(8079), 124–132. https://doi.org/10.1038/s41586-025-09423-y

Global CCS Institute. (2024). *Global Status report 2024*. Global CCS Institute. https://www.globalccsinstitute.com/wp-content/uploads/2024/10/2024-GSR_20241015.pdf

Gorup, M. (2019). Ethics of Discourse Analysis. In R. Iphofen (Ed.), *Handbook of Research Ethics and Scientific Integrity* (pp. 1–22). Springer International Publishing. https://doi.org/10.1007/978-3-319-76040-7_22-1

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*(4), 116–123. https://doi.org/10.1007/s40518-019-00137-0

Gowdy, J. M. (2000). Terms and Concepts in Ecological Economics. *Source: Wildlife Society Bulletin*, *28*(1), 26–33.

Grubert, E., & Sawyer, F. (2023). US power sector carbon capture and storage under the Inflation Reduction Act could be costly with limited or negative abatement potential. *Environmental Research: Infrastructure and Sustainability*, *3*(1), 015008. https://doi.org/10.1088/2634-4505/acbed9

Grubert, E., & Talati, S. (2024). The distortionary effects of unconstrained for-profit carbon dioxide removal and the need for early governance intervention. *Carbon Management*, *15*(1), 2292111. https://doi.org/10.1080/17583004.2023.2292111

Hajer, M. A., & Pelzer, P. (2018). 2050—An Energetic Odyssey: Understanding 'Techniques of Futuring' in the transition towards renewable energy. *Energy Research & Social Science*, *44*, 222–231. https://doi.org/10.1016/j.erss.2018.01.013

Halabi, B. (2025, October 22). US, Qatar warn EU climate rules risk LNG supplies. *Argus Media*. https://www.argusmedia.com/en/news-and-insights/latest-market-news/2744835-us-qatar-warn-eu-climate-rules-risk-lng-supplies

Hall, M., & Millo, Y. (2018). Choosing an Accounting Method to Explain Public Policy: Social Return on Investment and UK Non-profit Sector Policy. *European Accounting Review*, *27*(2), 339–361. https://doi.org/10.1080/09638180.2016.1261721

Halttunen, K., Slade, R., & Staffell, I. (2022). "We don't want to be the bad guys": Oil industry's sensemaking of the sustainability transition paradox. *Energy Research & Social Science*, *92*, 102800. https://doi.org/10.1016/j.erss.2022.102800

Hanieh, A. (2024). *Crude Capitalism*. Verso.

Hansson, A., Anshelm, J., Fridahl, M., & Haikola, S. (2022). The underworld of tomorrow? How subsurface carbon dioxide storage leaked out of the public debate. *Energy Research & Social Science*, *90*, 102606. https://doi.org/10.1016/j.erss.2022.102606

Harder, L. (1996). Depoliticising insurgency. *Studies in Political Economy*, *50*, 37–64.

Hayek, F. A. (Ed.). (1980). Liberty, Equality, and Merit. In *Justice: Alternative political perspectives* (1st ed., pp. 27–40). Wadsworth Pub. Co.

Herranen, O. (2023). Understanding and overcoming climate obstruction. *Nature Climate Change*, *13*(6), 500–501. https://doi.org/10.1038/s41558-023-01685-6

Hinton, J. (2020). Fit for purpose? Clarifying the critical role of profit for sustainability. *Journal of Political Ecology*, *27*(1). https://doi.org/10.2458/v27i1.23502

Hinton, J. B., & Cornell, S. E. (2022). Profit as a means or an end? A conceptual framework for an ecological economics approach to sustainable business. *Post-Growth Economics Network (PEN), s.l. Working Paper Series*, *03*.

Hodgson, G. M. (2015). Conceptualizing capitalism: A summary. *Competition & Change*, *20*(1), 37–52. https://doi.org/10.1177/1024529415611264

Huber, M. (2023). Carbon Removal Should Be a Public Good. *Jacobin*. https://jacobin.com/2023/08/carbon-removal-public-good-biden-capitalism-environment-climate-crisis

Hughes, S., & Zoelle, A. (2023). *COST OF CAPTURING CO2 FROM INDUSTRIAL SOURCES*. National Energy Technology Laboratory.

Humphreys, S. (2009). Introduction: Human rights and climate change. In M. Robinson, *Human Rights and Climate Change* (1st ed., pp. 1–34). Cambridge University Press. https://doi.org/10.1017/CBO9780511770722.002

Hunt, O. B., & Tilsted, J. P. (2024). 'Risk on steroids': Investing in the hydrogen economy. *Environment and Planning A: Economy and Space*, 0308518X241255225. https://doi.org/10.1177/0308518X241255225

IEA. (2022). *NORWAY2022.pdf*. International Energy Agency. https://iea.blob.core.windows.net/assets/de28c6a6-8240-41d9-9082-a5dd65d9f3eb/NORWAY2022.pdf

IEA. (2023). *Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach*. International Energy Agency. https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach

International Energy Agency. (2025). *World Energy Outlook 2025*. International Energy Agency. https://iea.blob.core.windows.net/assets/81980a53-9716-47f1-904e-b92a2c4d2ea4/WorldEnergyOutlook2025.pdf

IPCC. (2005). *Special Report on Carbon Dioxide Capture and Storage*. Cambridge University Press.

IPCC. (2014). *Summary for Policymakers, Climate Change 2014: Impacts, Adaptation and Vulnerability*. Cambridge University Press.

IPCC. (2018). *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781009157940

IPCC. (2022). *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Ishii, A., & Langhelle, O. (2011). Toward policy integration: Assessing carbon capture and storage policies in Japan and Norway. *Global Environmental Change*, *21*(2), 358–367. https://doi.org/10.1016/j.gloenvcha.2011.02.005

Islam, S. N., & Winkel, J. (2017). Climate Change and Social Inequality. *United Nations Department of Economic and Social Affairs*, *DESA Working Paper No.152*(DWP/152).

J. Daly, H. E. & Farley. (2011). *Ecological Economics, Second Edition* (2nd ed.). Island Press.

Jasanoff, S., & Kim, S.-H. (2013). Sociotechnical Imaginaries and National Energy Policies. *Science as Culture*, *22*(2), 189–196. https://doi.org/10.1080/09505431.2013.786990

Jerneck, A., Olsson, L., Ness, B., Anderberg, S., Baier, M., Clark, E., Hickler, T., Hornborg, A., Kronsell, A., Lövbrand, E., & Persson, J. (2011). Structuring sustainability science. *Sustainability Science*, *6*(1), 69–82. https://doi.org/10.1007/s11625-010-0117-x

Jessop, B. (2002). *The Future of the Capitalist State*. Polity.

Jessop, B. (2012). The State. In B. Fine, A. Saad-Filho, & M. Boffo (Eds.), *The Elgar companion to Marxist economics* (pp. 333–340). Edward Elgar.

Kaczmarczyk, P. (2021). *Growth models in a world of international trade and capital flows* [University of Sheffield]. https://etheses.whiterose.ac.uk/id/eprint/30219/1/Kaczmarczyk%2C%20Patrick%2C%20180238491.pdf

Kahn, H., & Wiener, A. (1967). *The use of scenarios*. Hudson Institute. https://www.hudson.org/technology/the-use-of-scenarios

Kanbur, R., & Shue, H. (2018). *Climate Justice: Integrating Economy and Philosophy* (1st ed.). Oxford University Press.

Kazlou, T., Cherp, A., & Jewell, J. (2024). Feasible deployment of carbon capture and storage and the requirements of climate targets. *Nature Climate Change*, *14*(10), 1047–1055. https://doi.org/10.1038/s41558-024-02104-0

Kearns, J., Teletzke, G., Palmer, J., Thomann, H., Kheshgi, H., Chen, Y.-H. H., Paltsev, S., & Herzog, H. (2017). Developing a Consistent Database for Regional Geologic CO2 Storage Capacity Worldwide. *Energy Procedia, 13th International Conference on Greenhouse Gas Control Technologies, GHGT-13, 14-18 November 2016, Lausanne, Switzerland*, *114*, 4697–4709. https://doi.org/10.1016/j.egypro.2017.03.1603

Kern, F., Gaede, J., Meadowcroft, J., & Watson, J. (2016). The political economy of carbon capture and storage: An analysis of two demonstration projects. *Technological Forecasting and Social Change*, *102*, 250–260. https://doi.org/10.1016/j.techfore.2015.09.010

Kinol, A., Si, Y., Kinol, J., & Stephens, J. C. (2025). Networks of climate obstruction: Discourses of denial and delay in US fossil energy, plastic, and agrichemical industries. *PLOS Climate*, *4*(1), e0000370. https://doi.org/10.1371/journal.pclm.0000370

Klima- og Miljødepartement. (2021). *Meld St 13 2020-2021: Klimaplan for 2021-2030*. https://www.regjeringen.no/contentassets/a78ecf5ad2344fa5ae4a394412ef8975/nn-no/pdfs/stm202020210013000dddpdfs.pdf

Klima- og Miljødepartement. (2023). *Omstilling til lavutslipp: Veivalg for klimapolitikken mot 2050*. https://files.nettsteder.regjeringen.no/wpuploads01/sites/479/2023/10/Klimautvalget-2050.pdf

Klima- og miljødepartementet. (2004). *Forskrift om begrensning av forurensning (forurensningsforskriften)—Lovdata*. https://lovdata.no/dokument/SF/forskrift/2004-06-01-931

Klinsky, S., Roberts, T., Huq, S., Okereke, C., Newell, P., Dauvergne, P., O'Brien, K., Schroeder, H., Tschakert, P., Clapp, J., Keck, M., Biermann, F., Liverman, D., Gupta, J., Rahman, A., Messner, D., Pellow, D., & Bauer, S. (2017). Why equity is fundamental in climate change policy research. *Global Environmental Change*, *44*(August), 170–173. https://doi.org/10.1016/j.gloenvcha.2016.08.002

Kloo, Y., Nilsson, L. J., & Palm, E. (2024). Reaching net-zero in the chemical industry—A study of roadmaps for industrial decarbonisation. *Renewable and Sustainable Energy Transition*, *5*, 100075. https://doi.org/10.1016/j.rset.2023.100075

Kuchler, M., & Bridge, G. (2018). Down the black hole: Sustaining national socio-technical imaginaries of coal in Poland. *Energy Research & Social Science*, *41*, 136–147. https://doi.org/10.1016/j.erss.2018.04.014

Lane, J., Greig, C., & Garnett, A. (2021). Uncertain storage prospects create a conundrum for carbon capture and storage ambitions. *Nature Climate Change*, *11*(11), 925–936. https://doi.org/10.1038/s41558-021-01175-7

Lee, B., & LiPuma, E. (2002). Cultures of Circulation: The Imaginations of Modernity. *Public Culture*, *14*(1), 191–213. https://doi.org/10.1215/08992363-14-1-191

Lefstad, L., Allesson, J., Busch, H., & Carton, W. (2024). Burying problems? Imaginaries of carbon capture and storage in Scandinavia. *Energy Research & Social Science*, *113*, 103564. https://doi.org/10.1016/j.erss.2024.103564

Lefstad, L., & Paavola, J. (2023). The evolution of climate justice claims in global climate change negotiations under the UNFCCC. *Critical Policy Studies*, *0*(0), 1–26. https://doi.org/10.1080/19460171.2023.2235405

Lenzi, D. (2021). On the Permissibility (Or Otherwise) of Negative Emissions. *Ethics, Policy & Environment*, *24*(2), 123–136. https://doi.org/10.1080/21550085.2021.1885249

Lenzi, D., Schübel, H., & Wallimann-Helmer, I. (2023). Justice in benefitting from carbon removal. *Global Sustainability*, *6*, e22. https://doi.org/10.1017/sus.2023.22

Levy, D. L., & Spicer, A. (2013). Contested imaginaries and the cultural political economy of climate change. *Organization*, *20*(5), 659–678. https://doi.org/10.1177/1350508413489816

Lockwood, T. (2024). 17th International Conference on Greenhouse Gas Control Technologies (GHGT-17). *Designing Carbon Contracts for Difference Incentives to Drive the Deployment of Carbon Capture and Storage in Europe*, *13*, 445–446. https://doi.org/10.1065/espr2006.08.338

Lohmann, L. (2008). Carbon trading, climate justice and the production of ignorance: Ten examples. *Development*, *51*(3), 359–365. https://doi.org/10.1057/dev.2008.27

Lohmann, L. (2012). *FINANCIALIZATION, COMMODIFICATION AND CARBON: THE CONTRADICTIONS OF NEOLIBERAL CLIMATE POLICY*.

L′Orange Seigo, S., Dohle, S., & Siegrist, M. (2014). Public perception of carbon capture and storage (CCS): A review. *Renewable and Sustainable Energy Reviews*, *38*, 848–863. https://doi.org/10.1016/j.rser.2014.07.017

Loria, P., & Bright, M. B. H. (2021). Lessons captured from 50 years of CCS projects. *The Electricity Journal*, *34*(7), 106998. https://doi.org/10.1016/j.tej.2021.106998

Ma, J., Li, L., Wang, H., Du, Y., Ma, J., Zhang, X., & Wang, Z. (2022). Carbon Capture and Storage: History and the Road Ahead. *Engineering*, *14*, 33–43. https://doi.org/10.1016/j.eng.2021.11.024

Mahgerefteh, H., Denton, G., & Rykov, Y. (2008). Pressurised CO2 pipeline rupture. *Institution of Chemical Engineers Symposium Series*, (154), 869–879.

Mann, M. (1984). The autonomous power of the state: Its origins, mechanisms and results. *European Journal of Sociology*, *25*(2), 185–213.

Marcuse, H., & Kellner, D. (2007). *One-dimensional man: Studies in the ideology of advanced industrial society* (Repr). Routledge.

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. https://doi.org/10.1016/j.erss.2016.11.004

Markusson, N., & Haszeldine, S. (2009). 'Capture readiness'–lock-in problems for CCS governance. *Energy Procedia*, *1*(1), 4625–4632. https://doi.org/10.1016/j.egypro.2009.02.284

Markusson, N., Kern, F., & Watson, J. (2011). Assessing CCS viability—A socio-technical framework. *Energy Procedia*, *4*, 5744–5751. https://doi.org/10.1016/j.egypro.2011.02.570

Markusson, N., McLaren, D., & Tyfield, D. (2018). Towards a cultural political economy of mitigation deterrence by negative emissions technologies (NETs). *Global Sustainability*, *1*, e10. https://doi.org/10.1017/sus.2018.10

Markusson, N., Shackley, S., & Evar, B. (2012). *The Social Dynamics of Carbon Capture and Storage*. Routledge.

Martin-Roberts, E., Scott, V., Flude, S., Johnson, G., Haszeldine, R. S., & Gilfillan, S. (2021). Carbon capture and storage at the end of a lost decade. *One Earth*, *4*(11), 1569–1584. https://doi.org/10.1016/j.oneear.2021.10.002

Marzban, E., & Karimi, F. (2026). Exploring alternatives and unfolding possibilities: A futures perspective on carbon capture and storage in the Nordic region. *Futures*, *175*, 103724. https://doi.org/10.1016/j.futures.2025.103724

Mazzucato, M. (2013). *The Entrepreneurial State*. Anthem Press.

McCulloch, M., & Ridley-Duff, R. (2019). *To profit or not to profit? That is the wrong question*. 7th EMES International Research Conference on Social Enterprise. https://emes.net/publications/conference-papers/7th-emes-conference-selectedpapers/to-profit-or-not-to-profit-that-is-the-wrong-question/

McLaren. (2012). Procedural Justice in Carbon Capture and Storage. *Energy & Environment*, *23*(2/3), 345–365.

Mendoza, M., Fletcher, R., Holmes, G., Ogden, L. A., & Schaeffer, C. (2017). The Patagonian Imaginary: Natural Resources and Global Capitalism at the Far End of the World. *Journal of Latin American Geography*, *16*(2), 93–116. https://doi.org/10.1353/lag.2017.0023

Meyer, L. H., & Roser, D. (2010). Climate justice and historical emissions. *Critical Review of International Social and Political Philosophy*, *13*(1), 229–253. https://doi.org/10.1080/13698230903326349

Middleton, R. S., Levine, J. S., Bielicki, J. M., Viswanathan, H. S., Carey, J. W., & Stauffer, P. H. (2015). Jumpstarting commercial-scale CO_2 capture and storage with ethylene production and enhanced oil recovery in the US Gulf. *Greenhouse Gases: Science and Technology*, *5*(3), 241–253. https://doi.org/10.1002/ghg.1490

Mintz-Woo, K., & Lane, J. (2021). Why and Where to Fund Carbon Capture and Storage. *Science and Engineering Ethics*, *27*(6), 70. https://doi.org/10.1007/s11948-021-00344-3

Mirowski, P. (2013). *Never let a serious crisis go to waste*. Verso.

Morrow, D. R. (2021). Is there a role for carbon capture and storage in a just transition? *One Earth*, *4*(11), 1546–1547. https://doi.org/10.1016/j.oneear.2021.10.022

Mosca, M. (2008). On the origins of the concept of natural monopoly: Economies of scale and competition. *The European Journal of the History of Economic Thought*, *15*(2), 317–353. https://doi.org/10.1080/09672560802037623

Narita, D. (2012). Managing uncertainties: The making of the IPCC's *Special Report on Carbon Dioxide Capture and Storage*. *Public Understanding of Science*, *21*(1), 84–100. https://doi.org/10.1177/0963662510367710

Nawaz, S., McLaren, D., Caggiano, H., Hudson, A. D., & Scott-Buechler, C. (2024). Carbon removal for a just transition. *Climate Policy*, 1–12. https://doi.org/10.1080/14693062.2024.2418305

Nordic Energy Research. (2021). *Nordic Clean Energy Scenarios*. https://pub.norden.org/nordicenergyresearch2021-01/#71543

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*(1). https://doi.org/10.1177/1609406917733847

Nozick, R. (Ed.). (1980). How Liberty Upsets Patterns. In *Justice: Alternative political perspectives* (1st ed., pp. 112–116). Wadsworth Pub. Co.

OED. (2020). *Longship—St.Meld.33*. https://www.regjeringen.no/en/dokumenter/meld.-st.-33-20192020/id2765361/

Oei, P.-Y., & Mendelevitch, R. (2016). European Scenarios of CO2 Infrastructure Investment until 2050. *The Energy Journal*, *37*(3_suppl), 171–194. https://doi.org/10.5547/01956574.37.SI3.poei

Okereke, C. (2008). *Global Justice and Neoliberal Environmental Governance: Ethics, Sustainable Development and International Co-Operation*. Routledge. https://doi.org/10.4324/9780203940747

Okereke, C., & Coventry, P. (2016). Climate justice and the international regime: Before, during, and after Paris. *Wiley Interdisciplinary Reviews: Climate Change*, *7*(6), 834–851. https://doi.org/10.1002/wcc.419

Olje- og energidepartementet. (2014). *Forskrift om utnyttelse av undersjøiske reservoarer på kontinentalsokkelen til lagring av CO2og om transport av CO2på kontinentalsokkelen—Lovdata*. https://lovdata.no/dokument/SF/forskrift/2014-12-05-1517

Olje- og energidepartementet. (2020). *Meld. St. 33 (2019–2020) Report to the Storting (white paper)*.

Oomen, J., Hoffman, J., & Hajer, M. A. (2022). Techniques of futuring: On how imagined futures become socially performative. *European Journal of Social Theory*, *25*(2), 252–270. https://doi.org/10.1177/1368431020988826

Otto, D., Thoni, T., Wittstock, F., & Beck, S. (2021). Exploring Narratives on Negative Emissions Technologies in the Post-Paris Era. *Frontiers in Climate*, *3*, 684135. https://doi.org/10.3389/fclim.2021.684135

Paluszny, A., Graham, C. C., Daniels, K. A., Tsaparli, V., Xenias, D., Salimzadeh, S., Whitmarsh, L., Harrington, J. F., & Zimmerman, R. W. (2020). Caprock integrity and public perception studies of carbon storage in depleted hydrocarbon reservoirs. *International Journal of Greenhouse Gas Control*, *98*, 103057. https://doi.org/10.1016/j.ijggc.2020.103057

Paul, D., & Amawi, A. (2013). *The Theoretical Evolution of International Political Economy: A Reader*. Oxford University Press. https://doi.org/10.1093/oso/9780195094435.001.0001

Pawar, R. J., Bromhal, G. S., Carey, J. W., Foxall, W., Korre, A., Ringrose, P. S., Tucker, O., Watson, M. N., & White, J. A. (2015). Recent advances in risk assessment and risk management of geologic CO2 storage. *International Journal of Greenhouse Gas Control*, *40*, 292–311. https://doi.org/10.1016/j.ijggc.2015.06.014

Petersen, H. I., Springer, N., Weibel, R., & Schovsbo, N. H. (2022). Sealing capability of the Eocene–Miocene Horda and Lark formations of the Nini West depleted oil field – implications for safe CO2 storage in the North Sea. *International Journal of Greenhouse Gas Control*, *118*, 103675. https://doi.org/10.1016/j.ijggc.2022.103675

Pickering, J., Vanderheiden, S., & Miller, S. (2012). "If Equity's In, We're Out": Scope for Fairness in the Next Global Climate Agreement. *Ethics and International Affairs*, *26*(4), 423–443. https://doi.org/10.1017/S0892679412000603

Prainsack, B. (2022). The Roots of Neglect: Towards a Sociology of Non-Imagination. *Tecnoscienza*, *13*(2), 13–34.

Rahman, M. J., Fawad, M., Jahren, J., & Mondol, N. H. (2022). Top seal assessment of Drake Formation shales for CO2 storage in the Horda Platform area, offshore Norway. *International Journal of Greenhouse Gas Control*, *119*, 103700. https://doi.org/10.1016/j.ijggc.2022.103700

Rawls, J. (1971). *A Theory of Justice*. Belknap Press of Harvard University Press.

Rawls, J. (Ed.). (1980). Justice as Rational Choice Behind a Veil of Ignorance. In *Justice: Alternative political perspectives* (1st ed., pp. 126–144). Wadsworth Pub. Co.

Ringstad, C. (2024). *Status på CO2-lagringslisenser i Norge*. Bellona, Oslo. https://bellona.no/publication/status-pa-co2-lagringslisenser-i-norge

Ripple, W. J., Wolf, C., Gregg, J. W., Rockström, J., Mann, M. E., Oreskes, N., Lenton, T. M., Rahmstorf, S., Newsome, T. M., Xu, C., Svenning, J.-C., Pereira, C. C., Law, B. E., & Crowther, T. W. (2024). The 2024 state of the climate report: Perilous times on planet Earth. *BioScience*, biae087. https://doi.org/10.1093/biosci/biae087

Roberts, J. T., Milani, C. R. S., Jacquet, J., & Downie, C. (Eds.). (2025). *Climate Obstruction: A Global Assessment* (1st ed.). Oxford University PressNew York. https://doi.org/10.1093/oso/9780197787144.001.0001

Robertson, B., & Mousavian, M. (2023). *The carbon capture crux: Lessons learned*. https://ieefa.org/resources/carbon-capture-crux-lessons-learned

Robinson, B. (2023). *Small decisions towards social justice: How leaders of not-for-profit social services can be supported to include social justice in decision-making* [Doctor of Professional Practice, Otago Polytechnic | Te Pūkenga]. https://doi.org/10.34074/thes.6190

Rochelle, G. T. (2024). Air pollution impacts of amine scrubbing for CO2 capture. *Carbon Capture Science & Technology*, *11*, 100192. https://doi.org/10.1016/j.ccst.2024.100192

Roessler, M. (2019). Political regimes and publicly provided goods: Why democracy needs development. *Public Choice*, *180*(3–4), 301–331. https://doi.org/10.1007/s11127-019-00638-y

Røttereng, J.-K. S. (2018). When climate policy meets foreign policy: Pioneering and national interest in Norway’s mitigation strategy. *Energy Research & Social Science*, *39*, 216–225. https://doi.org/10.1016/j.erss.2017.11.024

Roussanaly, S., Gundersen, T., & Ramirez, A. (2025). Putting the costs and benefits of carbon capture and storage into perspective: A multi-sector to multi-product analysis. *Progress in Energy*, *7*(1), 013002. https://doi.org/10.1088/2516-1083/ad9075

Rubiano Rivadeneira, N., & Carton, W. (2022). (In)justice in modelled climate futures: A review of integrated assessment modelling critiques through a justice lens. *Energy Research & Social Science*, *92*, 102781. https://doi.org/10.1016/j.erss.2022.102781

Ryan, G. W., & Bernard, H. R. (2003). Techniques to Identify Themes. *Field Methods*, *15*(1), 85–109. https://doi.org/10.1177/1525822X02239569

Sandel, M. J. (1982). *Liberalism and the limits of justice*. Cambridge University Press.

Sandel, M. J. (2010). *Justice: What’s the right thing to do?* (First paperback edition). Farrar, Straus and Giroux.

Sandel, M. J. (2013). Market reasoning as moral reasoning: Why economists should re-engage with political philosophy. *Journal of Economic Perspectives*, *27*(4), 121–140. https://doi.org/10.1257/jep.27.4.121

Scholvin, S., Black, A., & Robbins, G. (2025). De-risking green hydrogen? Insights from Chile and South Africa. *Energy Policy*, *198*, 114485. https://doi.org/10.1016/j.enpol.2024.114485

Schreurs, M. (2024). Jockeying for Climate Leadership Amidst Rising Global Tensions: China, USA and the European Union. In S. Biba (Ed.), *Europe in an Era of US-China Strategic Rivalry: Challenges and Opportunities from an Outside-in Perspective* (pp. 243–264). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-48117-8

Schreurs, M. A. (2023). Implications of the Russian War on Ukraine for Climate Policy and the Geopolitics of Energy. *Canadian Journal of European and Russian Studies*, *16*(2), 90–113. https://doi.org/10.22215/cjers.v16i2.2765

Scott, V., Gilfillan, S., Markusson, N., Chalmers, H., & Haszeldine, R. S. (2013). Last chance for carbon capture and storage. *Nature Climate Change*, *3*(2), 105–111. https://doi.org/10.1038/nclimate1695

Shirdel, S., Valand, S., Fazli, F., Winther-Sørensen, B., Aromada, S. A., Karunarathne, S., & Øi, L. E. (2022). Sensitivity Analysis and Cost Estimation of a CO2 Capture Plant in Aspen HYSYS. *ChemEngineering*, *6*(2), 28. https://doi.org/10.3390/chemengineering6020028

Shue, H. (1999). Global environment and international inequality. *International Affairs*, *75*(3), 531–545. https://doi.org/10.1111/1468-2346.00092

Shue, H. (2014). *Climate Justice: Vulnerability and Protection* (2nd ed.). Oxford University Press.

Shue, H. (2018). Mitigation gambles: Uncertainty, urgency and the last gamble possible. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *376*(2119), 20170105. https://doi.org/10.1098/rsta.2017.0105

Shue, H. (2019). Subsistence protection and mitigation ambition: Necessities, economic and climatic. *The British Journal of Politics and International Relations*, *21*(2), 251–262. https://doi.org/10.1177/1369148118819071

Siirila-Woodburn, E. R., Cihan, A., & Birkholzer, J. T. (2017). A risk map methodology to assess the spatial and temporal distribution of leakage into groundwater from Geologic Carbon Storage. *International Journal of Greenhouse Gas Control*, *59*, 99–109. https://doi.org/10.1016/j.ijggc.2017.02.003

Sovacool, B. K., Baum, C. M., & Low, S. (2022). Climate protection or privilege? A whole systems justice milieu of twenty negative emissions and solar geoengineering technologies. *Political Geography*, *97*, 102702. https://doi.org/10.1016/j.polgeo.2022.102702

Sovacool, B. K., Del Rio, D. F., Herman, K., Iskandarova, M., Uratani, J. M., & Griffiths, S. (2024). Reconfiguring European industry for net-zero: A qualitative review of hydrogen and carbon capture utilization and storage benefits and implementation challenges. *Energy & Environmental Science*, *17*(10), 3523–3569. https://doi.org/10.1039/D3EE03270A

Span, R., Mahgerefteh, H., Moe, A. M., Dugstad, A., Benrath, D., Jukes, E., Adnerson, E., Catalanotti, E., Durusut, E., Neele, F., Grunert, F., Gazendam, J., Barnett, J., Hammer, M., Brown, S., Munkejord, S. T., & Weber, V. (2020). *A Trans European CO2 Transportation Infrastructure for CCUS: Opportunities and Challenges*. European Zero Emission Technology and Innovation Platform. https://zeroemissionsplatform.eu/wp-content/uploads/A-Trans-European-CO2-Transportation-Infrastructure-for-CCUS-Opportunities-Challenges.pdf

Spangenberg, J. H. (2011). Sustainability science: A review, an analysis and some empirical lessons. *Environmental Conservation*, *38*(3), 275–287. https://doi.org/10.1017/S0376892911000270

Spash, C. L. (2012). New foundations for ecological economics. *Ecological Economics*, *77*, 36–47. https://doi.org/10.1016/j.ecolecon.2012.02.004

Spash, C. L. (2020). A tale of three paradigms: Realising the revolutionary potential of ecological economics. *Ecological Economics*, *169*, 106518. https://doi.org/10.1016/j.ecolecon.2019.106518

Spash, C. L. (2021). Apologists for growth: Passive revolutionaries in a passive revolution. *Globalizations*, *18*(7), 1123–1148. https://doi.org/10.1080/14747731.2020.1824864

Stavins, R. N. (2003). Experience with Market-Based Environmental Policy Instruments. In *Handbook of Environmental Economics* (Vol. 1, pp. 355–435). Elsevier. https://doi.org/10.1016/S1574-0099(03)01014-3

Stephens, J. C. (2014). Time to stop investing in carbon capture and storage and reduce government subsidies of fossil-fuels. *WIREs Climate Change*, *5*(2), 169–173. https://doi.org/10.1002/wcc.266

Sterba, J. P. (Ed.). (1980). *Justice: Alternative political perspectives*. Wadsworth Pub. Co.

Stilwell, F. (2011). MARKETISING THE ENVIRONMENT. *Journal of Australian Political Economy*.

Subraveti, S. G., Rodríguez Angel, E., Ramírez, A., & Roussanaly, S. (2023). Is Carbon Capture and Storage (CCS) Really So Expensive? An Analysis of Cascading Costs and CO_2 Emissions Reduction of Industrial CCS Implementation on the Construction of a Bridge. *Environmental Science & Technology*, *57*(6), 2595–2601. https://doi.org/10.1021/acs.est.2c05724

Sultana, F. (2022). Critical climate justice. *The Geographical Journal*, *188*(1), 118–124. https://doi.org/10.1111/geoj.12417

Swennenhuis, F., Mabon, L., Flach, T. A., & de Coninck, H. (2020). What role for CCS in delivering just transitions? An evaluation in the North Sea region. *International Journal of Greenhouse Gas Control*, *94*, 102903. https://doi.org/10.1016/j.ijggc.2019.102903

Tadjer, A., & Bratvold, R. B. (2021). Managing Uncertainty in Geological CO2 Storage Using Bayesian Evidential Learning. *Energies*, *14*(6), 1557. https://doi.org/10.3390/en14061557

Tjernshaugen, A. (2011). The growth of political support for CO_2 capture and storage in Norway. *Environmental Politics*, *20*(2), 227–245. https://doi.org/10.1080/09644016.2011.551029

Tønnessen, M. (2021). Karbonfangst i lys av generasjonsrettferdighet. *Norsk filosofisk tidsskrift*, *56*(2–3), 91–101. https://doi.org/10.18261/issn.1504-2901-2021-02-03-04

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, *28*(12), 817–830. https://doi.org/10.1016/S0301-4215(00)00070-7

UNSDG. (2023, March 20). New UN Report offers a “survival guide for humanity” in the face of climate change. *United Nations Sustainable Development Group*. https://unsdg.un.org/latest/stories/new-un-report-offers-survival-guide-humanity-face-climate-change

Van Beek, L., Oomen, J., Hajer, M., Pelzer, P., & Van Vuuren, D. (2022). Navigating the political: An analysis of political calibration of integrated assessment modelling in light of the 1.5 °C goal. *Environmental Science & Policy*, *133*, 193–202. https://doi.org/10.1016/j.envsci.2022.03.024

Vasudevan, S., Farooq, S., Karimi, I. A., Saeys, M., Quah, M. C. G., & Agrawal, R. (2016). Energy penalty estimates for CO2 capture: Comparison between fuel types and capture-combustion modes. *Energy*, *103*, 709–714. https://doi.org/10.1016/j.energy.2016.02.154

Vezzoni, R. (2024). A “return of the state” in energy transitions? The making of a hydrogen economy in the European Union. *ZFW – Advances in Economic Geography*, *68*(3–4), 195–212. https://doi.org/10.1515/zfw-2024-0050

Vincent, S., & O’Mahoney, J. (2018). Critical Realism and Qualitative Research: An Introductory Overview. In C. Cassell, A. Cunliffe, & G. Grandy, *The SAGE Handbook of Qualitative Business and Management Research Methods: History and Traditions* (pp. 201–216). SAGE Publications Ltd. https://doi.org/10.4135/9781526430212.n13

Vogel, J., Steinberger, J. K., O’Neill, D. W., Lamb, W. F., & Krishnakumar, J. (2021). Socio-economic conditions for satisfying human needs at low energy use: An international analysis of social provisioning. *Global Environmental Change*, *69*, 102287. https://doi.org/10.1016/j.gloenvcha.2021.102287

Vogel, S. K. (2023). Market Governance as a Balance of Power. *Politics & Society*, *51*(3), 319–336. https://doi.org/10.1177/00323292231183834

Vogel, Steven K. (2018). *Marketcraft: How Governments make Markets Work*. Oxford University Press.

Wang, N., Akimoto, K., & Nemet, G. F. (2021). What went wrong? Learning from three decades of carbon capture, utilization and sequestration (CCUS) pilot and demonstration projects. *Energy Policy*, *158*, 112546. https://doi.org/10.1016/j.enpol.2021.112546

WCED. (1987). *Report of the World Commission on Environment and Development: Our Common Future Towards Sustainable Development 2. Part II. Common Challenges Population and Human Resources 4* (pp. 1–301). World Commission on Environment and Development. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

Weinberg, A. M. (1972). Science and trans-science. *Minerva*, *10*, 209–222.

Wettestad, J., Inderberg, T. H. J., & Gulbrandsen, L. H. (2024). Exploring paths and innovation in Norwegian carbon capture and storage policy. *Environmental Policy and Governance*, *34*(2), 125–136. https://doi.org/10.1002/eet.2068

Wright, C., Nyberg, D., De Cock, C., & Whiteman, G. (2013). Future imaginings: Organizing in response to climate change. *Organization*, *20*(5), 647–658. https://doi.org/10.1177/1350508413489821

Yusoff, K., & Gabrys, J. (2011). Climate change and the imagination. *WIREs Climate Change*, *2*(4), 516–534. https://doi.org/10.1002/wcc.117

Zhang, Y., Jackson, C., & Krevor, S. (2022). An Estimate of the Amount of Geological CO_2 Storage over the Period of 1996–2020. *Environmental Science & Technology Letters*, *9*(8), 693–698. https://doi.org/10.1021/acs.estlett.2c00296

Zheng, Y., Gao, L., He, S., & Jin, H. (2023). Reduction potential of the energy penalty for CO2 capture in CCS. *Frontiers in Energy*, *17*(3), 390–399. https://doi.org/10.1007/s11708-023-0864-x

Zoback, M. D., & Gorelick, S. M. (2012). Earthquake triggering and large-scale geologic storage of carbon dioxide. *PNAS*, *109*(26).

Appendix I: Interview Guide

A project description and consent form was sent to interviewees approx. one week prior to the interview. Before the start of the interview, I reiterated my role, my research projects' focus and asked for permission to a) interview them and b) record the interview. Interview data is stored safely according to Lund University's data management plan and in accordance with the ethical approval. The below questions were sometimes adapted somewhat to fit the expertise of the particular interviewee, so not all questions were asked to all interviewees, and some follow-up questions are not listed here.

1. How long have you worked on CCS and what is your role?
2. How would you describe the dominant vision or 'story' guiding CCS deployment in the EU?
3. How are equity considerations (like distributive impacts, fossil industry accountability) incorporated into EU policy design? Can you point to concrete mechanisms or debates where these issues arose?
4. What governance or funding models (e.g. public ownership, global CO_2 storage commons) have been discussed to deploy CCS?
5. What role does the EU have for successful CCS? Vs Norway?
6. The fossil fuel industry is central to CCS infrastructure. How does the EU navigate potential conflicts of interest, given the industry's historical responsibility for emissions? Should they have a role in governance?
7. How do EU policymakers view Norway's role? Are there tensions around dependency on Norwegian storage?
8. Potential advantages of using CCS? Who will benefit from it do you think?
9. Potential disadvantages of using CCS? Who might feel these negative effects more?
10. How would you balance the need for CCS as a climate solution with concerns that the need for a profitable CO_2 market could delay CCS deployment?
11. How could we deal with distributing the benefits and burdens of CCS within the EU?

12. If CCS were to be fully implemented, how would you define success?
13. Do you think CO_2 transport and storage can be successful in the context of a competitive market? How could that be achieved?
14. What would a successful, fair and profitable EU CCS market look like?
    a. What role does the EU play here; how could the EU e.g. ensure a certain profit margin? (And what would such a profit margin need to be minimum for industry actors to want to work with CCS?)