Deciphering Climate Cryptogovernance

A Discursive Exploration of Early Blockchain Technology in International Climate Politics (from 2016 - 2018)

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Abstract

One of the most widely anticipated international environmental policy developments in recent years has been the incorporation of emerging blockchain-based technologies. Climate change is a prominent example of an issue area that has seen the application of blockchain. However, this emerging trend has remained relatively under-analysed in academic literature. This thesis thus explores *climate cryptogovernance* - which refers to the variety of governance processes in the climate realm which involve the deployment of cryptographic technology (i.e. blockchain). The overarching research question considered is: how is climate cryptogovernance conceptualised by influential actors and what are the implications of dominant conceptualisations for reinforcing or challenging how climate governance occurs?

The phenomenon of climate cryptogovernance is analysed by adopting a range of discursive approaches preeminent in the study of international environmental politics. Most notably, this thesis is centred around the concept of the *storyline*, theorised by Maarten Hajer as a component of the argumentative discourse analysis (ADA) approach. ADA is supplemented with critical perspectives to form a theoretical framework that first distils and then critically interrogates dominant conceptualisations of climate cryptogovernance. This theoretical framework is applied to a variety of sampled documents, disseminated by authors that are considered influential due to a connection to *international climate bureaucracies* such as the UNFCCC or World Bank.

This thesis analyses these documents in two sections of empirical analysis. Firstly, it is explored how blockchain technology is conceptualised in the communications of influential actors that partake in international climate governance. This is done through the identification of a dominant storyline of climate cryptogovernance. Secondly, the assumptions present in the dominant storyline of climate cryptogovernance are critically interrogated to draw out what implications this dominant storyline may hold for reinforcing or challenging the ways in which climate governance occurs.

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More generally, I would like to extend my thanks to the many remarkable people I have met - at Wageningen University, at the London School of Economics and beyond - who have inspired my approach to this research in profound and often intangible ways. Without these interactions, I would not have been able to develop the voice that is present in this research.

Finally, I must express my deep gratitude to my parents for their unfaltering support, throughout the creation of this thesis and many years prior. This accomplishment would not have been possible without them, and the support of my boyfriend, wider family and friends.

Foreword: A Note on Positionality

In order to remain candid about the scope of this research from the offset, it is necessary to foreground the position of the researcher in relation to the research. In line with the constructivist theoretical approach adopted in this thesis, this thesis is written with the understanding that any researcher studying climate cryptogovernance is intertwined with the knowledge that they are studying. In contrast to some research traditions in international environmental politics that explicitly or implicitly propose that a neutral gaze that separates an author from objects of analysis is viable, this thesis takes the stance that a researcher cannot exist outside of the reality of the material they are studying. The researcher and researched are interdependent in the social process of research (Denzin and Lincoln, 2005). Resultantly, the position of the researcher within the social world will influence the practice of research - from the earliest conceptualisation of the research topic right up until the writing up of the last sentence of the final product. For this reason, before this thesis is introduced, a brief positionality statement outlining attributes of the author that could shape the scope of this research is warranted.

I am currently a masters level student at a specialised agriculture and environment university in the Eastern Netherlands. However, I was raised in Singapore before spending several years prior to the Netherlands in the United Kingdom. My upbringing in Singapore, a world hub for technology and innovation, placed technology on my radar from an early age. Indeed, at the school that my parents taught at and I attended, we were educated in information technology from a young age and I had access to a computer from around the age of 10 years. For this reason, the use of computers and technology more generally has become an integral part of my life on the level of everyday usage, though more complex technologies such as blockchain and bitcoin have mostly evaded me. From a young age, I generally saw technology as a positive force for expression and development. Studying subjects related to human and physical geography that emphasised instrumental solutions to environmental approaches, I uncritically believed that when applied correctly, technology was always fundamental to progress and to the benefit of humankind.

However, upon attending university in London for a bachelor's degree in a department that was polarised between more instrumental and critical approaches to the study of environmental policy, I started to develop a scepticism for some technocratic approaches to policy-making. This is informed by my background in critical human geography and development studies, in addition to environmental policy and economics. Additionally, in response to the overbearing presence of headhunting financial institutions on campus and exposure to ecocentric anti-consumerist and radical anti-capitalist perspectives, at the time I developed a somewhat adversarial attitude to financial institutions and markets. These feelings of scepticism towards the blind acceptance of technology and markets as a driving force for good came at a time when blockchain exploded across the media in 2016 and 2017, and friends of mine were hoping to cash in on the boom. A lack of interest in finding out more about blockchain on my part, coupled with the unquestioningly critical stance I adopted, meant that my initial stance blockchain technology was undeniably one of dismissal.

Over time, my stance towards blockchain, and technology more generally have mellowed. Despite believing in the importance of taking a sceptical but open-minded approach to such technologies - which has heavily informed this thesis - I have also found some critical approaches ultimately unhelpful and uninterested in communicating accessibly to those who could potentially enact some form of change in environmental policy-making. I now increasingly see the possibility for the use of DLTs as one potential solution to an inherently unequal world, as opposed to technical fixes always being part of the problem. Indeed, during my time in the Netherlands, I was exposed to blockchain through a coursemate who works in environmental innovation. The inspiration for this research comes from this person, who spoke of the transformative impact of blockchain for the environment with such a bold enthusiasm that I was simultaneously intrigued and antagonised. The approach to this research is therefore in many ways indicative of my own ambivalent feelings and desire for a more nuanced understanding of the role of blockchain in climate change policy.

Abbreviations

ADA - Argumentative Discourse Analysis

COP - Conference of the Parties

CRC - Carbon Removal Credit

CMA - Conference of the Parties serving as the meeting of the Parties to the Paris Agreement

DLT - Distributed Ledger Technology

GHG - Greenhouse Gas

IPCC - Intergovernmental Panel on Climate Change

INC - Intergovernmental Negotiating Committee

MRV - Monitoring, Reporting and Verification

NGO - Non-governmental Organisation

OECD - Organisation for Economic Co-operation and Development

NDCs - Nationally Determined Contributions

PES - Payment for Ecosystem Services

PoW - Proof-of-Work

REDD+ - Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries

UNFCCC - United Nations Framework Convention on Climate Change

UNEP - United Nations Environmental Programme

WEF - World Economic Forum

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1. Introduction

1.1 Problem Statement

With the explosion of blockchain-based cryptocurrencies over the past few years, blockchain technology has increasingly entered the public domain. Blockchain can be most simply described as a decentralised virtual database of transactions that occur across a peer-to-peer network system (Savelyev, 2017). Blockchain is considered a cryptographic technology - for the reason that it is able to ensure that ledgering of transactions happens securely despite the potential presence of malicious third parties. For this reason, the prefix ‘crypto’ is frequently added to blockchain-related terminology, as with the example of ‘cryptocurrencies’ or more recently ‘cryptogovernance’. The key benefits of blockchain are twofold: firstly, blockchain enables the secure transfer of digital assets (or virtual representations of physical offline assets); secondly, blockchain allows for the disintermediation of such transfers by ensuring truthful records about asset owners that do not require a trusted intermediary, like a registrar, notary or financial institution (Savelyev, 2017).

These properties of blockchain have garnered blockchain a significant amount of attention. According to a World Economic Forum article, by 2027 as much as 10% of global GDP could be concentrated in blockchain-based technologies (Sinrod, 2018). Bitcoin - which is the cryptocurrency for which blockchain technology was initially theorised - has shed its initial reputation as a currency used for black market transactions on the dark web and is now embraced by the world’s largest financial institutions (Böhme et al., 2015). However, it is also increasingly the case that the applications of blockchain technology are extending beyond the private interests of the financial market and reaching into the realm of multi-governmental policy initiatives. This has been true of areas as diverse as record-keeping, female empowerment and refugee humanitarian aid (UN Blockchain, 2018). Numerous international environmental governance organisations have also shown an interest in such technology, including the United Nations Environmental Programme (UNEP, 2016a), the United Nations Framework Convention on Climate Change Secretariat (UNFCCC, 2018a) and the CITES Secretariat (CITES, 2017).

With curiosity about blockchain in the context of environmental policy emerging in 2017, a publication in *Nature* by French ecologist Guillaume Chapron (2017) distilled the optimism of many of the proponents of blockchain. Chapron (2017) was one of the first commentators to propose that "the environment needs cryptogovernance", identifying a number of ways that blockchain will enhance transparency and accountability in environmental governance. The core of the argument made by Chapron (2017: 404) and other proponents of blockchain is that a key feature, and benefit, of cryptogovernance in the context of the environment is the "outsourcing of trust, law and enforcement to computer code". Chapron (2017) and other proponents of incorporating blockchain into environmental policy argue that this outsourcing will ultimately induce cooperation and reduce fraud.

Climate change has become a particularly prominent environmental issue that advocates of blockchain technology have speculated could be cryptogoverned in the manner described above (Chapron, 2017; Chen, 2018). Indeed, aside from being one of the most omnipresent, uncertain and widely debated environmental issues of the late-20th and 21st centuries (Hulme, 2015), climate change is also an area where prominent international governance organisations have demonstrated a substantial amount of support for the development of blockchain-based climate initiatives. For example, the UNFCCC (2017), World Bank (2018) and World Economic Forum (2018) have all been vocal proponents of applying blockchain technology to the issue of climate change.

Intergovernmental organisations such as these can play an unparalleled role in climate governance, through their influence as distributors of knowledge, upholders of norms and facilitators of technological assistance (Biermann and Siebenhuner, 2009). For this reason, some authors have emphasised the significance of these multinational political agencies as climate governance actors in their own right, theorising them as "international climate bureaucracies" (Biermann and Siebenhuner, 2009: 37). With the requirement of signatories of the Paris Agreement to craft increasingly ambitious nationally determined contributions (NDCs) remaining at the heart of the Agreement, these so-called international climate bureaucracies have increasingly taken a leadership role in highlighting innovative technologies to achieve NDCs. This has been true of blockchain, where the UNFCCC (2018a) Secretariat and World Bank (2018) in particular have played influential roles through their advocacy of blockchain in a range of publications and events.

In spite of the growth of climate cryptogovernance and increasing support by environmental bureaucracies, a noteworthy aspect of the incorporation of blockchain into climate governance should be mentioned: uptake is in relatively early stages (WEF and PWC, 2018). Beyond small projects headed by startup companies and early-stage experimental technologies, the incorporation of blockchain into climate policy instruments is largely anticipatory. Importantly, despite the hypothetical discussions of harnessing blockchain as a tool to streamline climate governance raised above, there has been scant evidence of its widespread impact in practice to date (WEF and PWC, 2018). This is not to say that blockchain may not have a transformative impact on the state of climate governance. However, in light of an absence of widely implemented technologies at present, the recent impact of blockchain on climate governance arguably has much more to do with what is being communicated and hypothesised about blockchain than any material applications.

Indeed, in this prevailing context of climate cryptogovernance being relatively underdeveloped and still in a largely theoretical state, what is being said and communicated about blockchain in the context of climate change becomes all the more relevant. Particularly with a phenomenon as novel and technical as the incorporation of blockchain into climate policy, the ways in which knowledge claims are crafted by influential actors can have a substantial impact on how we come to understand the complex world around us (Hajer, 2002). This claim is informed by a rich body of constructivist literature in the study of international environmental politics, which proposes that language plays a vital role in constructing social reality (Hajer and Veersteg, 2005). Discourse analytical approaches offer the potential to unpack the plurality of novel ways which blockchain is understood to govern the climate (Feindt and Oels, 2005). When considering the vital role of language in shaping climate cryptogovernance alongside the substantial number of press releases, technical reports and news articles that have amounted online about blockchain, a discursive exploration of blockchain in international climate change politics has become increasingly worthwhile.

Up to this point, this introduction has contextualised climate cryptogovernance, the influence of international bureaucracies and the significance of communication and language in international climate politics. It logically follows that this thesis is centred on how blockchain technology and its impact on climate change are conceptualised through the communications of authoritative actors that partake in international climate governance.

The rationale for adopting such a focus has been provided loosely across the introduction: blockchain is a technology increasingly used in climate governance, climate bureaucracies are understood to be having a substantial influence on its uptake and language is understood to shape actors' perceptions of blockchain in the climate realm. However, a core question remains about the relevance of this research more broadly. Considering that a myriad of potential topics of research in international climate politics currently exist in the aftermath of the Paris Agreement, why focus on climate cryptogovernance specifically?

First and foremost, climate cryptogovernance is surprisingly under-researched. Although a small body of literature has focused on technical aspects of blockchain and its applications to climate change, a thorough exploration of when and how blockchain has emerged in climate policy is not accessible as of May 2019. Given that interest in blockchain for climate change solutions is only growing (WEF and PwC, 2018), the time is ripe for a comprehensive summary of what has occurred so far and how blockchain is predominantly understood to enable climate governance.

Secondly, as climate cryptogovernance continues to emerge, there is a dire need to consider not only what is being communicated, but also what possible limitations exist in the common claims made of climate cryptogovernance. More specifically, the role of blockchain for climate change has not been adequately analysed from interpretive approaches that would seek to denaturalise dominant understandings of climate cryptogovernance, nor critical approaches that seek to actively challenge these dominant understandings. Existing academic analyses of climate cryptogovernance have generally explored the potential utility of blockchain-based solutions for the climate (Chen, 2018), leaving a research gap for perspectives that are less instrumental by comparison. By synthesising perspectives that denaturalise fundamental assumptions about the role of blockchain in climate governance and hold them to critical scrutiny, this research plays a currently underfilled role in questioning whether the knowledge claims made about blockchain technology are as valid as they may initially appear.

These dual challenges of providing a thorough overview and critical interpretation of climate cryptogovernance are particularly timely in the context of recently emerging debates surrounding the use of blockchain as a viable climate governance tool. Discussions about using blockchain for climate policy have only come to the forefront since approximately 2016, and have rapidly gained traction since. This thesis documents these early discussions of climate cryptogovernance, with 2016 to 2018 marking a particularly notable time period to analyse as mainstream understandings started to take shape. As climate cryptogovernance has evolved and now continues to evolve along a number of possible trajectories, there is now more than ever a need to consider both the early conceptualisations and possible impacts of blockchain on the landscape of climate governance.

It is therefore around two aforementioned and currently unmet tasks - of distilling and critically interrogating climate cryptogovernance - that this thesis will be structured. These two tasks will be achieved through the empirical analysis of texts published by authors that represent or are related to climate bureaucracies that govern the climate at the level of international environmental policy. As foregrounded above, a discourse analytical approach will be taken in this analysis. Specifically, the argumentative discourse analysis (ADA) approach put forth by Hajer (2010), that combines a Foucauldian conceptualisation of discourse with perspectives from social interactionist theory, will be applied to documents published by climate governance actors from 2016 to 2018. This ADA analysis will then be complemented with perspectives from additional theoretical traditions - such as governmentality studies, science and technology studies and critical transparency studies - to form a theoretical framework through which the assumptions present in the dominant storylines will be analysed.

Having provided a preliminary foundation and rationale for the proceeding research, the research aims and research questions will be presented in greater detail.

1.2 Research Aims

The overarching research aim of this thesis is as follows:

> *To explore how climate cryptogovernance is conceptualised by influential actors and what the implications of these conceptualisations are for reinforcing or challenging how climate governance occurs.*

This overarching aim will be achieved by applying an approach informed by argumentative discourse analysis to analyse the external communications of climate bureaucracies and their affiliates.

Under this overarching aim, the two sub-aims of this thesis will be:

> *1. To provide an overview of the dominant storyline*[1] *associated with climate cryptogovernance that is disseminated by influential climate governance actors.*
>
> *2. To critically interrogate the claims of the dominant storyline of climate cryptogovernance.*

The first sub-aim will be achieved by presenting the findings of an argumentative discourse analysis of sampled texts produced by climate bureaucracies and actors that associate with them. This will result in the identification of a dominant storyline - understood to be dominant by virtue of distilling the knowledge claims of the most influential actors.

The second sub-aim will be achieved by assessing the results obtained in answering the first sub-aim, using a variety of critical perspectives from governmentality studies, science and technology studies and critical transparency studies. This will result in a comprehensive critical interrogation of the dominant storyline of climate cryptogovernance.

[1] For the purposes of this thesis, a 'storyline' is understood after Hajer (2010: 57) as a "narrative that allows actors to draw upon various discursive categories to give meaning to specific physical or social phenomena". This definition will be explored in greater depth in chapter 3.

1.3 Research Questions

The overarching research question that this thesis seeks to answer is as follows:

> *How is climate cryptogovernance conceptualised by influential actors and what are the implications of dominant conceptualisations for reinforcing or challenging how climate governance occurs?*

In answering the above question, this overarching research question will be broken down into two sub-questions with specific reference to the i. dominant conceptualisations of climate cryptogovernance and ii. possible implications of these constructions. The two sub-questions explored in this thesis are as follows:

1. *How is climate cryptogovernance conceptualised by actors associated with international climate bureaucracies?*

2. *What are the implications of dominant conceptualisations of climate cryptogovernance for reinforcing or challenging how climate governance occurs?*

The first research question considers a dominant storyline of climate cryptogovernance that draws on prevailing discourses to craft mainstream understandings of how blockchain governs the climate. In charting the dominant conceptualisations of climate cryptogovernance, this question will not only consider the dominant knowledge claims present, but also the actors that are involved in disseminating these claims and discourses they draw on.

The second research question harnesses the findings of the first research question to critically analyse the dominant storyline of climate cryptogovernance identified. Building on insights from ADA that storylines are inherently simplifying to allow for problem closure, the knowledge claims of the dominant storyline of climate cryptogovernance will be drawn out and critically interrogated. By identifying the disparity between the dominant storyline and contrasting critical perspectives, it will be considered what approaches to climate governance are implied by a shift toward climate cryptogovernance.

1.4 Conceptual Focus: Climate Cryptogovernance

Given that climate cryptogovernance is a central concept explored in this thesis, a clearer operationalisation of this somewhat ambiguous phrase is required before it is further discussed in later chapters. Indeed, despite climate cryptogovernance being selected as the conceptual focus of this thesis, it is not a phrase that is currently in common usage. This is not least due to the fact that relatively little has been written about the interface of climate change and blockchain to date.

Although not explicitly defined by Chapron (2017), who is one of the earliest known users of this phrase, the neologism of cryptogovernance is assumed to be a portmanteau that combines cryptographic technology (of which blockchain is the most notable type) and the broad notion of governance. This phrase conceptualises the increasing push toward including blockchain into governance processes, as has also been seen across several other issue areas. Following Katz and Lindell (2007), cryptographic technology is understood to describe technologies that are reliant on:

"techniques for securing digital information, transactions, and distributed computations" - Katz and Lindell (2007: 3)

For the purposes of this thesis, a general definition of governance proposed by Stoker (2004: 22) will be adapted to the context of cryptographic technology as a basis for operationalising climate cryptogovernance. This definition was selected for its applicability across multiple scales and broad resonance with common theorisations of the 'governance' concept across international environmental politics. The adapted definition originally proposed by Stoker (2004: 22) defines cryptogovernance as:

"the processes that create the conditions for ordered rule and collective action within the political realm through the deployment of cryptographic technology"

It should be noted that although this definition is intentionally broad, so as to not equate blockchain as analogous to all technologies that could be described as cryptographic, in contemporary environmental governance blockchain has overwhelmingly the cryptographic technology that actors focus on thus far.

Shifting focus to the ‘climate’ element of climate cryptogovernance, this thesis is aligned with the prevailing UNFCCC definition of climate change. This is due to its emphasis on the climate change inducing human processes that the largely procedural applications of blockchain seek to govern. The applications of blockchain to climate are understood to be part of a broader “procedural turn” in climate governance - by virtue of modifying or improving existing monitoring, reporting and verification (MRV) processes and therefore placing a greater emphasis on “getting the process right” than substantive outcomes in and of themselves (Gupta, 2008).

Such an emphasis stands in contrast to, for example, geoengineering technologies which might focus more broadly on the ultimate climate effects of combined natural and human processes (where a more general and less anthropocentric definition of climate change might be relevant).

Article 1 of the UNFCCC defines climate change as:

"a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.” - (UNFCCC, 2003)

Taking into account this specified definition of climate change and the earlier provided definition of cryptogovernance, the conceptual focus of this thesis - climate cryptogovernance - is defined as follows:

“The processes that create the conditions within the political realm for ordered rule and collective action toward mitigating anthropogenic greenhouse gas emissions, through the deployment of cryptographic technology.”

To draw the introduction to a close and foreground the chapters that will expand on this central concept of climate cryptogovernance, a brief outline of this thesis will be provided.

1.5 Overview of Chapters

This thesis is divided into eight chapters, which explore dominant conceptualisations of climate cryptogovernance by actors associated with international climate bureaucracies from 2016 to 2018. Chapter 1 has introduced the thesis and its aims. The remaining chapters are as follows:

Chapter 2 - Contextualising Climate Cryptogovernance

Chapter 2 serves as a more detailed background to climate cryptogovernance. Building on the introduction provided in the first chapter, it provides a deeper and more technical introduction to blockchain technology in the context of climate change governance. Areas elaborated upon include the policy context that climate cryptogovernance occurs in, the origins of blockchain in bitcoin, how blockchain technology works, the applications of blockchain and the historical use of blockchain for climate governance.

Chapter 3 - Theoretical Perspectives

Chapter 3 raises the multiple theoretical perspectives that are adopted throughout this thesis. Section 3.1 starts with a general discussion of dominant theoretical perspectives within the study of international climate politics. The chapter continues to zoom in to the specific theoretical and methodological approach taken in section 3.2, argumentative discourse analysis (ADA), and also raises a typology of mainstream discourses in international climate politics. Section 3.3 then raises a selection of theoretical perspectives that supplement ADA in chapter 6 to critically interrogate the dominant storyline of climate cryptogovernance. These include governmentality studies, science and technology studies and critical transparency studies.

Chapter 4 - Research Approach

Chapter 4 discusses the ontological and epistemological stance adopted in the thesis and then showcases the methodological approach adopted. Starting with the general research strategy, the chapter goes on to detail the specific procedures that were undertaken to carry out discourse analysis. Selection criteria during data collection and an overview of the collected sample of data is provided at the end of the chapter.

Chapter 5 - Distilling Climate Cryptogovernance

Chapter 5, which represents the first part of empirical analysis, sees the ADA approach adopted to distil the dominant conceptualisations of climate cryptogovernance by international climate bureaucracies and their associates. Using the storyline as an overarching concept (Hajer, 2010), a dominant storyline of climate cryptogovernance is broken down into eight components. These components elaborate upon how blockchain can be an effective technology to govern the global climate.

Chapter 6 - Interrogating Climate Cryptogovernance

Chapter 6, which marks the second part of empirical analysis, will utilise the findings of chapter 5 to critically interrogate the dominant storyline of climate cryptogovernance. Chapter 6 probes the findings of the ADA analysis by harnessing perspectives from governmentality studies, science and technology studies and critical transparency studies. Chapter 6 ultimately raises a variety of alternative perspectives that challenge the knowledge claims made in the eight identified components of the dominant storyline of climate cryptogovernance.

Chapter 7 - Discussion

Chapter 7 will shift focus towards the potential implications of the dominant storylines of climate cryptogovernance for reinforcing or challenging prevailing approaches to climate governance. By juxtaposing the claims of the dominant storyline of climate cryptogovernance against the counterclaims of critical perspectives, a tentative reading of what implications of blockchain might have on the future trajectory of climate governance will then be presented. This chapter will end with a discussion of the validity of the analysis presented, with reference to the possible limitations of the approach adopted in the thesis.

Chapter 8 - Conclusion

To draw the thesis to a close, chapter 8 summarises the analysis presented in chapters 5 through 7. The conclusion will draw out the broader implications of the findings of this thesis, offering final perspectives and recommendations related to climate cryptogovernance.

2. Contextualising Climate Cryptogovernance

Having introduced climate cryptogovernance in the first chapter, this chapter will further contextualise climate cryptogovernance to inform later empirical chapters which assume a basic knowledge of blockchain and climate policy. First, this chapter will provide a more detailed history of climate policy, international climate bureaucracies and blockchain itself. This will be done to place climate cryptogovernance against a backdrop of existing policy and technological developments. The chapter will then continue to outline the prevailing strategies through which climate cryptogovernance is achieved, and conclude with a discussion of energy usage.

2.1 The Policy Backdrop to Climate Cryptogovernance: Rio, Kyoto and Paris

In the shadow of the seemingly effective framework convention and protocol established to tackle ozone depletion - an issue with similar features to that of climate change (Sunstein, 2006) - in December 1990 the UN General Assembly established the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change (UNFCCC, 2018b). This led to the creation of the United Nations Framework Convention on Climate Change (UNFCCC), which opened for signature at the 1992 Earth Summit in Rio de Janeiro, Brazil and entered into force in 1994 (UNFCCC, 2003). At the heart of this international environmental treaty was the objective to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (ibid.). As a framework convention, the UNFCCC operates through specific international treaties (including protocols or agreements) which may be negotiated to specify further action towards the aforementioned objective of the UNFCCC.

At the third conference of the parties (COP), the world's first greenhouse gas emissions reduction treaty was adopted in the form of the Kyoto Protocol (UNFCCC, 1998). Though attempts were made to enhance the effectiveness of the Kyoto Protocol throughout its lifespan, through innovative mechanisms such as the clean development mechanism, joint implementation and emissions trading (UNFCCC, 2018b), the Kyoto Protocol was ultimately ineffective (IEM, 2006; Sunstein, 2006; Eckersley, 2007; Victor, 2011). With the impacts of climate change still looming in the distance, calls to rejuvenate the UNFCCC in light of the failures of the Kyoto Protocol culminated in the Paris Agreement of 2015 (UNFCCC, 2015) - with a brief detour via the Copenhagen Summit of 2009 which resulted in toothless outcomes.

The UNFCCC describes the Paris Agreement as a:

"landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future." - UNFCCC (2018c)

A selection of some of the key articles of the Paris Agreement that have particular relevance for contextualising the phenomenon of climate cryptogovernance are as follows (UNFCCC, 2015):

- *Long-term temperature goal (Article 2)* – reaffirms the goal of limiting global temperature increase to well below 2 degrees celsius, while pursuing efforts to limit the increase to 1.5 degrees celsius.

- *Mitigation (Article 4)* – establishes binding commitments by all Parties to prepare, communicate and maintain a nationally determined contribution (NDC) and to pursue domestic measures to achieve them.

- *Voluntary cooperation/Market- and non-market-based approaches (Article 6)* – recognises the possibility of voluntary cooperation among Parties to allow for higher ambition and sets out principles – including environmental integrity, transparency and robust accounting – for any cooperation that involves international transferal of mitigation outcomes.

- *Finance, technology and capacity-building support (Articles 9, 10 and 11)* – strengthens international cooperation on climate-safe technology development/transfer and building capacity in the developing world under a technology framework.

- *Climate change education, training, public awareness, public participation and public access to information (Article 12)* - encourages social engagement with climate change and associated issues for the populations of Parties to the agreement.

- *Transparency (Article 13), implementation and compliance (Article 15)* – seek to implement a robust transparency and accounting system to provide clarity on action and support by Parties, with flexibility for their differing capabilities of Parties.

In addition to these articles, the first decision taken by the agreement at COP21 also sets out a number of measures to enhance action prior to 2020 (UNFCCC, 2018c). These include strengthening the technical examination process, measures to strengthen high-level engagement and provision of urgent finance, technology and support. The decision also welcomes the efforts of all non-party stakeholders to address and respond to climate change, including those of civil society, the private sector, financial institutions, cities and other subnational authorities.

It is in the wake of the Paris Agreement, and its commitment towards actions and investment for a low-carbon, resilient and sustainable future, that the incorporation of blockchain into climate policy has begun to take place. For this reason, this thesis will often make specific reference to the Paris Agreement when discussing the presence of blockchain in climate policy. Indeed, given that international climate politics is situated around an agreement that explicitly encourages innovation, transparency, market-based approaches and multi-stakeholder engagement, it is no surprise that there has been a surge in interest in blockchain by climate policymakers. This surge of interest has been true of a variety of actors, including a collective of relatively influential organisations that oversee the creation and implementation of international environmental policy at the highest level - intergovernmental climate bureaucracies.

2.2 The UNFCCC and World Bank in Climate Cryptogovernance

In exploring climate cryptogovernance in international environmental politics, a number of possible sites of analysis across various scales exist. For the purpose of this thesis, a focus will be maintained on the international climate bureaucracy and associated organisations as a specific site of analysis.

It has already been mentioned in this introduction that intergovernmental organisations are presumed to be particularly influential in climate cryptogovernance. Given that it is these intergovernmental organisations that often become forums for the facilitation, creation and implementation of environmental policy by multiple actors on the global scale, it might seem logical that this would be the case. However, many theorists have explicitly focused on the role of intergovernmental organisations as actors in their own right, theorising them as international bureaucracies.

Biermann and Siebenhuner (2009) define international bureaucracies as:

“agencies that have been set up by governments or other public actors with some degree of permanence and coherence and beyond formal direct control of single national governments (notwithstanding control by multilateral mechanisms through the collective of governments) and that act in the international arena to pursue a policy.” - Biermann and Siebenhuner (2009: 37)

These are characterised through a hierarchically organised group of international civil servants with a given mandate, resources, identifiable boundaries and set of formal rules and procedures within the context of a policy area (Biermann and Siebenhuner, 2009). Such bureaucracies in the context of climate governance can include the secretariats of international environmental treaties, such as the UNFCCC secretariat, and the environmental wing of the secretariats of international organisations that typically govern beyond environmental policy, such as the World Bank. Indeed, the UNFCCC (2018a) and World Bank (2018) in particular have played influential roles as climate bureaucracies in raising the profile of blockchain for climate change. This is one of the main reasons that this thesis maintains a general focus on the activities of these climate bureaucracies and the non-bureaucratic actors that they associate with.

In the case of the UNFCCC, the push toward harnessing blockchain in the sphere of climate change has been spearheaded by a number of notable climate bureaucrats, including associate programme officer Alexandre Gellert Paris, who claims that:

”blockchain could contribute to greater stakeholder involvement, transparency and engagement and help bring trust and further innovative solutions in the fight against climate change, leading to enhanced climate actions” - UNFCCC (2017)

Specifically, the UNFCCC (2017) identifies the following specific benefits of harnessing blockchain technology to tackle climate change in an oft-cited 2017 article:

- ❏ Improved carbon emission trading (e.g. guaranteeing transparency in REDD+)
- ❏ Facilitated clean energy trading (e.g. peer to peer micro-grid trading)
- ❏ Enhanced climate finance flows (e.g. developing crowdfunding transparent ways)
- ❏ Better tracking of GHGs and less double counting (e.g. for the monitoring of NDCs

On 22nd January 2018, the tentative interest expressed by the UNFCCC was upgraded to an outright recognition of the potential of blockchain, in a press release titled “UN Supports Blockchain Technology for Climate Action” (UNFCCC, 2018a). Massamba Thioye, another leading figure in the UN’s work on exploring DLT and blockchain, stated that:

“the UN Climate Change secretariat recognizes the potential of blockchain technology to contribute to enhanced climate action and sustainability.” - UNFCCC (2018a)

The fact that the UNFCCC in particular has come out in support of blockchain has significant implications. Academic literature on the UNFCCC has highlighted the substantial cognitive influence of the UNFCCC, as it has been one of the key sources of information for policymakers, negotiators, media, science, business and civil society in the context of climate governance (Busch, 2009). The UNFCCC plays a substantial normative role in providing useful technical advice to facilitate climate policy (Depledge, 2005), and supports climate negotiations both in terms of negotiation management and logistics. However, their role is better characterised as guiding rather than dictatorial, with the UNFCCC playing a key role in identifying options for agreement and assisting implementation without prescribing particular approaches for actors to adopt (Busch, 2009).

Another influential environmental bureaucracy in the context of climate cryptogovernance is the World Bank. In addition to releasing an extensive working paper on Blockchain and emerging digital technologies for enhancing post-2020 climate markets, the World Bank (2018) has collaborated with a range of blockchain and climate orientated organisations. The most notable examples of these are the Hack4Climate, Innovate4Climate and Tech4Climate initiatives of the broader Connect4Climate (2018a) partnership, where the World Bank Group works together with the Italian Ministry of Environment and German Federal Ministry for Economic Cooperation and Development to “take on climate change by supporting ambitious leadership, promoting transformative solutions and empowering collective action”. The co-organisation of associated conferences are further manifestations of the World Bank’s interest in developing climate-orientated blockchain based solutions, including the Innovate4Climate conference and #Hack4Climate 2017 (Connect4Climate, 2018b).

These subtle but substantial developments align with how mainstream academic literature tends to describe the influence of the World Bank as an environmental bureaucracy. Marchinski and Behrle (2009) demonstrate how the World Bank plays an understated but significant normative role in shaping the way international agreements are operationalised and implemented, facilitating transnational cooperation on the regional scale and leading partnership formation. Due to its links to the private capital market, involvement in interest generating activities and relative freedom to pursue its own initiatives (ibid.), the World Bank has historically been one of the environmental bureaucracies with the largest amount of disposable resources and financial autonomy to experiment with emerging technologies such as blockchain (Nielson and Tierney, 2003).

An understanding of the policy context of climate change is a necessary preface to a discussion of blockchain in international climate change policy. However, at the heart of climate cryptogovernance is undoubtedly blockchain technology itself. In order for the communications of climate cryptogovernance advocates to be fully understood, a deeper technical exploration of blockchain and its applications is required.

2.3 Before Blockchain

Although blockchain has become increasingly recognisable in the sphere of climate governance, as evidenced in the introduction of this thesis, this is not to say that blockchain is simple or necessarily understood by the average climate policymaker. Blockchain and distributed ledger technologies (DLTs) encompass a vast range of technological solutions that are joined by a shared reliance on cryptography and the use of a growing list of records known as blocks, but in other senses can be very different. As will be demonstrated in this section, one application of blockchain can vary greatly to that of another, even in a single issue area such as climate change. To avoid essentialism and misrepresentation in the proceeding discussions about blockchain-based solutions targeted at climate change, it is vital to place in context the origins of blockchain and provide a basic outline of its functioning.

The first blockchain-like technology emerged in 1991, in a publication by Haber and Stornetta (1991) titled "How to time-stamp a digital document". In this article, they proposed a robust time-stamping solution for documents (including text, audio, video and so on) that ensured that users could not tamper with metadata (data that describes other data, including files) by backdating or forward-dating a document. Using cryptographic technology to do so, this solution to time dating used an elementary version of the technology that blockchain harnesses - a cryptographically secured chain of blocks. Cryptography has been a key discipline in the development of blockchain from its earliest inception, loosely defined by Katz and Lindell (2007: 3) as "the scientific study of techniques for securing digital information, transactions, and distributed computations".

Haber and Stornetta's predecessor technology to the blockchain was developed upon by other cryptographers as early as in 1993 to incorporate Merkle Trees, which are a feature of modern blockchain technology (Bayer et al., 1993). Over the next two decades or so, further technological developments specific to blockchain and within the broader context of information communications technology occurred to culminate in the invention of the modern blockchain in 2008 (see Narayanan et al. [2016] for a more detailed history of these developments).

2.4 The Invention of Blockchain

The modern blockchain was brought into existence in 2008 by an anonymous person (or group of people) known as Satoshi Nakamoto. Nakamoto (2008) theorised the blockchain in a paper outlining the now prominent Bitcoin cryptocurrency. It is worth mentioning that the phrase blockchain was not coined by Nakamoto and is instead a combination of two words (block and chain) used heavily in theorising bitcoin which has organically combined into common usage. The following paragraph will explain why Nakamoto saw a need for blockchain and bitcoin, along with how the blockchain that Nakamoto formally invented works.

Writing in the aftermath of the 2008 global financial crisis, Nakamoto (2008: 1) diagnosed an “inherent weaknesses of the trust based model” of internet commerce, where financial institutions often serve as trusted third parties to process electronic payments. The following are identified as prime issues with a trust based model mediated by financial third parties:

- ❑ 1. Cost of mediation increases transaction costs, which...
    - ❑ a. limits the minimum practical transaction size
    - ❑ b. cuts off the possibility for small casual transactions
- ❑ 2. Loss of ability to make non-reversible payments for nonreversible services, which…
    - ❑ a. allows the possibility of reversal, causing the need for trust to spread

To solve these issues, Nakamoto (2008) proposed that a virtual mechanism that functions like physical currency is needed to avoid cost and payment uncertainties, rendering the middleman that is required to make online payments obsolete. Nakamoto (2008) puts forth the following as a necessary technological development:

“an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party. Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers.” - Nakamoto (2008: 1)

In response to this need, Nakamoto proposes the bitcoin, underlain by blockchain technology. In a 2008 Bitcoin white paper, Nakamoto (2008: 1) presents a novel solution to the earlier identified double-spending problem, using a “peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions”. This, in essence, is what a blockchain is. The structure and functioning of a blockchain are outlined in this section.

Explaining blockchain in a short space of words is by no means simple, and what will be presented here is instead a broad outline of the features of blockchain that underlie its applications, as opposed to a thorough technical review. Overleaf, a brief explanation of the structure of a blockchain will be given, based on Nofer et al. (2017) and Zheng et al. (2016). For a more technical description, readers are encouraged to consult Zheng et al. (2016) directly.

2.5 The Structure of a Blockchain

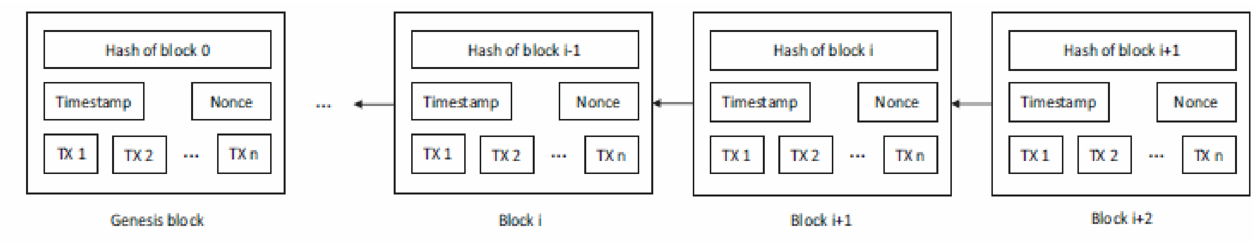

Figure 1 - Structure of a Blockchain (Extracted from Nofer et al., 2017)

A blockchain is a distributed ledger composed as a chain of data packages (blocks), where a block comprises multiple transactions (Zheng et al., 2016). The individual blocks which comprise a blockchain possess the following (visible in the diagram above):

- *Transaction Data (TX 1, TX2 etc.)* - The transaction data refers to the transaction information held within a block. For example, the transaction data for cryptocurrencies such as bitcoin often includes the sender, receiver and amount of coins of a given transaction (Nofer et al., 2017).

- *Timestamp* - This is simply a current timestamp at any given time, expressed as seconds since 1970-01-01 at 00:00 UTC (Nofer et al., 2017).

- *Hash Value of the Previous Block* - Each block is 'chained' to a previous block via a hash value - which in essence acts as an identifier of a block. This allows for the blocks to be arranged in a chain through *hashing* (Nofer et al., 2017). The previous block (which a block is chained to through the expression of this block's hash value) is known as a parent block. This referentiality of blocks ensures connectivity of the entire blockchain through to the first block in the chain (the ‘‘genesis block’’) (ibid.). Hashing is what creates a blockchain that cannot be tampered with, as tampering with a block causes the hash of a block to change which would make all blocks in the chain invalid (ibid.).

- *Nonce* - The nonce is a random number used for verifying the hash of a block through the *proof-of-work* mechanism. The cryptographic proof-of-work mechanism rules out the possibility that the blocks could be simultaneously tampered with by intentionally changing the hash values across the entire blockchain (Nofer et al., 2017). The proof-of-work mechanism achieves this by slowing down the creation of new blocks by requiring

> that cryptography is used to determine the hash of a block through the information provided by a nonce. It is because of the existence of the nonce that each block can possess a verifiable hash, equivalent to a unique identifiable fingerprint, which other blocks can link to through the proof-of-work mechanism (ibid.).

In describing the basic features of a blockchain, two important mechanisms that ensure that blockchain can outsource trust to computer code have arisen - *hashing* and *proof-of-work*. *Hashing* ensures that data cannot be tampered with, as this would break the referential chain comprised of blocks that feature the hash value of the previous block (Nofer et al., 2017). The *proof-of-work* mechanism ensures that the hash values of all blocks cannot be tampered with simultaneously by slowing down the creation of new blocks.

A third important mechanism comes into play when the majority of nodes in the network agree by a *consensus mechanism* on the validity of transactions in a block and on the validity of the block itself (Nofer et al., 2017). If this agreement via the consensus mechanism occurs, a block can be added to the chain (ibid.). According to Swanson (2015), this consensus mechanism:

''is the process in which a majority (or in some cases all) of network validators come to agreement on the state of a ledger. It is a set of rules and procedures that allows maintaining coherent set of facts between multiple participating nodes.'' - Swanson (2015: 4)

Therefore new transactions are not automatically added to the ledger. Rather, the *consensus mechanism* ensures that these transactions are stored in a block for a certain time (for example, 10 minutes in the case of Bitcoin blockchain) before being transferred to the ledger (Nofer et al., 2017). Afterwards, the information in the blockchain can no longer be changed.

To summarise, an archetypal blockchain prevents the tampering of transaction data through i. *hashing* (being connected to the Hash Value of the Previous Block) ii. *proof-of-work* (requiring a proof-of-work to be completed for each block, which requires time and computational resources) iii. *consensus* (requiring validation of usually more than 50% of the peer to peer network). It is these three basic features of a blockchain that ensure the fundamental promise of blockchain: that trust in transactions can be outsourced from intermediaries into computer code.

2.6 Implications of the Structure of a Blockchain

Having provided a basic technical overview of blockchain, focus will now shift to the implications of these technical features of blockchain. The applied explanation of blockchain provided below is an adaptation of an introductory overview by Savelyev (2017), who considers the legal and political implications of blockchain and condenses the inner-workings of blockchain into several key features accessible to laypeople. Given that the archetypal blockchain was designed in the context of bitcoin (ibid.), the features of blockchain introduced in this section will be oriented toward a traditional cryptocurrency application, though it is also these same features of bitcoin which allow for the myriad of other applications of blockchain to climate change policy that will be introduced in later sections 2.7 and 2.8. The key implications of blockchain's features are as follows:

- ❑ Decentralisation
- ❑ Value through mathematical algorithm.
- ❑ Absence of a single administrator of transactions.
- ❑ Resilience to data manipulations from outside.

2.6.1 Decentralisation

In theory, blockchain-based technologies do not have a centralized trusted authority (Nofer et al., 2016). In contrast to conventional administrative systems, the oversight of the blockchain transactions is instead carried out by a network of communicating nodes (Savelyev, 2017). Fundamentally, cryptocurrencies are nothing more than a computer file, created on the basis of an algorithm that is processed on computing power belonging to decentralised cryptocurrency community members. For example, in the case of bitcoin, even the Bitcoin protocol developers do not have control over Bitcoin-related transactions (Savelyev, 2017). As the relevant code for bitcoin is distributed on the basis of an MIT open-source license, it is available for inspection by any person that may wish to view it, and is subject to the possibility of modifications, which can become a standard only if accepted by the majority of a community using said technology (ibid.). However, it is vital to note that this decentralisation may not be the case for all DLT solutions, and different technologies may have different levels of administrator oversight (ibid.).

2.6.2 Value Through Mathematical Algorithm

Blockchain-based cryptocurrencies have no specific intrinsic value, (as with commodities with limited availability like gold), and there is no universal governmental authority (as in fiat money) behind blockchain (Savelyev, 2017). However, this is not to say that value does not exist in currency oriented blockchain applications. In the case of blockchain, value and validity is created through mathematics, cryptography, and computer code. In the context of cryptocurrencies specifically, units are created during a process known as 'mining' (Nofer et al., 2017). Each individual who has installed specialized software may 'mine' a cryptocurrency unit as a reward for solving a complex mathematical problem, associated with verification of transactions performed with said cryptocurrencies (Savelyev, 2017). With the example of the bitcoin currency and several other cryptocurrencies, the complexity of such problems grows over time with the amount of transactions stored in the Bitcoin network. The ultimate number of Bitcoins is defined by the protocol, and amounts to 21 million units (ibid.). As computational power is an inherently limited resource due to costs incurred by hardware and electricity used, this is limited availability is where bitcoin maintains value from.

2.6.3 Absencence of a Single Authority

As mentioned by Nakamoto (2008), it is commonly acknowledged that electronic money is subject to the risk of double-spending. Unlike physical currency, electronic money (like any regular computer data or file) can be duplicated and therefore be spent more than once (Savelyev, 2017). This is also true of other intangible assets that are traded on markets like money, such as sequestered carbon or some types of marketised ecosystem services in the case of market-based environmental policy mechanisms. The way that conventional electronic money prevents double-spending is by using a trusted central administrative body, such as Paypal, which goes through an established process for authorisation for each transaction undergone (Savelyev, 2017). While this is a valid solution in theory, a consideration in practice is that a great deal of power is held with this central administrative body, with implications for administrative errors, system overload and corruption (ibid.). Blockchain resolves the double-spending problem by using a peer-to-peer network, by listing all transactions ever performed in a decentralised and publicly available database (Nakamoto, 2008). To return to the case of bitcoin, every new transaction is distributed throughout the network and verified by miners (Nofer et al., 2017). It is subsequently fixed with a record of the time it was made (the timestamp) and the unique hash of a block (Zheng et al., 2016). Due to this process, the possibility to trace the entire history of transactions exists, with each particular bitcoin unit existing within a database of all transactions – the blockchain (Savelyev, 2017).

2.6.4 Resilience to Manipulation

Through cryptography, which is used to create records in the blockchain database, tampering with the contents of records is inhibited. When two users perform a transaction, such as the exchange of Bitcoin units, an encrypted record of the transaction is transmitted to all the other nodes in the network. In turn, these other nodes "verify the transaction by performing complex cryptographic calculations on the data in the record ('mining'), and notify one another each time a new 'block' of transactions is confirmed as legitimate" (Sabella et al., 2018: ch. 17). When the majority of the nodes agree that a block passes review, the nodes all add it to the Blockchain database and use the updated version of this database as a cryptographic basis for future encryption and verification of transactions (Savelyev, 2017). As explained when discussing the structure of a blockchain earlier in this section, the self-referentiality of the chain of blocks is guaranteed, as each block is connected chronologically to the previous block's hash.

Tampering is prevented, as each block is also computationally impractical to modify once it has been in the chain for a while. This is due to the fact that every block after it would also have to be regenerated, rendering it virtually impossible to rewrite information about a certain transaction once it is incorporated into the blockchain (Savelyev, 2017). Indeed, due to the consensus mechanism, such information will be rejected by the network, unless the intruder carrying out the tampering or manipulation managed to possess more than 50% of the overall computational power of the blockchain network (which would require an immense amount of inherently limited computational resources) (Swanson, 2014). As such, all members of the of a specific blockchain technology network have a single, shared version of 'truth', which is effectively irreversible (ibid.). This is the feature of blockchain that can create an unprecedented level of trust. The implication of these four structural features of blockchain is that blockchain has been implemented in a broad variety of other solutions, as will be explored in the following section which details the general applications of blockchain.

2.7 General Applications of Blockchain

Having explained the fundamentals of blockchain technology, focus will now shift to the theoretical applications of blockchain. Before outlining the applications of blockchain to the climate specifically, the general applications of blockchain will be briefly explained to theoretically ground some of these applications and place the climate applications of blockchain in the context of a broader trend towards the mainstream appropriation of blockchain. Cryptocurrencies, which have already been mentioned in length in the previous section, are one main general application of blockchain. However, since the invention of Bitcoin, the applications have branched out from cryptocurrencies to a myriad of “blockchain 2.0” solutions (Swartz, 2018).

Of these, one of the most relevant applications of blockchain for governance is the blockchain-based smart contract. The smart contract was originally theorised by Szabo (1997), who proposed that computer protocols be combined with user interfaces to execute the terms of a contract. The premise of the smart contract is that some types of contractual clauses (including collateral, bonding, delineation of property rights) can be embedded in computer code in a manner that could make breaches of contract costly for the breacher (ibid.). Szabo (1997) uses a vending machine as a simplified analogy to illustrate how a smart contract might function:

“Within a limited amount of potential loss (the amount in the till should be less than the cost of breaching the mechanism), a vending machine takes in coins, and via a simple mechanism… dispense[s] change and product according to the displayed price. The vending machine is a contract with bearer: anybody with coins can participate in an exchange with the vendor. The lockbox and other security mechanisms protect the stored coins and contents from attackers, sufficiently to allow profitable deployment of vending machines in a wide variety of areas. Smart contracts go beyond the vending machine in proposing to embed contracts in all sorts of property that is valuable and controlled by digital means.” - Szabo (1997)

Although at the time Szabo (1997) was writing, smart contracts were relatively challenging to operationalise, the advent of blockchain has made smart contracts all the more possible (Nofer et al., 2017). For example, Fairfield (2014) discusses the possibilities of blockchain in enforcing contract law, suggesting that it could be used in place of the legal and financial institutions previously required in overseeing the conditions of contracts for asset deals. This has been particularly true with the advent of Eretheum.

Eretheum is a blockchain based decentralised system that, unlike the currency-oriented focus of Nakamoto's original blockchain which was designed for the operation of the bitcoin economy, allows for running the programming code for any decentralized application (Buterin, 2014). Nofer et al. (2017) note that using blockchain technology, a variety of assets could be incorporated into smart contracts, including tangible assets (e.g. houses, cars) and intangible assets (e.g. shares, access rights). As above, trust is assured in this smart contract through the use of computer code, as, blockchain technology "allows [users] to establish contracts using cryptography and to replace third parties (e.g, a notary) that have been necessary to establish trust in the past" (Nofer et al., 2017: 185). This blockchain-based smart contract model has substantial implications for many market-based environmental policy mechanisms, with payments for ecosystem services and REDD+ transactions offering just two examples of where a contract exists between service provider and payer which could theoretically be written into computer code (Bolt, 2018).

The smart contract is just one of a number ways that blockchain technology has been able to branch out from peer to peer cryptocurrencies such as bitcoin and into other fields, but it is perhaps the most notable for climate governance and the monitoring, reporting and verification (MRV) of greenhouse gas emissions specifically. Before these climate specific applications of blockchain are unpacked further, a broad overview of the general applications of blockchain beyond cryptocurrency and smart contract applications is provided for context.

The table overleaf, extracted from Nofer et al. (2017), provides a brief summary of the myriad of financial and non-financial uses of blockchain - several of which will be elaborated upon in the context of climate change policy specifically in the following section.

Type	Application	Description	Examples
Financial Applications	Cryptocurrency	Networks and mediums of exchange using cryptography to secure transactions.	Bitcoin; Litecoin; Ripple; Moner.
	Securities Issuance, trading and settlement	Companies listing public issue shares directly and without a bank syndicate. Private, less liquid shares can be traded in a blockchain-based secondary market. Early projects try to tackle securities settlement.	NASDAQ private equity; Medici; Blockstream; Coinsetter
	Insurance	Properties (e.g. real estate, automobiles, etc.) might be registered using blockchain. Insurers can check the transaction history.	Everledger
Non-Financial Applications	Notary Public	Central authorization by notary is not necessary anymore, and can be replaced by decentralised blockchain.	Stampery; Viacoin; Ascribe.
	Decentralised proof of existence for document	Storing and validating the signature and timestamp of a document using blockchain.	proofofexistence.com
	Decentralised storage	Sharing documents without the need of a third party by using a peer-to-peer distributed cloud storage platform.	Storj
	Decentralised internet of things	The blockchain reliably stores the communication of smart devices within the internet of things.	Filament ADEPT (developed by IBM and Samsung)
	Anti-counterfeit solutions	Authenticity of products is verified by the blockchain network consisting of all market participants in electronic commerce (producers, merchants, marketplaces).	Blockverify
	Internet applications	Instead of governments and corporations, Domain Name Servers (DNS) are controlled by every user in a decentralized way.	Namecoin

Table 1 - Applications of Blockchain (Extracted from Nofer et al., 2017)

Blockchain has thus been harnessed by a diverse range of developers to meet a broad variety of goals, with relevance for governance across a range of issue areas. Given that this thesis has an explicit focus on the incorporation of blockchain into climate change policy, the applications of blockchain to climate change require further elaboration.

2.8 Climate Change Applications of Blockchain

In section 2.2, the four main ways that the UNFCCC (2018a) suggests blockchain could be harnessed in climate policy were briefly mentioned. This section expands on these four main areas of incorporation, as developed upon by Chen (2018). Delton Chen (2018) explores these applications in one of the earliest peer-reviewed academic journals devoted to blockchain technology & cryptocurrencies - the Journal of the British Blockchain Association.

The present climate change applications of blockchain area as follows:

- ❏ *a. Carbon stock-taking* for low-carbon projects and the Nationally Determined Contributions (NDCs) of parties to the 2015 Paris Climate Agreement;
- ❏ *b. Carbon offset trading* in carbon markets in relation to legal compliance and voluntary offsetting;
- ❏ *c. Peer-to-peer energy trading* in decentralized clean energy markets;
- ❏ *d. Cryptocurrencies* uncoupled with carbon markets, but orientated towards climate mitigation.

The most relevant of these to international climate politics are arguably carbon stock-taking and carbon offset trading, but given that the various proposed blockchain solutions are often entangled in one another when described in the communications of climate governance actors, this thesis maintains a broad focus on the myriad of blockchain-based solutions discussed. As such, in this subsection, each of these applications will be briefly described in turn, with some brief examples provided.

2.8.1 Carbon Stocktaking

One of the broadest and most widely discussed areas that it has been suggested that blockchain could bolster climate policy is through enhanced climate stocktaking. Carbon stocktaking is enshrined into the Paris Agreement, through the inclusion of article 4, which puts forth that all parties should prepare, communicate and maintain a binding nationally determined contribution (NDC) and pursue domestic measures to reduce carbon emissions (UNFCCC, 2015). Relatedly, article 14 of the Paris Agreement requires the CMA to periodically take stock of the implementation of the Paris Agreement over time, and to assess the collective progress of the NDCs in achieving the purpose of the Agreement and its long-term goals (ibid.). This process outlined in article 14 is called the global stocktake.

However, there have been widespread concerns that without transparent and standardised methodology, some nations would, either unintentionally or intentionally, shirk commitments to this emerging climate response that the Paris Agreement seeks to achieve (Millar et al., 2017). This is where commentators have suggested blockchain could play a role. Due to the vast complexities of these stocktakes and presently poor operationalisation of the commitments at the Paris Agreement, there is no one unitary way that commentators have suggested that blockchain be integrated into carbon stocktaking. Indeed, several proposed solutions exist at multiple scales (UNFCCC, 2018a; Chen 2018) - at the carbon 'supply chain' level of REDD+, the level of carbon markets and the aggregate level of nationally determined contributions.

<u>I. REDD+</u>

Ever since some of the earliest applications of smart contracts to the environment in payment for ecosystem service schemes (PES), commentators have discussed the incorporation of blockchain technology into Reduction of Emissions from Deforestation and forest Degradation (REDD). REDD was initially developed into the Kyoto Protocol in 2007 at COP 13 in Bali, and was further elaborated upon in 2010 at COP 16 in Cancun to become REDD+ and gain an extended title of "Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries" (Baryak and Murafa, 2016). At its most basic, REDD+ involves payments from developed nations to developing nation forest conservation projects, with the intention of maintaining the carbon sequestration services of these forests while preventing leakage (emissions occurring elsewhere) and ensuring permanence (sustained reduced emissions) and additionality (emissions above and beyond what would have otherwise occurred) (ibid.).

Although there have been notable criticisms of the current trajectory of REDD+, both in its misdiagnosis of the key contributors to deforestation (Weatherley-Singh and Gupta, 2015) and poor implementation (Brockhaus et al., 2014), REDD+ continues to play a key role post-Kyoto in the Paris Agreement. REDD+ forms a significant component of the nationally determined contributions (NDCs) of the Paris Agreement, and 56 out of 162 countries mention REDD+ (Hein et al., 2018). It has been suggested that blockchain could be used to enhance the implementation of REDD+ post-Paris Agreement, through the medium of the smart contract, outlined in the previous section. Such a proposal would work for REDD+ projects that function in the form of PES schemes (World Bank, 2018), under which payments are made to landowners who have agreed to take certain actions to manage their land or watersheds to provide an ecological service (in this case, services such as carbon sequestration that are provided through maintaining forest cover) (IIED, 2018a). Chen (2018) argues that to overcome the unique technical and political challenges that exist in REDD+ carbon sequestration projects based on forest management along the supply chain, smart contracts could be harnessed.

An example of this was the Smart Contract for Good programme that was thought up by industry group Carbon Conservation, and carried out in Indonesia (Koh, 2017). Through use of a blockchain based smart-contract, Carbon Conservation automatically distributed funding on an annual basis to villages in Aceh, when they purportedly reduced incidences of fire in a pilot project that began in late 2017 (ibid.). Due to the blockchain-based nature of the smart contract, the release of funds was automatic and the data log was permanently documented on an immutable, transparent and accessible record for donors to inspect. The funds were released using data from remote sensing or satellite imaging technology that monitors forest fires and/or ground site inspections (ibid.). The blockchain technology partner, Dappbase, explain that the rationale behind using such a blockchain-based Smart Contract in PES-like schemes aimed at reducing emissions from deforestation is that potential issues of red tape and corruption that would prevent distribution of aid money to communities can be circumvented (Ibid.). Additional projects that operate in a similar manner that have arisen include Gain Forest and Bitland (Chen, 2018).

II. Carbon Markets

Blockchain may be applied to streamline the overall aggregate functioning of mandatory carbon markets by enhancing monitoring, reporting and verification (MRV) of projects within markets. For example, a 2015 study by the Stockholm Environment Institute found that 0.6 billion metric tonnes of carbon dioxide were misallocated under the carbon markets of the Kyoto Protocol (Kollmuss et al., 2015). Similarly, Interpol has collaborated with environmental agencies from across the globe to undertake substantial research into carbon market crime, detailing how cartels have exploited the carbon market through fraud and tax evasion (Interpol, 2013).

One of the benefits that carbon markets offer as a policy mechanism is the incentivisation of low carbon development, as low-carbon projects typically receive carbon offsets/credits as a source of revenue for reducing carbon emissions and/or sequestering carbon (Chen, 2018). However, a major challenge in carbon MRV at this level is that the carbon amounts must accurately undergo measurement, reporting and verification and then also be monitored to avoid instances of leakage (where carbon emission is diverted and simply occurs elsewhere) or double counting. Not only are these accounting processes challenging to carry out at times, but they can also be vulnerable to freeriding and corruption (Chen, 2018). Due to the purported ability of blockchain to enshrine trust in computer code and ensure absolute transparency, it has been suggested that the technology could ensure effective MRV processes by mitigating these possibilities (Chapron, 2017).

III. Nationally Determined Contributions (NDCs)

When scaling up supply chain oriented stocktaking proposals to the international level, there are few concrete examples to speak of. Nevertheless, this has been a scale which commentators have highlighted. For example, the UNFCCC (2017) emphasise of the NDCs that blockchain:

“technology could provide more transparency regarding GHG emissions and make it easier to track and report emission reductions, thereby addressing possible double counting issues. It could serve as a tool to monitor the progress made in implementing the Nationally Determined Contributions, or ‘NDCs’ under the Paris Agreement…” - UNFCCC (2017)

Chen (2018) uses two examples from supply chains to suggest how accountability might be enhanced by blockchain in carbon stocktaking at the aggregate level of NDCs. Firstly, supply chain approaches, such as those that have been used to verify the origins of authentic and ethical diamonds or sustainable tuna, may have relevance for carbon stocktaking (WWF, 2018; Provenance, 2018). This proposed mechanism is not dissimilar to the way that blockchain has sometimes been used to enhance individual REDD+ project functioning, but vastly scaled up to the national level. By requiring data verification at each step in a supply chain, a blockchain ledger for carbon stocktaking could operate similarly to ensure that the supply chain for carbon stocktaking is monitored and recorded.

A second example that the UNFCCC (2018a) and Chen (2018) provide is that of the collaboration between IBM and Energy Blockchain Lab, who are currently working together to develop a blockchain platform for trading carbon assets in China (IBM, 2018). As Chen (2018: 5) proposes, “in theory, a similar approach could be used to record the carbon stock take of entire nations—helping to deliver on the Paris Climate Agreement.” As of May 2019, this represents one of the most detailed case studies demonstrating how blockchain might feasibly enhance transparency in the MRV processes of NDCs.

2.8.2 Voluntary Carbon Offset Trading

A second area in which it has been suggested blockchain could strengthen climate policy is in the context of voluntary carbon offsetting. The UNFCCC (2018a) suggested that blockchain could enhance MRV in the context of company targets. Owing to concerns that international carbon markets formed under climate agreements may suffer from a lack of ambition, voluntary carbon offsetting has been proposed (Bayon et al., 2012). Critics of conventional carbon markets argue that without stringent laws to raise carbon prices and reduce carbon emissions, current measures fall short (ibid.). Instead, individuals and organisations have the opportunity to purchase carbon offsets in the voluntary carbon market, facilitated by online carbon trade exchanges such as that developed by CTX (2018). It has been proposed that blockchain could be used to enhance these voluntary offsets markets. Two existing startups offer evidence for how this could occur.

Examples: Nori and Climate Coin

Nori (2018) uses blockchain technology to create the “world’s first carbon removal marketplace”. Buyers can pay for a verified carbon removal activity with a simple transaction that doesn’t require a broker. One Nori token is made exchangeable for one Carbon Removal Certificate (CRC) (ibid.). One CRC is equivalent to 1 tonne of carbon dioxide (or its equivalent warming potential in other greenhouse gases like methane and/or nitrous oxide) removed from the atmosphere and stored elsewhere (such as in the soil, plants, materials, minerals, the earth’s geologic subsurface area, the oceans or other aquatic reserves) (ibid.). As a result, Nori (2018) claim that through their offerings, there is for the first time a market-driven price on removing 1 tonne of carbon dioxide from the atmosphere.

WIth Nori’s DLT-based platform, the way that the efficient voluntary marketisation of carbon is achieved through blockchain is as follows (adapted from Nori, 2018):

- ❏ a. a project lists itself in the Nori platform by uploading information defining project location and boundaries as well as historical operating data.
- ❏ b. the project submits a carbon removal claim report. Annual operating data updates must be verified before Nori can issue CRCs.
- ❏ c. a verifier confirms that the supplier’s data is valid and that the carbon dioxide has been removed and measured correctly. This verification is attributed in the smart contract.
- ❏ d. the CRC is listed for sale in the Nori market queue in a first-in, first-out basis.
- ❏ e. once at the front of the queue, the next buyer purchases the CRCs by sending NORI tokens to the smart contract acting as market operator for the CRC.
- ❏ f. the CRC owner immediately changes to the sending address of the NORI tokens in step five. The CRC smart contract record is now “retired” and no longer allows a change of ownership.

Each of these steps occurs on the public blockchain. Through the interface of Nori (2018), anyone interested could potentially trace the history of who removed the carbon dioxide, how it was verified to be removed, who purchased the CRCs, and when the transaction took place. The transparency of the blockchain provides cryptographic proof that what is stated on the blockchain is what actually occurred in the digital world, thus ensuring easy auditability of the lifecycle of the CRC (Nori, 2018).

Similarly, Climate Coin (2018), a cryptoasset based in Ethereum technology, allows users to buy carbon credits to either offset their own carbon emissions or to keep as an investment (as carbon credits are anticipated to appreciate in value over time). Their stated aim is to:

"democratise the carbon system… by creating a technology infrastructure that allows individuals and corporations to compensate their offsets by buying carbon credits through [Carbon Coin's] tokens, and zero/negative emission producers to monetise their position by perceiving additional income directly peer to peer without intermediaries" - Climate Coin (2018)

2.8.3 Peer to Peer Energy Trading

A widely anticipated application of blockchain to the energy market, with implications for climate change, has been the potential for blockchain to decentralise energy provision and provide accessible low-carbon alternatives to conventional energy sources (Chen, 2018). Advocates of decentralised energy have argued that allowing commercial and residential energy users to purchase electricity from renewable sources using a town grid or a local microgrid can cause substantial reductions carbon emissions generated by conventional energy systems (Hartnett, 2018). Blockchain technology offers promising opportunities for mainstreaming decentralised energy provision by providing the technology required to manage the decentralized power sharing, battery storage, feed-in tariffs, and other financial incentives on decentralised grids (ibid.). Chen (2018) offers three examples of where this has already ocurred: LO3 Energy's project called Brooklyn Microgrid (LO3 Energy, 2018); Power Ledger's platform for monetizing surplus energy (Power Ledger, 2018); and TenneT's pilot home energy network (TenneT, 2018).

To develop on the particularly notable first example, in Brooklyn, New York, LO3 developed a blockchain-based model in line with the new sharing economy, where although the “utility provider still maintains the electrical grid that delivers power, the actual energy is generated, stored, and traded locally by members of the community” through solar panels (LO3 Energy, 2018). The blockchain platform that achieves this is Exergy, which has sparked external interest and investment from large energy companies such as Centrica, a UK based energy firm (Centrica, 2018).

Exergy ensures that energy can be traded by staking token on a blockchain to access the marketplace (Exergy, 2018a). Available data and transaction behaviours are verified into blocks and, where needed, linked to the actual control of assets and functioning of energy transactions (Exergy 2018b). Exergy is an example of a blockchain that is not wholly transparent, and is instead a private, permissioned blockchain that is formed of a network of distributed computing nodes globally (ibid.). Some of these nodes are Exergy-enabled devices, developed by LO3 Energy and their associated third-party providers, which control, manage and validate actual electricity flows on the power grid. Others exist to verify and monitor marketplace rules and activity (ibid.).

Chen (2018) even speculates that “other blockchain applications will likely emerge, especially when electric vehicles put greater demand on the electricity grid as they replace the existing fleet of petrol and diesel vehicles”, raising interesting questions about the future climate impact of currently emission-heavy transportation (OECD and IEA, 2014).

2.8.4 Cryptocurrencies

A final way that it has been suggested that blockchain could play an active role in realising climate policy is through the trading of climate-oriented green tokens, or cryptocurrencies (Chen, 2018). These green tokens are disseminated with a climate-related philosophy, but unlike the blockchain-based solutions which focus on existing carbon markets, such as Nori and Climate Coin, the tokens’ supply and price are uncoupled to carbon metrics. These green tokens and cryptocurrencies might be characterised as a grassroots environmental movements that trade these assets within a ‘living laboratory’ of people who share a common aim, such as the crowdfunding of a project or the increasing of trade in a green token (Chen, 2018).

Some examples are CarbonCoin (CarbonCoin, 2018) and SolarCoin (SolarCoin, 2018). CarbonCoin (2018) is a cryptocurrency based on the Bitcoin protocol, but created with the goal of correcting a fundamental issue with using blockchain for environmental purposes that will be discussed in the following section - high energy consumption. CarbonCoin aims to achieve this by removing the need for mining for profit, which is the feature of cryptocurrencies that is responsible for using high volumes of electricity, and through the funding of planting of trees. This comes at a price of making the governance of CarbonCoin 'opaque' by removing the absolute transparency provided by conventional bitcoin (Chen, 2018), but nevertheless is a possible application of blockchain for the purposes of climate mitigation.

Conceptualised in an academic paper in around the time Bitcoin was starting to gain traction (Gogerty and Zitoli, 2011), SolarCoin is a blockchain-based currency that is issued into circulation when solar energy is verified to have been produced. The SolarCoin (2018) Foundation endows solar energy producers with DLT-based digital tokens at a rate of 1 SolarCoin (SLR) per MWh of solar energy produced. The blockchain used by SolarCoin is similar to that of bitcoin, in that it is a decentralized, incorruptible and auditable record of solar energy produced, but it uses a lower energy proof of stake algorithm which uses less than 0.001% of the power of Bitcoin (ibid.). However, the fundamental difference between SolarCoin and bitcoin-like currencies is that SolarCoin (2018) couples "the disbursement of digital coins to real world useful economic and environmental activity: verifiably produced solar energy". Solarcoin thus incentives investment by the anticipated growth in the generation of solar power over time.

2.9 The Elephant in the Room: Energy Demand

The cases of CarbonCoin and SolarCoin raises a notable conflict which has haunted discussions surrounding blockchain and climate. Though the aforementioned examples present ways in which blockchain can streamline climate policy, concerns have emerged that the energy demand that the proof-of-work mechanism requires could counteract any carbon mitigation benefits (Truby, 2018a). After all, to ensure that blockchain can provide the benefit of immutability that it does, the proof-of-work mechanism forces a deliberate use of computer processing and, by proxy, energy (Savelyev, 2017).

On the reverse side, it should be noted that not all blockchain based solutions require mechanisms as energy intensive as bitcoin-like technologies, such as SolarCoin and its energy efficient stake of use mechanism (Chen, 2018). Furthermore, for permissioned, commercial instances of blockchain, electricity demand is much lower. For example, Microsoft's Coco Framework offers an alternative to the proof-of-work of the Ethereum consortium network by using 'trusted enclaves' which greatly reducing latency and electricity demand (Microsoft, 2018).

Moreover, Chen (2018) highlights that the internet requires 4 to 6 times more energy than bitcoin generation, placing it on par with aviation as a source of carbon emissions, and that trade-offs between the environment and the digital economy may be inevitable. Due to the sheer complexity associated with estimating the energy demand of modern society with blockchain use in contrast a counterfactual society without blockchain, it is impossible to truly determine which would be more energy efficient. However, this is a consideration that has plagued discussions on blockchain and climate nonetheless, and will be considered going forward as the dominant ideas expressed about climate cryptogovernance are analysed.

2.10 Summary

Chapter 2 has provided contextual information related to blockchain and its climate applications. In doing so, chapter 2 has contextualised climate cryptogovernance. Topics explored include:

- ❑ The climate policy backdrop to climate cryptogovernance.
- ❑ The role of the UNFCCC and World Bank in climate cryptogovernance.
- ❑ The history of blockchain.
- ❑ The technology behind blockchain.
- ❑ The general applications of blockchain.
- ❑ The climate change specific applications of blockchain.
- ❑ The debate surrounding the energy usage of climate change specific applications of blockchain.

Having contextualised the central phenomenon of climate cryptogovernance, chapter 3 will introduce the array of theoretical perspectives that will be adopted in this thesis to examine climate cryptogovernance.

3. Theoretical Perspectives

The following chapter will provide an overview of the bodies of research that this thesis draws on and synthesise elements of these into a theoretical framework that will underpin analysis. Firstly, the dominant perspectives that exist in international climate politics will be briefly outlined to provide a background to the adoption of a discursive institutionalist analytical approach. Then, a deeper focus will be placed on the substituent bodies of research that form neo institutionalism to foreground one particular strand that will be adhered to in this thesis: discursive institutionalism. From a general description of discursive institutionalism, this section will then continue to zoom in to explore the theoretical and methodological basis for analysis: argumentative discourse analysis (ADA). Additionally, a typology of three discourses which will be combined with ADA to operationalise the notion of 'discourse' will also be introduced.

Having contextualised ADA within the study of international climate politics and introduced its middle-range concepts, additional theoretical perspectives that will inform analysis in the second half of this chapter will be also raised. These perspectives come from traditions such as governmentality studies, science and technology studies and critical transparency studies. To conclude this section, the various perspectives raised will be synthesised together, structured and summarised according to the later sections of empirical analysis to form a coherent theoretical framework for the thesis.

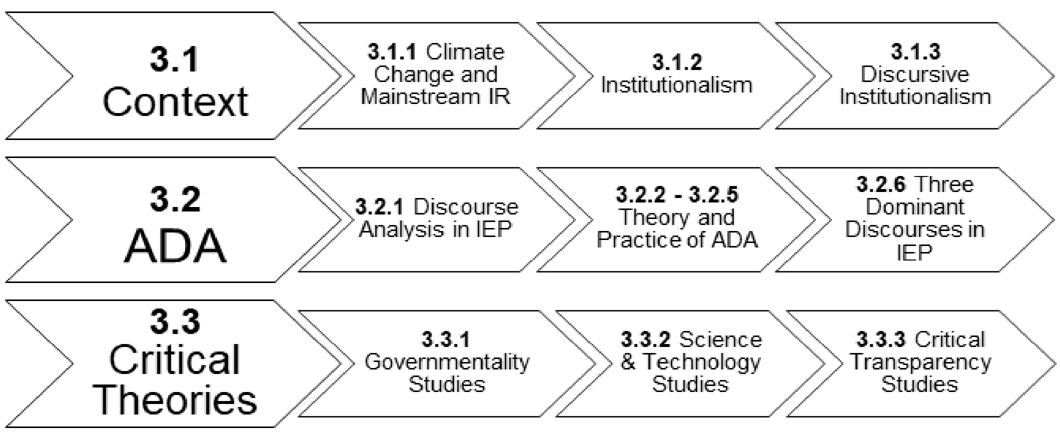

Figure 2 - Overview of Chapter 3.

Section 3.1 contextualises the theories of this thesis.
Section 3.2 introduces theories related to ADA, which are used primarily in chapter 5.
Section 3.3 introduces critical theories, which are used primarily in chapter 6.

3.1 Situating ADA within Mainstream International Relations Literature

3.1.1 Climate Change and Mainstream International Relations Theories

In order to adequately contextualise the rationale for adopting the discursive institutionalist approach (to be later introduced and adopted in this thesis), it is worth briefly surveying the range of theoretical perspectives in IEP and locating discursive institutionalism in the context of these disparate traditions. As foregrounded by chapter 2, climate change began to be perceived as an issue worthy of mainstream political attention, and subsequently an object of political analysis, around the mid to late 1980s (Kellogg, 1987). The emergence of climate change as an international problem occurred at a time when the international relations literature could be crudely characterised as being situated on either side of a broader 'neo-neo' debate in international relations, which took place against the backdrop of a thawing Cold War (Baldwin, 1993). From the 1980s to 1990s, neorealist and neo(liberal) institutionalist scholars waged a theoretical debate on whether international institutions were able to overcome the effects of competition within an international world order and instead promote cooperation (ibid.).

Generally speaking, neorealist perspectives operate under the core assumption that states act in a manner that secures their own national interests given a global state of anarchy (absence of a supreme authority, such as a world government, to induce cooperation) (Baldwin, 1993). Neorealist authors argue that "peace through accommodation" occurs between states (Morgenthau and Thompson, 1985), as a tenuous balance of power is negotiated by sovereign states following their own interests. Neorealist literature emphasises that states seek relative gains compared to other states (Powell, 1991). Even when cooperation might lead to absolute gains for all participants involved in negotiations, the primary concerns of states is not with these absolute gains but rather with the possibility of losing their position relative to other states in the international system (Mearsheimer 1994). Fundamentally, for neorealists, it is systemic structure that defines the nature of international politics (Waltz 1990), as the absence of a sovereign power over states and lack of political hierarchy or monopoly on legitimate use of force leads to the existence of international anarchy (Lipson, 1984).

Despite the strong presence of neorealist perspectives in international relations literature as a whole, there has been a notable shortage of neorealist perspectives in the literature on climate change politics (Paterson, 1997). It has been suggested by some that this is because the climate, and environment more broadly, are seen to belong to the realm of 'low' politics as opposed to the 'high' politics that neorealism is usually concerned with, such as security (Trombetta, 2008). For example, Purdon (2017) seeks to advance a neorealist understanding of international climate politics, and is able to cite a broad body of research in international relations more generally but only a few notable works in the context of international climate politics (including Grundig, 2006; Vezirgiannidou, 2008).

Instead, the pre-eminent body of work in the study of international climate politics has overwhelmingly been under theories of neo(liberal) institutionalism. Neo institutionalist scholars have historically focused away from national interests, instead exploring the role of international institutions in shaping the behaviour of actors. For example, Keohane and Nye (1977: 55) argue that institutions create a network of interactions which "will be difficult either to eradicate or drastically rearrange". To their understanding, once a treaty that governs states' climate change responsibilities has been established and enshrined in institutions, actions of parties to the treaty will be shaped to a certain extent by the treaty's content, bounding the range of acceptable courses of action (ibid.). In addition to these institutions, this theoretical tradition has emphasised the importance of regimes in influencing environmental negotiations. A regime is commonly understood as the "implicit and explicit principles, norms, rules, and decision-making procedures around which actor expectations converged" (Kranser, 1982: 2).

This relatively broad understanding of what a regime is reflects the fact that *institutions* themselves have a broad variety of understandings depending on the approach in political science/international relations. These range from a traditional understanding of institutions as organisations, to early sociological conceptions of institutions as practices, to rationalist conceptions of institutions as norms, to a body of constructivist sociological conceptions of institutions as norms (theorised distinctly to the rationalist strand) (Duffield, 2007). Regardless of their theorisation of institutions, neo institutionalist scholars are united by the fundamental belief that instead of international institutions being epiphenomenal and a slave to the material power of sovereign states, as some strong neorealist perspectives might propose, these institutions are able the alter behaviours of actors (Schweller and Priess, 1997).

A prominent example of a publication from this tradition is ‘Institutions for the Earth’ by Haas et al. (1993), who identify three key functions of effective institutions: building national capacity, improving the contractual environment, and elevating governmental concern. The neo institutionalist tradition has heavily influenced the study of international climate politics, with the vast majority of research concerning the governance of climate change focusing on the development of the international climate change regime, the UNFCCC and the Kyoto Protocol/Paris Agreement, and their implementation (Okereke et al., 2009).

3.1.2 Disaggregating Institutionalism

Despite continuing to share a common belief in the role of institutions, it is important to note that neo institutionalist research in international climate change politics and beyond has diverged among several distinct lines over time. Schmidt (2010) explores the trajectory of neo institutionalism since the late 1970s and early 1980s, exploring how neo institutionalism very quickly split into a number of different approaches. These are divided along a continuum, ranging from universalistic to particularistic generalisations, from positivist to constructivist stances, and from static to more dynamic explanations of political action (ibid.).

The preeminent early approach to neo institutionalist research, as developed in the mid-1980s by March and Olsen (1984), inspired a fairly uniform body of work that the stressed the importance of the *collective* component of collective action, rather than reducing political action to its methodological individualist parts. However, by the mid-1990s three neo institutionalist approaches had become articulated, as elaborated on by Hall and Taylor (1996). These three ‘neo institutionalisms’ were rational choice, historical, and sociological institutionalism:

- *Rational choice* institutionalism focuses on rational actors who pursue their preferences following a ‘logic of calculation’ within political institutions, defined as structures of incentives.
- *Historical* institutionalism instead details the development of political institutions, described as regularized patterns and routinized practices, which are the (often unintended) outcomes of purposeful choices and historically unique initial conditions in a ‘logic of path-dependence.’

- *Sociological* institutionalism sees political institutions as socially constituted and culturally framed, with political agents acting according to a ‘logic of appropriateness’ that follows from culturally-specific rules and norms.

Schmidt (2010) also charts the emergence of a fourth, more recent strand of work in neo-institutionalism - *discursive* institutionalism (also historically referred to as ideational institutionalism or constructivist institutionalism). Discursive institutionalism is a broad collective of approaches to neo institutionalism that builds on the recent turn to ideas and discourse in international relations more broadly, and are in some respects a development of the three aforementioned neo institutionalist approaches.

Institutions - whether understood in either of the three other new institutionalist terms as socially constituted, historically evolving, or interest-based rules of interaction - are pushed along the linguistic turn that occurred in many social sciences in the late 20th century, as the importance of discourse in defining repertoires of acceptable ideas and interactions is emphasised (Schmidt, 2008). However, discursive institutionalism is also more than just an extension of the three neo institutionalist approaches outlined by Hall and Taylor (1996). Discursive institutionalism itself provides a unique theoretical approach to understand how and when ideas in discursive interactions may enable actors to overcome constraints which explanations couched in terms of rational behaviour, historical rule, and/or cultural norms would understand as impediments to action (Schmidt, 2010).

To this point, section 3.1 has situated discursive institutionalism within mainstream international relations literature. This has been done in order to place in broader context the family of theoretical approaches that this thesis will draw from. The predominant theoretical approach that will be adopted in this thesis falls under the family of discursive institutionalist approaches. As such, a deeper exploration of discursive institutionalism and the rationale behind adopting such an approach is warranted to conclude this section.

3.1.3 Discursive Institutionalism

Discursive institutionalism is an umbrella term that is used to describe a diverse range of works in political science that consider the "substantive content of ideas and the interactive processes by which ideas are conveyed and exchanged through discourse" (Schmidt, 2010: 3). Schmidt (2010) elaborates on the three key elements of this definition to provide a deeper understanding of how DI works, along the lines of the substantive content of ideas/discourses, interactive processes through which this occurs and the communicative exchange of knowledge.

With respect to the *substantive* element of ideas and discourses, DI authors consider a range of different forms of knowledge - ranging from cognitive ideas justified in terms of interest-based logics (such as Hall, 1993), to normative ideas that are legitimated through an appeal to appropriateness and values (such as March and Olsen, 1989), to the representation of ideas through discourse, such as frames, narratives, myths, collective memories, stories, scripts, and more (such as Roe, 2006; and most notably for this thesis, Hajer, 2010).

With respect to the *interactive* dimension, DI authors understand the discursive process through which ideas are constructed in a 'coordinative' policy sphere and deliberated in a 'communicative' political sphere (Schmidt, 2008). The notion of a coordinative policy sphere encompasses the broad range of policy actors that are engaged in the construction of policy ideas. For example, these could be organized in 'epistemic communities' of elites with shared ideas (Haas, 1992), 'advocacy coalitions' of elites with shared ideas and policy access (Sabatier, 2010), or 'advocacy networks' of activists contesting ideas in international politics (Keck and Sikkink, 2014).

The notion of a *communicative* policy sphere incorporates the broad range of political actors who bring ideas developed in light of coordination to the public for deliberation and legitimation. Examples of these actors could include political leaders involved in the top-down policy-experts engaged in public debates, but also in the 'policy forums' of those engaged in 'communicative action' (Habermas, 2012). Alternatively, they could be members of civil society that are engaged in bottom-up discursive interactions of grass-roots organisations and social movements (Goodin and Dryzek, 2006).

However, the *institutionalism* component of discursive institutionalism also suggests that discursive institutionalism is not only about the dissemination of ideas or 'texts', but additionally the institutional context in which and through which ideas are communicated through the means of discourse. It should simultaneously be noted that the institutions that DI considers are not analogous to the external rule-abiding structures that the three other institutionalisms highlight - whether these be rationalist incentives, historical paths or cultural frames. A key point of departure of DI is that institutions are conceptualised as simultaneously constraining structure and enabling constructs of meaning, which are internal to sentient agents. The background ideational abilities of these agents explain how they create and maintain institutions at the same time, and their discursive abilities enable them to communicate critically about institutions to change or maintain them. Discursive institutionalism thus shares with the other neo institutionalisms a core focus on the importance of institutions, but often differs in its definition of institutions, in its objects and logics of explanation, and in the ways in which it deals with change.

In sum, section 3.1 has placed in context the school of thought that this thesis can be described as loosely adhering to - discursive institutionalism. Although this overview of discursive institutionalism is useful for grounding the theoretical approach adopted in this thesis, approaching DI as a unitary body of research can also raise more questions than answers. The differences between particular approaches within DI are stark, and any discursive institutionalist approach will ultimately require its own further theoretical grounding before it is adopted for analysis. With this in mind, section 3.2 will now turn to the discursive institutionalist approach that this thesis will adopt - argumentative discourse analysis.

3.2 Argumentative Discourse Analysis

The primary methodological and theoretical approach that this thesis will adopt in seeking to examine climate cryptogovernance is that of argumentative discourse analysis (ADA). Theorised by Maarten Hajer, ADA is an approach within the broader family of discursive institutionalism that places a strong emphasis on the representation of ideas through discourse and the analysis of these ideas (Schmidt, 2010). This emphasis is made possible through the integration of institutionalist and discourse analytical approaches.

3.2.1 Discourse Analysis in IEP

Discourse analysis is a methodological approach that has emerged in the context of the turn to postpositivist interpretivism, but also has roots in ideological analysis, rhetorical analysis, the sociology of scientific knowledge and language philosophy (Hajer, 2010). In contrast to conventional approaches to policy analysis, discourse analytical approaches aim to problematise the linguistic, identity and knowledge foundations of policy making (Feindt and Oels, 2005). Discursive analytical approaches thus attempt to chart how environmental issues and a related set of subjects and objects are produced through discourse and rendered goverenable (ibid.).

Discourse analysis encompasses a vast selection of analytical approaches, that differ with regard to their ontological and epistemological stances, as well as their methodology (Feindt and Oels, 2005). Discursive analytical approaches, in all of their diversity, have become an integral tool to analysing environmental issues and their political arrangement (Hajer and Versteeg, 2006; Feindt and Oels, 2005). Hajerian ADA has become a particularly valuable approach to analysis for its ability to embrace a postpositivist conceptualisation of discourse while simultaneously remaining grounded within institutional literature. Hajer (2010: 4) synthesises elements of several discourse analytical traditions to gain an insight into “why a particular understanding of the environmental problem at some point gains dominance and is seen as authoritative, while other understandings are discredited”.

In attempting to do this, argumentative discourse analysis is an approach that attempts to make sense of regularities and variations in what is being communicated through text - in the hopes of understanding the social backgrounds and implications of specific modes of communication

(Hajer, 2010). Discourse under this conception is seen as internally related to the social practices in which it is produced, and is thus an ensemble of ideas, concepts and categorisations. However, Hajerian ADA also places a strong emphasis on the consideration of the relationship between these ensembles and institutions in the context of environmental problems. Discourse, from an ADA perspective, is therefore defined as:

“a specific ensemble of ideas, concepts, and categorizations that are produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities.” - Hajer (2010: 45)

Initially applying his ADA approach to the environmental issue of acid rain, Hajer (2010) crafts ADA around two different discourse-theoretical approaches. Firstly, Hajer adopts the work of postmodernist vanguard Michel Foucault. Hajer (2010) merges these Foucauldian concepts with the work of social psychologists Michael Billig and Rom Harré to form a number of middle range concepts that form a discourse-theoretical framework. These will briefly be discussed in the following section.

3.2.2 Theoretical Basis of ADA: Foucault and Discourse

The work of French philosopher Michel Foucault is largely the theoretical inspiration for ADA. Hajer identifies the strengths of Foucault’s later work on the social discourses of discipline and punishment, as well as sexuality, where Foucault broke these discourses into “the multiplicity of component discourses that were produced through a whole array of practices in various institutional contexts” (Hajer, 2010: 48). In contrast to Hajer’s adapted understanding of discourse, Foucault’s conceptualisation of discourse is broader and less explicitly oriented around the structure of language (ibid.). For Foucault, discourse is considered to be:

“ways of constituting knowledge, together with the social practices, forms of subjectivity and power relations which inhere in such knowledges and relations between them. Discourses are more than ways of thinking and producing meaning. They constitute the 'nature' of the body, unconscious and conscious mind and emotional life of the subjects they seek to govern.” - (Weedon, 2000: 108)

Hajer (2010) found an affinity with Foucault's notion of discourse and his claim that an analysis of discourse should centre around the illumination of smaller, less conspicuous practices, techniques, and mechanisms, which Foucault labelled to as 'the disciplines'. These cumulatively determined how large institutional systems operated in an indeterminable way. Foucault was a critique of conventional political theory at the time for focusing too heavily on institutions and too little to these smaller constituent practices or 'disciplines' (Burchell, 1991: 4).

Foucault's emphasis on the discursive plurality of everyday, physical mechanisms - by systems of micropower that are essentially non-egalitarian and asymmetrical (Foucault 1975: 222) - has significant implications for his understanding of change over time and the causality of this change. A focus on the plurality of discourse led Foucault to reject traditional understandings of history that understood history in terms of causality, instead favouring an analysis of the interplay between plural discourses that render "apparent the polymorphous interweaving of correlations" (Foucault, 1991: 58). Foucault therefore spoke of different types of transformation as opposed to a univocal process of social change (Hajer, 2010). He emphasized the need to investigate 'micro-powers' that brought about transformations (Foucault, 1991: 48). Simultaneously, and with respect to the causality of these changes, Foucault also proposed that transformations would happen according to definable rules, and that there was some form of 'discursive order' that could be illuminated (Hajer, 2010). Uncovering such a discursive order would illuminate the regulated discursive practices through which objects are constituted as communicable entities in a given society (ibid.).

This outlined conceptualisation of discourse put forth by Foucault saw an ambiguous relationship between subject and discourse. As Hajer (2010: 50) describes, Foucault saw that "the role of the subject was seen as conditional upon the discursive field in which various positions and functions of the subject were inscribed". Indeed, an often contested claim about agency made by Foucault and adherents to his theories is that there is no a priori thinking subject trying to express or transcribe his or her preconceived ideas in language (Foucault 1968: 63). Instead, the subject has their own ideas formed in the context of a set of regulated practices within a system of polymorphous interweaving of correlations (Hajer, 2010). Foucault thus shares a view common amongst post-positivist theorists that discourse should not be understood as a medium through which individuals can manipulate the world, as conventional social science theorists might suggest (Bernstein, 1990). Rather, discourse itself is part of reality, and also constitutes the discoursing subject (ibid.). To view this understanding of discourse in the context of institutional approaches, Foucault's theory of discourse would suggest that reference to vested interests or institutional backgrounds would be an unsatisfactory circular explanation, as institutions are only powerful in so far as they are constituted as authorities vis-à-vis other actors through discourse (Hajer, 2010). In this vein, interests cannot be taken as existing a priori, but instead are constituted through discourse (ibid.).

Due to this denial of agency, Hajer (2010) found elements of Foucault’s theories somewhat limited. In particular, he saw that the role of the discoursing subject remained ambivalent in the Foucauldian understanding of discourse (ibid.). Harnessing Foucault's theoretical concepts as a source of inspiration for the study of discourse formation in politics, Hajer saw a need to devise middle-range concepts. Hajer (2010) proposed that through these middle-range concepts, the interaction between discourses could be related to individual strategic action in a manner that was, on one hand, non-reductionist, but on the other hand, did not endow a solely passive role for the individual subject. Hajer (2010: 53) thus sought to bridge “a conceptual gap between Foucault's abstract work and the study of concrete political events”, and develop a Foucauldian-inspired theory of permanence and change that moved beyond coincidental recombinations.

3.2.3 Theoretical Basis of ADA: Repurposing Foucauldian Concepts Along The Argumentative Turn (1)

Seeking to develop a discourse analytical theory that was “both theoretically sophisticated and practically operationable”, Hajer (2010: 53) looked to discourse-theoretical ideas that had recently been developed in the field of social psychology. Specifically, Hajer looked to the work on social interactive discourse theory developed by Billig and Harré (Billig et al., 1988; Davies & Harreé 1990; Harré, 2003) that centred on the level of interpersonal interaction. Hajer (2010) saw such a theory as a valuable corrective of Foucault's theory. Where Foucault argued that human interaction is firmly limited within subject positions shaped by discourses available to subjects, social interactionists proposed that human interaction was an exchange of arguments, or contradictory suggestions of how individuals make sense of reality (Hajer, 2010). For this reason, a social interactionist approach to discourse analysis argues for an examination of specific discursive practices, defined as “all the ways in which people actively produce social and psychological realities” (Davies & Harré, 1990: 45).

The *first major corrective* to the Foucauldian notion of discourse that Hajer proposed in his ADA approach was the incorporation of argumentative interaction. Where Foucault and his contemporaries saw the need for a linguistic turn in political science, which focused on discursive systems, social interactionists such as Billig and Harré contrastingly saw the need for an argumentative turn, arguing that:

"to understand the meaning of a sentence or whole discourse in an argumentative context, one should not examine merely the words within that discourse or the images in the speaker's mind at the moment of utterance. One should also consider the positions which are being criticized, or against which a justification is being mounted. Without knowing these counter-positions, the argumentative meaning will be lost." - Billig (1999: 121)

From such a perspective, climate politics would be understood as an argumentative struggle, in which actors attempt to make others see the problems according to their views and position other actors in specific ways (Hajer, 2010). Thus, in contrast to Foucault's conceptualisation of discourse, a social interactionist perspective not only rejects the claim that actors do not have an intuitive idea about discourse - such a perspective goes even further to suggest that actors constantly practice discourse. Argumentative interaction, from the perspective of Hajer (2010), is therefore a key moment in discourse formation that needs to be explored to be able to explain the prevalence of certain discursive constructions. In ADA, Hajer (2010) adopts social interactionist perspective and applies it to Foucault's work to see actors as "active, selecting and adapting thoughts, mutating and creating them, in the continued struggle for argumentative victory against rival thinkers" (Billig 1999: 112). Hajer (2010) argues that in this context, both Foucauldian and social interactionist perspectives are compatible, at least in principle, as they are both grounded in a relational ontology and share a focus on the study of 'practices'.

Following this first corrective, Hajer (2010) outlines how ADA then investigates how subjects *actively* compete to determine:

"the boundaries between the clean and the dirty, the moral and the efficient, or how a particular framing of the discussion makes certain elements appear as fixed or appropriate while other elements appear problematic" - Hajer (2010: 55)

To summarise the first adaptation that Hajer proposes to Foucauldian ideas, Hajer (2010) uses social-interactive discourse theory to provide a means through which the subject can be studied as actively involved in the production and transformation of discourse. In doing so, Hajer finds that social interactionist theory fills a gap left by Foucault with respect to the role of the subject.

3.2.4 Theoretical Basis of ADA: Repurposing Foucauldian Concepts Along The Argumentative Turn (2)

The second corrective that Hajer (2010) proposes to Foucault's concepts is with respect to social change and permanence. Hajer embraces the immanentist view of language put forth by Davies and Harré (1990). This view of language sees similarities between statements (i.e. historical continuity) to be explained by memory or historical references that people draw upon in new speech situations, and thus emphasises that political context is also to be analysed as a discursive construction (ibid.). In essence, such a view of language sees that rules, distinctions, or legitimate modes of expression, only have meaning to the extent that they are taken up (Hajer, 2010). This has implications for the analysis of power structures through discourse, as rules and conventions that constitute the social order are understood to be constantly reproduced and reconfirmed in actual speech situations, whether this be in documents, debate or any other means of linguistic communication (ibid.).

Hajer (2010) sees an immanentist view of language as being relevant for the discursive study of interpersonal communication. Hajer (2010: 56) puts forward that "analysing policy papers becomes important even if they do not include 'hard' new proposals or legislation" and that "it becomes imperative to examine the specific idea of reality or of the status quo as something that is upheld by key actors through discourse". Similarly, it becomes vital to consider the ways in which oppositional forces seek to challenge dominant constructs (Ibid.).
The agency of the subject is thus further incorporated into the theoretical basis for ADA, as change and permanence are understood to come to depend on active discursive reproduction or transformation. However, this does not necessarily endow actors with unbounded agency, as holders of specific positions are seen as entangled in routinised webs of meaning. Davies and Harré (1990) write that:

“Once having taken up a particular position as one's own, a person inevitably sees the world from the vantage point of that position and in terms of the particular images, metaphors, story lines and concepts.” - Davies and Harré (1990: 45)

In the context of these routinised understandings, in which actors have at least a certain degree of choice with respect to practices available to them, Davies and Harré (1990) use the concept of the storyline. Adopting this into his ADA approach, Hajer interprets the storyline as a:

“subtle mechanism of creating and maintaining discursive order: … a generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to specific physical or social phenomena” - Hajer (2010: 57)

To summarise the second corrective that Hajer proposes to Foucauldian ideas, social-interactive discourse theory emphasises the role of the ‘appropriate storyline’ in structuring reality, which in turn endows the subject with a certain amount of agency in the context of how discourse influences social change and permanence over time. In contrast to the Foucauldian assumption that people draw on comprehensive discursive systems for their cognition, Hajer (2010) sees value in a social interactionist approach which sees cognition as evoked through storylines. These storylines play a key role in the positioning of subjects and structures. From this view, change takes place through the emergence of new storylines that re-order hitherto accepted understandings.

3.2.5 Doing argumentative discourse analysis: Hajer's Middle Range Concepts

Having provided the theoretical basis for argumentative discourse analysis, Hajer's middle-range concepts that are associated with this approach will now be introduced. These concepts will be adopted heavily in this thesis, forming the basis of the theoretical framework adopted.

Combing Foucauldian notions of discourse and social interaction theory, Hajer (2010) draws attention to the socio-cognitive processes through which discourse coalitions are formed. Argumentative discourse analysis focuses on the constitutive role of discourse in political processes and positions the discoursing subjects centrally. However, the subject is positioned centrally in the context of a duality of structure: social action originates in human agency of cognisant human subjects, but these same subjects are inherently limited by social structures of various types that can both enable and constrain agency (Hajer, 2010: 59). With respect to an understanding of change, social reality is transformed through the process of interaction between agents and structures that perpetually adjusts, transforms resists, or reinvents social arrangements (ibid.). Hajer's approach involves the formulation of several 'middle' range concepts for operationalising ADA, which include storylines and discourse coalitions.

Hajer (2010) sees that debates on issues like climate change are interdiscursive in nature. This is to say that understanding of complex environmental phenomena necessarily requires a combination of knowledge claims that are the product of distinct discourses (ibid.). To be able to analyse this interdiscursive communication, Hajer (2010) develops the concepts of the storyline and discourse-coalition to demonstrate how discursive orders are maintained or transformed. The use of these concepts is grounded by Hajer's belief that the political power of a text is not necessarily derived from its consistency, but instead comes from its multi interpretability, which provides actors with opportunities to create their own understanding of a problem, re-shaping elements of it (Hajer, 2010: 62). It is through this re-shaping, determined by the effects of particular storylines, that the regulation of conflict over inter-discursive issues like climate change occurs (ibid.).

Following Davies and Harré (1990), *storylines* are defined by Hajer as:

"narratives on social reality through which elements from many different domains are combined and that provide actors with a set of symbolic references that suggest a common understanding." - Hajer (2010: 63)

Hajer (2010: 64) interprets storylines as holding the following features:

- a. Storylines have the functional role of facilitating the reduction of the discursive complexity of a problem and creating possibilities for problem closure.
- b. As they are accepted and more and more actors start to use the storyline, they get a ritual character and give a certain permanence to the debate. They become 'tropes' or figures of speech that rationalize a specific approach to what seems to be a coherent problem.
- c. Storylines allow different actors to expand their own understanding and discursive competence of the phenomenon beyond their own discourse of expertise or experience. In other words, a story-line provides the narrative that allows the scientist, environmentalist, politician, or whoever, to illustrate where his or her work fits into the jigsaw.

Hajer (2010: 64) uses the storyline concept as an analytical term to represent several established concepts within the constructivist political tradition, including the discursive practice of the metaphor, analogy, historical reference, clichés, and appeal to collective senses of fear and guilt. The ADA approach sees these "shallow and ambiguous" discursive practices as the bread and butter of communication networks among diverse actor perceptions and understandings, representing prime vehicles of change (ibid.).

Beyond these possible substituent components of a storyline, Hajer (2010) finds the power of a storyline to be not only plausibility of an argument itself, but also by the trust that people have in the author that crafts the argument, the practice in which it is produced and the acceptability of a storyline for an actor's own discursive identity. From the ADA perspective, storylines thus play a vital role in the clustering of knowledge, positioning of actors, and, ultimately, in the creation of coalitions amongst the actors of a given domain (ibid.). This gives rise to another important middle-range concept in ADA: the discourse coalition. The ADA approach makes the assumption that in the struggle for discursive hegemony, coalitions are formed among potentially divergent actors that are united in an attraction to a specific set of storylines.

Discourse-coalitions are defined as:

"the ensembles of (1) a set of storylines; (2) the actors who utter these storylines; and (3) the practices in which this discursive activity is based" - Hajer (2010: 66)

It is through these discourse coalitions that the reproduction of a discursive order (see structuration and institutionalisation below) is maintained through the routinisation of cognitive commitments that are implicit in storylines (Hajer, 2010). Discourse-coalitions are formed if previously independent practices are actively related to one another, and if a common discourse is created in which several practices gain meaning in a common political project (ibid.).

To this point, section 3.2 has provided a theoretical background to ADA and introduced the middle-range concepts which will inform the empirical analysis of this thesis. This has been done to make the theoretical grounding of this thesis as transparent as possible. To draw section 3.2 to a close, focus will now shift to operationalising a concept central to ADA which some critics have found can be too vaguely operationalised at times: discourse.

3.2.6 Dominant Discourses in International Climate Politics

As the discussion of concepts within ADA approaches comes to a close, focus will now specifically shift to operationalising the most fundamental concept of ADA - discourse itself. Despite being a concept so central to this analytical approach, it can easily be the case that the notion of "specific ensembles of ideas, concepts and categorisation that are produced, reproduced and transformed in a particular set of practices" (Hajer, 2010: 2) remains vaguely applied when translated into practice unless further elaboration is provided. This thesis operationalises discourse by using a framework first proposed by Bäckstrand and Lövbrand (2006), who develop a typology of discourses that is influenced by the discussed ADA approach by Hajer (2010). Building on the observations by Hajer (2010) about the discourse of ecological modernisation, Bäckstrand and Lövbrand (2006) identify three predominant discourses that both underpin and are transformed by policy practice and academic debates within climate governance. These are the discourses of ecological modernisation, green governmentality and civic environmentalism, which will be referred to in the first half of empirical analysis (chapter 5).

The main discourse that Hajer (2010) focuses on in his study of acid rain, ecological modernisation, is a discourse grounded in the compatibility of economic growth and environmental protection. This discourse is what underlies the 1980 Brundtland Report (WCED, 1987) which challenged prevailing environmentalist logic at the time that there were fundamental "limits to growth", as suggested by the Club of Rome in 1972 (Meadows et al., 1972). Under such a discourse, a liberal market order is reconcilable with environmental goals, as sustainable development is understood to be a feasible and desirable goal to pursue. Ecological modernisation is thus characterised by a 'win-win' storyline, based on the experiences of advanced industrialised economies in internalising environmental externalities of economic development, such as carbon emissions (Bäckstrand and Lövbrand, 2006). These externalities can be internalised through the application of technological innovation, market-led strategies and flexible, decentralised and multi stakeholder policy making (ibid.). Concerned less with North-South and equity issues in comparison to other prevailing discourses, the ecological modernisation discourse is a fundamentally technocratic and neoliberal economic discourse that calls for a revitalisation, rather than a fundamental restructuring, of existing institutions (ibid.).

Green governmentality is a discourse that exists alongside ecological modernisation in mainstream international environmental politics (Bäckstrand and Lövbrand, 2006). This discourse is predicated on a “form of power tied to the modern administrative state, mega-science and big business” and involves the governmental administration of life itself - including individuals, populations and the natural environment (Bäckstrand and Lövbrand, 2006: 54). To ground this discourse, Bäckstrand and Lövbrand (2006) use the Foucauldian notion of governmentality (explained in further detail in section 3.3.1). Governmentality is a concept often used in the study of IEP as for understanding multiplicity of rationalities, authorities and agencies that seek to shape the conduct of human behaviour and render the environment governable (ibid.). The discourse of green governmentality encompasses the “new eco-knowledges and practices that organize and legitimize common understandings of the environmental reality and enforce ‘the right disposition of things’ between humans and nature” (Bäckstrand and Lövbrand, 2006: 54). This discourse emphasises the role of sound science and well-trained authoritative professionals that can credibly define environmental risks and legitimate particular methods to measure, predict and manage changes in the climate - such as the cases of satellite imagery and computer modelling (ibid.). Ultimately, it is through a detached “global gaze” that this form of instrumental control reshapes the natural world into a form amenable to state protection, management and control (Bäckstrand and Lövbrand, 2006).

The discourse of civic environmentalism is characterised by the language of participation and ‘stake-holding’ in the context of the global environmental agenda. Such a discourse is marked by a ‘democratic efficiency’ storyline that puts forth that in order build more effective environmental multilateralism, all publics who are affected by environmental issues or have a legitimate interest or stake should have a substantive voice in finding policy solutions (Bäckstrand and Lövbrand, 2006). This discourse was mainstreamed into IEP through the 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, entering both policy practice and academic debates. This discourse underlies the active participation of major groups and nonstate actors, such as NGOs and civil society, which has in turn resulted in more polycentric and ‘glocal’ governance arrangements (ibid.). However, a particularly relevant distinction in this discourse for the study of climate cryptogovernance is between a reform-oriented and a radical resistance version of the discourse of civil environmentalism (Bäckstrand and Lövbrand, 2006). These are distinguished by their disparate views on the role of states and the capitalist economy. The reformist version, which might also be described as ‘participatory multilateralism’, sees transnational civil society as complementing existing state practices to encourage a pluralistic global environmental order (ibid.). Such a view legitimises the existence of public-private partnerships between NGOs, business and governments, resulting in cross-sectoral cooperation. By contrast, the 'radical' version highlights the power relations that imbue international institutions (Bäckstrand and Lövbrand, 2006). Often informed by neo-Gramscian and other anti-capitalist perspectives, the radical version advocates for a fundamental restructuring of consumption patterns and existing institutions in order to achieve a more just world that is unhindered by structural conditions such as sovereignty, capitalism and patriarchy (ibid.).

Having briefly laid out the typology of discourses proposed by Bäckstrand and Lövbrand (2006), this subsection closes with a proviso often made by theorists that adapt Foucauldian concepts into comparatively rigid frameworks. Although this subsection has presented these 'discourses' as relatively coherent and rigid, it should be noted that these are a simplifying model of the inherently ambiguous concept of discourse. As such, the three proposed discourses should be understood as a "rough map for understanding the discursive framing of contemporary global environmental politics" as opposed to fully coherent and infallible categories (Bäckstrand and Lövbrand, 2006: 52).

Although the typology of discourses in undoubtedly a useful framework for analysis, each discourse is heterogeneous and thus in a constant state of change and redefinition, with overlaps and conflicts between the discourses when making sense of environmental governance. The three discourses proposed by Bäckstrand and Lövbrand (2006) will be returned to both in the first section of empirical analysis which considers the discourses that storylines draw upon, and also in the discussion section of the thesis which considers what modes of governance are reinforced or marginalised through the blockchainisation of climate policy.

In sum, section 3.2 has explained the theoretical foundations of argumentative discourse analysis (ADA) and introduced a typology of discourses which will be combined with ADA to form the main theoretical approach. This approach will be harnessed in the first half of empirical analysis. In the second half of empirical analysis, a range of critical perspectives will be adopted to challenge the findings of the ADA analysis. These perspectives are raised in section 3.3.

3.3 Additional Theoretical Perspectives: Problematising Knowledge

In addition to ADA, which represents the key component of the theoretical framework of this thesis, complementary perspectives will be adopted from bodies of literature that critique or destabilise international climate politics to an even greater degree than mainstream discursive institutionalist perspectives. In the context of this thesis, such perspectives are understood as critical perspectives - by virtue of critiquing power relations and/or the stability of knowledge itself. This body of critical perspectives will be used in the second half of the empirical section (chapter 6) to question several of the assumptions present in the dominant storylines of climate cryptogovernance that are highlighted in the first section of empirical analysis using ADA. The main perspectives that will inform the analysis undertaken in the second section of theoretical analysis mainly fall under multiple traditions with a strong presence in the study of international environmental politics. These will be briefly introduced below with reference to preceding analysis. The 'critical' theoretical approaches adopted in this thesis largely originate in Governmentality Studies, Science and Technology Studies and Critical Transparency Studies.

3.3.1 Governmentality Studies

This subsection will briefly introduce the concept of governmentality and its applications to climate governance, with relevance for the second section of empirical analysis. A number of theoretical perspectives explored in chapter 6 would be best described as adhering to governmentality studies; a heterogeneous body of theories that are united by common inspiration from the concept of 'governmentality' proposed by Michel Foucault and a shared concern for the role of knowledge production in the formation of modern governmental practices (Lövbrand and Stripple, 2013). In his work presented at the Collège de France in Paris, Foucault (2007) proposed a manner of analysing government that focused on political reason and the underlying mentalities of politics that articulate the field of reality, along with the subjects upon which it is to intervene (Barry, Osborne and Rose 1996: 2).

Foucault saw the preeminent mode of control in liberal societies as 'government', diminishing the former influence of central and unified state sovereignty in modern European rule (Lövbrand and Stripple, 2013). Governmentality is understood by Foucault as 'the conduct of conduct', and can be described most simply as an 'art' for acting upon the actions of individuals, thus shaping, guiding and correcting how they conduct themselves (Burchell, 1996). Authors who have gone on to adapt this concept have applied it in a number of ways, using what Burchell (1996: 34) describes as a Foucauldian “analytics of government” in order to ask questions about government that highlight the contextually situated and co-constitutive relationships between truth, subjectivity, techniques of domination and techniques of the self. In contrast to global governance studies, which are generally more interested in the ‘who’ of governing, scholars of governmentality studies typically consider the ‘how’ questions of government (Dean 1999).

From the initial concept proposed by Foucault, academics from across a vast range of disciplines have expanded and applied this concept of governmentality in a variety of manners (Dean, 1999). With relevance for the theoretical perspectives adopted in this thesis, two specific adaptations of the original concept will briefly be contextualised here: firstly, the focus on technologies through which conduct is conducted, and secondly the critical lens with which some authors have used the governmentality concept to critique neoliberalism as a contemporary form of rule.

Some governmentality scholars have placed a specific emphasis on the ‘technologies of government’, which encompass the assemblages of techniques, instruments and apparatuses that render rationalities operable and enable the ‘conduct of conduct’ (Rose, 1999). Rationalities here are understood to be the “collective and taken for granted body of knowledge and styles of thinking that render aspects of reality thinkable and governable” (Lövbrand and Stripple, 2013: 33). In analysing these technologies and the rationalities to which they are interlinked, it is possible to explore the types of knowledge that actors draw upon to justify particular modes of exercising power (ibid.). In the context of this thesis, technologies of government that will be interrogated using perspectives from governmentality studies include the techniques, instruments and apparatuses that are associated with the measuring, reporting, verification and auditing of carbon.

A specific rationality of government that has received particular attention from governmentality scholars has been neoliberalism (Death, 2013). Neoliberalism as a rationality emphasises government beyond the state and is sceptical about the excesses and inefficiencies of the welfare state (ibid.). Such a rationality instead privileges the notion of a ‘free market’ and a ‘civil society’ in which a diversity of groups and individuals interact in an unrestricted liberal context (Rose and Miller, 1992: 173). Associated technologies of government are deployed to shape the ‘free’ neoliberal subject to achieve governmental purposes and objectives (Dean, 1999). Dean

(1999) understands the neoliberal rationality to rest up ‘technologies of agency’ and ‘technologies of performance’. The former ‘technologies of agency’ refers to practices of self-esteem and empowerment, whereby active and free citizens are rendered informed and responsible consumers capable of making rational choices (ibid.). The latter ‘technologies of performance’, by contrast, works to carve and optimise agency ‘at a distance’ through calculation and benchmarking (ibid.).

Through its ability to highlight neoliberalism as a rationality and associated technologies of agency and performance, critical scholars have found a strong theoretical approach in governmentality through which to challenge preeminent practices in contemporary governance. For example, Lemke (2002) uses the lens of governmentality to chart how neoliberalism operates through a reorganisation or restructuring of government techniques, shifting the regulatory competence of the state onto ‘responsible’ and ‘rational’ individual who must assume responsibility for governance activities and the possible failure thereof. Similarly, an analysis of technologies understood to be associated with a neoliberal rationality has allowed for theorists to develop an understanding of how seemingly benign and disinterested practices such an accounting can enable a restructuring of power relations in society, with the potential for empowerment of capital interests at the expense of civil society (Swyngedouw, 2005; Turnhout et al., 2014). Although the use of a governmentality framework for critical ends has at times been the subject of critique from purists who see this adoption as a misinterpretation of the original concept theorised by Foucault (2007), such a use nevertheless offers a potentially useful source of critique through which the *how* of governance can be illuminated and challenged.

In sum, this thesis will at times adopt theoretical perspectives from governmentality studies in the second section of empirical analysis. This will be done to firstly interrogate the technologies through which conduct is conducted in climate governance, and secondly critically consider arguments that see such technologies as tools for perpetuating neoliberalism as a contemporary form of rule.

3.3.2 Science and Technology Studies

This subsection will briefly introduce perspectives from science and technology studies and their applications to climate governance, with relevance for the second half of empirical analysis. In response to an unquestioning and often uncritical understanding of scientific knowledge and associated technological developments in the context of international environmental politics, a number of constructivist and critical theorists in science and technology studies have sought to develop a more nuanced body of perspectives. Historically, dominant neo institutionalist perspectives seeking to understand the relationship between science and environmental policy have fallen back on a one-way decisionist model, where the forms of knowledge associated with scientific and technical knowledge are seen as unproblematic and external inputs to decision-making (Jasanoff, 1990). Critics have suggested that such perspectives underemphasise the potential importance and politicisation of science (Lidskog and Sundqvist, 2015). While there have undoubtedly been coherent attempts to better theorise the importance of science, such as the epistemic community approach put forth by Haas (1989), these attempts may at times overemphasise the importance of science and may still place an untenable distinction between scientific and political knowledge (Lidskog and Sundqvist, 2015).

It is here that sociological perspectives from science and technology studies, also sometimes referred to as the sociology of scientific knowledge, can have valuable insights. Lidskog and Sundqvist (2015) highlight several insights that this body of perspectives can have for the study of international climate politics. Firstly, these perspectives highlight that knowledge never moves freely, and requires support from actors within the preeminent social order. This insight builds on the work of Bruno Latour (2015), who highlights through actor-network theory that knowledge is inherently embedded in its sociomaterial context. From such a perspective, for scientific knowledge about blockchain to be created, transmitted and stabilised in the social world, material and social networks must be arranged in a conducive way - despite the outward appearance of freely-moving knowledge (ibid.). In the context of climate cryptogovernance, these insights hold relevance for considering the extent to which blockchain-based climate technologies can be understood as neutral in their functioning.

Secondly, the value of science is not inherent in its content, but rather negotiated by scientists through multi-actor processes. The theoretical backing for such an insight comes from the concept of boundary work, which describes how the value of scientific knowledge is negotiated

(Gieryn, 1983; Jasanoff, 1990). Gieryn (1983) uses the concept of boundary work to demonstrate how the boundaries of science are somewhat ambiguous, contextually variable and prone to being ruptured - providing room for negotiations as actors define their particular domain as scientific and the knowledge of those outside said domain is defined as unscientific or irrelevant. In the context of climate cryptogovernance, these insights hold relevance for understanding contexts in which blockchain technology might be framed as endowed with authority as providing neutral and scientifically-validated in some contexts, but as an experimental and unreliable technological fix in other circumstances.

Thirdly, in contrast to mainstream understandings of the science-policy interface, some authors have argued that science and policy are co-produced and interdependent (Jasanoff, 1996). This understanding of the relationship between scientific knowledge and policy formation is predicated on a dialectical model, where policy influences and the creation and stabilisation of knowledge while such knowledge simultaneously provides justification for said policy. Such a model implies not only that uncertain scientific knowledge can gain relevance in the 'right' policy context, but also policies that are potentially unstable within the policy context can be bolstered by scientific knowledge deemed to be relevant. Science and policy are considered part of the same culture, or as part of a common social project that strengthens the legitimacy of both science and policy (Jasanoff and Wynne, 1998). In the context of climate cryptogovernance, these insights hold relevance for critically considering whether arguments for applying blockchain to climate arise independently of political context.

In addition to the above general theoretical insights, more specific theories from science and technology studies crafted for the purposes of comprehending blockchain technology within will also be raised. Specifically, a distinction proposed by Swartz (2017) about blockchain projects will be harnessed - where blockchain solutions are understood to range from radical to incorporative approaches.

Radical approaches resonate with the earliest aims of blockchain, such as those proposed in the earliest incarnation of blockchain imagined by Nakamoto (2008). These projects are oriented toward “revolutionary social, economic, and political change” and attempt to bring about a new techno-economic order around the political themes of decentralisation, autonomy, and privacy (Swartz, 2017: 70). This orientation resonates with two predominant modes of blockchain that have been implicit in emerging technologies since the invention of Bitcoin: digital metallism and infrastructural mutualism.

In the digital metallist mode, blockchain functions as the “ultimate market mechanism” (Swartz, 2017: 70) that enables trade in any form of value beyond the reach of the existing financial systems and government oversight. In infrastructural mutualist mode, blockchain-based solutions enable peer-to-peer information transmission that facilitated the distribution of resources in a new open-network commons (ibid.).

In contrast to these radical rationales, incorporative approaches aim to innovate within existing financial structures. Swartz (2017) terms these incorporative, as they do not necessarily aim to alter the underlying financial system in their political or social philosophies. Rather, they seek to integrate blockchain into existing systems or to improve the efficiency of said systems.

Swartz (2017) argues that incorporative applications often benefit from the “revolutionary aura” of radical projects, even if radical advocates might see such incorporative projects as not aligned with the original aims of blockchain put forth by Nakamoto. However, Swartz (2017) also notes that distinction between radical/incorporative is better theorised as a fluid spectrum rather than a binary distinction, and that it is not difficult to imagine how the creators of radical projects may find themselves pursuing short-term rational self-interest to slot into existing structures to achieve scalability. Nevertheless, this distinction offers yet another valuable theoretical perspective with which to understand the potential aims and ends of blockchain solutions, and to unpack claims about ‘radical’ orientation of blockchain-based solutions that are often put forth by advocates for climate cryptogovernance.

In sum, this thesis will at times adopt theoretical perspectives from science and technology studies in the second part of empirical analysis. This will be done to both challenge common understandings of how science and technology operate in a general sense, as well as to critically consider the operating of blockchain more specifically.

3.3.3 Critical Transparency Studies

This subsection will briefly introduce and contextualise the theories from critical transparency studies that are used in the second part of empirical analysis. Although a diversity of perspectives exists under critical transparency studies, and some of these perspectives could arguably be subsumed under the broader body of science and technology studies to some extent, what differentiates and unites these theories is that they adopt a questioning approach to transparency in the context of environmental governance.

Although commentators have taken a questioning stance on transparency in environmental governance since the emergence of market-based governance by disclosure approaches in the late 20th century, one of the most complete volumes of work advancing critical transparency studies come from the publication “Transparency in Global Environmental Governance: Critical Perspectives”, edited by Gupta and Mason (2014). In this volume, Gupta and Mason (2014) carve out a critical transparency studies perspective in the context of international environmental politics, with a collection of contributions that challenge dominant institutionalist perspectives to transparency that generally see transparency and associated information disclosure as a unilaterally positive means through which to minimise information asymmetries. In contrast to such dominant institutionalist approaches, a critical theoretical perspective emphasises that in studying transparency:

“its uptake, institutionalization and effects need to be analyzed within broader, often contested, political-economic and normative contexts within which disclosure is being deployed.” - Gupta and Mason (2014: 41)

Drawing on constructivist and critical political economy research traditions, critical transparency studies thus emphasises the historicity and socio-political conditioning of transparency and disclosure practices, additionally acknowledging the value-laden and normative nature of transparency as a construct. Here, constructivist analyses of science and knowledge are implemented to consider whose information counts and is accorded political primacy in the context of inherently social decisions about what is valid knowledge and whose information counts (Jasanoff, 1990). The political economy element pertains to a discussion of the relationship between transparency and markets, where the political hegemony of ‘liberal environmentalism’ - understood to be a norm complex that privileges approaches to environmental governance that are market-enabling (Bernstein, 2002) - ultimately provides the insight that transparency in contemporary environmental governance is likely to have few market-restricting effects, and may even serve to reinforce ecologically damaging concentrations of power (Gupta and Mason, 2016).

Developing these theoretical approaches in their study of transparency in climate governance, Gupta and Mason (2016) propose a set of four (potentially conflicting) rationales for implementing transparency-based solutions. These rationales are understood to have implications for the ultimate effect of transparency-based governance, and form one of several theoretical perspectives applied in the second empirical section of this thesis. The first rationale they propose is a democratisation driver, underpinned by the spread of 'right to know' and freedom information laws that have mushroomed across the globe in recent decades (Florini, 2007). This rationale also pertains to the fostering of accountability, given the presumed relationship that disclosure of relevant information is necessary to hold actors to account for their actions or inactions, allowing for answerability and redress (Gupta and Mason, 2016).

The democratisation rationale for disclosure has the potential to clash with a second rationale of uptake: a marketisation driver. This driver privileges market-based solutions to global challenges under neoliberal logics, and can be observed in the embrace of voluntary transparency approaches - such as those that blockchain seeks to implement in product supply chains and voluntary carbon markets (Haufler, 2010). Ultimately, this marketisation rationale uses disclosure to ascribe economic value to elements of the environment that are historically opaque, such as carbon emissions, or alternatively to compensate for performance or ensure the effective functioning of markets (Gupta and Mason, 2016).

The third marketisation rationale is closely linked to a privatisation rationale. This rationale emphasis the importance of disclosure for enhancing private gain and the reach and power of private authority in international governance (Gupta and Mason, 2016). Together, these marketisation and privation rationales are often aligned with globally hegemonic (neoliberal) discourses privileging market-based solutions, economic valuation of environmental goods and services, and an enhanced role for private authority in global climate governance (Gupta and Mason, 2016: 83). The shift from marketisation to privatisation as an important imperative for disclosure refers, however, to governance systems where private authority permeates all aspects of the disclosure and use of sustainability-related information. It is thus stronger than a marketisation rationale, and implies a deepening of disclosure in voluntary and private governance to crowd out the development of public legal obligations on the disclosure of climate information (ibid.).

The final rationale, a technocratisation rationale is highly relevant to consider in the context of climate cryptogovernance. Due to the increasing importance of carbon offset markets and high-profile carbon fraud and credibility challenges, a wave of professional auditing and certifying techniques have put forth by those who want to see disclosure systems made more effective (Gupta and Mason, 2016). This rationale for transparency is explicitly design-focused in response to accelerating technological gains and interconnected information and communication systems. These have increasingly pertained to widespread release and use of climate data (ibid.).

Authors critiquing dominant understandings of transparency in public policy have also turned to the proposed relationship between transparency and accountability. While it is often assumed that transparency will automatically ensure accountability (Fox, 2007), one contribution of critical transparency studies is to highlight how this may not necessarily be the case. Fox (2007) offers a particularly insightful framework to use for illuminating the potentially tumultuous relationship between the two concepts.

Fox (2007) diagrammatically represents situations where transparency and accountability may or may not overlap. There may be situations where there is transparency but not necessarily accountability, and there is solely dissemination and access to information. Conversely, there may be situations where there is accountability, by means of sanctions, compensation and/or remediation, but not necessarily transparency (ibid.). A situation that integrates both transparency and accountability is understood to be institutional answerability, where there is power of civil society and public bodies “not only to reveal existing data, but also to investigate and produce information about actual institutional behaviour” (Fox, 2007: 668).

<table>
<tr><th>Transparency</th><th>Accountability</th></tr>
<tr><td>Dissemination and Access to Information</td><td></td></tr>
<tr><td colspan="2">Institutional ‘Answerability’</td></tr>
<tr><td></td><td>Sanctions, Compliance and/or Remediation</td></tr>
</table>

Figure 3a - Relationship between Transparency and Accountability (Fox, 2007)

A further distinction that Fox (2007) makes is between two types of transparency and two types of accountability. Fox (2007) understands that transparency can be both *opaque*, where disseminated information does not adequately reveal how institutions actually behave in practice, or *clear*, where there is reliable information about institutional performance. Similarly, accountability is understood to range from *soft*, where only answerability is present as actors are called to justify their actions, to *hard*, where there is answerability plus the possibility of sanctions (ibid.).

<table>
<tr><th colspan="2">Transparency</th><th colspan="2">Accountability</th></tr>
<tr><td>Opaque</td><td>Clear</td><td>Soft</td><td>Hard</td></tr>
<tr><td colspan="2">Dissemination and Access to Information</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Institutional ‘Answerability’</td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Sanctions, Compliance and/or Remediation</td></tr>
</table>

Figure 3b - Relationship between Transparency and Accountability (Fox, 2007)

Using this model, Fox (2007) argues that there is a need to distinguish between transparency and accountability because one does not necessarily generate the other. There is overlap - in that clear transparency is a form of soft accountability. However, Fox (2007: 669) warns that “one should not expect answerability from opaque transparency, and one should not expect hard accountability from answerability”.

In sum, theoretical perspectives from critical transparency studies will be applied in the second part of empirical analysis. This will be done with the intention of critically interrogating the potential rationales for blockchain-based climate transparency and to unpack the relationship between transparency and accountability.

3.4 Theoretical Framework

To draw this section to a close, the diverse range of theoretical perspectives explored will be synthesised to form a theoretical framework for this thesis. This theoretical framework has Hajerian argumentative discourse analysis at its centre, with the middle-range concept of the storyline forming the backbone of analysis.

In the first empirical section, *Chapter 5 - Distilling Climate Cryptogovernance*, ADA will be the main theoretical basis for analysis. The notion of discourse propagated by Hajer will be supplemented with the framework of three discourses proposed by Bäckstrand and Lövbrand (2006) - covering green governmentality, ecological modernisation and civic environmentalism. Using these combined theoretical perspectives, analysis will centre around the ways in which influential actors conceptualise climate cryptogovernance and in doing so construct social reality through their communicative actions. This approach is adopted to allow for a structured reading which distils the multiplicity of ideas identified in the sampled texts. This relationship between cognisant actors and conceptualisations of climate cryptogovernance - generated in communicative practices through a dominant storyline which draws on prevailing discourses - is represented below in figure 4a.

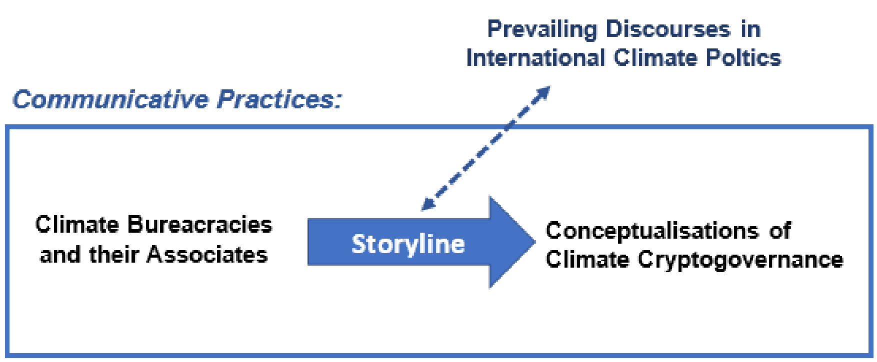

Figure 4a - Theorised Relationship between Influential Actors and Conceptualisations of Climate Cryptogovernance

In the second section of empirical analysis, *Chapter 6 - Interrogating Climate Cryptogovernance,* the findings of the first empirical section will be critically interrogated. Using theoretical perspectives that offer the ability to denaturalise and/or challenge dominant forms of knowledge, a critical analysis of the storylines identified in the first section will be undertaken. Theoretical perspectives from bodies of literature such as governmentality studies, science and technology studies and critical transparency studies will be applied to earlier findings from chapter 5, while maintaining a continued emphasis on the storyline as an analytical concept. These critical perspectives build on the insight of ADA that storylines are inherently simplifying to allow for discursive closure, and therefore may gloss over particular elements of phenomena (Hajer, 2010). These 'glossed over' elements are to be uncovered through critical analysis. Figure 4b presents a theoretical framework which represents the role that these critical perspectives in critically interrogating the dominant storyline.

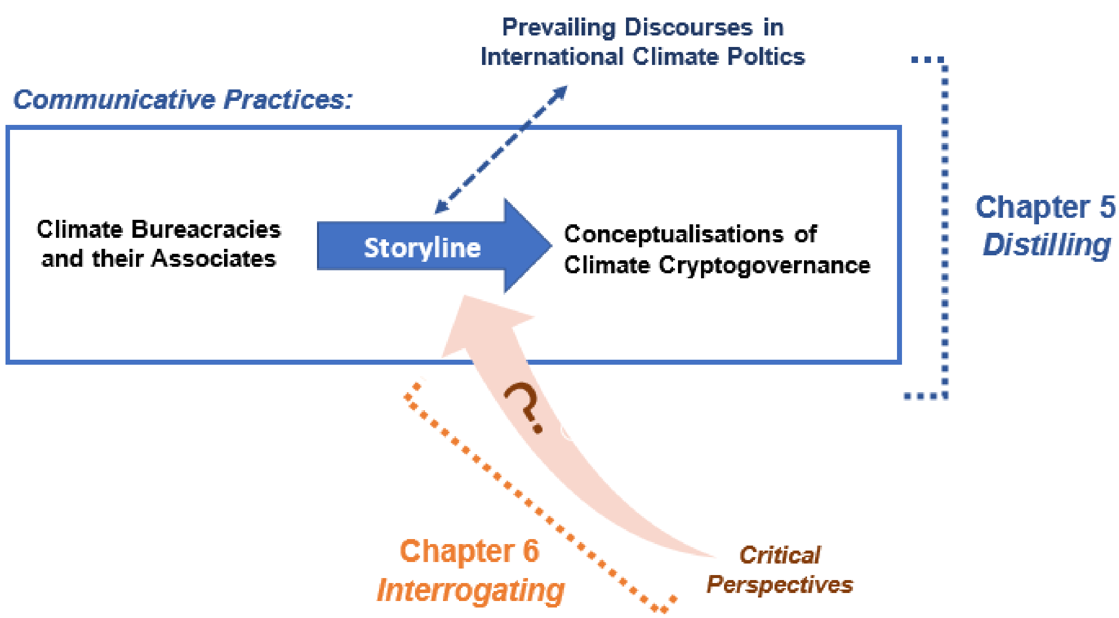

Figure 4b - Theoretical Framework

In sum, ADA is the foundational theoretical approach adopted, upon which a variety of additional perspectives that might be described as critical are overlain. In order to explore how the theoretical approaches explored in this chapter will be translated into practice, chapter 4 will explore the research approach adopted in this thesis. This approach will then be applied in the empirical chapters - chapter 5 *(Distilling Climate Cryptogovernance*) and chapter 6 (*Interrogating Climate Cryptogovernance*).

4. Research Approach

This chapter explores the methodology adopted to undertake empirical analysis and the assumptions that support the methodological decisions made. First, the philosophical assumptions of the research approach will be outlined to foreground the methodology. To follow, the sampling strategy and collected materials will be introduced. Then, the specific methods adopted in this thesis will be raised. These are those commonly adhered to under argumentative discourse analysis (which was introduced in the previous chapter). Specifically, this section will introduce an approach to ADA that Nielsen (2016a) has developed, which will be used to undertake analysis primarily using the middle-range concept of the storyline.

4.1 Research Paradigm: Ontological, Epistemological and Methodological Positions

As foregrounded in the theoretical perspectives section, the general approach of this thesis is rooted in discursive institutionalism, with additional insights from critical perspectives. Regardless of the disparities between some of these approaches in their institutional focus and normative stance, these research traditions are united by generally operating under a relatively strong constructivist approach. Subsequently, the methods and practice of this research were informed by the emergent paradigm of constructivist research. The key assumptions of this paradigm will be discussed below in the context of ontology, epistemology and methodology, with the intention of making the rationale behind adopting the particular research approach as explicit as possible within the constructivist tradition. This research adheres to the constructivist commitment to multiple realities (relativist ontology), an interactive researcher-subject relationship (subjectivist epistemology), and a mutually constructed research product (interpretive methodology) (Guba and Lincoln, 2003).

With respect to *ontology*, understood here as the study of being that is concerned with *what* constitutes reality (Crotty, 1998), this research makes the assumption of ontological relativism. This is to say that there are multiple realities constructed by actors of research, and the version of reality laid out in this research is but one depiction (ibid.). The relativist ontology adopted here rejects claims that one possible correct reality exists. However, in line with work by Manning (1997) and others on authenticity in constructivist research, this research does not make the assumption that all possible versions of reality that could be represented in research are value-free, nor considered equally valid in all contexts. As the variety of potential theoretical interpretations is infinite, the researcher must choose from competing and potentially falsifiable interpretations, and examine and provide convincing arguments for the relative credibility of alternative knowledge claims (Kvale, 1995:26). Despite the limitless possibilities that exist, certain interpretations may be more plausible than others and provide deeper insights into phenomena, given the specific cultural context and the general purposes of the study (Manning, 1997). The research approach of this thesis thus upholds the assumption of ontological relativism, but with the acknowledgement that certain versions of reality may be broadly interpreted as more valid than others in particular contexts.

With respect to *epistemology*, understood here to be concerned with *how* knowledge can be created, acquired and communicated (Cohen et al., 2007), this research adopts a subjectivist epistemology. Such an epistemological stance poses the question “What is the relationship of the knower to the known?” (Guba & Lincoln, 2003: 83). The fundamental point of departure of this epistemological stance from positivist research is the belief that the world does not exist independently of the viewer’s knowledge of it (Grix, 2004). As such, the knowledge gained in this thesis is seen to be shaped by a dynamic inquiry process, whereby the researchers’ questions, observations and comments shape the knowledge interpreted from textual sources and simultaneously the textual sources themselves influences the meanings ascribed by the researcher (Manning, 1997). Subsequently, all knowledge generated is inherently unstable (Lather, 1993), and because the knower and known are interlinked, all knowledge produced is value-bound (Smith, 1983). From this approach, different people may construct meaning in different ways, and ‘truth’ is a consensus formed by co-constructors. Knowledge is therefore seen in this thesis as situated in culture and time. This thesis will feature a strong focus on reflexivity in light of the belief that the social world can only be understood from the positions of the individuals participating in it (Cohen et al., 2007).

With respect to *methodology*, understood here to refer to the strategy which underlies the choice of particular methods (Crotty, 1998), this research adopts an interpretive methodology. An interpretive methodological approach seeks to be inductive and generated from the data as opposed to preceding it (Cohen et al., 2007: 22). Unlike positivist methodology, where a researcher generally begins with a theory and tests theoretical propositions using empirical data as in the scientific method, with interpretive methodology, a researcher begins with data and undertakes a recursive process of deriving a theory about the phenomenon of interest (Creswell, 2009). As such, research approach adopted in this thesis is based on the assumption of social realities being embedded within and impossible to abstract from their social settings, requiring interpretation of reality through “sense-making” as opposed to a hypothesis testing process (ibid).

Having made explicit the ontological, epistemological and methodological basis from which this thesis operates, focus will shift from the abstract discussion of philosophical underpinnings to the substantive methodological choices that were made as a result of these underpinnings.

4.2 Data Collection Strategy

The data examined in this thesis comes from a variety of publicly communicated textual sources accessible via the internet. The texts collected were purposively sampled over a period from July to December 2018, based on criteria that were carefully chosen on the basis of an initial literature review. The justification for a sole focus on textual analysis was twofold.

Firstly, the texts disseminated externally by actors represent a purposive and rich source of communications that draw upon and constitute prevailing discourses (Nielsen, 2016b). Climate cryptogovernance is still in early, hypothetical stages, which although inhibits the study of actual implemented projects, does make for a wealth of rich textual material that can be accessed electronically. This is particularly true given the information and communications technology orientation of the subject matter studied.

Secondly, a sole focus on textual data represents the most feasible methodological strategy. Due to a lack of funding and limited time to complete this thesis in, travelling to interview prominent stakeholders involved in climate cryptogovernance or observe relevant events was not feasible. Textual data, on the other hand, is readily accessible and does not suffer from issues related to access, gatekeeping and ethics.

From the insights of an unstructured initial literature review, which provided early information about the texts covering blockchain and climate, a number of criteria were determined for selection of a text. These can be summarised as follows:

- i. explicitly discusses blockchain;
- ii. explicitly discusses the relationship between blockchain and the climate;
- iii. externally communicated by authors regarded as 'trustworthy', by way of representing or being directly or indirectly linked to international climate bureaucracies;
- iv. accessible online between 15th July 2018 and 15th November 2018.

To provide clarity about how and why textual sources were selected or not, the several criteria mentioned in the above statement will be further operationalised below:

<u>I. Explicitly discusses blockchain as a technology</u>

Given the increasing promise of harnessing developments in information technology and data science for policy, a range of potential technologies are often cited as promising solutions to environmental issues - of which blockchain is just one (UNEP, 2016a). However, this thesis has elected to maintain focus on solely blockchain. As demonstrated in the first two sections of this thesis, blockchain alone presents a wealth of material for analysis. Subsequently, a distinction is made between blockchain and aggregate terms that include blockchain, such as "Fintech". Similarly, this thesis will not sample texts which exclusively focus on technologies that are sometimes used in tandem with blockchain as part of the 'fourth industrial revolution' (which blockchain is seen to be one component of) but are ultimately distinct, such as the Internet of Things. The documents sampled must feature at least some discussion of *blockchain* specifically as a technological solution to climate change.

<u>II. Explicitly discusses the interactions between blockchain and the climate.</u>

Blockchain has increasingly been employed in a broad range of fields that have either direct or indirect linkages to climate change policy. These include energy policy and migration policy (UN Blockchain, 2018), to mention just a few. While these policy areas are undoubtedly relevant in the context of climate governance - particularly energy policy, which was often touched on by climate-focused texts - it was determined that texts must explicitly discuss at least the *interactions between blockchain and climate change*. This interaction may occur in the broadest sense, including a discussion of formal policy agreements, frameworks and instruments such as those under Paris Agreement, but equally also including specific instrumental approaches to incorporating blockchain into climate governance, such as cryptocurrencies or climate consumerism. Additional issue areas and linkages may also be present in the sampled materials, but no texts that discuss other issue areas with a solely implicit relationship between blockchain and climate governance were sampled.

III. Authored by actors that are widely regarded as 'trustworthy', by way of representing or being directly or indirectly linked to official international climate governance bureaucracies

This purposive sampling criterion rests on the assumption of ADA that for particular storylines to gain traction and become adopted by discourse coalitions, they must be credible, acceptable and disseminated by trusted actors (Hajer, 2010). Early reviews of the literature available found an overwhelming number of short, overtly optimistic articles produced by small blockchain commentators. While these authors put forth coherent arguments, they would command low footfall, low recognition and had blatantly vested interests in furthering blockchain caucuses, therefore holding little influence and relevance for understanding the dominant ways in which climate cryptogovernance is understood. Purposive sampling along the lines of trustworthiness was thus deemed necessary for determining textual sources that could feasibly command actors to adopt a storyline and join a discourse coalition. Right from the offset, potential challenges come into view of transforming trustworthiness into a specific sampling criterion. What is trustworthiness? Who has the authority to decide whether an actor is trustworthy or not? How can trustworthiness be determined?

The general stance taken here is that the collective trust held in texts is influenced by authorship, which gains legitimacy from the recognisability of an institution. However, the term 'institution' can be vague to operationalise under a constructivist research paradigm which often focuses beyond tangible multigovernmental fora onto language. Therefore, this research reverts to its institutionalist origins, to specifically operate under the assumption that it is largely the international environmental bureaucracies associated with climate governance that hold formalised political power on the global stage. These bureaucracies, such as the UNFCCC and World Bank, are presumed to command the largest degree of legitimacy and agenda-setting power (Biermann and Siebenhuener, 2009).

Non-bureaucratic actors that hold a similar degree of authority will be those that interact in the same contexts as these bureaucratic actors - whether this is through the mode of involvement in an international environmental negotiation or agreement, formal or informal partnership, dissemination of peer-reviewed information, attendance at events organised by bureaucracies and so on. For this sampling criterion, an article will be sampled if it is *explicit or theoretically plausible that the author of a text would interact with one or more international environmental bureaucracies* to govern climate change.

For example, although a small, blockchain startup company may not have widespread recognition, a direct link to the UNFCCC and the associated possibility of influencing more powerful actors would make a text by such an actor relevant to sample. Alternatively, while an author writing in a respected peer-reviewed academic journal such as *Nature* or for a representative of a powerful non-state actor such as *IBM* or *Greenpeace* may not have explicit ties to environmental bureaucracies, it is theoretically plausible that due to the scale of the recognition they command, that international bureaucracies would engage with such ideas. By contrast, the type of author that this purposive sampling criterion attempts to exclude are those with low recognition and an unambiguously vested interest in shoehorning the benefits of blockchain. In line with the assumptions of this research project, the ability of the researcher to deem whether an actor is authoritative or not will be inherently subjective, based on their interpretation of the evidence available in the situated context in which research is undertaken.

<u>iv. Published online</u>

Given that the internet is the privileged forum for public communications as of 2018, focus was placed on sampling texts that were published online. This is not to say, however, that texts had to be created for the purpose of dissemination via the internet. Sampled materials also included electronic versions of documents provided or produced in physical versions at events and conferences, which were then later replicated online. Unlike some of the other criteria laid out above, this sampling criterion largely represents a practical consideration, as opposed to a theoretically grounded decision.

4.3 Collected Data

Using these purposive sampling criteria, a body of 50 texts, authored by 33 authors from 2016 to 2018 were collected. Texts were sampled in a relatively systematic way; not necessarily because the validity or reliability of the research depends on it - as might be an assumption of positivist approaches to textual analysis - but rather because this was the most consistent way to ensure that as many texts as possible were collected. The texts ranged from press statements, reports, news articles, conference materials and academic papers. Table 2 below provides a brief summary of the types of documents collected.

Document Type	**Number**	**Typical Author(s)**
Web Article	22	Various, ranging from small think tanks, to larger multigovernmental organisations (MGOs), such as the WEF and WTO
Official Report	7	Large actors, including MGOs (e.g. World Bank, UNEP), non-profits (e.g. WEF) and consultancies (e.g. PWC)
Conference Materials	7	Organisers of climate relevant events, such as CIGI and the World Bank
Policy Brief	5	Think tanks, such as the ELI, CIGI and the IIED
Journal Article	2	Academics researching blockchain and climate
Book Excerpt	2	Academics researching blockchain and climate
White Paper	2	Blockchain developers
Web Page	2	Blockchain developers
Press Release	1	UNFCCC

Table 2 - Sampled Documents

4.4 Reading Storylines: Operationalising the ADA Approach

Given that ADA is the foundational theory of this thesis, the methodological approach of ADA for identifying storylines requires some further elaboration. Even when storylines are deconstructed using contrasting theoretical perspectives to ADA in later sections, analysis is still grounded by the interpretive reading of storylines within the studied texts. The challenge to identifying storylines and placing these storylines in context is, as Nielsen (2016b) notes, that there is relatively little guidance on how to undertake a structured ADA. This is particularly true when one compares ADA to discourse analytical perspectives that employ elements of Gramscian political economy, such as critical discourse analysis (CDA), which are comparatively elaborated (Fairclough and Wodak, 1997). Below it will briefly be explained how storylines were identified in the context of this thesis, using a framework harnessed by Nielsen (2016b) that was developed under the practices of those such as Hajer (2010), Bulkeley (2000) and Cotton et al. (2014). The process followed by Nielsen (2016b) is as follows:

Stage 1: Drafting some ex-ante notes on what the key storylines might be, based on preliminary research derived from an initial literature review.

Stage 2: Testing these initial draft ideas of what the storylines are against a broader range of material to see if they correspond to key arguments adhered to by different actors, or if these storylines exist across a range of other types of material.

Stage 3: Refining the storylines developed so far, either by reshaping the existing ones developed in the first two stages, or by creating/removing additional storylines to better reflect what has been observed.

Stage 4: Repeating the above three steps for a number of rounds, with the data collection becoming more focused.

For example, in a second round of text collection, the texts sought out would seek to fill gaps identified in the first round. In line with the ontological and epistemological positions adopted, there is no predetermined endpoint for this repetitive process. It is not the case that this process is done to fully capture an objective reality, but rather that this process is completed to the point *where an inherently subjective but comprehensive understanding of the nature of the phenomenon study is gained.*

Stage 5: Connecting the storylines to discourse - i.e. evaluating how the storylines fit with discourses identified in the literature, or outlining a new discourse based on the storylines.

Throughout stages, this process was assisted through the use of qualitative research software, specifically ATLAS TI, in order to code specific elements of the text so that they could be referred back to and analysed collectively in the context of contributing to particular storylines. These codes are available in *Appendix 1*.

4.5 Summary

To summarise, this chapter has outlined the methodological approach that this thesis will adopt. First, the philosophical underpinnings of this methodology were presented - including a relativist ontology, subjectivist epistemology and interpretive methodology. Then the four sampling criteria used were raised, along with a summary of the collected data. This chapter concluded with an overview of how discourse analysis was undertaken in practice, including details of data analysis software used. Having presented the contextual background (chapter 2), theoretical framework (chapter 3) and methodological approach (chapter 4), the next two empirical chapters will provide a discursive exploration of climate cryptogovernance.

5. Distilling Climate Cryptogovernance

Using the middle-range concepts developed by Hajer (2010), this section will present the findings of an argumentative discourse analysis of a range of texts outlining climate cryptogovernance. Section 5.1 will start with a short history of climate cryptogovernance, with an emphasis on key events and document publications by international climate bureaucracies.

Having provided an overview of the trajectory of climate cryptogovernance in the context of international environmental politics, the dominant storyline identified will be presented. This dominant storyline of climate cryptogovernance at its core argues that blockchain is a potentially effective means by which to govern the climate. Moreover, this dominant storyline was interpreted as consisting of eight components that supported and expanded upon this core claim. In section 5.2 of these components will be explored individually.

To end the chapter, section 5.3 will provide a brief discussion about *which* actors within discourse coalitions generally advanced particular elements of the dominant storyline.

5.1 The Trajectory of Climate Cryptogovernance from 2016 to 2018

5.1.1 Experimenting with Blockchain Integration: Early Support (2016 to mid-2017)

Although it is reasonable to assume that small scale advocacy for the incorporation of blockchain into climate policy has existed since the invention of Bitcoin, the mainstream uptake of blockchain has a much more recent history. Indeed, the first time blockchain appears to be officially referenced in a publication by a multigovernmental environmental organisation is in 2016. In the UNEP Fintech Report titled ‘Fintech And Sustainable Development – Assessing The Implications’, published in December 2016, UNEP explores how financial technology (‘fintech’) was emerging as a “core disruptor of the financial system” (UNEP, 2016a: 1). This fintech focused report builds on a section of the second edition of the ‘The Financial System We Need’ report, published earlier in September 2016 (UNEP, 2016b). Although the UNEP fintech report was not explicitly focused on blockchain, blockchain was seen to be a particularly notable component of Fintech in achieving sustainability, with its potential to be a:

“disruptive force in the financial sector in opposition to the centralized, trusted and guarded current state model of today’s financial transactions.” - UNEP (2016: 2)

At this time, there were also small pockets of interest in the specific application of blockchain to the climate, scattered around the climate policy community. For example, a research group at the Zurich-based foundation Cleantech 21 collated initial findings on DLT's potential for climate action. They discussed these with different Parties at COP22, held in November 2016 in Marrakesh, as well as with representatives from the UNFCCC secretariat, different NGOs and corporations (CLI, 2018b). They engaged with members of the Liechtenstein delegation to form the Climate Ledger Initiative, an organisation that today frequently plays a substantial role in both organising and participating in blockchain and climate-related events (ibid.).

While smaller-scale initiatives and individual commentators had thus clearly begun to consider the implications of blockchain technology for climate action, it was not until around May 2017 when Guillaume Chapron published an article in *Nature* that the promises of cryptogovernance for the environment (and climate) seemed to catch on in mainstream policy circles. In this article, Chapron (2017) speaks generally of the potentially transformative impact of blockchain for environmental governance, as outlined in the introductory section of this thesis.

An ecologist by training, Chapron (2017) discusses the blockchain within the entirety of environmental governance, but provides an example of how blockchain could enhance incentives for climate governance as seen by a March 2017 Ethereum-based trading platform for carbon credits on the Russian market. Although it is hard to capture the exact role of Chapron's article in sparking interest in blockchain, the article has 38 journal and grey literature citations to date registered with Google Scholar (2019). Furthermore, there are references back to this article in texts published by the UNFCCC (2017). It is reasonable to suggest that this article by Chapron (2017) played at least some part in putting blockchain on the academic and political agenda.

The publication of Chapron article coincides with a high profile event at which blockchain was placed on display to the climate policy community. From 22nd to 26th May 2017, the inaugural Innovate4Climate event headed by the World Bank and German and Spanish governments took place in Barcelona, Spain (World Bank, 2017). This first Innovate4Climate event focused on engaging diverse stakeholders as a new global platform to advance the post-2015 framework.

Topics discussed included:

"Unlocking the Trillions in private sector investment needed to scale up national climate plans and to accelerate the global transition to a low-carbon, climate-resilient future…; de-risking investments; driving low-carbon pathways through transformative policies and carbon pricing; and supporting the implementation of NDCs" - World Bank (2017a)

While blockchain appeared to be relatively marginal in this first event which discussed the above topics in broader terms, this paved the way for the centrality of blockchain for climate governance as a discussion point at the second Innovate4Climate Event on 22nd to 24th May 2018, where two sessions explicitly explored the current and potential role of DLT for climate action (Climate-KIC, 2018a).

5.1.2 The Path to UNFCCC Support (mid to late 2017)

Not long after the first Innovate4Climate event, on 24th June 2017, the Centre for International Governance Innovation (CIGI) headed Blockchain ClimateCup Roundtable occurred (Aganaba-Jeanty et al., 2017). Specifically, the International Law Research Program at CIGI, which is a Canadian governance think tank, held a widely attended roundtable discussion dedicated to the application of DLTs to meeting the reporting, accountability and transparency requirements of the Paris Agreement on climate change (ibid.). The roundtable attracted high profile attendees nonetheless, including Alexandre Gellert Paris of the UNFCCC Secretariat and multiple representatives from the Canadian government and German development agency Gesellschaft für Internationale Zusammenarbei (GIZ) (ibid.).

The Blockchain ClimateCup Roundtable marks a notable moment in the trajectory of climate cryptogovernance. Not only does it represent the first time that an event was held explicitly to develop solutions to the Paris Agreement using blockchain technology, but documents produced at this event by DAO IPCI - an organisation that aims to develop blockchain-based smart contract technology for carbon markets - generated a relatively fleshed out proposal of how NDCs could theoretically be ledgered using blockchain (DAO IPCI, 2018). These papers form one of the most detailed technical proposals that is currently publicly accessible for the integration of blockchain into the Paris Agreement (DAO IPCI, 2017).

It was also in June 2017 that the UNFCCC first published an article that discussed blockchain in the context of climate change. On 1st June, the UNFCCC published on its website “How Blockchain Technology Could Boost Climate Action”, citing improved carbon emission trading, facilitated clean energy trading, enhanced climate finance flows and better tracking and reporting of greenhouse gas emissions (UNFCCC, 2017). Referencing the Innovate4Climate 2017 conference, the article expands on claims put forth by Chapron (2017) and applies these to climate governance: that because of the distributed nature of blockchain, it could improve governance and sustainability in support of collective action to tackle climate change (ibid.). Although optimistic, the tone of the article was generally cautious, with an underlying sense that “more work [is] needed for blockchain to fully support climate action” (UNFCCC, 2017). The extent of support from the UNFCCC at this time was therefore as follows:

“The United Nations Climate Change (UNFCCC) secretariat recognizes the general potential of Blockchain technology. In particular, transparency, cost-effectiveness and efficiency advantages, which in turn may lead to greater stakeholder integration and enhanced creation of global public goods are currently viewed as the main potential benefits. The secretariat, therefore, specifically supports initiatives that lead to innovation at the intersection of Blockchain and climate.” - UNFCCC (2017)

In the UNFCCC (2017) article, one such initiative to lead innovation was explicitly identified: the upcoming “Blockchain for Climate hackathon to be organized by the government of Liechtenstein, Cleantech21, INFRAS and ETH Zürich, in the margin of COP23”. From 12th to 16th November 2017, 100 distributed ledger technology and blockchain specialists from 33 countries attended a 24-hour hackathon held alongside the COP23 climate change conference (Hack4Climate, 2018). In addition to being attended by a contingent of UNFCCC representatives, high profile strategic partners included Volkswagen, Microsoft, GIZ and the Children’s Investment Fund Foundation (ibid.). Where other events focused more on ‘top-down’ knowledge diffusion, the Hack4Climate event was blatantly ‘bottom-up’ oriented through the development of multiple potential solutions created by blockchain developers. Beyond explicitly integrating technical stakeholders and organisations into the broader push towards climate cryptogovernance expressed in the earlier events of 2017, Hack4Climate is a further manifestation of how climate cryptogovernance continued to receive greater legitimacy from the UNFCCC, national governments and non-governmental supporters.

A pivotal moment that came not long after the UNFCCC (2017) was one that accelerated the incorporation of blockchain caucuses into the arena of international climate politics: the development of the Climate Chain Coalition (CCC). At the One Planet Summit, held on the second anniversary of the Paris Agreement on 12th December 2017, a multi-stakeholder initiative composed of 12 organisations met in Paris, France and established an open global initiative, named the Climate Chain Coalition (CCC, 2018). As of August 2018, over 100 organisations have joined the CCC. To use their own words, the CCC is:

"an open global initiative to support collaboration among members and stakeholders to advance blockchain (distributed ledger technology) and related digital solutions (e.g. IoT, big data) to help mobilize climate finance and enhance MRV (measurement, reporting and verification) to scale climate actions for mitigation and adaptation" - CCC (2018)

The UNFCCC had a significant hand in facilitating the creation of the CCC, with the intention of encouraging exploration and eventual use of this technology in support of climate action. In fact, it was the CCC which acted as a springboard for the UNFCCC to officially announce their support for the use of blockchain in meeting the aims of the Paris Agreement (UNFCCC, 2018).

5.1.3 UNFCCC Support and Beyond (2018)

A pivotal moment for blockchain in international climate governance was the formalised support of the UNFCCC following the establishment of the CCC. On 22nd January 2018, the UNFCCC produced an article titled "UN Supports Blockchain Technology for Climate Action" (UNFCCC, 2018a). This article restated the potential benefits of blockchain, announced the creation of the CCC and its charter and formally stated support for using blockchain for climate action. Massamba Thioye, who is noted as leading the UNFCCC work exploring DLT and blockchain, is said in the article to have stated the following:

"The UN Climate Change secretariat recognizes the potential of blockchain technology to contribute to enhanced climate action and sustainability" - UNFCCC (2018a)

In the context of the CCC specifically, Thioye also says:

“To fully and promptly mobilize this potential, broad collaboration among stakeholders is needed to direct resources to priority areas, avoid duplication of effort, and help avoid the pitfalls of working on a new technology with countless unknowns” - (UNFCCC, 2018a)

The significance of this article is substantial, given that up to this point the UN had been reticent to state explicit support for the use of Blockchain technology (UNFCCC, 2017). Indeed, even though the World Bank had seemingly been more proactive in developing events that explored the interface between blockchain and climate, even they had not disseminated a statement of support as outright as that by the UNFCCC.

Since then, the official legitimation of blockchain for climate action by the UNFCCC, traction has only continued to grow - as demonstrated by the release of several significant publications across 2018. On 19th March 2018, the World Bank (2018) disclosed the report ‘Blockchain and Emerging Digital Technologies for Enhancing Post-2020 Climate Markets’, one of the most developed reports to date detailing the utility of blockchain for climate applications. On 16th April 2018, the UN Principles for Responsible Investing Initiative released a technical primer on blockchain, including a section on climate change (UN PRI, 2018). On 21st June 2018, the first full-length academic book dedicated to blockchain and climate was published, named ‘Transforming Climate Finance and Green Investment with Blockchains’ (Marke, 2018). On 14th September 2018, the World Economic Forum collaborated with PricewaterhouseCoopers to release an extensive report outlining the future for blockchain and climate, entitled ‘Building Block(chain)s for a Better Planet’ (WEF and PwC, 2018). Such influential and mounting publications are released alongside the occurrence of even further blockchain-focused events, both side-events at COPs and standalone events. Perhaps most significantly of these events, on 25th September 2018, the OECD, UNEP and the World Bank Group hosted a high-level discussion on Financing Climate Futures, which resulted in a detailed summary report that discusses blockchain (OECD, UNEP and World Bank, 2018). Where climate cryptogovernance will develop to remains to be seen.

5.1.4 A Brief Chronology of Blockchain in Climate Governance

Considering the historical events provided above, it is possible to provide a timeline of significant events that chart the evolution of climate cryptogovernance (table 3, overleaf).

Year	Event	Significance
1991	Pe-decessor to Blockchain Technology Theorised	Early cryptographic work that later was developed into blockchain.
1997	Smart Contract Theorised	Early theorisation of what was to become a key application of blockchain technology.
2008	Publication of Bitcoin White Paper	Blockchain theorised for the first time.
2009	First Bitcoin Transaction	First practical operationalisation of blockchain technology
2016	Publication of UNEP Fintech Report	First time blockchain is acknowledged by an international environmental bureaucracy.
2017	Chapron Article Published in Nature	First peer reviewed journal article linking blockchain and the environment.
	Innovate for Climate Conference	World Bank headed climate event where blockchain was a significant discussion point.
	Blockchain ClimateCup Roundtable	First event focusing on the relationship between blockchain and climate change governance.
	UNFCCCC Web Article About the Ways Blockchain Could Support their Work	Initial sign of UNFCCC support for innovation at the interface between blockchain and climate.
	Hack4Climate Conference	First event explicitly focusing on DLT development for climate change.
	Climate Chain Coalition Created	Formal partnership of a variety of key actors in climate cryptogovernance, backed by UNFCCC.
2018	UNFCCC web article about CCC charter	UNFCCC formalises support of blockchain in CCC charter article
	Publication of World Bank Finance report	First extended report by a multigovernmental organisation on blockchain in climate finance.
	'Transforming Climate Finance and Green Investment with Blockchains' book Published	First full-length academic book on blockchain and climate published.
	WEF/PWC Report Published	Extended report discussing the future of climate and blockchain and areas for further development.
	Financing Climate Futures event	High profile standalone event discussing blockchain and climate held by the OECD, UNEP and WB.

Table 3 - The Evolution of Climate Cryptogovernance

5.2 The Dominant Storyline of Climate Cryptogovernance

Using the middle-range concepts developed by Hajer (2010), this section will present the findings of an argumentative discourse analysis of a range of texts detailing climate cryptogovernance. A dominant storyline of climate cryptogovernance was identified from this analysis, which was encountered across the texts.

The dominant storyline of climate cryptogovernance identified in the texts had a simple core argument: blockchain is a potentially effective tool for governing the issue of climate change. Moreover, the dominant storyline can be described as consisting of eight components which support, expand upon and put into context this overarching claim. These eight components were often harnessed differentially by actors depending on authorship.

The eight identified components of the dominant storyline of climate cryptogovernance are as follows: i. Reliability; ii. Measurability; iii. Transparency; iv. Accountability; v. Future Ambition; vi. Neutrality; vii. Radicalism; viii. Inclusiveness.

In this subsection, each component of the dominant storyline will be further expanded upon and supported by notable examples from the texts.

5.2.1 Reliability

A key component of the dominant storyline identified in the texts highlighted the ability of blockchain technology to ensure *reliability* in climate governance processes. Specifically, the key rationale of this storyline is that through enshrining trust away from human actors and into efficient and neutral computer code of blockchain and associated technologies, the management of carbon and subsequent mitigation of climate change can be achieved.

An example of this reliability component of the storyline is provided by Sven Braden, who is a member of the Climate Ledger Initiative and co-founder of the Life Climate Foundation Liechtenstein:

"Right now, in terms of mitigation, everything goes through the UNFCCC and the CDM –it's centralised. One of the major challenges is in synching databases to ensure all ledgers have the

same information. With blockchain, you don't have to check the datasets and that they all add up, you just have to check the hash." - Lovett (2018)

According to this component of the storyline, blockchain enables climate governance - at least in this context of existing MRV protocol under the UNFCCC - through the technologised streamlining of existing administrative processes. The major challenges for mitigation are seen as pertaining to the reformation of existing administrative processes through blockchain technology. Thus the key tenet of this storyline component is not that existing technologies and procedures are not wholly flawed, but rather that they are characterised by a certain degree of unreliability that can be reduced through further technological development.

Resultantly, this component often emphasises the importance of trust, harking back to the earliest arguments made about cryptogovernance by Chapron (2017) in his discussion of environmental cryptogovernance. It is understood to be through computer code that blockchain can replace the need for human trust by ensuring reliability and reducing uncertainty. This logic of this component is summarised by an overview of the CIGI Climate Cup Roundtable event:

"As the technology eliminates the need for a trusted party to facilitate digital relationships or curate data, it also vastly expands the range of automatable operations about which it is possible to have reliable information." - Aganaba-Jeanty et al. (2017)

Similarly, the World Economic Forum diagnoses a fundamental lack of reliability in existing carbon markets that could be reduced through the application of blockchain:

"Differing standards and regulations in different jurisdictions and the potential for double counting have resulted in a lack of confidence from potential market participants. And without a universal ledger it isn't easy to track how much carbon you've used or – if you offset it –what the impact of your reduction has been on a tangible level." - Walker (2017)

All in all, the *reliability* component of the storyline proposes that through enshrining trust into computer code, blockchain can achieve optimal climate mitigation and adaptation in the context of presently unreliable governance arrangements. Focus will now shift to a related component of the storyline which was often identified by actors as being integral to ensuring this *reliability* - *measurability*.

5.2.2 Measurability

A further element of the identified storyline of climate cryptogovernance pertains to *measurability*, where carbon and other GHGs are kept a focal point when cryptogoverning the climate. With this component, the world is understood through the lens of carbon accounting as complex processes are simplified down to their quantifiability in terms of carbon for the purposes of governance. Key technical phrases that are used in this storyline include: carbon stocktaking, carbon leakage, additionality, double counting (of carbon), and the aggregated acronym of MRV (monitoring, verification and reporting). Indeed, the fundamental promise of blockchain through this storyline is to provide what the WEF describe as:

"next-gen sustainability monitoring, reporting and verification" - WEF (2018)

CIGI elaborate upon the centrality of relevant data on GHGs:

"As blockchain applications are fundamentally mechanisms to record, store and act upon data, climate change mitigation and adaptation actors must be diligent in applying the technology to focus on the critical relevant data." - Aganaba-Jeanty et al. (2017)

For the aforementioned technological applications of blockchain in ensuring *reliability* and *transparency* to occur, the *measurability* component of the storyline thus requires the quantification of carbon for MRV purposes. A particularly notable manifestation of this component is in discussions of REDD+, which were a feature of multiple texts. In the case of REDD+, discussion was explicitly centred on the translation from actions to commodifiable carbon for the sake of enhancing climate governance. This stands in contrast to discussion of some other applications of blockchain to climate governance - such as decentralised energy - where the application of blockchain is proposed to have theoretical co-benefits for carbon mitigation that need not necessarily be incorporated into MRV processes. Discussing a DLT solution targeted at REDD+ which was raised at the Innovate4Climate conference, a Daily Planet article states the following:

"Developed in close cooperation with Cleantech21, REDD-Chain exemplifies how DLT might be used in forest conservation. It posits a global forest ledger where every square meter of land is identified using remote sensing, satellite, and/or drone technology. Then, the forest can be

monitored using images taken at different time intervals—to determine whether it's still intact. Recorded on a publicly accessible distributed ledger, this data could be used to stimulate climate finance. For example, countries could be paid to keep their forests intact and plant new trees." - Lariviere (2017)

The above example demonstrates typical rhetoric of this component of the storyline, with its emphasis on quantifying carbon and other GHGs. Forests are understood as carbon sinks which through technical development can be rendered amenable to management and control.

It should be noted that while carbon was overwhelmingly a focal point, there were also times that this storyline extended out to encompass greenhouse gasses more broadly, such as the case that the WEF (2018) made for "transparent and trustworthy GHG emissions data" when climate cryptogoverning. Similarly, the Climate Ledger Initiative (2018) and others have made a case in the context of NDCs for:

"National Greenhouse gas inventories: Blockchain technology can help to manage flows of GHG relevant data for the establishment of national GHG inventories" - CLI (2018a)

In sum, it is this *measurability* component of the storyline that allows the fundamental relationship between blockchain and climate governance to exist: the transactions of gases that blockchain records must be rendered measurable for blockchain to act upon them. This is particularly true of carbon stocktaking. Only once measured, quantified, and aggregated can these gases, and carbon dioxide in particular, be effectively cryptogoverned. The next component of the storyline to be discussed is one that concerns the all-important communication of these measurements acted upon by blockchain - *transparency.*

5.2.3 Transparency

The *reliability* component of the storyline often interacted with another widely disseminated component of the storyline regarding *transparency*. In fact, it was often due to the ability of blockchain to enhance transparency that authors proposed that blockchain could truly ensure that blockchain enhances reliability. However, the *transparency* storyline extends far beyond its connections to reliability, and was one of the most consistently present storylines within the articles explored. In the context of sampled texts, one would be hard pressed to find a discussion of blockchain where transparency was not mentioned in some shape or form.

This component of the storyline diagnoses that the current activities of climate governance are all too often opaque in nature, and suffer from a lack of transparency. As the WEF puts forth in the case of carbon trading:

"Since its inception, carbon trading has suffered from some issues that have suppressed its potential. The market is beset by a lack of visibility, which prevents people from trusting the carbon credit as an asset." - WEF (2018)

The above quote highlights a common thread within the transparency component - the importance of transparency for integrating stakeholders into marketised climate governance. This storyline suggests that a lack of transparency is behind many of the fundamental issues of climate governance, such as a lack of participation and associated lack of funding and political will. Blockchain is posited as a solution to this lack of funding, because, put simply by World Bank headed initiative 'Connect4Climate':

"It increases transparency and thus stakeholder involvement." - Connect4Climate (2018a)

Similarly, as the Carbon Ledger Initiative argues in the case of blockchain technology:

"Major transparency advances are well within reach, which is vital for successful stakeholder integration and thus to reach a larger scale." - CLI (2018a)

However, there were reasons even beyond this functional rationale for augmenting transparency which were present in the storyline. Indeed, a strong normative element was present in the transparency component, as transparency was put forth as a vital element of good governance (as observed more broadly in climate governance by Gupta, 2009). The ClimateCoop for example, described as a "blockchain based collaboration & governance platform enabling dynamic community development & project formation for SDGs" (ClimateCoop, 2018), argued for the value of the transparent and openly accessible features of blockchain in maintaining the common public sector principles of "Transparency, Democracy, Incorruptibility & Auditability" (ibid.). Thus at times, the transparency component of the storyline maintained a strong normative element, which stands in contrast to the technical slant of the *reliability* and *measurability* components.

Another point of departure of the *transparency* component from some of the other components, such as that of *reliability*, was that the *transparency* component was often more explicitly coupled with specific elements of the Paris Agreement. Specifically, there was frequent discussion of the 'Blockchainization' of Article 6 of the Paris Agreement in the context of climate cryptogovernance. For example, in an article written by Dr. Jon Truby for Nature Asia, the following is written:

"Article 6 of the Paris Agreement urges nations to 'apply robust accounting' methods to ensure transparency in their emissions mitigation efforts. The public, decentralised and immutable nature of DLTs may be the key to ensuring accurate emissions reporting. More accurate and verifiable results can be recorded by enabling climate data to be input and shared on a blockchain; not only by government sources, but also by NGOs, local communities and businesses." - Truby (2018b)

Despite some specific applications, the *transparency* component was generally characterised by a somewhat ambiguous proposed relationship between blockchain, transparency and effective climate governance. Transparency was often taken for granted in the storyline as being unequivocally positive and automatically leading to substantive climate impacts. For example, Laura Altinger, a senior climate change adviser to the UN Economic and Social Commission for Asia and the Pacific, is reported as saying:

"As long as you agree on the MRV behind it, it kind of gives it the transparency and the credibility and allows you to develop a mechanism based on the Paris Agreement for internationally transferrable mitigation outcomes and carbon trade across borders..." - Namgyal (2018)

It is worth noting that adherents to this component that proposed a more developed relationship between transparency and climate outcomes often also cited accountability, in conjunction with the *transparency* component. For example, an article in the Daily Planet claims:

"transparent decentralised ledger could indeed be a more trustful way of recording impact and

validating delivery on environmental commitments for various stakeholders" - Lariviere (2018)

Regardless of how it was applied, the widely used *transparency* component of the storyline generally proposed the following: blockchain enhances transparency and transparency is required for effective climate governance. Given the centrality of accountability to climate cryptogovernance more broadly, this will be discussed in greater detail in the following subsection.

5.2.4 Accountability

The *reliability* and *transparency* storyline components often interacted with an associated *accountability* component. The *accountability* component often combined with the transparency storyline to identify a lack of accountability in present climate governance, that could be solved by using blockchain to augment the amount of transparent and reliable information. Specifically, the *accountability* component often proposed that due to a lack of transparency and reliability of information about measurable greenhouse gas emissions, governance actors were unable to make informed decisions or penalise free-riders. For example, the Climate Ledger Initiative claims the following of the Paris Agreement:

"Two of the most fundamental challenges facing the Paris Agreement are to ensure that different countries exchange information on their greenhouse gas (GHG) emissions safely and transparently, as well as take responsibility for their promised actions." - CLI (2018a)

By bringing to light the actions of actors through the transparency of blockchain technology, these actors could be held accountable to their formerly opaque activities. What was seldom present in the *accountability* component, however, was the specific redress mechanisms through which. For example, the Jon Truby article in Nature Asia suggested the following:

"Blockchain would facilitate localised reporting of climate data to help hold nations to account on their mitigation results, regardless of political obstacles." - Truby (2018b)

Similarly, the World Economic Forum and PwC made use of the *accountability* component in their report on blockchain in climate governance, making the following ambitious claims:

“Next-gen sustainability monitoring, reporting and verification: blockchain has the potential to transform both sustainability reporting and assurance, helping companies manage, demonstrate and improve their performance, while enabling consumers and investors to make better-informed decisions. This could drive a new wave of accountability and action, as this information filters up to board-level managers and provides them with a more complete picture for managing risk and reward profiles” - WEF and PwC (2018)

This is not to say that there were not also somewhat clearer proposals by actors harnessing this storyline; often by those writing from a legal perspective. CIGI, for example, argues that:

“all the agreements, commitments made, actions performed within ClimateCoop should be within a legally enforceable context, making all the actors legally responsible & accountable for their actions.” - Aganaba-Jeanty et al. (2017)

Regardless of the way in which the accountability storyline was utilised, the crux of this storyline was that with transparency that blockchain provides also comes a heightened level of accountability, as the actions of nation states and other actors are called into question. The largely functional storyline components discussed above that detailed *how* blockchain can govern climate change - spanning *reliability, measurability, transparency* and *accountability* - were tempered by cautious discussions of limitations and untapped potential of blockchain. To this effect, the next component to be discussed concerns *future ambition*.

5.2.5 Future Ambition

A further component that modulates all of those mentioned so far regards the factors that limit the uptake and effective use of blockchain in climate governance. It should be noted that this component does not represent an outright critique of climate cryptogovernance by the actors that promoted it. Instead, this component details barriers that are framed as necessary to overcome in order for blockchain to achieve its full potential in the realm of climate change governance. The key argument of this component is that there is a need for further development of blockchain which can be achieved through future ambitions.

Although this key message of this component is straightforward, this does not mean that this *future ambition* component was homogenous when encountered in the sampled texts. To capture its usage by actors fully, this component will be presented in three subsections detailing the three current limiting areas which are understood to be surpassable with future developments:

I. Energy Usage
II. Technological Limitations
III. Inadequate Governance Arrangements

I. Energy Usage

A prominent area for future development was based on a current paradox in climate cryptogovernance: blockchain and associated DLTs are expected to enable reductions in greenhouse gas emissions, but they themselves are dependent on a relatively high amount of energy consumption that in turn is likely to increase emissions through energy generation from non-renewable sources (depending on mining location).

Many authors of the sampled texts wrote openly about the energy consumption of blockchain, while acknowledging there was still a potential role for blockchain in climate change policy. Indeed, high energy usage has been such a prominent limitation to the application of blockchain that it has warranted a whole charter article of the UNFCCC-backed Climate Chain Coalition (CCC). The charter states that the CCC acknowledges a:

"Responsibility for addressing challenges attributable to DLT applications: As organizations concerned about environmental integrity generally and climate change specifically, we recognize some negative effects and current challenges of many DLT applications (in particular those using the blockchain with proof-of-work consensus) regarding their levels of energy consumption and GHG emissions. We are transparent and forthcoming while we actively seek appropriate solutions to address these challenges" - UNFCCC (2018a)

Similarly, in a report where the WEF and PwC sang the praises of blockchain more generally, authors were also transparent about the present energy consumption of bitcoin and other conventional cryptocurrencies which may have climate change policy applications, stating that:

“the upper estimate of bitcoin’s energy consumption in July 2018 was 70 terawatt hours per year 86 – the same amount of energy as Austria consumed in 2014 and around 0.35% of total global energy consumption that year.” - WEF and PwC (2018)

To remedy such issues, organisations like the EU-backed Climate-KIC have supported the Climate Ledger Initiative in exploring ways to offset the potential carbon footprint associated with blockchain’s high energy uses. A Daily Planet article states that:

“One of the major concerns around upscaling the use of blockchain is that the cryptocurrency has a particularly high energy footprint. Climate-KIC has supported the Climate Ledger Initiative in finding ways to offset the carbon footprint or exploring how renewable-powered labelling can help alleviate adverse impacts.” - Lovett (2018)

However, authors were at times also quick to say that despite the challenges of the high energy consumption of blockchain, blockchain and climate governance are not irreconcilable. Instead, what is needed is further development of DLTs and viable alternatives to the proof-of-work mechanisms that maintain blockchain’s unique properties for climate governance. In fact, some actors adopting this storyline even suggest that the energy usage of blockchain and its potential application to climate governance are reconcilable to such an extent that the positive benefits of blockchain could feasibly surpass the carbon emissions associated with it.

For example, the same Climate-KIC backed Daily Planet article mentioned above also goes on to rationalise that:

“DLT-enabled systems are poised to bring disruptive change into the highest greenhouse gas emitting industries affecting all stakeholders” - Lovett (2018)

Nevertheless, adherents to the future ambition component of the storyline frequently discussed the problematic energy consumption of blockchain with the acknowledgement that there was a need for further development in order for the mainstream climate cryptogovernance to become a viable reality. Future ambitions for development were also characteristic of other technological shortcomings of blockchain for climate governance, which represent a second area of the future ambition component.

II. Need for Further Development of Technological Solutions

Another facet of the future ambition component emphasised the need for further technological development of blockchain-based solutions more generally. This stemmed from identifiable technical limitations that exist in current, small-scale applications of blockchain to climate change. The current limitations of blockchain-based solutions, such as scalability, integration between blockchain applications and data insecurity, make it a technology that is not yet fully matured and in need of further development. For example, in the context of data confidentiality CIGI raises specific concerns:

"In the face of growing hype about blockchain, some are warning that the technology may still have vulnerabilities —for example, if everyone in the network relies on the same code, one mission-critical defect could take down the whole system" - CIGI (2018)

Despite a growing interest in blockchain for climate change, the future ambition component emphasises that the technology is not quite ready to meet the grand promises made by some commentators and that more work is needed before blockchain fully meets some of the expectations laid out for it.

This component therefore emphasised uncertainty surrounding the scaling up of blockchain-solutions from the level of small-scale pilot projects to widely adopted technology. For example, in discussing concrete use cases that demonstrate the possibility of climate cryptogovernance, the Climate Ledger Initiative writes that:

"It is still early stage for use cases that specifically address the tools and instrument of the Paris Agreement." - CLI (2018a)

Similarly, the UNFCCC has used this component in its recurring calls for initiatives that spark innovation in climate cryptogovernance and ultimately lead to concrete, scalable and robust solutions that could be utilised widely to meet the Paris Agreement NDCs. The UNFCCC writes that:

"The secretariat supports initiatives that lead to innovation at the intersection of blockchain and climate change." - UNFCCC (2017)

This need for technological innovation and further development has been even argued in the context of blockchain's relation to other developments in 'fintech' more broadly. The WEF and PwC argue, for example, that:

"there are a number of technical challenges with blockchain, and the ability to overcome these may determine the extent of its deployment over the coming years. Blockchain is often not a complete solution in itself – the greatest benefits will be realized when distributed ledgers and smart contracts are used in collaboration with other Fourth Industrial Revolution technologies, including Artificial Intelligence and the Internet of Things." - WEF and PwC (2018)

Regardless of the specific reason proposed for further technological development being required, it is through the discussion of technological limitation that the future ambition component of the dominant storyline often acted as a precautionary counterpoint to some of the more hyperbolic components that relayed the radical and disruptive potential of climate cryptogovernance. However, it is not necessarily just blockchain itself that actors have argued require further ambition, the institutional arrangements of climate cryptogovernance have also seen regular mention.

III. Need for Further Development of Governance Arrangements

Beyond the technological limitations of climate cryptogovernance, many actors identified a variety of challenges that exist in the governance arrangements around blockchain that require further consideration. Given the relatively recent rise of DLTs, the legislation surrounding climate cryptogovernance is relatively lacking in contrast to more mature digital technologies, such as the internet and its social media platforms and search engines. The WEF and PwC identified how a need for further development of a legal and regulatory environment amenable to climate cryptogovernance is required for its effective rollout:

"As technologists focus over the next few years on fixing the technical limitations of blockchain and building networks that form the infrastructure layer of the crypto stack, a fit-for purpose legal and regulatory environment for blockchain must also be established and operable across jurisdictions globally" - WEF and PwC (2018)

The *future ambition* component thus also emphasises the occasionally overlooked necessity of regulation in the context of a technology that has been heralded for removing layers of administrative bureaucracy and streamlining existing governance arrangements. As with many other aspects of the dominant storyline of climate cryptogovernance, proposals for strengthening governance arrangements were by no means uniform. They varied between areas as diverse as:

"facilitating standard setting, to creating codes of conduct, to guaranteeing transparency and security, and, finally, to ensuring a more robust public dialogue on the up and downsides of the technology" - Rejeski and Reynolds (2018)

Particularly notable in the application of this *future ambition* component to governance arrangements was that, depending on the position of the author, either a 'carrot' and/or a 'stick' approach to regulation for strengthening blockchain technology was highlighted. A report by OECD summarises these two possible approaches in the context of climate cryptogovernance, arguing that:

"governments need to implement the proper regulatory framework to seize the opportunities created by blockchain and mitigate the risks." - OECD et al. (2018)

Writing on the implications of energy usage, academic Jon Truby is interviewed by *Nature* about his research, where he highlights examples of both 'stick' and 'carrot' approaches in the need for further development of governance arrangements. He recommends:

"an approach that imposes new taxes, charges, or restrictions to reduce demand by users, miners, and miner manufacturers who employ polluting technologies, and offers incentives that encourage developers to create less energy-intensive/carbon-neutral blockchain." - Truby (2018b)

Whether it is energy usage, technological limitation or inadequate governance arrangements that are considered, the resounding logic of the future ambition component is that until there is action taken to overcome resolvable issues, we will not see a full realisation of climate cryptogovernance.

5.2.6 Neutrality

Shifting away from the technicalities of blockchain and toward the values claimed to be associated with climate cryptogovernance, *neutrality* was another identified component of the dominant storyline. This component of the storyline understood that blockchain is a neutral technology, making it ideal to govern the contentious issue of climate change. According to the sampled texts, the immutability that blockchain brings - with the resulting possibility of transparency and accountability - makes it the ideal tool to bring a degree of impartiality and neutrality to climate governance processes.

The merits of blockchain in this context are raised by CIGI:

"Measuring and managing greenhouse gas emissions, mobilizing financial resources for mitigation and adaptation efforts, and improving transparency around climate action are key priorities of the Paris Agreement on climate change, and each requires the coordinated action of several arms-length participants — a seemingly opportune fit for distributed ledger technology" - Aganaba-Jeanty et al. (2017: 1)

According to this component of the storyline, the "arms-length" distance that immutable, decentralised and transparent blockchain solutions can bring to climate governance make it the ideal neutral and disinterested technology to unite climate actors. This neutrality component is further reinforced by claims that blockchain can be applied to situations which may favour powerful governance actors to avoid any power imbalances. For example, an article published by G20-oriented think tank consortium 'G20 insights' argues the following of DLTs:

"By design, they move away from a global economic order centered around powerful but not always trustworthy intermediaries – whether financial institutions, GAFA and BAWT type companies (Google, Amazon, Facebook, Apple and Baidu, Alibaba, Weibo, Tencent, respectively), or in some cases governments themselves." - Maupin (2017a)

Where climate governance formerly may have been prejudicially influenced by powerful intermediaries, the neutrality that blockchain endows on climate governance processes reduces the control of such actors. Mention in the above quote of "governments themselves" also nods to the importance of neutrality in the context of geopolitical tensions across the global north/south divide. As discussed in an article written for ‘Nature Asia’ by Jon Truby, director of Qatar University’s Centre for Law and Development:

“Transparent verification would also improve the credibility of results, removing the need to trust government climate data. It could relieve the burden on any government struggling to report accurate climate data; a task that is not always easy for countries in crisis.” - Truby (2018b)

The limited capabilities of the developing world and associated lack of reliability in existing governance arrangements are understood to be limiting factors to effective climate governance. Importantly, not only could blockchain ameliorate these reliability issues, but it could do so in a way that sidesteps unpalatable political interference from developed nations through the neutral, transparent and credible automated verification of blockchain.

Some adherents to this component of the storyline took a meta perspective and even suggested that the application of blockchain to climate governance itself could, and should, occur neutrally. Blockchain is acknowledged as a technology for which neutral and value-free judgements can be made about its applicability. For example, in article 4 of the Climate Chain Coalition formed at the 2017 One Planet Summit, and supported by the UNFCCC, the following was listed:

“4. Technology Neutrality: We recognize that DLT evolves constantly and therefore, maintain a neutral position regarding the applicability of DLT.” - UNFCCC (2018a)

The technological knowledge associated with blockchain is seen as a value-free object which actors can utilise to make rational choices. Herein lies the value of blockchain as a technology - not only can it unite potentially mistrusting actors towards progress on averting a climate crisis through its indiscriminate, predictable nature, but it can also avoid politically charged issues that occur during policy design through the neutral gaze that can be adopted when considering its possible applications.

5.2.7 Radicalism

Another component of the storyline, which has been palpable not only in the texts on climate and blockchain, but also often in literature on blockchain more broadly, is the radicalism of blockchain as a solution. This component puts forward that blockchain technology is a ‘gamechanging' innovation that will fundamentally change the way that we currently structure modern societies.

For example, the first of the few existing peer-reviewed journal articles that explicitly focus on blockchain technology, from the Journal of British Blockchain society, describes blockchain as disruptive, stating that:

"a new economy will need a toolbox of radical policies and reliable financial tools that can manage the low-carbon transition" - Chen (2018)

Blockchain is portrayed through this component of the storyline as a technology capable of restructuring contemporary society in a way previously unachievable. Julie Maupin of the Max Planck Institute for Comparative Public Law writes for G20 Insights, a publisher of policy briefs which is contributed to by a variety of think tanks, to state that distributed ledger technology is:

"ushering in a "New Industrial Revolution" (NIR, also known as "Industry 4.0"). These include innovations such as "the Internet of Things (IoT), Big Data, cloud computing, Artificial Intelligence (AI), robotics, additive manufacturing, new materials, augmented reality, nanotechnology and biotechnology" - Maupin (2017a)

The reasons that blockchain is justified as so radical vary across actors adopting this component of the storyline, and often varied depending on the context of the text. For example, the Environmental Law Institute (2018) summarises this radical-value proposition of blockchain as being that:

"it could democratize information and decentralize authority" - Rejeski and Reynolds (2018)

Similarly, speaking of the role of blockchain in the context of achieving the two degree goal of the Paris Agreement, the World Bank emphasises the role of disruptive technologies such as blockchain. They argue that these slot into the Paris Agreement due to this agreement signalling:

"a paradigm shift to a bottom-up approach" - World Bank (2017b)

Here we see the often-mentioned claim that blockchain could enable bottom-up approaches and ensure the collaboration of a diversity of actors in an unprecedented way. Blockchain not only governs the climate in a bottom-up manner, but the extent to which this is done is 'disruptive' and indicative of a 'paradigm shift' in its radicalness.

The WEF and PwC adopted this component in a similar manner, expanding on it further:

"The potential for blockchain lies in its architectural ability to shift, and potentially upend, traditional economic systems – potentially transferring value from shareholders to stakeholders as distributed solutions increasingly take hold. If harnessed in the right way, blockchain has significant potential to enable a move to cleaner and more resource-preserving decentralized solutions, unlock natural capital and empower communities." - WEF and PwC (2018)

In certain instances, this component was even deployed in a manner that implied that blockchain was so disruptive that caution is needed in its rollout in climate governance. For example, CIGI argues the following:

"That blockchain is inherently disruptive cannot be ignored, but this could be advantageous in disrupting existing patterns of behaviour that exacerbate climate change. As we look ahead to COP 23 in November, blockchain technology warrants serious consideration as a tool to support a global effort to combat climate change." - Aganaba-Jeanty et al. (2017)

CIGI even offers the recommendation that members of the blockchain community:

"should engage early on with established players, such as banks and regulators, to build trust and acceptance around disruptive ideas, perhaps starting with those that are least disruptive" - Aganaba-Jeanty et al. (2017)

Irrespective of the degree to which actors understood blockchain as radical, the basis of this widely harnessed component is that blockchain will bring radical and previously unseen changes to the realm of climate governance. Interestingly, this purported radicalism does not seem to posit climate cryptogovernance as a fringe movement accessible to a forward-thinking few - as might be implied by the term 'radical'. On the contrary, a further notable component of the dominant storyline was inclusiveness, which will now be explored in greater detail.

5.2.8 Inclusiveness

A final component of the dominant storyline concerns the actors who partake in climate cryptogovernance. Although the actors adopting storylines in this category generally emphasised different aspects of *who* climate cryptogoverns depending on authorship, the common thread running through them is that climate cryptogovernance allows for the broadening out of cryptogovernance. The common theme running through this inclusiveness component was the increased possibility of participation, with blockchain being seen as a driving force in the democratisation of climate government under the auspices of the Paris Agreement. This participation is proposed to take place not only in the broadening out on a national level in both the developed and developing worlds, but with the governance of climate change being scaled down to the individual level, as blockchain is seen as a force for making climate governance accessible to the average person.

To this effect, and given the broadness of this component of the storyline, this final component will be dissected into three main areas. The inclusiveness component of the storyline will be expanded upon with respect to:

I. Inclusiveness across actors
II. Inclusiveness across scales
III. Inclusiveness across capabilities

<u>I. Inclusiveness across actors</u>

One aspect of inclusiveness that was identified throughout the texts heralded the benefits of including a variety of actors in the context of governing the climate with blockchain. For example, the UNFCCC harnesses this storyline to embrace its role as a facilitator of collaboration. Prior to the establishment of the Climate Chain Collective multistakeholder initiative, the UNFCCC created a call for partnership, stating that it:

"seeks to engage in mutually beneficial collaborative partnerships with non-arty stakeholders, including the private sector" - UNFCCC (2017)

Similarly, in a 2018 report by the WEF and PWC it is written that blockchain-based solutions for climate change:

“will require deliberate collaboration between diverse stakeholders ranging from technology industries through to environmental policy-makers, underpinned by new platforms that can support these stakeholders to advance not just a technology application, but the systems shift that will enable it to truly take hold.” - WEF and PwC (2018)

The adoption of this strategy as a facilitator of multistakeholder, governance-beyond-the-state has often been understood in light of the diminishing possibility of collective action at the level of the nation state in the wake of the ineffectiveness of the Kyoto Protocol and the failures at Copenhagen (Bäckstrand and Lövbrand, 2016). This drive toward inclusiveness across actors is physically manifested in the number of multistakeholder initiatives and events that have been created under the desire for stimulating innovation in climate cryptogovernance. Perhaps the most long-standing example of this is the World Bank headed Hack4Climate initiative where:

“Public and private sponsors financed and organized as part of the Climate Ledger Initiative (CLI), an international, multi-stakeholder initiative at the intersection of climate and DLT..., bringing together DLT/blockchain talent, private and public sector innovators, as well as NGOs and academia.” - Connect4Climate (2018b)

Such a ‘UN+ approach’ - that encourages a variety of stakeholders to collaborate above and beyond what might be considered the bare minimum action to take (Au et al., 2011) - is enshrined in the use of NDCs, where governments define their own mitigation and adaptation measures. In this component of the storyline, the pooling of resources for multiple actors allows for ‘coalitions of the ambitious’ that encompass a variety of actors united in technology partnerships. A range of actors including, but not limited to, DLT/blockchain developers, private and public sector organisations, NGOs and academia are thus positioned as vital to the successful climate cryptogovernance.

However, more than simply making normative claims about how it is important that multiple actors should take part in climate cryptogovernance, the inclusiveness across actors element of this component is also tied up with the logic that blockchain will actively encourage wider participation with material outcomes. The GHG institute, a charity that trains experts on how to credibly account for GHG emissions, identifies the potential for blockchain to draw stakeholders into climate governance, suggesting that:

"Blockchain will be one unexpected force that is capable of stimulating higher levels of participation and ambition and mobilizing large-scale investments into climate actions to achieve the Paris goals." - Baumann (2017)

Overall, this first actor-inclusiveness strand of the inclusiveness component, therefore, puts forth not only that collaboration between a diversity of stakeholders is vital in order for blockchain to govern the climate, but also that collaboration between stakeholders can be a novel way to gain buy-in to climate governance more broadly. Beyond solely discussing the type of actor, adherents to the *inclusiveness* component often also focused on the scales over which actors operate.

II. Across Scales

The inclusiveness component also considers inclusiveness from a second dimension - across scales. Many of the sampled texts made reference to blockchain ensuring effective climate action through bottom-up activities. In line with an increasing turn towards 'polycentric' governance structures that cross the local to domestic to transnational levels (Au et al., 2011), blockchain was understood to be a technology which enabled participation over a range of geographical scales. Adherents to the inclusiveness component of the dominant storyline often supported such a multi-scalar understanding of climate change action. For example, DAO IPCI highlight the:

"tremendous potential of blockchain technology to considerably enhance climate actions at multiple levels" (IPCI.io, 2018)

Similarly, a Climate-KIC backed Daily Planet article explores the discussions occurring at COP23 in Bonn, stating that participants at a Carbon Ledger Initiative side event:

"discussed that while blockchain has emerged from the bottom-up, it can be used in top-down approaches such as calculating greenhouse gas inventories combined with INDCs (Intended Nationally Determined Contributions) and Article 6 mechanisms." - Lovett (2017)

There has been an explicit emphasis on the importance of micro, bottom-up approaches in ensuring carbon mitigation at the macro level. Speaking of the Hack4Climate hackathon, the Daily Planet writes that:

“there is a bottom-up movement ready to help implement [blockchain for climate change governance].” - Yeates (2017)

In this sense, by operating at the local scale, blockchain may offer the ability for local actors to regain power through a purported ‘democratisation’ of climate governance achieved by the decentralised nature of blockchain. This was also often the case for blockchain applications involving small-scale investment and distributed ownership, such as the climate benefits of decentralised grid energy. An author for the Climate Investment Funds, which operate in conjunction with multilateral development banks, proposes that blockchain will:

“fuel new experiments in secure identity, distributed ownership, and financial transactions. These tools will push us to rethink scale, enabling investment and insurance for more local, less mainstream climate projects” - CIF (2018)

Blockchain is thus proposed to govern the climate at multiple levels, operating at the micro-scale in a bottom-up manner but ultimately leading to global climate impacts. In the context of inclusivity across scales, it is worth paying explicit attention to the purported rescaling of climate governance down to the individual level by blockchain. In fact, it was often proposed in the texts that climate cryptogovernance will allow for individuals to govern the climate in ways previously unachievable. Policy expert Julie Maupin, writing for G20 Insights, summarises the logic of this storyline:

“By design, [blockchain solutions] move away from a global economic order centered around powerful but not always trustworthy intermediaries… and toward a more decentralized and democratic order which empowers individuals directly through systemically embedded transparency, accountability, and inclusiveness mechanisms.” - Maupin (2017)

Such a rescaling of climate governance involves a redistribution of the responsibility for climate change, as individuals are understood to be the ones that can cause and must tackle climate change through their own actions. This is particularly true in the context of the market, the main site of operation for blockchain, where individual actions at the micro scale are seen to diffuse bottom-up to the macro scale. Blockchain here also verges into broader discussions on green consumerism, as demonstrated in the following quotes by an author writing for the WEF:

"And crucially, for the first time consumers will be able to understand the environmental impact of the products they are buying – both positive and negative – at the point of sale, and will be able to mitigate this in an instant, with millions of micro-transactions scaling up to make a huge collective impact." - Walker (2017)

Through its democratising and transparency inducing properties, information asymmetries are vanquished for individual consumers as they are empowered in their decision-making. Responsibility is placed in the hands of the people, as the cumulative decisions of individuals and their micro-scale transactions are purported to scale up to culminate in collective impacts. In an article by the WEF, it is claimed that:

"It is not an overstatement to say that we all need to take responsibility for the carbon consequences of every choice we make. What is exciting is that by creating a global, trusted and accessible carbon currency, with the help of new digital technologies available to us, we are on the cusp of being able to do so." - Walker (2017)

The individualisation storyline is thus inherently linked to earlier discussions of the inclusiveness across actor type that shifts the site of climate cryptogovernance away from the nation state under prevailing UN+ trends. Indeed, under the individualisation storyline, it is the ineffectiveness of coordinated climate action by the state which invokes a shift in responsibility down to the individual level. The WEF writes:

"Yet even if every country satisfied their Paris commitments to reduce carbon emissions, this would still not be sufficient to create a safe climate. Individuals and businesses will need to do more to plug this gap, and we urgently need to find a way to help them do this, while working on longer-term shifts in parallel." - Walker (2017)

All in all, the *inclusiveness* component also emphasises that through blockchain, the locus of climate governance can increasingly be rescaled in ways previously unimaginable. Individual action becomes all the more possible with cumulative impacts at higher-order levels.

III. Across Capability

A third and final notable dynamic regarding inclusiveness in climate cryptogovernance is raised in the discussion of capability and a potential north-south divide in the governance arrangements required for the adoption of blockchain technology. In line with prevailing international governance practice with respect to the commonly acknowledged principles of 'common but differentiated responsibilities' and the need for financial and technical assistance, there is a general premise that developing countries should adopt blockchain technology with the assistance of more developed nations (Okerere and Schroeder, 2009). The inclusiveness storyline proposes that with support from developed nations, blockchain could be a powerful tool to draw developing nations into the heart of climate governance processes.

According to the inclusiveness component, a fundamental problem in climate governance at present is the lack of reliable climate data from developing countries in particular and subsequent exclusion from administrative processes - as also explored in the *reliability* and *neutrality* components. Blockchain is seen as a possible solution to this, as argued by Jon Truby (2018b):

"[Blockchain] could relieve the burden on any government struggling to report accurate climate data; a task that is not always easy for countries in crisis." - Truby (2018b)

In addition to this lack of reliability associated with the operations of developing nations, a lack of capacity due to financial and technical limitations is also identified. The UNFCCC throughout its lifetime has to had to consider the dynamics between developing and developed nations that are ever present in its functioning - both explicit in its amendment texts and implicit in the operations and negotiations of the actors. Writing in the context of blockchain, the UNFCCC harnesses the *inclusiveness* component with respect to capability, stating that they:

"support stakeholder capacity building with regard to the deployment of shared tools and systems to advance climate change governance, especially in developing countries" - UNFCCC (2018a)

Inclusiveness along the lines of capability is further seen in claims that blockchain is a powerful tool for ensuring sustainable development. Originating out of the widely cited Brundtland Report that established sustainable development as an objective for achieving human development goals while maintaining the capacities of natural systems upon which the economy and society depend (WCED, 1987), the notion of sustainable development has since solidified itself as one of the premier concerns of international politics. Indeed, the replacement of the Millennium Development Goals with the Sustainable Development Goals in 2015 marked sustainable development as a priority on the international agenda (Biermann et al., 2017).

Blockchain has been proposed as a possible tool to achieve sustainable development. For example, the UNFCCC states that they:

"recognize that climate change is one of the Sustainable Development Goals (SDGs) and will encourage the development of DLT-based innovations for climate change which can simultaneously contribute to the achievement of SDGs." - UNFCCC (2017)

Further exemplifying this in the context of increasing energy demand in emerging economies, Dr. Philippa Ryan from the University of Technology Sydney Law department presented at a special UN session in Geneva on meeting the 13th SDG on climate action in September 2018. This presentation identified that:

"one of the challenges is to help developing countries meet their increasing demand for electricity without adopting high emission solutions" - Douglass (2018)

In this application of the inclusiveness component, climate cryptogovernance thus enables such environment and development objectives to be reconciled, as developing nations are included through opportunities to develop while avoiding carbon intensive trajectories of the past through technological fixes. Overall, the inclusiveness component of the dominant storyline stipulates that blockchain is a technology that can broaden out who is included in climate governance - over actor types, over scales and over actor capabilities.

5.2.9 Overview of Storyline Components

Having elaborated upon the dominant storyline of climate cryptogovernance, identified eight substituent components within it and provided textual support for these, a broad overview of this storylines can be garnered. Table 4 below presents the components of the storyline, distilled into one sentence:

Component	Summary
Reliability	Blockchain enhances reliability of existing governance arrangements by shifting power away from uncertain human actors and into predictable computer code.
Measurability	By maintaining a focus on quantifiable metrics (particularly those related to carbon and other GHGs), blockchain can efficiently govern the climate.
Transparency	Blockchain offers innovative solutions to enhance transparency that will overcome barriers to collective climate action, such as lack of trust and participation.
Accountability	By ensuring reliable and transparent information, blockchain allows for climate governance actors to be held accountable for their actions.
Future Ambition	There must be efforts to resolve existing problems with blockchain-based governance to ensure its effectiveness - with respect to: ❏ high energy requirements, ❏ technological limitations, ❏ and inadequate governance arrangements.
Neutrality	Blockchain is a neutral technology in both its functioning and implementation, making it ideal to govern climate change.
Radicalism	Blockchain is a radical technological innovation that will fundamentally change the way climate governance occurs.
Inclusiveness	Blockchain can allow for increased inclusiveness of climate governance: ❏ across types of actor, ❏ across scale, ❏ and across capabilities.

Table 4 - Summary of Identified Storylines of Climate Cryptogovernance

5.3 Actors Harnessing the Dominant Storyline

The dominant storyline components laid out above were espoused by particular actors, which were deemed influential by virtue of being sampled under the ‘climate bureaucracy’ sampling criterion. To detail the intricacies of every one of these actor’s communicative actions would be a lengthy task, meaning that any summary presented in this thesis will be somewhat simplifying. Although efforts were made to specify where particular actors associated from climate bureaucracies may divert from dominant storylines, the necessity to provide a broad overview of the actors that harnessed the dominant storyline of cryptogovernance may somewhat mask the extent to which they adopted particular components in differentially depending on the context.

For example, authors from the WEF and World Bank often heavily depended on components pertaining to the effectiveness of marketisation and business involvement, whereas authors representing the UNFCCC usually adopted components more evenly and were somewhat more cautious by carefully harnessing the *future ambition* component that identified a need for further development while highlighting current potential. Nevertheless, these actors, and all others sampled, can be described as subscribing largely to the dominant storyline and thus and part of a dominant discourse coalition. Specifically, members of a discourse coalition in the context of climate cryptogovernance advocacy can be considered to be both climate bureaucracies, such as the UNFCCC and World Bank, as well as the actors that interact with them to adopt shared storylines, such as blockchain technology developers, corporations, consultancies, think tanks, media outlets and civil society groups.

It is also relevant in this section to briefly mention the heterogeneous actors that were notable in their departure from the dominant storyline or those that even opposed the dominant storyline of climate cryptogovernance. Due to the sampling criterion of association with climate bureaucracies, all actors adhered more or less to the dominant storyline with substantiation from one or more of its substitute components. Even if some actors did stray from the logic of these components - by emphasising particular arguments that were best adapted to the context of their authorship - there were no objections to blockchain that were irreconcilable with the dominant storyline.

However, it should be noted anecdotally that during an informal initial literature review without rigid sampling criteria, there was a small but notable set of critiques from less influential and unified actors. In contrast to other policy endeavours - such as REDD+, where volumes of critical literature have been disseminated through academic and informal challenges - the policies and programmes associated with blockchain have not been tackled head on to such an extent. However, it is acknowledged here that contrary perspectives that challenged dominant storylines do exist in some form, usually centred around specific blockchain solutions proposed and around the critique of market-based or technical approaches to climate governance. Due to the time restrictions, regrettably these were not explored in-depth.

Table 5 summarises possible groups of actors to consider, together with their overall stance in relation to the dominant storyline of climate cryptogovernance.

Stance	**Type**	**Examples**
In Favour - adhered to dominant storyline and its substituent components	International environmental bureaucracies, blockchain developers, business actors, large consultancies and think tanks.	Authors from the UNFCCC; World Bank; Climate Chain Coalition; WEF; PwC.
In Favour - largely adhered dominant storyline, but with a notable emphasis on a component such as *future ambition* somewhat weakens the strength of the dominant storyline.	Small and specialised think tanks/civil society groups, individual academic authors.	Environmental Law Institute *(notably strong emphasis on need for development of governance arrangements)*; Dr. Jon Truby *(notably strong emphasis on energy usage of blockchain)*
Against - challenged dominant storyline and its substituent components	No homogenisable group of actors, mainly individual critics of a market-based or technocratic approach to climate governance.	Individual activists critiquing blockchain

Table 5 - Summary of Actor Positioning

5.4 Discursive Mapping of the Dominant Storyline

The dominant storyline of climate cryptogovernance and its substituent components are understood to be interrelated with a set of discourses (Hajer, 2010). In this section, the typology of discourses introduced in section 3.2.6 will be used to map the components of the dominant storyline to three discourses understood to be prevalent in international climate politics (Bäckstrand and Lövbrand, 2016). Readers will recall that Hajer interprets the storyline as

"a generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to specific physical or social phenomena" - Hajer (2010: 57)

Here, discourse is understood to refer to the "specific ensembles of ideas, concepts and categorisation that are produced, reproduced and transformed in a particular set of practices" (Hajer, 2010: 2). In order to represent the components of the dominant storyline of climate cryptogovernance as fully as possible, these ensembles must also be explored.

In section 3.2.6, the notion of discourse was operationalised in the context of this thesis through a typology of three dominant discourses - ecological modernisation, green governmentality and civic environmentalism (Bäckstrand and Lövbrand, 2006). Ecological modernisation emphasises the compatibility of economic growth and environmental protection. Green governmentality emphasises the role of sound science and well-trained authoritative professionals that can credibly define environmental risks and legitimate particular methods to measure, predict and manage changes in the climate. Civic Environmentalism emphasises inclusivity, participation and multilateralism in the context of the global environmental agenda.

The eight components of the dominant storyline can be discursively mapped onto a venn diagram, with reference to these three predominant discourses. This discursive mapping exercise is carried out with the proviso that the three proposed discourses should be understood as a "rough map for understanding the discursive framing of contemporary global environmental politics" (Bäckstrand and Lövbrand, 2006: 52) as opposed to fully coherent and infallible categories that fully capture Hajer's understanding of discourse.

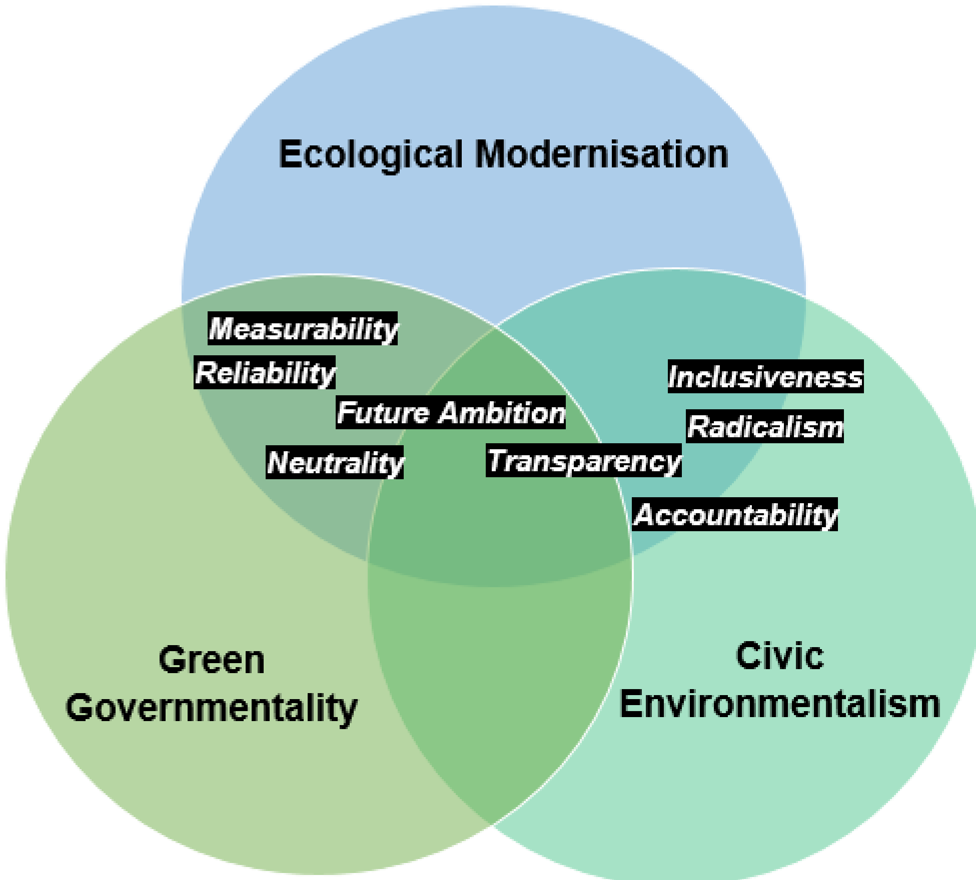

Figure 5 - Discursive Mapping of Storyline Components

Storyline components were identified as generally drawing on at least two of the three discourses. This placement is informed not only by the malleability and broad application of each storyline component, but also by insights from Bäckstrand and Lövbrand (2006) about the overarching influence of the discourse of ecological modernisation - particularly in the context of its increasing coalescence with the discourse of green governmentality.

Largely technical and market-oriented storyline components, pertaining to *measurability*, *reliability* and *neutrality*, were understood to draw largely on a complex of ecological modernisation and green governmentality. The *future ambition* component, although drawing on all three discourses, is also skewed towards these two discourses due to its heavily technical emphasis on improving blockchain-based technologies.

By contrast, the *inclusiveness*, *radicalism* and *accountability* components were understood to draw largely on the discourse of civic environmentalism, due to their emphasis on the broadening out and democratisation of climate governance. *Inclusiveness* and *radicalism* were understood to also draw on ecological modernisation, on account of this inclusiveness and radicalism occurring both largely in the context of pre-existing markets. However, they also represent a move away from green governmentality on account of claiming to redistribute power diffusely through the decentralised nature of blockchain. The *accountability* storyline drew to a lesser extent of the discourse of ecological modernisation, as it pertained to possible legal and reputational ramifications of largely market-based blockchain technologies. Arguably the most chameleonic storyline with respect to the discourses it drew on, *transparency* is placed in the centre and skewed toward civic environmentalism. Although the empowering and democratising effects of transparency were often the mainstay of this component, the scientific and market-oriented modes through which blockchain-based transparency was understood to operate also led the component to draw on aspects of the other two discourses.

5.5 Summary

In sum, climate cryptogovernance is a novel phenomenon that has gained traction in recent years, with 2016 and 2018 containing many of the earliest notable developments. When analysing texts from this period using an argumentative discourse analysis approach, a dominant storyline of climate cryptogovernance is identifiable. This storyline - which is understood as dominant by virtue of representing the views of influential climate bureaucracies and their associates - argues blockchain is a potentially effective tool to govern climate change.

This dominant storyline consists of eight components that support, expand upon and put into context this overarching claim. The eight identified components of the dominant storyline of climate cryptogovernance are as follows: i. Reliability; ii. Measurability; iii. Transparency; iv. Accountability; v. Future Ambition; vi. Neutrality; vii. Radicalism; viii. Inclusiveness. These components were harnessed by actors in a multitude of ways and can each be roughly mapped on to the three prevailing discourses of ecological modernisation, green governmentality and civic environmentalism. In the following chapter, each of these eight storyline components will be critically interrogated using theoretical perspectives from a range of traditions that seek to challenge the orthodoxies of international environmental politics.

6. Interrogating Climate Cryptogovernance

A key function of storylines, as per the understanding of Hajer (2010), is that they facilitate the reduction of the complexity of a problem and allow for possibilities of problem closure by resting upon established discourses. Such an understanding of storylines implies that complexity and uncertainty still loom behind the knowledge claims made by actors. The storylines that actors harness to influence collective understandings of climate cryptogovernance are inherently simplifying, and for this reason, certain elements and understandings of the applications of blockchain to climate change policy can easily be obscured. This section aims to illuminate some of these obscured elements by denaturalising the key assumptions made in the dominant storyline of climate cryptogovernance.

6.1 Reliability? An Introduction to Chapter 6

The first component of the dominant storyline that was introduced related to *reliability*. The *reliability* component proposed that blockchain enhances the reliability of existing governance arrangements by shifting power away from uncertain human actors and into predictable computer code. This reliability underpins both the dominant storyline of climate cryptogovernance and many of the other components introduced in chapter five as well.

While this component is theoretically sound in its basis in the structural features of blockchain, it largely remains to be seen whether this reliability will actually take hold when translated into the practice of governance. In making universalising claims of enhanced reliability which will ultimately lead to outcomes such as transparency, accountability and inclusiveness, blockchain advocates may gloss over the messy realities of climate cryptogovernance that occur in specific contexts over time and space.

Although blockchain in a vacuum may unequivocally adhere to the arguments made by its advocates in chapter 5, the complexity of climate governance lends itself to a variety of possible outcomes in practice. This is before even considering the normative components of climate cryptogovernance, which can also be re-interpreted from a variety of theoretical lenses for analysing climate governance that deviate from the ontological and epistemological assumptions that blockchain advocates operate under.

This brief analysis of the *reliability* component thus serves as an introduction to chapter six, which will interrogate the components of the dominant storyline of climate cryptogovernance by offering a range of critical perspectives. The dominant storyline identified in the previous section will be deconstructed along the remaining seven identified components of:

i. Measurability, ii. Transparency, iii. Accountability, iv. Future Ambition, v. Neutrality, vi. Radicalness and vii. Inclusiveness.

Although this section will offer critical perspectives on these components of climate governance, the purpose of this section is not to systematically critique the incorporation of blockchain into climate governance using one unified critical theory. Rather, the intent of this section is to offer a range of alternative perspectives on the constructs present in components of the dominant storyline that challenge taken for granted assumptions and re-imagine how cryptogovernance might occur in reality. Through the denaturalisation and re-evaluation of these assumptions, a more nuanced appreciation of climate cryptogovernance can be gained that developed considers more than just the simplified and deceptively stable content of influential governance actors' public-facing communications.

6.2 Interrogating Measurability

In considering how blockchain could govern the climate, the *measurability* component of the storyline placed a great emphasis on the importance of monitoring, reporting and verifying measured quantities of greenhouse gasses. This was generally with an emphasis on carbon. It was only through the measurement of these gasses that blockchain technology could operate to ensure reliability, transparency and accountability through the numerical transactions it ledgers. This component of the storyline appears wholly uncontroversial in the context of a policy backdrop of market-based approaches to climate change, where it is through voluntary and mandatory carbon markets that carbon and other greenhouse gases can be mitigated most efficiently (Bäckstrand and Lövbrand, 2016). However, critical bodies of literature in science and technology studies have increasingly questioned the explanatory abilities and innocuity of a mindset that aims to render the world governable through numerical operations.

6.2.1 Measurement and Narrow Representation

At its core, blockchain relies on the quantification of human processes that emit GHGs. Quantification, understood to be “the production and communication of numbers”, is a vital step in rendering objects of governance more amenable to control (Espeland and Stevens, 2008). For example, the efficiency benefits that are implemented with blockchain under the *reliability* storyline are only possible due to the depersonalisation and objectification of inherently complex processes into numerical form (Espeland and Stevens, 1998). Blockchain, as an auxiliary technology that builds on decades of technocratic approaches to climate governance (Bäckstrand and Lövbrand, 2016), is hardly pathbreaking in its emphasis on quantification. Regardless, by further pushing particular understandings of the world to the forefront, there is increasingly the risk of further crowding out alternative ways of conceptualising climatic phenomena that look beneath the legible veneer of numbers (Scott, 1998).

According to some authors, there exists a possibility that the kind of quantification that climate cryptogovernance requires results in a narrow and simplified interpretation of reality, filtered through the lenses mentioned above and legitimated by an understanding of numbers as disinterested and trustworthy (Rose, 1993). For example, Scott (1998) sees measurement as an inherently political task due to the necessity of making critical choices about what to measure and in order to render an object of interest measurable. According to such an understanding, knowledge and control require a narrowing of vision to make objects more legible, as calculations are combined with other observations to create an aggregate view of a slice of the world (ibid.). Where *measurability* might be framed by blockchain advocates as an objective and necessary collection of quantitative data to augment transparency by some, it might be understood by others as a reductive basis for centralised control, coordination and exchange that crowds out understandings of the world that resist quantification.

6.2.2 Measurement and Power (1): Measurementality

Further to providing a narrowed understanding of complex social processes, some authors have been explicit on how measurement and quantification can act as a means of control for specific ends. Turnhout et al. (2014) invoke Latour (2004) to argue that the use of particular forms of seemingly neutral quantitative knowledge under prevailing discourses are anything but neutral, as ecological phenomena are made legible to specific political and economic logics. According to such a perspective, the degree of control over quantified GHGs that blockchain secures is a further push towards ensuring that the environment is numerically measured in a manner that can be broken down into discrete GHG units that are commensurable and exchangeable in carbon markets.

Turnhout et al. (2014) make use of the phrase measurementality to theorise how GHGs are used (distinct from the phrase *measurability* used here to describe a component of the dominant storyline). Turnhout et al. (2014) understand measurementality to be:

"an 'art of neoliberal governance' that emerges from privileging scientific techniques for assessing and measuring the environment as a set of standardized units which are further expressed, reified, and sedimented in policy and discourse and which, in turn, render the environment fungible." - Turnhout et al. (2014: 583)

In spite of a long history of using measurement as a form of control by centralised states (e.g. Scott, 1998; Agrawal, 2005), Turnhout et al. (2014) understand the kind of measurementility that blockchain further enables to be intrinsically tied up with new models of transparency that have emerged under paradigms of new public management and neoliberalism. Contemporary measurementality is fundamentally distinct from historic forms due to the unprecedented surge of effort into the design of MRV systems and the extent to which MRV aims to standardise how performance is measured and reported upon (ibid.). Climate cryptogovernance, from this perspective, is both a result of and further contributor to the privileging of scientific techniques in climate policy for fundamentally economic ends. For some critical scholars, the carbon focus of climate cryptogovernance represents 'neoliberalism by design', where certain understandings of climate and nature more broadly are privileged.

In the words of Lockie (2014), what is emphasised by market-based technologies such as blockchain is:

"natures that can be defined through clearly delineated property rights; natures that can be reduced to simple and transferable common values; natures that comply with the requirement of markets for well understood and calculable risks; natures that are not, therefore, characterized by excessive uncertainty, complexity or the possibility of discontinuity and threshold effects." - Lockie (2014)

The *measurability* emphasised by climate cryptogovernance is therefore seen by some as part of a broader historical trend of rendering territories and their inhabitants (both human and non-human) measurable and commensurable through the standardisation of knowledge and therefore subject to the control of market logics (Turnhout et al., 2014). This standardisation stands in stark contrast to the inherent uncertainty largely acknowledged to be present in the climate system (Rockström et al., 2009). Not dissimilarly to the observations made by Turnhout et al. (2014) of the ecosystem services concept in biodiversity governance, the quantified carbon focus associated with climate cryptogovernance allows for the production of seemingly complete and market actor-friendly knowledge about carbon emissions. Simultaneously, this may shift attention away from more base questions about power relations within politics and governance between the state, market and civil society (ibid.).

6.2.3 Measurement and Power (2): Audit Society and Resistance

The hidden power-relations behind a supposedly neutral focus on measurement of GHGs can also be understood in the context of what Power (1997) has termed 'audit society' - where audit is used by governments in conjunction with related technologies to make society amenable to governing. Contrary to dominant perspectives on auditing, Power (1997) understands audit as an active process of making things auditable. Such a process does not exist a priori, but involves first creating a "legitimate and institutionally acceptable knowledge base", and then "the creation of environments which are receptive to this knowledge base" (Power, 1997: 289). Individuals are thus transformed into calculable actors, as they are made visible in a manner which conforms to the audit process (Power 1997).

This transformation of individuals into calculable actors under the presumption of pre-existing auditable facts generated through quantification is laden with power. What 'matters' in policy terms is negotiated through the creation of standards, performance and audit processes for assessing performance to these standards (O'Keefe, 2018). As the actions of auditees are assessed against, the subjects of audit are made not only calculable, but also calculating, as their goals and actions shift according to the focus of audit (Dean, 1999). For this reason, the appropriate actions, thoughts and behaviours of audited actors are likely shaped by audits, and audited actors assess themselves according to said values (Power 2000). Contrary to the logics of the *transparency* and *accountability* components, Power (2000) understands that more than anything else, it is the act of auditing that holds symbolic importance as a source of legitimacy for auditing bodies.

The alternative perspectives raised here are not done so to deny the importance of measurement and quantification in climate governance. Not only would this be a gross simplification, but critical authors also have highlighted how numerical operations can serve not only to depoliticise contested issues, but also re-politicse them. Numbers having been a source of cogent social and political critique across history, and ever more so today with the advent of activism using big data (Hansen and Porter, 2017). To quote Diaz Bones and Didier (2016):

"Categorization and quantification may have their uses and misuses but this depends on agencies and socio-political constellations and also on (e)valuating positions. There is no reason to condemn or avoid quantification (or quantitative methods) per se…" - Diaz Bones and Didier (2016: 26)

Instead, the point to be considered here is that a GHG focus, underlain by quantification and reinforced by the implementation of auditing technologies such as blockchain, should not be understood to be necessarily complete, neutral nor beyond critique. Overall, instead of the GHG measurement required for blockchain resulting in complete and neutral information, an emphasis on measurability may result in an inherently reductive and political representation of the world.

6.3 Interrogating Transparency

It was identified in the previous chapter that the *transparency* component of the storyline was marred by an ambiguous proposed relationship between the transparency provided by blockchain and effective climate governance. Transparency was often taken for granted as being unequivocally positive and automatically leading to substantive climate impacts. However, this relationship is not necessarily the case, and requires further scrutiny. Gupta (2008) identifies that this assumed positive relationship has been characteristic of assumptions about governance by disclosure in environmental governance more broadly. Although on one hand, a 'procedural turn' in climate governance has the likely benefits of being non-patronising, progressive and potentially emancipatory in its approach, these benefits are not innate or universal in all situations (ibid.).

6.3.1 Mediators of Transparency-Based Governance

On the face of it, it seems difficult to argue that the invoking of transparency under the principles such as democracy and participation would be anything other than positive. Nevertheless, such principles that are so often implicit in the purported benefits of climate cryptogovernance have been the subject of fierce critique, given the existence of a variety of mediating factors (Turnhout et al., 2014). Criticisms boil down to the possibility that in spite of seemingly progressive claims, the reality of governance through transparency falls short. For example, civil society actors seldom have the privileged access to knowledge or required skills for authority to perform the epistemic checks that would bring about the proposed transparency outcomes (Neves-Graça, 2006). Attempting to discuss the procedures and outputs of current blockchain-based solutions for climate policy with a total layperson would be a masterclass in such an epistemic distance preventing the purported surveilling effects of transparency.

Furthermore, the information asymmetry reducing effects of transparency that are unequivocally simple in theory are unlikely to take hold in practice. Turnhout et al. (2014) cite numerous examples of reality falling short of the intended relationship, with unanticipated effects from the introduction of accounting procedures including cherry-picking, myopia, gaming the systems and means–ends reversals. Although climate cryptogovernance seeks to prevent some of these ‘greenwashing’ tactics through its use of immutable ledgering, there is nothing to stop blockchain-based solutions in themselves being adapted in particular ways, with the possibility of selective disclosure of immutable information.

To this effect, Gupta and Mason (2016) list possible mediators of the effectiveness of information disclosure in climate governance, including inadequate design of disclosure; the attributes of information disclosures (whether they are standardised, accurate and comprehensible); the quantity of disclosed information (complete or partial); and the influence of intermediaries, such as auditors, verifiers, and certifiers. With respect to the latter category, these intermediaries will likely decrease in the context of climate cryptogovernance, but may still exist to varying degrees in decentralisation of system design and oversight. Although actors involved with the technical design and analysis of transparency systems have often highlighted the potential limits to governance by transparency (Gupta and Mason, 2016), such contingencies appear to have been lost in translation with the *transparency* component.

6.3.2 Alternative Conceptualisations of Transparency

The above discussion about the contingency of transparency demonstrates an inherent flaw in the way that the *transparency* component conceptualises transparency. A rationalist understanding of transparency as an inherent part of a system that can be achieved/not achieved to varying extents denies the contingency and context-specificity of how transparency operates in practice (Cook et al., 2015). What might be described as a constructivist approach to transparency disputes rationalist logics of transparency being an innate and pre-existent characteristic of a system (ibid.). Instead, constructivist perspectives often highlight that it is the auditing processes of human actors that make systems transparent, and transparency is never a fulfilled ideal but always partial, conditional and in a state of negotiation. Neyland (2007), for example, theorises transparency in terms of the mobilisation of 'visibles' in order to support the claims of transparency through auditing, even if the organisations functioning does not necessarily improve in substantive ways.

What implications do these insights hold for climate cryptogovernance? When transparency is no longer understood to be pre-existing and external to human processes, along with the various context-specificities inherent in processes, a more nuanced understanding of transparency and its possible effects in climate politics can be developed. As one of many possible examples of an axis along which these context specificities could be considered, Gupta (2008) has proposed four possible criteria to hold transparency and disclosure in environmental politics to greater scrutiny and better consider its possible impacts in context. This framework considers who discloses information (e.g. states, private organisations, environmental bureaucracies), to whom information is disclosed (state to state, private sector to citizen, private sector to state and so on), what kinds of information are disclosed (e.g. GHG emissions, decision making process or outcomes, financial data), and the ends to which disclosure is intended to meet (e.g. enhanced accountability, enhanced participation, enhanced choice).

6.3.3 Disclosure to What Ends?

The last category in particular, exploring the 'ends' of transparency, suggests that the aims behind information disclosure assured through blockchain-based solutions could be differential and are not exclusively in the interests of all stakeholders. Turnhout et al. (2014) emphasise in the context of their concept of measurementality that the assumed neutrality of information to be made transparent, using technologies such as blockchain, is problematic. For example, Hulme et al. (2011) highlight that the extensive design of MRV systems can obscure the implementation of the policies in themselves and the various values that are imbued in purportedly neutral governance processes.

Multiple scholars have explored how potential outcomes to be derived from transparency can vary substantially depending on various motivations. Gupta and Mason (2016) detail how climate transparency is connected to the ever-more heterogeneous and fragmented nature of climate governance that aims to encompass multiple state and non-state actors across scales. Such arrangements render the rationales and potential benefits of governing through increased transparency divergent, and potentially contrary to one another. In this vein, Gupta and Mason (2016) identify four possible rationales that embody different logics of climate governance: the marketisation, privatisation, democratisation and technocratisation rationales.

For example, Gupta and Mason (2016) use case studies of transparency in Carbon Disclosure Project data and REDD+ to demonstrate how the noble aims of public and private transparency driven by the democratisation norms can easily become blunted by rationalist managerial norms of technocratisation. More specifically, they find that the professionalisation and specialisation of climate transparency have seen climate information that was intended as ‘public’ become restricted or rendered opaque to relevant publics. This occurred due to the managerial and financial auditing interests of subscribing organisations and scientific and technical experts (ibid.). The differential rationales behind such examples imply a warning for blockchain and its purported transparency benefits: information disclosure is not in itself necessarily as effective in ensuring inclusive governance as some claim it to be. Without intentional creation of standardised and accessible channels for information to be transmitted, there is no way of ensuring that the data made transparent by blockchain technology will be publicly accessible or comparable.

Turnhout et al. (2014) have even gone as far to argue that under marketisation and privatisation rationales for transparency, informed by the logics of new public management, effectiveness and efficiency, there has been to a shift towards the dominance of economic modes of governance. The self-regulating modalities of governance through transparency enables the acting at distance upon the actions of others (Rose, 1999). In light of this focus on self-regulation and a retreating standardisation of MRV systems - albeit a standardisation that some actors in climate cryptogovernance, such as those under Climate Coin Coalition, have sought to strengthen - such trends present a risk that the extent to which objectives are met is at the whim of self-regulating actors, under a liberal and non-prescriptive approach to self-governance.

Such differential ways that transparency can be operationalised should be examined against the claims of some blockchain advocates to highlight that transparency is not necessarily a silver bullet for every imaginable desired outcome in international climate politics. Analysed alongside additional contextual dimensions, and the possible rationales for transparency, a more nuanced understanding of transparency can be garnered than that of the *transparency* component.

6.4 Interrogating Accountability

Another potentially over deterministic component of the dominant storyline pertains to the ability of blockchain to ensure climate governance actors are held accountable for their actions. According to the dominant storyline, *transparency* and *accountability* were often understood to be handmaidens in achieving effective climate governance under the Paris Agreement. The illuminating power of transparent information would resolve inefficiencies by holding the formerly opaque malpractices of guilty parties to account. However, this may not be the case - due to complex pathways from transparency to accountability, the challenges of holding states to account, and the growing challenges of establishing responsibility.

6.4.1 Complex Pathways from Transparency to Accountability

Some critical authors have suggested there is not necessarily a unitary relationship between transparency and accountability, or indeed even a unitary type of transparency or accountability. To develop a more comprehensive understanding of the relationship between transparency and accountability, Fox (2007) proposes a model of two faces of transparency which may or may not map on to two faces of accountability. Similarly to the authors discussed in the previous subsection, Fox (2007) identifies how transparency can be clear or opaque depending on the extent to which they reveal how institutions actually behave in practice. In theory, blockchain is meant to bring such a clear transparency to the practice of international climate governance through providing open access to immutable information. However, clear transparency in itself does not even ensure that actors are held to account.

Fox (2007) differentiates between soft and hard accountability - where soft accountability refers to a situation where states are only made answerable to their actions, but hard accountability also includes the possibility of formal sanctions. Fox (2007) argues that although clear transparency can map neatly on to soft accountability under the banner of institutional ‘answerability’ (where actors are called to justify their decisions) there is nothing automatic about the hard accountability. The sanctions, compensation or remediation that would result in the transformative changes imagined of climate cryptogovernance are not a direct outcome of increased transparency.

6.4.2 Holding States to Account: Easier Said than Done

This disconnect between transparency and accountability is particularly true in the context of climate change governance, due to limited mechanisms through which actors can formally be held to account. Any implicit assumptions the illumination of formerly opaque practices through information disclosure may be able to hold states to account under the UNFCCC have been moot from the outset if they were based on the assumption that this could be simply done under existing legal frameworks. Mason (2008) outlines how the very nature of transnational environmental issues, such as climate change, are not amenable to conventional pathways of accountability. Diplomatic efforts to hold actors to account through treaty negotiations clash with the geopolitical interests of other states, as the principle of state sovereignty inhibits the potential for collective actions between governments (ibid.). Here, the exclusive political authority of states over their own populations as a basis for public international law becomes a barrier to redress - as associated rules of voluntary consent to international regulation and non-interference by other states in domestic affairs weaken the effectiveness of intergovernmental attempts to hold offenders to account (Mason, 2008).

Any claims about the ability of blockchain to hold actors accountable must therefore also be considered alongside the already contentious nature of UNFCCC MRV systems, both voluntary and mandatory, where the verification of reported actions has been seen as a potential impingement upon national sovereignty or an attempt to shift governance away from transnational experts and other non-state actors (Gupta and Mason, 2012). A seemingly simple relationship between transparency and accountability becomes further complicated by systems of transparency becoming ever-more politicised sites of conflict and negotiation over who bears responsibility for taking and action and who should subsequently be held accountable to whom and how (ibid).

6.4.3 Accountability in the Absence of Clear Responsibility

Looking beyond the nation state, we see further challenges in operationalising accountability as responsibility becomes increasingly diffuse and operates at multiple scales. Swyngedouw (2005) highlights a further inherent contradiction in the *accountability* component resulting from the intended *inclusiveness* of climate cryptogovernance. According to Swyngedouw, there is a clash between:

"the improved transparency associated with horizontal networked interdependencies versus the grey accountability of hierarchically articulated and non-formalised and procedurally legitimised, associations of governance." - Swyngedouw (2005: 2003)

Here, the *inclusiveness* component that manifests in the multi-stakeholder initiative approaches to climate cryptogovernance poses a direct challenge to the purportedly simplistic relationship between *transparency* and *accountability*. As responsibility moves beyond the state, traditional redress mechanisms that might have plausibly held states accountable for their actions, such as those enshrined in international environmental law or institutions, become even less feasible. Indeed, despite the potential for the mobilisation of international civil society against the unambitious achievements of particular actors in contributing to NDCs or other targets that might be made visible through blockchain, if there is no explicit redress mechanism, nothing is certain as to the ultimate outcomes of transparency. Any imagined preventative effect that it might have through the possibility of being held accountable will not occur automatically.

This is even before considering that in discussing accountability for climate damage, we open a whole Pandora's box of discussions about cause-effect relationships between the actions of actors and substantive impacts that manifest in the inherently chaotic, interdependent and uncertain climate system. Resultantly, despite promising claims put forward by some actors advancing climate cryptogovernance, the impacts of blockchain in achieving effective outcomes through the union of transparency and accountability are likely to fall short due to complex pathways from transparency to accountability and challenges when holding actors to account.

6.5 Interrogating Future Potential

In the *future ambition* component of the storyline, it is posited that there must be efforts to resolve existing problems with blockchain-based governance to ensure its effectiveness - including high energy requirements, technological limitations and inadequate governance arrangements. The identification of these flaws with the pushes towards blockchain-based government are coherent within current understandings of climate cryptogovernance, and will not form the basis for the preceding critical analysis. However, whether the broader enterprise of climate cryptogovernance which *future ambitions* are targeted towards is worthwhile is a different matter, and will be explored from a variety of alternative perspectives. Whether *future ambitions* should be funnelled towards climate cryptogovernance can be contested by considering the potential motivations behind blockchain-based governance and the salience of blockchain in the context of climate governance more broadly.

6.5.1 Blockchain Control as Part of a Procedural Turn

Blockchain can be understood as part of a broader 'procedural turn' in climate governance, where focus has shifted to establishing procedures for governing the climate (such as information generation or accessibility) as opposed of mandating specific outcomes (Gupta, 2010). Although the aforementioned storylines offer seemingly logical proposals to revitalise existing climate governance arrangements, critical authors have also offered alternative perspectives on the potential implications of such a procedural turn that emphasises the modernisation of processes within climate governance.

Käll (2018) describes the increasing incorporation of blockchain into modern life to finetune existing procedures as a component of the "Intensification of the Societies of Control". Käll (2018) draws on Haraway (1991) to describe this process as move towards the treatment of information as a commodity, where actors beyond the state "pervasively control everything and everyone through seizure and control over information" in a way that is amenable to governing through markets. Under such a process, blockchain ensures that smart-contract like solutions lead to intensified proprietary control through automatised codes, as the possibility to control carbon as property becomes ever more enforceable.

Considering the broad body of constructivist literature that suggests it is market-friendly environmental policy initiatives that are those most likely to gain traction (Bernstein, 2002), the future ambitions of climate cryptogovernance advocates to mainstream blockchain would appear to be feasible if technological and political obstacles can be overcome. A further move toward the "intensification of control" is rational in the context of an existing market-based infrastructure that relies on the allocation of enforceable property rights to avoid market failures under pre-eminent market-based approaches, such as international carbon trading. However, in attempting to further this particular set of approaches to climate governance, there also exists the argument that the dominant storyline of climate cryptogovernance detracts focus from more fundamental issues.

6.5.2 Misguided Ambitions?

Some authors have argued that an emphasis on the procedural that highlights managerial processes and financial auditing without asking more fundamental questions about the responsibility of unfettered markets misses the point. For example, Harmes (2011) has explored how the "business argument" that climate change solutions are achieved by correcting information asymmetries and providing full information to investors can smother broader questions about corporate responsibility for climate risk and damage. In the case of blockchain, could fundamental concerns about lack of political will, funding, robust legal frameworks and adequate economic incentives for green transitions be marginalised by an overemphasis on blockchain and its process-orientation?

To further illustrate this possible misdiagnosis of the most pressing climate issues to tackle, it is worth considering the claim made by some actors harnessing the *inclusiveness* component that a limiting factor to mitigating greenhouse gas emissions is that consumers have imperfect information about the climate impacts of their products. For example, writing for the WEF, the chief executive of Ecosphere+ sees an unresolved issue in climate change action being that "consumers, led by socially conscious millennials with increasing buying power, want to purchase greener products and invest in sustainable projects" but are presently unable to (WEF, 2018).

A growing body of critical theorists have argued against such a diagnosis, arguing that green consumerism overemphasises the agency of individual consumers when the ability to enact substantial change in consumption patterns lies with large producers (Scales, 2014). Furthermore, the seemingly empowering nature of disseminating information about climate-friendly production could gloss over core issues, such as the intensity of resource consumption (ibid.) This may admittedly be an extreme example of where the identification of pressing climate issues to govern through *future ambition* by blockchain advocates might be particularly unambitious. However, such claims should not be ignored, given that they risk muddying the overall debate on where to focus efforts in the climate change realm and obscuring solutions which might be less market friendly.

Although the trajectory of climate cryptogovernance remains to be seen, there is a strong possibility that regardless of any future ambitions, blockchain may be just a mere bandaid on a much deeper wound when it comes to ultimately reducing emissions. Recent analyses have highlighted how the Paris Agreement is unlikely to result in committed emission reductions despite promising pledges, with the intention to reduce emissions with five yearly updates not necessarily translating into the immediate and urgent action needed to meet targets. For example, the G20 would need to roughly halve emissions by 2030 to meet the Paris goals, but adequate long-term strategies to do so are still lacking (Climate Transparency, 2018). In 15 of the G20 countries, energy-related carbon dioxide emissions continued to rise in 2017, and 82% of the G20 energy supply continues to come from fossil fuels (ibid.). In the words of NASA scientist James Hansen, “as long as fossil fuels appear to be the cheapest fuels out there, they will be continued to be burned” (Milman, 2015). These issues are likely to be more than procedural, requiring substantial departures from current approaches to climate governance which presently do little to challenge established consumption patterns and trends.

A question to be considered here is that if climate action is more important than ever, should the largely procedural future ambitions of blockchain advocates be those that debate should centre around? It may well be the case that the largely procedural issues that are diagnosed in the dominant storylines of climate cryptogovernance are low hanging fruit that may offer maximum return on efforts by augmenting the effectiveness of current market-based approaches. However, it may also be the case that efforts may be better allocated elsewhere to more pressing issues beyond the scope of blockchain, at the very least in policy debates.

6.6 Interrogating Neutrality

Earlier discussions on the purported neutrality of a quantifiable GHG focus in climate cryptogovernance foreground broader discussions on whether blockchain as a technology can truly be ‘neutral’ in practice. According to the *neutrality* component of the storyline, blockchain as a technological solution is both neutral in its functioning and moreover can also be applied neutrally on the basis of objective benefits of its applicability. In this section so far, it has already been suggested that purportedly neutral technologies, such as blockchain-based auditing, are not inherently neutral or objective in their functioning despite dominant claims (Power, 1998). In this section, the latter half of the neutrality component regarding the neutral implementation of blockchain-based solutions into climate governance will be explored. Authors from critical schools will be drawn on to consider the possibility that even if blockchain removes the need for intermediary influence in governance procedures, the implementation of blockchain technology carries political values in and of itself and may privilege particular technocratic and decentralised economic modes of governance.

6.6.1 Neutrality at the Science-Policy Interface

Turnhout et al. (2014) question claims about the neutrality of applying particular technologies such as blockchain in the context of an uncritical technocratisation of climate governance. In spite of widespread usage of accounting and business management methodologies, the generation of transparent and reliable information about GHG emissions is ultimately delegated to expert natural scientists (ibid.). The flows of knowledge upon which blockchain is applied are a result of standardised scientific method producing GHG-related outputs for a science-policy interface that is understood to be linear. In this linear science-policy interface, the generation of objective and neutral knowledge is assumed not only to exist prior its use in decision making, but also to be crucial to its effectiveness (Turnhout et al., 2014).

This decisionist conceptualisation of science with respect to policy that understands the outputs of the scientific method as a neutral input to policymaking has been widely debated in academic literature. Jasanoff (2006) has put forth the idea of co-production to describe a model of the science-policy interface where science and policy mutually constitutive. From such a perspective, the application of blockchain onto existing carbon and GHG-centred scientific knowledge into would not be inherently neutral and tied to the disinterested needs of science in an apolitical vacuum, but rather interlinked with an inherently political science-policy interface that shapes how governance of the global climate occurs (ibid.).

The co-production model of the science-policy interface holds direct relevance for the incorporation of blockchain technology into climate policy. Turnhout et al. (2014) argue that under a neoliberal paradigm, certain quantifiable metrics related to climate are those that are made transparent under the market logics. In order for blockchain technologists who seek to implement their platforms into existing structures of MRV, programmers must be well attuned to the requirements of these existing market logics and forms of scientific knowledge. Considering that it is international carbon markets in which knowledge about blockchain is being experimented with, it is a focus on *measurability* that transforms carbon as a commodity through which usable knowledge is channelled. Imagining a possible set of all potential blockchain based applications and forms of associated knowledge, it is those which are deemed as policy-relevant under dominant economic rationalities that will stabilise (Turnhout et al., 2014).

The knowledge being disseminated about the applicability of blockchain does therefore not simplify fill a pre-existing gap in climate policy. This knowledge coalesces with a specific scientific, cultural, and political context - in this case, one centred around international carbon markets (Law, 2009). As discussed of *measurability*, the notion of carbon as a tradable entity sees the stabilisation of knowledge that performs a world made up of carbon that can be made measurable, valuable, governable and exchangeable (Turnhout et al., 2014). The incorporation of blockchain technology sharpens the focus on representations of climate that can be counted and made to count, while phenomena that resist such conceptualisation are relegated in the realm of international climate policy (ibid.). Such perspectives from the sociology of scientific knowledge see all knowledge as inherently political, particularly within the context of a science-policy interface, denying the possibility of the neutral applicability of blockchain-based solutions apparent in the dominant storyline of climate cryptogovernance.

6.6.2 Impartial By Design?

It should also be noted that the design of blockchain-based solutions themselves also have political implications. A useful distinction here is between incorporative and radical blockchain solutions for climate cryptogovernance, where incorporative projects slot into existing (financial) institutions and radical projects mark a departure from said institutions (Swartz, 2017). The variety of early technologies explored earlier in this thesis could be slotted at multiple points along such a spectrum - with intentions to overlay blockchain on to existing MRV systems being decidedly incorporative, and attempts to develop alternative currencies linked to renewable energies like SolarCoin being comparatively radical.

The point to be made here is not that there is an inherent value in seeking out incorporative or radical approaches, but instead that in being translated from general computer scientific theories into practice, blockchain-based solutions interact with their external environment in ways that could either reinforce or disrupt established ways of doing things (Swartz, 2017). Given theoretical insights that aside from exceptional circumstances, further technological development is overwhelmingly likely to occur to immature solutions that slot readily into existing societal structures (Bailey and Wilson, 2009), it is entirely possible that even the act of implementing a certain form of blockchain technology at the behest of another is inherently value-laden.

All in all, in contrast to such claims about *neutrality* associated with the application of blockchain technology, some authors have highlighted that even seemingly objective knowledge and technologies may be value-laden. The insights raised in this subsection not only challenge claims of neutrality in climate cryptogovernance, but also hint at a potential misrepresentation of blockchain in its common description as ‘radical’ in the aggregate. The following section will explore perspectives that further challenge the universally radical and disruptive nature of blockchain technology.

6.7 Interrogating Radicalism

If, as suggested above, blockchain technology is not necessarily neutral, but interacts with social context, then what implications does this have for the *radicalism* component of the storyline? After all, claims of the potentially radical and transformative impact of blockchain on climate governance were a mainstay of the sampled texts. The sheer fact that blockchain can be introduced into climate governance in a way that is neutral according to some actors, but radical according to others already raises a potentially frayed discussion. In this section, the descriptor ‘radical’ will be critically considered and the importance of context raised.

6.7.1 Marketised Radicalism

Käll (2018) highlights that discussions surrounding blockchain have featured the idea that the technology is radical since the earliest conceptualisation in blockchain by Nakamoto (2008). The logic here, as mirrored in the *radicalism* component, is that the possibility of decentralised power over information results in a democratisation of information and a reclaiming of capitalist value systems at the individual level. What such a perspective obscures, however, is the inevitable co-option of blockchain into dominant economic processes, as advanced encryption “follows rather than ruptures… control logics” (Käll, 2018: 138). Such a trend is currently visible, with some of the world’s largest corporations harnessing blockchain not only for the operation of financial services more generally, but also to meet explicit climate finance goals (WEF, 2018).

The subsequent enhancing of property rights and control over carbon nod to a further entanglement between digital and physical elements, under smart contract like mechanisms (Käll, 2018). This predominant way which blockchain is used in climate cryptogovernance ultimately reinforces property rights to carbon and further renders it a tradable commodity - in essence, maintaining the stronghold of market-based approaches. There is not necessarily a clear right or wrong answer to the question of whether such approaches are the best tool for tackling climate change. However, what does seem abundantly clear is that a technology that fundamentally reinforces the power of markets is hardly radical in the conventional sense of the word.

Of course, claims of radicalism should be considered beyond conventional understandings too - in the context of the potentially pluralistic meanings of the descriptor ‘radical’. Radicalism in the context of the dominant storyline of climate cryptogovernance may well denote a shift against established ways of doing things in the most general terms, as opposed to the more applied political understanding of restructuring of social structures and value systems through revolutionary action. However, due to the ambiguity of such a descriptor, we once again see even the most decidedly unradical proposals that simply fine-tune existing MRV processes borrowed from the radical glow of blockchain-based solutions, which might be more convincingly described as radical or disruptive (Swartz, 2017). While there is a case to be made that local-level, small-scale applications of blockchain, such as the facilitation of microgrid energy transmission, are indeed radical in general terms, the same can hardly be said of approaches that automate REDD+ or enable climate finance.

6.7.2 Radical to Incorporative: the Importance of Context-Specificity

If blockchain is often reformist within current structures at best, then why can one observe so much hyperbole about its radical capabilities? While some might dismiss the purported *radicalism* of climate cryptogovernance as part of a calculated ploy and understand blockchain as a neoliberal trojan horse designed to disenfranchise, a more nuanced approach suggests the reality lies in the imagined techno-economic ‘blockchain dreams’ that have been the basis of blockchain discussions since its inceptions. It appears not much has changed from when Swartz (2017) explored the techno-economic futures proposed by blockchain activists in 2017 and wrote that “it truly is difficult to overstate the claims made by some blockchain enthusiasts.” Swartz (2017) understood many blockchain projects to be a form of “utopian science fiction” which may map a coming reality, but are nevertheless speculative visions that may result in hyperbole.

Even beyond the possibility for exaggerated claims of radicalism due to the anticipatory nature of climate cryptogovernance, there exists diversity within the range of blockchain-based solutions. Such diversity may provide blockchain as an aggregate with a radical glow in spite of the existence of fundamentally unradical technologies. A further distinction here made by Swartz (2017) is again particularly relevant, as blockchain solutions are conceptualised and lying on a spectrum between radical and incorporative. Although blockchain, in its purest form put forth by Nakamoto (2008) does indeed offer potentially radical promises of decentralisation and circumvention of traditional financial systems, a broad range of blockchain applications are instead attempts to innovate within the existing financial system. Such incorporative approaches are labelled as such as they seek to incorporate blockchain into the existing processes to make them more efficient, not dissimilarly to the manner in which blockchain is being proposed as part of a ‘procedural turn’ in market-based international climate governance. Swartz (2017) argues that incorporative blockchain applications nevertheless benefit from the revolutionary aura of radical projects, in spite of the fact that some radical commentators would likely see such goals as far afield of the original goals of bitcoin.

Although Swartz (2017) does admit that this distinction between radical and incorporative approaches is somewhat murky in practice, it does offer a useful framework for understanding why the *radicalism* component of the storyline has been so prevalent despite an array of arguments for the majority of proposed applications of blockchain to international climate change policy being anything but radical. In line with these perspectives, it is worth keeping in mind that proponents of blockchain may fall back on claims of radicalism - a practice that could go unchecked due to a lack of awareness about basic principles of blockchain technology and its applications among the general public. Context is therefore key, and radicalism must be considered on a case by case basis. Overall, the *radicalism* component of the storyline fails to consider adequately both whether the descriptor 'radical' is accurate for climate cryptogovernance and the importance of discussing radicalism in context.

6.8 Interrogating Inclusiveness

A final component of the dominant storyline which will be critically considered discusses *who* actually partakes in climate cryptogovernance. The *inclusiveness* component emphasised the inclusive and multistakeholder nature of climate cryptogovernance - with the potential for involvement of a diverse range of actors across scales and in both the global north and global south. Building on the three substituent ways in which the inclusiveness component was understood to be applied in chapter 5, this component will be critically considered with reference to the following forms of inclusiveness:

I. Inclusiveness across actors
II. Inclusiveness across scales
III. Inclusiveness across capabilities

<u>I. Inclusiveness Across Actors</u>

6.8.1 The Ideology Behind Inclusiveness

A common manner in which the *inclusiveness* component was applied was through claims that blockchain technology would usher in an unprecedented age of participation across actor types through its decentralised nature. The UN+ approach that engages a broad variety of stakeholders across international organisations, national governments, business and civil society is understood to offer opportunities for innovative and multistakeholder governance-beyond-the-state initiatives. These promise to optimise the integration of a range of actors into the design and practice of climate cryptogovernance. However, a range of possible considerations exist about who will actually take part in climate governance and where the balance of power will locate in context. While it is entirely feasible that greater and more equal participation will occur in practice (assuming the design of blockchain solutions adheres to the decentralised characteristics for which it is known), this subsection considers a potentially less inclusive facet of climate cryptogovernance - the design and rollout of solutions in themselves.

With respect to the design and implementation of blockchain-based systems, Swyngedouw (2005) is critical of the multistakeholder orientation of beyond-the-state governance initiatives in environmental policy. Such initiatives have featured heavily in the context of climate cryptogovernance, as seen by UNFCCC-backed initiatives such as the Climate Chain Coalition and the multistakeholder World Bank events under the Connect4Climate banner. Such approaches have claimed to offer greater stakeholder integration, harnessing the language of grassroots empowerment and civic environmentalism. However, Swyngedouw suggests there is a:

“contradictory nature of governance-beyond-the-state and, in particular, on the tension between the stated objective of increasing democracy and citizen empowerment on the one hand and their often undemocratic and authoritarian character on the other.” - Swyngedouw (2005: 1993)

He argues that such a shift from ‘government’ to ‘governance’ occurs through this restructuring - as has occurred in the issue area of climate change long before the advent of blockchain - which is associated with the consolidation of new technologies of government that result in a democratic deficit (Dean, 1999). Swyngedouw argues that a destatisation occurs through the externalisation of state functions through deregulation and decentralisation, the upscaling of governance from the national state to such as the EU, IMF and WTO, and the down-scaling of governance to ‘local’ practices with a view to creating greater local differentiation through the incorporation of new social actors. For Swyngedouw (2005), these processes lead to new institutional arrangements part of organising the ‘conduct of conduct’, embedded in the consolidation of neoliberal ideological polity. From such an understanding, governance beyond the state does not necessarily lead to democratic inclusiveness, but instead a scalar reorganisation that constructs the market as the preferred institution of resource mobilisation and allocation, with an associated bio-political engineering of individualised responsibility (Harvey, 2005).

6.8.2 Increased Participation and Democratic Deficits

The practice of governance beyond the state initiatives that have been detailed as innovative arrangements in the dominant storyline of climate cryptogovernance may thus experience substantial power imbalances that render them far from being democratic. Critics have argued that ad-hoc and context-specific ways that such initiatives operate in differ greatly from those associated with pluralist democratic rules and codes. In direct contrast to the codified, transparent and legible procedures of democratic governing, the mechanisms of many less formalised multistakeholder initiatives is less clear and potentially swayed by coalitions of economic, sociocultural or political elites (Swyngedouw, 2005). The rescaling of policy arrangements in the ad-hoc coalitions formed by blockchain advocates results in:

"a new constellation of governance articulated via a proliferating maze of opaque networks, fuzzy institutional arrangements, ill-defined responsibilities and ambiguous political objectives and priorities." - Swyngedouw (2005: 1999)

From such a perspective, the network-based forms of governance beyond the state are not democratic in the same way that pluralist democracies enshrine national citizenship and entitlement participation. Instead, a comparative lack of codified rules and regulation leads to this arrangement being full of what Beck (2009) describes as "unauthorised actors". While the relative lack of codification and informal networks that craft climate cryptogovernance solutions potentially allow for innovative forms of organising and governing, they also bring potential conflict around entitlements and institutional power. The status, inclusion, legitimacy, representational system, scale of operation and accountability of these actors may be characterised by disparities between actors that are ultimately opaque (Swyngedouw, 2005).

What then must be considered alongside the possible benefits of polycentric climate cryptogovernance carried out by flexible and decentralised arrangements, is also that responsibility and subsequent accountability may become more diffuse and ambiguous. Where some might see benefits, others have identified junctures for less accountable and paradoxically more autocratic systems of governance where specific actors who may operate beyond 'hard' accountability wield considerable power.

6.8.3 Power Dynamics between Actors

In considering who is ultimately shaping climate cryptogovernance, it is important to consider entitlement and status in the form of admission to climate cryptogovernance multistakeholder partnerships. Swyngedouw (2005) explores how the assignment of such status is not neutral, and conferred upon participants who already hold a certain power or status. While political citizenships enshrined in democratic systems is founded on a ‘one person one vote’ rule, holder entitlements of the multistakeholder partnerships that sculpt recognisable processes of climate cryptogovernance are predicated on a willingness-to-accept (inclusion to partnerships) on one hand, and willingness-to-participate on the other.

This has implications for would-be blockchain solution developers who reject mainstream political action or adhere to alternative political views, such as deep ecologist, anti-globalist and anti-capitalist actors (Swyngedouw, 2005). The new choreographies of governance that characterise the governance beyond the state initiatives of climate cryptogovernance thus may give rise to the prominence of particular social actors, and consolidate the presence of others but exclude or diminish other social actors (ibid.). More aptly, they may continue to exclude actors who have never had a seat at the table in the first place. Considering the largely reformist nature of the blockchain-based initiatives which have sparked the most interest, it is possible that actors largely ideologically aligned with market-based approaches and from the global north will be those that are at the centre of decision-making, while the status of social democratic and anti-privatisation groups that seek to represent those in the developed world are on the margins.

At least with respect to the design and implementation of blockchain solutions, it appears as if imagination may have run away with some commentators about the level of participation and decentralisation that blockchain allows for in climate governance. The balance of power in climate cryptogovernance is largely mediated by the nature of the network-based governance that climate cryptogovernance which characterised by particular ideologies, potential democratic deficits and power relationships associated with inclusion.

<u>II. Across Scales</u>

A closely related application of the inclusiveness component of the storyline relates to claims of inclusiveness across scales. The above discussion of inclusiveness across actor type has already explored how by democratising certain elements of climate governance, blockchain advocates claim a re-scaling of climate change down to the individual actor level is possible. This subsection will explore this further with an explicit emphasis on individualisation and exemplary governance.

6.8.4 Reconsidering Individualisation

A common trend in contemporary climate governance that scholars of governmentality studies have focused on has been this individualisation of responsibility. Some scholars have identified a range of critiques on this responsibilisation, many of which are applicable to the dominant storylines of climate cryptogovernance. Speaking of governance-beyond-the-state mechanisms, Swyngedouw (2005) argues that flexible approaches, such as the coalitions that develop blockchain based solution, are:

"embedded within autocratic modes of governing that mobilise technologies of performance and of agency as a means of disciplining forms of operation within an overall programme of responsibilisation, individuation, calculation and pluralist fragmentation." - Swyngedouw (2005)

From such a perspective, instead of empowering civil society and small-scale startups in the face of an overbearing state, it is again the market that is put to the forefront through technologies of power. Cruikshank (1993) has theorised such processes as mobilisation of 'technologies of citizenship', including self-esteem and empowerment, where the rationalisation of blockchain technology as a means of 'saving the planet' through actively taking control of purchases. According to some critical authors, although these technologies seem on the face of it conducive to environmental action, actors fail to see how these instruments contribute to the consolidation of 'authoritarian neoliberalism' that champions virtues of self-managed risk, prudence and self-responsibility (ibid.). Earlier discussions about the saliency of blockchain as a solution also come into play here, as focus on the actions of individuals raises more fundamental questions about the battle between structure and agency in reducing emissions, and possibly downplays the institutionalised role of more powerful actors within and beyond the state.

Soneryd and Uggla (2015) highlight the paradox between 'simple solutions', such as buying blockchain-enhanced products with transparent supply chains or offsetting emissions with blockchain-based credits, in contrast to the acknowledgement of the global, transboundary and complex character of environmental problems. Under such processes of individualisation, citizens are transformed into rational actors with free will who “understand and enact their lives in terms of choice” (Rose, 1999: 87) - an assumption that is subject to debate in light of the activities of large corporations, financial institutions, state policies and multilateral agencies (Soneryd and Uggla, 2015).

6.8.5 Limits of Exemplary Governance

Such discussion of personalised power also raise relevant perspectives not only about the individual subjects who are theorised to partake in climate cryptogovernance, but also about exemplary governance in the context of widely publicised individual blockchain success stories placed on display at high-profile events by developers. This mode of summit diplomacy has been common of climate cryptogovernance and its range of hackathons and side events. In the current underdeveloped state of climate cryptogovernance, when climate governance has been re-scaled down to the individual level, it has frequently been done so at these high-profile events. Death (2011) has explored such events at length, arguing that such events have increasingly become “advertising and branding sites through which the conduct of conduct is conveyed”

Death (2011) highlights not only the somewhat limited effectiveness of exemplary governmenance in sparking broader change, but also highlights that the reliance on a model of agency which emphasises individualised, consumer-based, choice-oriented government is problematic. By privileging particular charismatic individuals that spearhead blockchain and associated prototype solutions, there is the impression that individual developers and small startups are located at the heart of power of world politics and that progress towards sustainable development stems from behavioural change (Death, 2011). However, such charismatic demonstrations of blockchain may do little unpack the structural constraints on individual choice, which is particularly true of the developing world as explored above (Paterson, 2009). To quote Death (2011), such structural constraints remain:

“largely untouched by theatrical speeches, voluntary partnerships, market mechanisms and quotas for major group participation” - Death (2011: 14)

Ultimately, the individualisation heralded by the *inclusiveness* component may be ideologically driven and with political consequences - both with respect to individual consumerism and exemplary governance by high-profile actors.

III. Across Capabilities

In considering the balance of power between actors, it also becomes necessary to revisit one of the most widely discussed themes in international climate politics - the dynamics between the developed and developing world, or global north and global south. It was suggested in the inclusiveness component that although the implementation of blockchain in developing nations may require the assistance of more developed nations, blockchain nethertheless offers value in ensuring reliability of existing flows of information and finance. This was particularly argued in the current context of an existing lack of capacity of developing nations in producing reliable data for programmes such as REDD+. However, due to both geopolitical barriers to north-south harmonisation and unique challenges of adapting the designs of the global north to the global south, these arguments may not hold water.

6.8.6 Geopolitical Barriers to North-South Harmonisation

Mason and Gupta (2016) see potential drawbacks of such technocratic rationale for disclosure from actors of the global south within MRV systems, characterised by applying expert-led problem-solving approaches to developing nations for the redress of capacity constraints and gaps in data availability. Although capacity constraints are undoubtedly existent, the technocratic push towards institutionalising current MRV systems can put the spotlight on the capacity-constrained who ultimately have the fewest obligations and capabilities to mitigate climate change in the multilateral context (ibid.). In light of the downplaying and continued shirking of climate responsibilities from some of the richest and largest emitting nations, proponents of blockchain across both north and south may misdiagnose the most pertinent issues. The implementation of blockchain-based solutions to enhance control over the conduct of developing nations, through fine-tuning of MRV in mechanisms such as REDD+, may sidestep more pressing questions about historical responsibility for climate harm and who has the present ability to take the most action (Okereke and Schroeder, 2009).

Similarly, the breezy manner in which it is has been argued as part of the *inclusiveness* component that blockchain could slot into existing governance arrangements is also challenged by alternative perspectives. Gupta and Mason (2016) identify how an independent review of REDD+ MRV identified a high-level of political conflict over potential infringements of national sovereignty, quoting Luiz Alberto Figueiredo, Brazil's under-secretary for environment, as saying:

"No developing country will have international verification of its actions, especially if they are national policies" - Luiz Alberto Figueiredo, quoted in Gupta and Mason (2016)

The blockchain dreams of an automated REDD+ MRV system - computerised but ultimately designed and administered by blockchain developers and policymakers of the global north - may not hold water when considering geopolitical realities.

6.8.7 Equality in Design, Divide in Practice

Furthermore, the harmonisation of blockchain for climate governance between north and south also suffers from a representational deficit in climate governance. Some authors have argued that the needs and perspectives of those in the global south whose actions are to be governed by blockchain are likely to be subordinated to those of developers and policymakers based in the global north (Al-Saqaf and Seidler, 2017). It is possible to view the outcomes of such a representational deficit in the present solutions of climate cryptogovernance already. In explicitly discussing blockchain-based policy solutions, such as those required for climate cryptogovernance, Al-Saqaf and Seidler (2017) point to equality in design, divide in practice. The requirements for blockchain of fast and reliable internet access, as well as significant processing power for mining, are vast limiting factors to effective implementation in many situations (ibid.).

Al-Saqaf and Seidler (2017) provide evidence along these lines to demonstrate that substantial parts of the developing world suffer from weak telecommunications infrastructure, not to mention isolated regions of the developed world. The decentralisation benefits of blockchain may also be slashed by requirements of bandwidth, power and storage, as participation becomes mediated on access to telecommunications infrastructure. Subsequently, particular individuals, groups and regions would likely miss out on the benefits of such technology for climate governance due to sociomaterial realities, in spite of well-intentioned claims by blockchain advocates that such limitations could easily be remedied by technology transfer.

Al-Saqaf and Seidler (2017) also suggest that a reason for the disparities in the design of blockchain solutions and their applicability to the south is that the major blockchain developers are overwhelmingly based in countries of the global north, resulting in codes and interfaces that are amenable to particular cultures and countries while overlooking the realities of the global south. Such realities within the context of the global south bolster claims by Mason and Gupta (2016) that market-oriented governance by disclosure approaches may be characterised by ongoing conflicts over the stringency and political reach of MRV systems - a practical consideration that is absent in the optimistic claims of the inclusiveness *component*.

In sum, due to geopolitical tensions and a lack of consideration of context in adapting technologies to certain situations in the global south, the north/south harmonisation imagined by the *inclusiveness* storyline may be untenable in practice.

6.9 Summary

The perspectives presented in this section have been collated to critically interrogate the dominant storyline and stimulate critical discussion on the knowledge claims presented in its substituent components. Using the first *reliability* component as a springboard to discuss the seven other components, this chapter has critically considered the claims of the i. *measurability*, ii. *transparency*, iii. *accountability*, iv. *future ambition*, v. *neutrality*, vi. *radicalness* and vii. *inclusiveness* components of the dominant storyline of climate cryptogovernance. In the following chapter, these critical perspectives will be further considered alongside the findings of the argumentative discourse analysis of chapter 5 to discuss both the implications of climate cryptogovernance and the validity of the analysis presented in this thesis.

7. Discussion: Actualising Climate Cryptogovernance

Having now recounted a brief history of climate cryptogovernance, identified a dominant storyline and highlighted some possible critiques of its components, a discussion of what the future might hold for climate governance will be provided. In order to offer insights into what types of climate governance may be reinforced or obscured by climate cryptogovernance, the findings of chapter 5 and chapter 6 will be juxtaposed against one another. This will be done with regards to both a juxtaposition of the storyline components alongside critiques, as well as the communicated certainty of the dominant storyline against the uncertainty inherent in climate governance. Following these comparisons, an overarching discussion of the likely material impacts of climate cryptogovernance will be provided. To conclude the chapter, these insights will be appended by a discussion of the scope of analysis of this thesis - with respect to theoretical considerations, reflexivity and material considerations.

7.1.1 Juxtaposing Storyline Components Alongside Critiques

In the first section, the components of a dominant storyline were distilled. Several of these were mapped predominantly to the discourses of ecological modernisation and green governmentality - including the *measurability, reliability, neutrality* and *future ambition* components. However, a number of components, including the *inclusiveness, radicalism, accountability* and *transparency* components were also characterised by a discourse of civic environmentalism.

However, in the second section, which collated critical perspectives from a number of traditions, it was suggested that many of the ideas (e.g. blockchain as a radical technology), concepts (e.g. participatory governance), notions (e.g. democratisation) and categorisations (e.g. disruptive/non-disruptive innovation, accountable/unaccountable) associated with civic environmentalism that advocates of climate cryptogovernance have invoked may not live up to their promises in practice. These insights, from traditions that have often sought to challenge policy orthodoxies and offer critical perspectives, suggested that instead it was pre-existing power relations that were maintained. This is understood by some critics to occur at the behest of politically and economically powerful actors - meaning existing power relations were often maintained at the expense of a more redistributive approach imagined in the dominant storyline of climate cryptogovernance.

What implications do these two conflicting sets of findings then have for the future of climate cryptogovernance, as the ‘blockchain dreams’ of the sampled texts become inscribed into material reality? Taking into account the analysis of the last two chapters, it appears as if climate cryptogovernance has increasingly been imagined into international climate policy in an incorporative manner, as opposed to a radical way. The most widely anticipated applications of blockchain have been in augmenting the efficiency of existing market-based approaches grounded in the discourse of ecological modernisation. This is unsurprising, considering that blockchain has increasingly taken on the identity of fintech, with its incorporation into mainstream financial markets and away from bottom-up cryptocurrency solutions imagined in the earliest iterations of blockchain. However, this incorporative approach does stand in contrast to much of the civic environmentalist language that some storyline components draw upon.

This is not to deny the potentially radical, bottom-up impacts of some technologies, which may well have occurred in some contexts - particularly those which offer authentic and scalable alternatives to high carbon practices, such as energy generation and transmission. However, all things considered, the communications of some of the most influential actors in international climate governance seemed to reinforce predominant approaches to MRV as part of a ‘procedural turn’ in climate governance. This is in spite of the prevalence of language in these same communications that could arguably be described as drawing from a *strong* version of the civic environmentalism discourse that emphasises disruptive and radical change.

7.1.2 Juxtaposing Communicated Certainty Against Inherent Uncertainty

In addition to an initial assessment that climate cryptogovernance is likely to reinforce dominant, market-based modes of governance at the behest of legitimately ‘alternative’ modes, it has also been noted that discussions of how blockchain could solve such diagnosed problems in theory may be entirely different to how climate cryptogovernance might play out in practice. This includes whether how storylines would be translated into reality to solve climate problems at scale, in particular contexts and over time. Swartz (2017) uses the work of Anthony Giddens (1991) to explore the practices of some blockchain advocates, demonstrating how a desire to accomplish the future and a desire to “colonise” such a future rapidly is amenable to bold claims:

“As soon as a proposal is offered – whether as a white paper, a slide deck, or a blog post – it is treated as though it already exists, ready to go. Indeed, blockchain projects exist in a particular temporality and have their own sense of the past and future, of change. It performatively leans

into a future, always just around the corner, which might as well be here already." - Swartz (2017)

The degree of belief required to usher in a new techno-economic order is understandable (Swartz, 2017), particularly from the Hajerian ADA understanding of multiple actors vying to secure their preferred version of reality (Hajer, 2002). However, if the technology being discussed is "one step behind its promises", blockchain advocates are in essence operating as if a speculative future has already arrived in the present and subsequently risk making speculative claims that cannot be actualised (Swartz, 2017). The problems that blockchain technologists diagnose and argue could be solved by the implementation of their technology are solvable in an anticipated blockchain future of extended rollout across multiple contexts at the scale at which the UNFCCC operates, whereas the issues that blockchain is currently suited for at its current stage of technological development are most likely on the local level. This has been seen in the concrete examples raised in chapter two.

A tension thus exists between making bold future-oriented claims to garner the necessary support to scale up the pilot projects and develop robust technologies on one hand, and crafting authentic proposals about the current ability of blockchain to solve diagnosable problems on the other hand. Indeed, given the uncertainty inherent in climate change, operating in a foreseeable future is not particularly feasible. Despite the best attempts of humanity to govern the climate, the complexity of the global climate system does not render it amenable to absolute control (if such a control over the 'natural' world could ever exist in the first place).

Although it cannot be known a priori how storylines will reinforce particular types of climate governance and ultimately be translated into material reality, it seems as if the balance is tipped toward unfeasibly diagnosing blockchain as a future-proof solution to grand issues. In the case of climate cryptogovernance, there is a relative dearth of countervailing storylines or storyline components that keep the promises of blockchain in check. There remains an often unspoken contradiction between the technological fetishism and grand claims of *reliability*, *transparency* and *accountability* in the dominant storyline and the *future ambitions* of developers. To quote a developer that is interviewed in Swartz (2017), "it's not magic beans, it's just software" - a reminder that should be heeded if proponents of blockchain want to avoid potentially creating unachievable expectations through their communications.

By overpromising, despite potentially underdelivering, the dominant storyline of climate cryptogovernance risks crowding out alternative approaches to climate governance which might consider less procedural or less market-friendly perspectives. Considering then, that although on the face of it climate cryptogovernance may favour established types of market-based governance and that the claims of advocates are skewed towards being overly optimistic, what resultant material impacts are we ultimately likely to see?

7.1.3 The Material Impacts of Climate Cryptogovernance

Having recounted the range of claims being made and considered their potential impacts, it will now be explored more explicitly what substantive material implications blockchain will have for climate change policy and politics going forward. On one hand, we see bold and promising claims made by advocates of climate cryptogovernance as they seek to colonise the future with discussions of the transformative impact of blockchain. On the other hand, a wealth of the critical perspectives raised here have critiqued trojan horse neoliberalism and light-touch technocratic and procedural approaches that avoid inhibiting markets, claiming that they will not amount to the urgent changes to established practices that will be required to prevent dangerous climate change. Of course, there was diversity within both of these camps and these two ideal types are somewhat exaggerated, but these two caricatures are fairly indicative of many of the arguments raised in the chapters of this thesis. Considering these two divergent views, alongside insights from sections 7.1.1 and 7.1.2. that the dominant storyline of climate cryptogovernance may privilege dominant types of climate governance, what material impacts of climate cryptogovernance will we actually see as the dominant storyline is translated into material impacts?

Overriding these two camps, the stance taken in this thesis is that there is a third way that better anticipates the likely future of climate cryptogovernance translated into practice. Although both these optimistic and pessimistic perspectives offer valuable insights into climate cryptogovernance - through imagining what it could be and what it cannot respectively - both visions of a future under climate cryptogovernance mischaracterise the relationship between individual practice and collective political choice. The promise highlighted in the dominant storyline of climate cryptogovernance that privileges blockchain and its developers as revolutionary torch-bearers falls back on the notion of a heroic subject and collective will which exists outside of the practices of those who comprise this collectivity. By contrast, some of the more critical views that can be applied to climate cryptogovernance see the individual as fundamentally powerless in light of the structural immensity of the state and capital, with climate cryptogovernance being a light-touch distraction to bigger issues. Following Paterson and Stripple (2010), a more fruitful way of understanding the relationship between practice and structure in phenomena such as climate cryptogovernance is to see individual practice as part of the reproduction of structures such as capital and state.

This perspective, borrowing from Foucault's notion of governmentality, might be understood as a purer application of governmentality to environmental politics in contrast to approaches that synthesise the concept with anti-capitalist perspectives (Paterson and Stripple, 2010). From such a perspective, power operates through individual practice, not over and against it. Simultaneously, the remaking of individual practices involves reconstructing collectives themselves (Paterson and Stripple, 2010). Power is productive of subjectivity, and not solely repressive with respect to the individual subject. Collectivity is constantly made and remade, without preexisting collective political community (ibid.).

With an emphasis on individual subjects, practices like those involved in climate cryptogovernance as understood entailing the 'conduct of conduct' through moulding and mobilising certain subjectivities to govern emissions in various ways (Paterson and Stripple, 2010). Looking to the future, overly-deterministic claims cannot therefore be made about the future that blockchain will govern. Without a preexisting collective political community to be invoked, the future is instead understood as in a constant state of being made and remade under productive notions of power. Any cryptogoverned future is inevitably resistant to being fully captured by language, let alone predicted on the basis of language alone. Nevertheless, while acknowledging such contingency, it should also be remembered that theoretical pluralism does also have value in conceptualising the complexity of a phenomenon. Indeed, the rationale for presenting both the storyline components of the sampled texts and considering a range of critical perspective is that they together offer potentially insightful and divergent frameworks for understanding climate cryptogovernance - even if they are necessarily reductionistic in themselves to represent an inherently elusive 'reality'.

In sum, it does seem possible that at present, the bold claims made in the dominant storyline of cryptogovernance (as raised in chapter five) do have a greater presence than more nuanced and sceptical perspectives. This has possible implications for implementing climate cryptogovernance in particular ways that prioritise associated dominant forms of technical and economic knowledge in climate governance. Furthermore, the simplifying problem closure accomplished by these claims in contrast to the inherent uncertainty in the future of climate cryptogovernance may further reinforce these ways of governing climate change at the expense of alternative approaches. However, such a tentative reading must be accompanied by the acknowledgement that any cryptogoverned future is contingent, context-specific and marked by a mutually constitutive relationship between structure and agency, as opposed to a privileging of either.

In offering these tentative future implications for climate cryptogovernance, which have been obtained from inherently subjective readings, it is important to consider the scope of the research and discuss its validity. To be as candid as possible about the validity of presented results, this section will thus end with a discussion of the scope of analysis presented in this thesis and the potential limits of the findings of this research.

7.2 Scope of Analysis

In order to ensure the validity of any claims made about the past, present and future of climate cryptogovernance throughout the course of this thesis, a thorough discussion of the potential values and limitations of the approach adopted is required. As such, this section will discuss the extent to which the research proposed here can be considered valid. In accordance with best practice as a reflexive researcher, it is vital to acknowledge that this thesis has adopted a specific body of theoretical and methodological approaches in the hope of presenting and analysing inherently complex phenomena. Such considerations about the scope of analysis arise from the theoretical framework applied, the positionality of the researcher and the material conditions in which the research was undertaken across the study period.

7.2.1 Theoretical Considerations

With respect to the choice of analytical tools specifically, it is possible that contradictions may exist from the synthesis of a variety of different perspectives in the theoretical framework of this thesis. Although multiple attempts have been made to make explicit the epistemological, ontological and methodological basis of the research apparent to unite diverse perspectives, it is possible that there are contradictions in the assumptions these theories make which render the frameworks used in this thesis somewhat inconsistent. For example, some governmentality scholars have critiqued the application of critical perspectives that discuss tendencies towards neoliberalism into an analysis of governmentality (Death, 2014). Such theorists claim that when governmentality and neoliberalism become almost synonymous in analysis, the usefulness of governmentality as a concept is reduced to the elements of the world where neoliberal power relations are hegemonic (ibid.).

Death (2014) instead argues that it is more fruitful to adopt a broader analytics of governmentality that is able to map the different scales and alternative articulations of local climate governmentalities, such as that operationalised by Dean (1999) in his ‘analytics of government’, which examines the fields of visibility, regimes of knowledge, techniques and technologies and the production of subjectivity that a variety mentalities and rationalities of government employ. Similarly, even by adopting ADA as a primary analytical framework, it became apparent that where some may see ADA as a theoretically plausible adaptation of Foucauldian ideas to better theorise change and agency in climate politics, others may see a corruption of the initial principles and lack of compatibility between a Foucauldian and social interactionist understanding of language. Although the pluralism of theories adopted throughout the thesis allows for a diversity of theoretical perspectives in the hopes of best theorising climate cryptogovernance, this admittedly comes at the cost of potential inconsistencies in the overall research approach.

Furthermore, it is important to engage with criticisms of the largely constructivist perspectives raised in this thesis to delineate potential shortfalls of the approach adopted, as informed by a variety of alternative theoretical perspectives in international environmental political literature. Purdon (2017) suggests that constructivist perspectives are limited in theorising international environmental politics, and following Sterling-Folker (2002: 91) proposes constructivist literature suffers from emphasising only socially constructed political constraints “that have been learned and can be unlearned with human effort”. Although this claim is contestable, as what is described here is not a fundamental limitation of constructivism but rather differing theorisations of human agency, there is indeed a possibility that the theoretical framework adopted in this framework may detract focus away from structural conditions. Purdon (2017) may be correct in identifying that contemporary realist perspectives offer more developed insights on constraints on the transcendence of group politics, while acknowledging the possibility of such political transcendence. Indeed, from a neorealist approach, even an exploration of climate cryptogovernance as a theme might be considered frivolous given that it is currently the mainstay of epiphenomenal institutions as opposed to powerful nation states, and largely exists in non-committal language as opposed to material programmes.

On the topic of structural considerations, neo-Gramscian purists might also take fundamental issue with the Foucauldian conceptualisation of discourse that this thesis loosely adopts after Hajer (2010). For example, when determining the original discourse analytical approach to adopt, a variety of sources on critical discourse analysis were identified that took an alternative approach to discourse analysis that harnessed neo-Gramscian theory (Fairclough, 2013). Although some of the philosophical assumptions of this thesis might not lend themselves well to neo-Gramscian discourse analysis, it is important to acknowledge that authors championing these perspectives might see the approach adopted in this thesis as undertheorising the concept of hegemony and being all the weaker for its ignorance of the historical materialism of discourse.

Fundamentally, what has to be acknowledged with respect to these all criticisms is that a variety of potential theoretical vantage points exist that could be used to illuminate climate cryptogovernance. However, there is a strong case to be made that in the case of climate cryptogovernance, a constructivist emphasis on language is the most powerful framework from which to understand the phenomena (see chapter one). Although there are inevitably shortfalls to such an approach, it has been applied in an open and reflexive manner, with acknowledgement of such limitations.

7.2.2 Reflexivity

It has been acknowledged throughout this thesis that all findings are inherently clouded by the author's own positionality as a researcher. While this is not necessarily a limitation of the methodological approach adopted by myself as an author, so much as a fundamental assumption of it, this does have implications for the scope of analysis. Although throughout the methodological chapter, and the thesis more broadly, attempts were regularly made to adopt a reflexive approach to the research undertaken and highlight its values and limitations, it is entirely possible that my own positionality may shape the findings of this research. This could occur at any point in the research process, including creation and design of research methods, and throughout any of the practical stages of data collection, as well as during data analysis and the writing up of research (Flick, 2014). As opposed to presenting universal truths in this research, what is instead presented is a necessarily subjective reading of climate cryptogovernance, filtered through my perspective as a researcher. The foreword to this thesis serves as a ‘positionality statement’, and introduced the possible ways in which the analysis presented is influenced by the various lenses that I look through as a researcher.

To give but one example, my background of having solely lived in predominantly English speaking environments (including Singapore, the UK and an international university in the Netherlands where English was used as a lingua franca) prevents the possibility of analysing climate cryptogovernance in non-English contexts. Blockchain has increasingly been applied in particular contexts in Latin America (LEDSLAC, 2018), for example, yet these perspectives will not be included in the analysis presented here on account of being communicated in Spanish. The cultural competence developed throughout the course of writing this thesis is thus just one factor that bounds the scope of analysis. Although attempts have been made to acknowledge potential influences on the research outcomes resulting from authorship, any attempt to do so completely requires a level of self-awareness that is unobtainable considering the conceptualisation of bounded agency under a post-positivist paradigm.

It is also worth restating here that I am by no means a long-standing scholar of blockchain nor climate MRV, and while every attempt has been made here to not misrepresent either of these or the interface between them, my understanding may not delve into the technical specificities that an established blockchain developer or carbon administrator could. The claim being made here is not that the results of this thesis are non-transferrable, imprecise or irrelevant. On the contrary, adherence to common, justified methodological approaches and explicitness of assumptions made mean that the results gained here draw wide transferability. Rather, it is being acknowledged that the versions of reality presented in this thesis is by no means unitary, and should not be interpreted as such.

7.2.3 Material Constraints

Furthermore, the largely linguistic focus of this essay does not deny the existence of material constraints that may influence the validity of research somewhat. For example, the relatively limited content to analyse coupled with time and resource constraints, mean that the analysis presented in this thesis is limited to a relatively small number of sources over a relatively short period of time. Other potentially insightful methodological approaches, such as interviews or participant observation, have not informed results through methodological triangulation - further limiting the scope of analysis.

Similarly, a number of sampling assumptions were imposed, which although are justified for theoretical and practical reasons in earlier sections, will have inevitably narrowed the scope of the research. Not only will have this led to certain perspectives being removed from analysis, but the justifications made for sampling particular sources over others can themselves be contested. Whether climate bureaucracies, as theorised by Biermann and Siebenhuner (2009), are as impactful as this thesis proposes is up for debate. Such a claim would undoubtedly be contested under stronger constructivist perspectives that do not locate the site of a predetermined argumentative power in any one particular set of actors. This insight also calls back to discussions about potential inconsistencies of the theoretical perspectives synthesised together throughout this thesis - which did ultimately harness such stronger constructivist perspectives alongside ‘weaker’ discursive institutionalist approaches.

Ultimately, regardless of these potential caveats to the analytical power of this thesis, this research has attempted to justify all choices actively made with respect to the research approach, and remained forthright about the possible limitations of said decisions. Where specific choices have been made, there has been an acknowledgement of potential influences and no grand claims of research objectivity or universality. This research is very much situated in the time and place it was written in by its author, which although will impact the reproducibility or reliability of said research under a conventional positivist paradigm, nevertheless makes the findings of this thesis valid under the dominant paradigm of postpositivism.

Where conventional approaches to research in environmental politics might strive for reliability or reproducibility, it has been explored at length throughout this thesis why such goals are not possible nor desirable under the research paradigm adopted. In spite of acknowledged limitations and an admittedly bounded scope of analysis, this research has raised a variety of findings that provide insights into climate cryptogovernance, with relevance for the theory and practice of the incorporation of blockchain into international climate change policy.

7.3 Summary

To summarise, this chapter has considered the ways in which the communications of influential actors about climate cryptogovernance is likely to impact climate governance more broadly. Juxtapositions between chapter 5 and chapter 6 - with respect to critical perspective and uncertainty - were provided to substantiate the claim that it possible that prevailing forms of technocratic and market-friendly climate governance will be those privileged by the dominant storyline climate cryptogovernance. However, this analysis is tempered by an awareness that there can be no determinism when it comes to discussing the material impacts of language, and that any cryptogoverned future is inevitably resistant to being fully captured by language. Furthermore, the analysis of all chapters of this thesis is understood to be inherently limited in its scope; as a result of the theoretical framework applied, the positionality of the researcher and the material conditions in which the research was undertaken across the study period. To draw this thesis to a close, these findings will be summarised in a conclusion, followed by concluding remarks and recommendations resulting from said findings.

8. Conclusions

The final chapter will summarise the findings of this thesis, with reference to the research aims initially introduced in chapter one. Subsequently, concluding remarks and implications of the findings of the research will be presented to close the thesis.

8.1 Overview

This thesis has explored the communicative activities of influential climate governance actors that craft dominant conceptualisations of climate cryptogovernance. This was done by identifying a dominant storyline related to climate cryptogovernance that these actors harness and considering eight substituent components that underpin this storyline. These same components were then challenged by applying a range of critical perspectives to the assumptions present in the dominant storyline of climate cryptogovernance. Juxtaposing these two sets of findings together, this thesis then sought to develop a tentative understanding of the possible implications of these communicative actions associated with climate cryptogovernance on how climate governance occurs.

A summary of each of these three sections, aligned with the aims of this thesis, is provided below.

<u>I. Distilling Climate Cryptogovernance (Chapter 5)</u>

The first section of empirical analysis presented the dominant storyline of climate cryptogovernance harnessed by actors associated with climate bureaucracies. This was done in order to achieve the first sub-aim of this thesis, which was to *provide an overview of the dominant storyline associated with climate cryptogovernance that is disseminated by influential climate governance actors.* This storyline - which is understood as dominant by virtue of representing the views of influential climate bureaucracies and their associates - argues blockchain is a potentially effective tool to govern climate change.

This dominant storyline consists of eight components that support, expand upon and put into context this overarching claim to conceptualise climate cryptogovernance. The eight identified components of the dominant storyline of climate cryptogovernance pertained to: i. Reliability; ii. Measurability; iii. Transparency; iv. Accountability; v. Future Ambition; vi. Neutrality; vii. Radicalism; viii. Inclusiveness. These components were harnessed by actors in a multitude of ways and can each be roughly mapped on to the three prevailing discourses of ecological modernisation, green governmentality and civic environmentalism.

II. Interrogating Climate Cryptogovernance (Chapter 6)

In chapter 6, critical approaches from traditions such as governmentality studies, science and technology studies and critical transparency studies offered contrasting perspectives to the dominant storyline of climate cryptogovernance. These were harnessed in order to achieve the second sub-aim of this thesis, which was to *critically interrogate the claims of the components of the dominant storyline of climate cryptogovernance*. By harnessing the first *reliability* component as a springboard to discuss the seven other components, the dominant storyline components related to i. *measurability*, ii. *transparency*, iii. *accountability*, iv. *future ambition*, v. *neutrality*, vi. *radicalness* and vii. *inclusiveness* were critically interrogated in turn. Ultimately, the findings of this chapter suggested that the dominant storyline of climate cryptogovernance may obscure the messy realities of using blockchain to govern the climate.

III. Discussion: Actualising Climate Cryptogovernance (Chapter 7)

The findings from the first and second sections of analysis were then discussed, with reference to the possible implications of incorporating blockchain into global climate policies. This was done with a view to achieving the overarching research aim of exploring not only *how climate cryptogovernance is conceptualised by influential actors,* but also *what the implications of these conceptualisations are for reinforcing or challenging how climate governance occurs.* Considering the discussed storylines and critical perspectives together, it was tentatively suggested that the current trajectory of climate cryptogovernance may be along reformist lines that do little to challenge preeminent modes of climate governance - despite claims to the contrary implied in some of the identified storyline components.

However, it was also acknowledged that nothing can be presupposed when it comes to the future of climate cryptogovernance. The role that blockchain will play in one, ten or even a hundred years time does not necessarily bear any relationship to the blind promises that some blockchain advocates might make, nor the neoliberal power grab that some critical theorists might imagine. Instead, the future remains malleable to both the actions of individual actors and broader structures such as state and capital, as characterised by a mutually constitutive relationship between agency and structure. Beyond providing explicit insights into what the implications of dominant conceptualisations of climate cryptogovernance are for reinforcing or challenging how climate governance occurs, reflexive discussions were also provided about the extent which the findings of this thesis could be considered valid.

8.2 Concluding Remarks

What this thesis has ultimately attempted to do is distil the key messages of blockchain proponents, critically reflect on them and consider what a future might look like under climate cryptogovernance. Throughout this thesis, blockchain has been neither understood to necessarily be a technological marvel nor a neoliberal ploy - contrary to what some commentators located on either end of this spectrum might propose. Instead, the analysis of this thesis has attempted to draw out the potential utility of blockchain while simultaneously acknowledging that the means through which it is communicated may obscure a variety of alternative considerations. The future we see under blockchain is unlikely to be a decentralised carbon-neutral utopia, nor is it likely to be late-stage capitalist dystopia. Based on a discursive analysis of climate cryptogovernance from 2016 to 2018, there is nothing set in stone about how climate cryptogovernance at present.

What we should be wary of as climate cryptogovernance continues to evolve, however, is simplifying claims that blockchain technology is an unambiguous force for good in the climate realm without nuance and acknowledgement of where blockchain might fall short. As seen in the simplifying storyline of climate cryptogovernance and contradictions between its components, language can frame blockchain as a panacea for climate change when in actual fact it would be more authentically described as a reformist solution that may offer tangible benefits, but will not challenge root issues. The danger of blockchain being framed - at times disingenuously - as a cure-all for the climate is that its growing presence in policy debates may crowd out other solutions that might be more accurately described as a genuine departure from that delivers the urgent climate action required. Particularly, by benefiting from the radical-orientation of some blockchain-based solutions, it is possible that formal and informal spaces for the consolidation of novel and genuinely radical climate change solutions in policy arenas are being filled unauthentically.

As such, the key recommendation provided by this thesis to ensure that, where possible, climate cryptogovernance is portrayed with candour. Communication about blockchain for climate change should strive to be as balanced about the possible applications of blockchain without resorting to grand narratives that ignore the practical realities and inherent uncertainties of implementation. Of course, there are not necessarily hard and fast rules about how this could be done, but the analysis presented in this thesis has suggested that all too often the most influential actors shaping collective understandings of climate cryptogovernance have gotten wrapped up in 'blockchain dreams' without considering some of the realities of application. International climate governance actors should ensure that future external communications sufficiently highlight the present limitations.

Such a recommendation is not made to deny the existence of a number of actors who have offered nuanced accounts of blockchain in climate policy that highlight its potential applications while acknowledging a need for further development and combination alongside a range of other policy tools. However, these actors were not necessarily the ones that were the majority, nor the ones that will be playing the greatest role in shaping collective understandings of climate cryptogovernance. Instead, they were often specialised, academically focused and relatively marginal in discussions.

To conclude, we thus return to a phrase that was first seen at the start of this thesis:

"The environment needs cryptogovernance" - Guillaume Chapron (2017), writing in *Nature*

At least in the case of climate change, blockchain may indeed enhance co-ordinated actions to improve the quality of the environment. However, the environment - framed as separate from human society as a fundamentally anthropocentric construct - does not *need* anything that pre-exists human thought. In a literal sense, it is humanity that needs the climatic system for safe minimum standards of living conditions. Although the above framing in simplistic terms serves a rhetorical purpose, it should not be ignored how such practices of blockchain advocates reinforce unrealistic expectations about the possibility of human ingenuity. Blockchain is not a silver bullet. Carbon emissions will likely continue to get worse, and blockchain is not going to save us from a potential climate catastrophe. Could it make existing climate governance more efficient? Potentially, but there is a need to portray its relative pros and cons authentically and emphasise that it can be part of broader incremental change as opposed to a harbinger of radical change.

However, these critiques of the enthusiasm of blockchain activists must be understood alongside the power of language and the rationale for making such claims. “The environment could see improvements by harnessing cryptogovernance as part of a holistic set of policies” does not quite have the same impact as the above quote, but probably more aptly summarises the well-considered argument Chapron (2017) makes in his article. Looking to the future, the challenge is thus to maximise the impact of communications while minimising loss of nuance and candour. It’s a fine line to walk, but one well worth walking. If the best we can in the battle to mitigate climate change at this point is to put our weight behind climate cryptogovernance, then the least we should do is maintain a certain degree of integrity about its merits and limitations while doing so.

Appendix 1

List of Codes Used in ATLAS ti Qualitative Analysis Software:

Accountability
Carbon Focus
Climate Finance
Collaboration
Counter (opposing views to dominant storylines)
Dependency
Deregulation
Energy Usage
Funding
Further Development - Technology
Further Development - Governance Infrastructure
History
Indigenous Knowledge
Individualisation
Marketisation
Measurement
North South Dynamics
Opaqueness
Outcomes
Paris Agreement
Partnership
Place
Privatisation
Radical Change
REDD
Reliability
Scale
Sustainable Development
Security
Solutions
Speculative
Supply Chain
Technology
Threats
Transparency
Uncertainty
UNFCCC Actions
World Bank Actions

Bibliography

Primary Sources:

Aganaba-Jeanty, T., Anissimov, S. And Fitzgerald, O. (2017). *Blockchain Climatecup Round Table*. [Online] Toronto, Canada: Centre For International Governance Innovation. Available At: https://www.Cigionline.org/Sites/Default/Files/Documents/2017_toronto_climatecupweb-final1.Pdf [Accessed 28 Oct. 2018].

Baumann, T. (2017). *What is Blockchain GHG Management? - GHG and Carbon Accounting, Auditing, Management & Training | Greenhouse Gas Management Institute*. [online] GHG and Carbon Accounting, Auditing, Management & Training | Greenhouse Gas Management Institute. Available at: http://ghginstitute.org/2017/10/18/what-is-blockchain-ghg-management/ [Accessed 16 Nov. 2019].

Baumann, T. (2018). *Using Blockchain To Achieve Climate Change Policy Outcomes*. IETA Insights. [online] Available at: https://www.ieta.org/resources/Resources/GHG_Report/2017/Using-Blockchain-to-Achieve-Climate-Change-Policy-Outcomes-Baumann.pdf [Accessed 28 Oct. 2018].

Chen, D. (2018). Utility Of The Blockchain For Climate Mitigation. *The Journal Of The British Blockchain Association*, [Online] 1(1), Pp.1-9. Available At: https://Mahb.Stanford.Edu/ Wp-content/Uploads/2018/06/3577-utility-of-the-blockchain-for-climate-mitigation.Pdf.

CIGI (2017). *Blockchain ClimateCup Round Table*. [online] Centre for International Governance Innovation. Available at: https://www.cigionline.org/publications/blockchain-climatecup- round-table [Accessed 28 Oct. 2018].

Cleantech 21 (2017). *Blockchain for Climate – Kickstart & COP23 Hackathon*. [online] Available at: http://cleantech21.org/fileadmin/user_upload/PressRelease_SB46_17052017_Blockchain Kickstart_FF.pdf [Accessed 28 Oct. 2018].

CLI (2018a). *Resources - Climate | Ledger Initative*. [online] Climateledger.org. Available at: https://www.climateledger.org/en/Focus/Resources.36.html [Accessed 28 Oct. 2018].

ClimateCoop (2018). *Climate Coop: SDG Collaboration Redefined*. [online] dCentra. Available at: https://www.dcentra.io/climatecoop/ [Accessed 28 Oct. 2018].

Climate Investment Funds (2018). *A New Story to Spark the Future of Climate Action*. [online] Climate Investment Funds (CIF) and the Institute for the Future (IFTF). Available at:

https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/cif_iftf_future_of_climate_action.pdf [Accessed 16 Jan. 2019].

Climate-KIC (2018). *Distributed Ledger Technology for Climate Action Assessment*. [online] Available at: https://www.climate-kic.org/wp-content/uploads/2018/11/DLT-for-Climate-Action-Assessment-Nov-2018.pdf [Accessed 10 Nov. 2019].

Connect4Climate (2018b). *#Hack4Climate - Why Climate needs Blockchain | Connect4Climate*. [online] Connect4Climate. Available at: https://www.connect4climate.org/ initiative/hack4climate-why-climate-needs- blockchain-cop23 [Accessed 28 Oct. 2018].

Connect4Climate (2018c). *Hack4Climate | Connect4Climate*. [online] Connect4Climate. Available at: https://www.connect4climate.org/initiatives/hack4climate [Accessed 28 Oct. 2018].

DAO IPCI (2017). *'blockchainization' Of The Paris Agreement Article 6*. [Online] Toronto: Cigi. Available At: https://www.Cigionline.org/Sites/Default/Files/Documents/Presentation-dao%20ipci_blockchain%20and%20the%20paris%20agreement.Pdf [Accessed 28 Oct. 2018].

DLT4NCM Project Team (2018). *Permissioned Disruption: Thinking Beyond Blockchain To Co-create A Global Network Of Carbon Markets (Under Article 6)*.

Douglass, K. (2018). *The flipside of the Bitcoin: How blockchain could underpin sustainable energy*. [online] Phys.org. Available at: https://phys.org/news/2018-09-flipside-bitcoin-blockchain-underpin-sustainable.html#jCp [Accessed 16 Jan. 2019].

Elsevier (2018). *Energy-intensive Bitcoin transactions pose a growing environmental threat*. [online] Phys.org. Available at: https://phys.org/news/2018-07-energy-intensive -bitcoin-transactions-pose-environmental.html#jCp [Accessed 16 Jan. 2019].

Fitzgerald, O. (2017). *Building Climate Accountability from the Bottom Up*. [online] Centre for International Governance Innovation. Available at: https://www.cigionline.org/ articles/building-climate-accountability-bottom [Accessed 28 Oct. 2018].

Gellert Paris, A. (2017). *Discussion: Legal, political and implementation challenges of the Paris Agreement on Climate Change*. Available at: https://www.cigionline.org/sites/default/files/ documents/Presentation-Alexandre%20Gellert%20Paris_Potential%20for%20Blockchain%20to%20Enhance%20Climate%20Action.pdf

GLOCHA (2018). *#GCAS2018 Blockchain for Climate Action Event in San Francisco – Welcome to GloCha*. [online] Glocha.org. Available at: https://www.glocha.org/2018/08/07/gcas2018-blockchain-for-climate-action-event-in-san-francisco/ [Accessed 16 Jan. 2019].

Gold Standard (2018). *UNFCCC SB48 | The Gold Standard*. [online] Goldstandard.org. Available at: https://www.goldstandard.org/blog-item/unfccc-sb48 [Accessed 16 Nov. 2019].

Herweijer, C. and Swanborough, J. (2018). *8 ways blockchain can be an environmental game-changer*. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2018/09/8-ways-blockchain-can-be-an-environmental-game-changer/ [Accessed 16 Jan. 2019].

Hübner, C. (2018). *Mehr als nur Bitcoin*. [online] Auslandsinformationen. Available at: http://www.kas.de/wf/en/33.52121/ [Accessed 16 Nov. 2019].

IIED (2018b). *Can blockchain unblock climate finance?*. [online] International Institute for Environment and Development. Available at: https://www.iied.org/can-blockchain-unblock-climate-finance [Accessed 16 Jan. 2019].

IPCI.IO (2018). *Blockchain is a powerful solution to save the planet, new book explains*. [online] Ipci.io. Available at: https://ipci.io/blockchain-is-a-powerful-solution-to-climate-change- problem-the-new-book-claims/ [Accessed 16 Nov. 2019].

Jackson, A., Lloyd, A., Macinante, J. and Hüwener, M. (2018). Networked Carbon Markets. Transforming Climate Finance and Green Investment with Blockchains, pp.255-268.

Lariviere, C. (2018). *Innovate4Climate: Distributed Ledger Technology for Climate Action*. [online] Available at: https://dailyplanet.climate-kic.org/innovate4climate- distributed-ledger-technology-for-climate-action/ [Accessed 15 Oct. 2018].

Lovett, G. (2018). *COP23 explores the role of blockchain in climate action*. [online] Climate-KIC. Available at: https://dailyplanet.climate-kic.org/attention-role-blockchain-implementing -paris-agreement/ [Accessed 15 Oct. 2018].

Maupin, J. (2017a). *The G20 Countries Should Engage with Blockchain Technologies to Build an Inclusive, Transparent, and Accountable Digital Economy for All*. Policy Area: The Digital

Economy. [online] G20 Insights. Available at: http://www.economics-ejournal.org/economics/discussionpapers/2017-48 [Accessed 28 Oct. 2018].

Maupin, J. (2017b). *Blockchains and the G20: Building an Inclusive, Transparent and Accountable Digital Economy*. Policy Brief No. 101 — March 2017. Waterloo, Canada: CIGI.

Namgyal, T. (2018). *UN looks to blockchain, 'climate coin' to rouse sleepy carbon markets | MLex Market Insight*. [online] Mlexmarketinsight.com. Available at: https://mlexmarketinsight.com/insights-center/editors-picks/energy-and-climate-change/cross-jurisdiction/un-looks-to-blockchain,-climate-coin-to-rouse-sleepy-carbon-markets [Accessed 16 Jan. 2019].

OECD, UNEP And World Bank (2018). *Synthesis Report: Financing Climate Futures*. [Online] New York, Usa: OECD. Available At: http://www.oecd.org/Environment/Cc/Climate-futures/ [Accessed 29 Oct. 2018].

Poseidon (2018). *Carbon on Blockchain*. [online] Available at: https://poseidon.eco/ [Accessed 28 Oct. 2018].

Rejeski, D. and Reynolds, L. (2018). *Blockchain Salvation*. [online] Environmental Law Institute. Available at: https://www.eli.org/sites/default/files/eli-pubs/policy-brief-14-web.pdf [Accessed 16 Jan. 2019].

Sarant, L. (2018). Clamping down on Bitcoin's thirst for energy. *Nature Middle East*.

Slaughter, A. (2018). *Foreword* in Marke, A. (2018). *Transforming Climate Finance And Green Investment With Blockchains*. 1st Ed. Academic Press.

Truby, J. (2018a). Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies. *Energy Research & Social Science*, 44, pp.399-410.

Truby, J. (2018b). Using Bitcoin technology to combat climate change. *Nature Middle East*.

UNEP (2016a). *Fintech And Sustainable Development – Assessing The Implications*. Inquiry Report. [Online] UNEP. Available At: http://UNEPinquiry.org/Publication/Fintech-and-sustainable-development-assessing-the-implications/ [Accessed 28 Oct. 2018].

UNFCCC (2017). How Blockchain Technology Could Boost Climate Action | UNFCCC. Retrieved From https://UNFCCC.Int/News/How-blockchain-technology- could-boost-climate-action

UNFCCC (2018a). Un Supports Blockchain Technology For Climate Action | UNFCCC. Retrieved From https://UNFCCC.Int/News/Un-supports-blockchain-technology-for-climate-action

UNFCCC (2018d). *Blockchain & Distributed Ledger Technologies to Support Global Climate Action | UNFCCC*. [online] UNFCCC.int. Available at: https://unfccc.int/about-us/partnerships/current-calls-for-partnerships/call-using-distributed-ledger-technologies-including-blockchain-to-support-global-climate-action#eq-5 [Accessed 16 Jan. 2019].

UN PRI (2018). *Responsible Investment And Blockchain*. [Online] Un Pri. Available At: https://www.Unpri.org/Download?Ac=4522 [Accessed 29 Oct. 2018].

Van Rijmenam, M. and Ryan, P. (2018). *Blockchain: Transforming Your Business and Our World*. 1st ed. Routledge.

Walker, L. (2017). *How blockchain will help save the environment*. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2017/09/carbon-currency-blockchain-poseidon-ecosphere/ [Accessed 16 Jan. 2019].

WEF (2018). *Report: More than 65 Ways Blockchain Technology Can Fix Global Environmental Challenges*. [online] World Economic Forum. Available at: https://www.weforum.org/press/2018/09/report-more-than-65-ways-blockchain-technology-can-fix-global-environmental-challenges/ [Accessed 16 Jan. 2019].

WEF And PwC (2018). *Building Block(Chain)S For A Better Planet*. Fourth Industrial Revolution For The Earth. [Online] Geneva, Switzerland: Wef. Available At: http://www3.Weforum.org/Docs/Wef_building-blockchains.Pdf [Accessed 29 Oct. 2018].

World Bank (2017b). *Registries And Blockchain For The Next Generation Of Carbon Markets*. Available At: http://pubdocs.worldbank.org/en/815631516223630890/ Registries-and-blockchain-UNFCCC-Sept-22-2017-v02-rm.pdf [Accessed 29 Oct. 2018].

World Bank (2018). *Blockchain And Emerging Digital Technologies For Enhancing Post-2020 Climate Markets (English)*. [Online] Washington D.C.: World Bank Group. Available At:

http://Documents.Worldbank.org/Curated/En/942981521464296927/Blockchain-and-emerging-digital-technologies-for-enhancing-post-2020-climate-markets [Accessed 27 Aug. 2018].

Yeates (2017). *Blockchain: opportunities and challenges*. [online] Climate-KIC. Available at: https://dailyplanet.climate-kic.org/blockchain-opportunities-and-challenges/ [Accessed 15 Oct. 2018].

Yeates (2018). *Hackathon explores ways blockchain can tackle climate change*. [online] Climate-KIC. Available at: https://dailyplanet.climate-kic.org/hackathon-explores-ways-blockchain-can-tackle-climate-change/ [Accessed 15 Oct. 2018].

Secondary Sources:

Aganaba-Jeanty, T., Anissimov, S. And Fitzgerald, O. (2017). *Blockchain Climatecup Round Table*. [Online] Toronto, Canada: Centre For International Governance Innovation. Available At: https://www.Cigionline.org/Sites/Default/Files/Documents/2017_toronto_climatecupweb-final1.Pdf [Accessed 28 Oct. 2018].

Agrawal, A. (2005). Environmentality. Current Anthropology, 46(2), Pp.161-190.

Al-saqaf, W. And Seidler, N. (2017). Blockchain Technology For Social Impact: Opportunities And Challenges Ahead. Journal Of Cyber Policy, 2(3), Pp.338-354.

Au, B., Conrad, B., Deng, L., Hale, T., Liepprand, T., Lieber, A., ... Wang, J. (2011). *Beyond a global deal. A UN+ Approach to climate governance.* Berlin: Global Public Policy Institute.

Bäckstrand, K. (2003). Civic Science for Sustainability: Reframing the Role of Experts, Policy-Makers and Citizens in Environmental Governance. *Global Environmental Politics*, 3(4), pp.24-41.

Bäckstrand, K. and Lövbrand, E. (2006). Planting Trees to Mitigate Climate Change: Contested Discourses of Ecological Modernization, Green Governmentality and Civic Environmentalism. *Global Environmental Politics*, 6(1), pp.50-75.

Bailey, I. and Wilson, G. (2009). Theorising Transitional Pathways in Response to Climate Change: Technocentrism, Ecocentrism, and the Carbon Economy. *Environment and Planning A: Economy and Space*, 41(10), pp.2324-2341.

Baldwin, D. (1993). *Neo-realism Neo-liberalism*. New York: Columbia University Press.

Barry, A., Osborne, T. and Rose, N. (1996). Foucault and political reason: liberalism, neo-liberalism and rationalities of government. Chicago, Ill: University of Chicago Press.
Dean, M. (1999). Governmentality. Thousand Oaks, Calif.: SAGE.

Baumann, T. (2017). *What is Blockchain GHG Management? - GHG and Carbon Accounting, Auditing, Management & Training | Greenhouse Gas Management Institute*. [online] GHG and Carbon Accounting, Auditing, Management & Training | Greenhouse Gas Management Institute. Available at: http://ghginstitute.org/2017/10/18/what-is-blockchain-ghg-management/ [Accessed 16 Jan. 2019].

Baumann, T. (2018). *Using Blockchain To Achieve Climate Change Policy Outcomes*. IETA Insights. [online] Available at: https://www.ieta.org/resources/Resources/GHG_Report/2017/Using-Blockchain-to-Achieve-Climate-Change-Policy-Outcomes-Baumann.pdf [Accessed 28 Oct. 2018].

Bayer, D., Haber, S. And Stornetta, W. (1993). Improving The Efficiency And Reliability Of Digital Time-stamping. *Sequences Ii*, Pp.329-334.

Bayon, R., Hawn, A. And Hamilton, K. (2012). *Voluntary Carbon Markets*. London: Routledge.

Bayrak, M. and Marafa, L. (2016). Ten Years of REDD+: A Critical Review of the Impact of REDD+ on Forest-Dependent Communities. *Sustainability*, 8(7), p.620.

Bayrak, M. And Marafa, L. (2016). Ten Years Of Redd+: A Critical Review Of The Impact Of Redd+ On Forest-dependent Communities. *Sustainability*, 8(7), P.620.

Beck, U. (2009). World Risk Society. Cambridge: Polity Press.

Bernstein, R. (1990). *The Restructuring of Social and Political Theory*. Philadelphia: University of Pennsylvania Press.

Bernstein, S. (2002). Liberal Environmentalism and Global Environmental Governance. *Global Environmental Politics*, 2(3), pp.1-16.

Biermann, F., Kanie, N. and Kim, R. (2017). Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability*, 26-27, pp.26-31.

Biermann, F. and Siebenhüner, B. (2009). Managers of Global Change. 1st ed. MIT Press.

Biermann, F. and Siebenhüner, B. (2009). *Managers of Global Change*. 1st ed. MIT Press.

Billig, M., Condor, S., Edwards, D. and Middleton, D. (1988). *Ideological Dilemmas*. London u.a.: Sage.

Billig, M. (1999). *Arguing and Thinking*. Cambridge: Cambridge Univ. Press.

Böhme, R., Christin, N., Edelman, B. And Moore, T. (2015). Bitcoin: Economics, Technology, And Governance. *Journal Of Economic Perspectives*, 29(2), Pp.213-238.

Bolt, J. (2018). *Blockchain: Promising Applications For Sustainable Agriculture In A Development Context*. [Online] Wur. Available At: https://www.Wur.Nl/En/Newsarticle/ Blockchain-promising-applications-for-sustainable-agriculture-in-a-development-context.Htm [Accessed 24 Oct. 2018].

Brockhaus, M., Di Gregorio, M. And Mardiah, S. (2014). Governing The Design Of National Redd+: An Analysis Of The Power Of Agency. *Forest Policy And Economics*, 49, Pp.23-33.

Brockington, D. (2009). Celebrity And The Environment. Zed Books.

Bulkeley, H. (2000). Discourse Coalitions and the Australian Climate Change Policy Network. *Environment and Planning C: Government and Policy*, 18(6), pp.727-748.

Burchell, G. (1991). *The Foucault effect*. Chicago: Univ. of Chicago Press.

Burchell, G. (1996). Liberal governmentalities and technologies of the self. In A. Barry, T. Osborne, & N. Rose, *Foucault and political reason: liberalism, neo-liberalism and rationalities of government* (pp. 19–35). London: UCL Press.

Busch, P.O. (2009). 'The climate secretariat: making a living in a straitjacket' in Biermann, F. and Siebenhüner, B. (2009). Managers of Global Change. 1st ed. MIT Press.

Buterin, V. (2014). *A Next-generation Smart Contract And Decentralized Application Platform*. Ethereum White Paper. [Online] Available At: http://Blockchainlab.com/Pdf/Ethereum_ white_paper-a_next_generation_smart_contract_and_decentralized_application_platform-vitalik-buterin.Pdf [Accessed 24 Oct. 2018].

CarbonCoin (2018). *An Energy Efficient Digital Currency That Plants Trees — Carboncoin*. [Online] Carboncoin.Cc. Available At: https://Carboncoin.Cc/ [Accessed 27 Oct. 2018].

Cass, L. (2017). The Politics Of Climate Change. *Oxford Research Encyclopedia Of International Studies*.

CCC (2018). *Climate Chain Coalition*. [Online] Climate Chain Coalition. Available At: https://www.Climatechaincoalition.Io/ [Accessed 29 Oct. 2018].

Centrica (2018). *Centrica And Lo3 Energy To Deploy Blockchain Technology As Part Of Local Energy Market Trial In Cornwall*. [Online] Centrica.com. Available At: https://www.Centrica.com/News/Centrica-and-lo3-energy-deploy-blockchain-technology-part-local-energy-market-trial-cornwall [Accessed 27 Oct. 2018].

Chapron, G. (2017). The Environment Needs Cryptogovernance. *Nature*, 545(7655), Pp.403-405.

Chen, D. (2018). Utility Of The Blockchain For Climate Mitigation. *The Journal Of The British Blockchain Association*, [Online] 1(1), Pp.1-9. Available At: https://Mahb.Stanford. Edu/Wp-content/Uploads/2018/06/3577-utility-of-the-blockchain-for-climate-mitigation.Pdf.

CITES (2017). Sixty-ninth Meeting Of The Standing Committee - Information Documents | Cites. Retrieved From https://cites.org/Eng/Com/Sc/69/Inf/Index.Php

Cleantech 21 (2017). *Blockchain for Climate – Kickstart & COP23 Hackathon*. [online] Available at: http://cleantech21.org/fileadmin/user_upload/PressRelease_SB46_ 17052017_BlockchainKickstart_FF.pdf [Accessed 28 Oct. 2018].

CLI (2018a). *Resources - Climate | Ledger Initative*. [online] Climateledger.org. Available at: https://www.climateledger.org/en/Focus/Resources.36.html [Accessed 28 Oct. 2018].

CLI (2018b). *About - Climate | Ledger Initative*. [Online] Climateledger.org. Available At: https://www.Climateledger.org/En/About.12.Html [Accessed 28 Oct. 2018].

Climate Coin (2018). *Climate Coin White Paper*. [Online] Climate Coin. Available At: https://Climatecoin.Io/Uploads/Whitepaper-official-v5.3-1.Pdf [Accessed 27 Oct. 2018].

ClimateCoop (2018). *Climate Coop: SDG Collaboration Redefined*. [online] dCentra. Available at: https://www.dcentra.io/climatecoop/ [Accessed 28 Oct. 2018].

Climate Investment Funds (2018). *A New Story to Spark the Future of Climate Action*. [online] Climate Investment Funds (CIF) and the Institute for the Future (IFTF). Available at:

https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/cif_iftf_future_of_climate_action.pdf [Accessed 16 Jan. 2019].

Climate-kic (2018). *Eit Climate-kic Shines The Spotlight On Distributed Ledger Technology At Innovate4climate - Climate-kic*. [Online] Climate-kic. Available At: https://www.Climate-kic.org /News/Innovate4climate-distributed-ledger-technology-for-climate-action/ [Accessed 28 Oct. 2018].

Climate-KIC (2018). *Hackathon explores ways blockchain can tackle climate change*. [online] Climate-KIC. Available at: https://dailyplanet.climate-kic.org/hackathon-explores-ways-blockchain-can-tackle-climate-change/ [Accessed 15 Oct. 2018].

Cohen, L., Manion, L. and Morrison, K. (2007). *Research methods in education 6th ed*. London: Routledge.

Connect4Climate (2018). *Hack4Climate | Connect4Climate*. [online] Connect4Climate. Available at: https://www.connect4climate.org/initiatives/hack4climate [Accessed 28 Oct. 2018].

Connect4Climate (2018a). *Connect4climate*. [Online] Available At: https://www.Connect4climate.org/ [Accessed 27 Aug. 2018].

Connect4Climate (2018b). *#Hack4Climate - Why Climate needs Blockchain | Connect4Climate*. [online] Connect4Climate. Available at: https://www.connect4climate.org/initiative/hack4climate-why-climate-needs-blockchain-cop23 [Accessed 28 Oct. 2018].

Cook, W., Van Bommel, S. And Turnhout, E. (2016). Inside Environmental Auditing: Effectiveness, Objectivity, And Transparency. Current Opinion In Environmental Sustainability, 18, Pp.33-39

Cook, W., Van Bommel, S. And Turnhout, E. (2016). Inside Environmental Auditing: Effectiveness, Objectivity, And Transparency. *Current Opinion In Environmental Sustainability*, 18, Pp.33-39.

Cotton, M., Rattle, I. and Van Alstine, J. (2014). Shale gas policy in the United Kingdom: An argumentative discourse analysis. *Energy Policy*, 73, pp.427-438.

Creswell, J. (2009). *Research design*. Thousand Oaks, Calif.: Sage Publications.

Crotty, M. (1998). *The foundations of social research*. London: Sage Publications.

Cruikshank, B. (1993). Revolutions Within: Self-government And Self-esteem. Economy And Society, 22(3), Pp.327-344.

Ctx (2018). *Gem & Ctx Join Forces With Climatecoin At Innovate4climate - Carbon Trade Exchange*. [Online] Carbon Trade Exchange. Available At: https://Ctxglobal.com/Gem-ctx-join-forces-with-climatecoin-at-innovate4climate/ [Accessed 27 Oct. 2018].

DAO IPCI (2017). *'blockchainization' Of The Paris Agreement Article 6*. [Online] Toronto: Cigi. Available At: https://www.Cigionline.org/Sites/Default/Files/Documents/Presentation-dao%20ipci_blockchain%20and%20the%20paris%20agreement.Pdf [Accessed 28 Oct. 2018].

Davies, B. and Harré, R. (1990). Positioning: The Discursive Production of Selves. *Journal for the Theory of Social Behaviour*, 20(1), pp.43-63.

Dean, M. (1999). Governmentality. London: Sage.

Death, C. (2011). Summit Theatre: Exemplary Governmentality And Environmental Diplomacy In Johannesburg And Copenhagen. Environmental Politics, 20(1), Pp.1-19.

Death, C. (2014). The Limits of Governmentality. In Bulkeley, H. (Ed.) & Stripple, J. (Ed.), 2014, *Governing The Climate: New Approaches To Rationality, Power And Politics.* Cambridge: Cambridge University Press, P. 77-9

Demeritt, D. (2006). Science Studies, Climate Change And The Prospects For Constructivist Critique. *Economy And Society*, 35(3), Pp.453-479.

Demeritt, D. (2006). Science Studies, Climate Change And The Prospects For Constructivist Critique. *Economy And Society*, 35(3), Pp.453-479.

Depledge, J. (2005). Against the grain: the United States and the global climate change regime. *Global Change, Peace & Security*, 17(1), pp.11-27.

Diaz-bone, R. And Didier, E. (2016). The Sociology Of Quantification - Perspectives On An Emerging Field In The Social Sciences. *Historical Social Research / Historische Sozialforschung*, 41(2), Pp.7-26.

DLT4NCM Project Team (2018). *Permissioned Disruption: Thinking Beyond Blockchain To Co-create A Global Network Of Carbon Markets (Under Article 6)*.

Douglass, K. (2018). *The flipside of the Bitcoin: How blockchain could underpin sustainable energy*. [online] Phys.org. Available at: https://phys.org/news/2018-09-flipside-bitcoin-blockchain-underpin-sustainable.html#jCp [Accessed 16 Jan. 2019].

Dryzek, J. (2013). *The politics of the earth*. Oxford: Oxford University Press.

Duffield, J. (2007). What Are International Institutions?. *International Studies Review*, 9(1), pp.1-22.

Eckersley, R. (2007). Ambushed: The Kyoto Protocol, The Bush Administration's Climate Policy And The Erosion Of Legitimacy. *International Politics*, 44(2-3), Pp.306-324.

Elsevier (2018). *Energy-intensive Bitcoin transactions pose a growing environmental threat*. [online] Phys.org. Available at: https://phys.org/news/2018-07-energy-intensive-bitcoin-transactions-pose-environmental.html#jCp [Accessed 16 Jan. 2019].

Espeland, W. And Stevens, M. (1998). Commensuration As A Social Process. *Annual Review Of Sociology*, 24(1), Pp.313-343.

Espeland, W. And Stevens, M. (2008). A Sociology Of Quantification. *European Journal Of Sociology*, 49(03), P.401.

Exergy (2018a). *Home - Exergy.Energy*. [Online] Exergy.Energy. Available At: https://Exergy.Energy/ [Accessed 27 Oct. 2018].

Exergy (2018b). *Exergy White Paper*. [Online] Available At: https://Exergy.Energy/Wp-content/Uploads/2018/04/Exergy-bizwhitepaper-v10.Pdf [Accessed 27 Oct. 2018].

Fairclough, N. (2013). Critical discourse analysis and critical policy studies. *Critical Policy Studies*, 7(2), pp.177-197.

Fairfield, J. (2014). Smart Contracts, Bitcoin Bots, And Consumer Protection. *Washington And Lee Law Review Online*, [Online] 71(2), Pp.35-50. Available At: https://Scholarlycommons.Law.Wlu.Edu/Wlulr-online/Vol71/Iss2/3/ [Accessed 24 Oct. 2018].

Feindt, P. and Oels, A. (2005). Does discourse matter? Discourse analysis in environmental policy making. *Journal of Environmental Policy & Planning*, 7(3), pp.161-173.

Fitzgerald, O. (2017). *Building Climate Accountability from the Bottom Up*. [online] Centre for International Governance Innovation. Available at: https://www.cigionline.org/articles/building-climate-accountability-bottom [Accessed 28 Oct. 2018].

Flick, U. (2014). *An introduction to qualitative research*. London: SAGE.

Florini, A. (2007). The Right to Know: Transparency for an Open World (Initiative for Policy Dialogue at Columbia). Columbia University Press.

Foucault, M. (1968), ‘Politics and the Study of Discourse’, repr. in Burchell et al. (1991), 53–72.

Foucault, M. (1991). *Discipline and Punish*. London: Penguin.

Foucault, M. (2007). *Security, Territory, Population (Michel Foucault: Lectures at the Collège de France)*. New York: Picador/Palgrave Macmillan.

Fox, J. (2007). The Uncertain Relationship Between Transparency And Accountability. *Development In Practice*, 17(4-5), Pp.663-671.

Gellert Paris, A. (2017). *Discussion: Legal, political and implementation challenges of the Paris Agreement on Climate Change*.

Giddens, A. (1991). *Modernity And Self-identity*. Cambridge: Polity Press.

Gieryn, T. (1983). Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists. American Sociological Review, 48(6), p.781.

Gieryn T F, 1983, “Boundary Work And The Demarcation Of Science From Non-science, Strains And Interests In Professional Interests Of Scientists” American Sociological Review 48 781–795

GLOCHA (2018). *#GCAS2018 Blockchain for Climate Action Event in San Francisco – Welcome to GloCha*. [online] Glocha.org. Available at: https://www.glocha.org/2018/08/07 /gcas2018-blockchain-for-climate-action-event-in-san-francisco/ [Accessed 16 Jan. 2019].

Gogerty, N. And Zitoli, J. (2011). Deko: An Electricity-backed Currency Proposal. *Ssrn Electronic Journal*.

Gold Standard (2018). *UNFCCC SB48 | The Gold Standard*. [online] Goldstandard.org. Available at: https://www.goldstandard.org/blog-item/unfccc-sb48 [Accessed 16 Jan. 2019].

Goodin, R. and Dryzek, J. (2006). Deliberative Impacts: The Macro-Political Uptake of Mini-Publics. *Politics & Society*, 34(2), pp.219-244.

Google Scholar (2018). *The Environment Needs Cryptogovernance - Citing Articles*. [Online] Available At: https://Scholar.Google.Co.Uk/Scholar?Start=10&Hl=En&As_sdt=0,5&Sciodt=0,5&Cites=17382056152246714818&Scipsc= [Accessed 22 Oct. 2019].

Grix, J. (2004). *The Foundations of Research*. New York: Palgrave Macmillan.

Grundig, F. (2006). Patterns Of International Cooperation And The Explanatory Power Of Relative Gains: An Analysis Of Cooperation On Global Climate Change, Ozone Depletion, And International Trade. *International Studies Quarterly*, *50*, 781–801.

Guba, E. and Lincoln, Y. (2003). *Fourth generation evaluation*. Newbury Park, Calif.: Sage Publ.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). Thousand Oaks, CA, US: Sage Publications, Inc.

Gupta, A. (2008). Transparency Under Scrutiny: Information Disclosure In Global Environmental Governance. *Global Environmental Politics*, 8(2), Pp.1-7.

Gupta, A. (2010). Transparency In Global Environmental Governance: A Coming Of Age?. Global Environmental Politics, 10(3), Pp.1-9.

Gupta, A. and Mason, M. (2014). Transparency in global environmental governance. Cambridge, MA: MIT Press.

Gupta, A. And Mason, M. (2016). Disclosing Or Obscuring? The Politics Of Transparency In Global Climate Governance. *Current Opinion In Environmental Sustainability*, 18, Pp.82-90.

Gupta, A. And Mason, M. (2016). Disclosing Or Obscuring? The Politics Of Transparency In Global Climate Governance. Current Opinion In Environmental Sustainability, 18, Pp.82-90.

Gupta A, Lövbrand E, Turnhout E, Vijge M, 2012, "In Pursuit Of Carbon Accountability: The Politics Of Redd+ Measuring, Reporting And Verification Systems" Current Opinion In Environmental Sustainability 4 726–731

Haas, P. (1989). Do regimes matter? Epistemic communities and Mediterranean pollution control. International Organization, 43(03), p.377.

Haas, P. (1992). Introduction: epistemic communities and international policy coordination. *International Organization*, 46(01), p.1.

Haber, S. And Stornetta, W. (1991). How To Time-stamp A Digital Document. *Journal Of Cryptology*, 3(2).

Habermas, J. (2012). *Between facts and norms*. Cambridge [u.a.]: Polity Press.

Hack4climate (2018). *Hack4climate - Bringing Together Developers And Climate Experts*. [Online] Hack4climate - Bringing Together Developers And Climate Experts. Available At: https://Hack4climate.org/#Home [Accessed 29 Oct. 2018].

Hajer, M. (2002). discourse analysis and the study of policy making. *European Political Science*, 2(1), pp.61-65.

Hajer, M. (2010). *The politics of environmental discourse*. Oxford: Clarendon.

Hajer, M. and Versteeg, W. (2005). A decade of discourse analysis of environmental politics: Achievements, challenges, perspectives. *Journal of Environmental Policy & Planning*, 7(3), pp.175-184.

Hall, P. (1993). Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. *Comparative Politics*, 25(3), p.275.

Hans Krause Hansen And Tony Porter (*2017*) What Do Big Data Do In Global Governance?. Global Governance: A Review Of Multilateralism And International Organizations: January-march 2017, Vol. 23, No. 1, Pp. 31-42.

Haraway, D. (1991). *Simians, Cyborgs, And Women: The Reinvention Of Nature.*. Routeledge.

Haraway, D. (2005). *Simians, Cyborgs, And Women*. London: Free Assoc. Books.

Harmes, A. (2011). The Limits Of Carbon Disclosure: Theorizing The Business Case For Investor Environmentalism. *Global Environmental Politics*, 11(2), Pp.98-119.

Harmes, A. (2011). The Limits Of Carbon Disclosure: Theorizing The Business Case For Investor Environmentalism. *Global Environmental Politics*, 11(2), Pp.98-119.

Harré, R. (2003). *Social being*. Oxford: Blackwell.

Hartnett (2018). *Beyond Bitcoin: As Blockchain Adoption Accelerates, A Need To Manage Energy And Climate Emerges - Rocky Mountain Institute*. [Online] Rocky Mountain Institute. Available At: https://www.Rmi.org/Beyond-bitcoin-blockchain-adoption-accelerates- need-manage-energy-climate-emerges/ [Accessed 27 Oct. 2018].

Harvey, D. (2005). Brief History Of Neoliberalism, A. Cary: Oxford University Press.

Haufler, V. (2010). Disclosure as Governance: The Extractive Industries Transparency Initiative and Resource Management in the Developing World. Global Environmental Politics, 10(3), pp.53-73.

Hein, J., Guarin, A., Frommé, E. And Pauw, P. (2018). Deforestation And The Paris Climate Agreement: An Assessment Of Redd + In The National Climate Action Plans. *Forest Policy And Economics*, 90, Pp.7-11.

Herweijer, C. and Swanborough, J. (2018). *8 ways blockchain can be an environmental game-changer*. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2018/09/8-ways-blockchain-can-be-an-environmental-game-changer/ [Accessed 16 Jan. 2019].

Hübner, C. (2018). *Mehr als nur Bitcoin*. [online] Auslandsinformationen. Available at: http://www.kas.de/wf/en/33.52121/ [Accessed 16 Jan. 2019].

Hulme, M., Mahony, M., Beck, S., Gorg, C., Hansjurgens, B., Hauck, J., Nesshover, C., Paulsch, A., Vandewalle, M., Wittmer, H., Boschen, S., Bridgewater, P., Diaw, M., Fabre, P., Figueroa, A., Heong, K., Korn, H., Leemans, R., Lövbrand, E., Hamid, M., Monfreda, C., Pielke, R., Settele, J., Winter, M., Vadrot, A., Van Den Hove, S. And Van Der Sluijs, J. (2011). Science-policy Interface: Beyond Assessments. Science, 333(6043), Pp.697-698.

Hulme, M. (2015). *Why we disagree about climate change*. Cambridge: Cambridge University Press.

Ibm (2018). *Energy Blockchain Labs Inc. | Ibm*. [Online] Ibm.com. Available At: https://www.Ibm.com/Case-studies/Energy-blockchain-labs-inc [Accessed 27 Oct. 2018].

IIED (2018a). *Markets And Payments For Environmental Services*. [Online] International Institute For Environment And Development. Available At: https://www.Iied.org/ Markets-payments-for-environmental-services [Accessed 27 Oct. 2018].

IIED (2018b). *Can blockchain unblock climate finance?*. [online] International Institute for Environment and Development. Available at: https://www.iied.org/ can-blockchain-unblock-climate-finance [Accessed 16 Jan. 2019].

Institut Economique Molinari (IEM) (2006). *The Economic Costs And Ineffectiveness Of The Kyoto Protocol*. Economic Note. [Online] IEM. Available At: http://www.Institutmolinari.org/ Img/Pdf/Note20066.Pdf [Accessed 10 Sep. 2018].

Intergovernmental Panel On Climate Change (Ipcc), Houghton, J. (1990). Ipcc First Assessment Report. Geneva: Wmo.

Intergovernmental Panel On Climate Change (Ipcc) (2013). *Ipcc Factsheet: What Is The Ipcc?*. [Online] Available At: https://www.Ipcc.Ch/News_and_events/Docs/Factsheets /Fs_what_ipcc.Pdf [Accessed 10 Sep. 2018].

Intergovernmental Panel On Climate Change (Ipcc) (2013). *Ipcc Factsheet: What Is The Ipcc?*. [Online] Available At: https://www.Ipcc.Ch/News_and_events/Docs/Factsheets/ Fs_what_ipcc.Pdf [Accessed 10 Sep. 2018].

Interpol (2013). *Guide To Carbon Trading Crime*. [Online] Available At: https://www.Interpol.Int/Media/Files/Crime.../Guide-to-carbon-trading-crime-2013 [Accessed 24 Oct. 2018].

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution Of Working Groups I, Ii And Iii To The Fifth Assessment Report Of The Intergovernmental Panel On Climate Change [Core Writing Team, R.K. Pachauri And L.A. Meyer (Eds.)]. Ipcc, Geneva, Switzerland, 151 Pp.

IPCI.IO (2018). *Blockchain is a powerful solution to save the planet, new book explains*. [online] Ipci.io. Available at: https://ipci.io/blockchain-is-a-powerful-solution-to-climate-change- problem-the-new-book-claims/ [Accessed 16 Jan. 2019].

Jackson, A., Lloyd, A., Maciante, J. and Hüwener, M. (2018). *Distributed Ledgers Networked Carbon Markets*.

Jasanoff, S. (1990). The Fifth Branch. Cambridge, Mass.: Harvard University Press.

Jasanoff, S. (1996). Beyond Epistemology: Relativism and Engagement in the Politics of Science. Social Studies of Science, 26(2), pp.393-418.

Jasanoff, S. and Wynne, B. (1998). Scientific Knowledge and Decision Making, in S. Rayner and E. Malone (eds) *Human Choice & Climate Change*, 4 vols, pp. 1-112. Columbus, OH: Battelle Press.

Jasanoff S. (2004). States Of Knowledge: The Co-production Of Science And Social Order: Routledge, London.

Käll, J. (2018). Blockchain Control. *Law And Critique*, 29(2), Pp.133-140.

Katz, J. And Lindell, Y. (2007). *Introduction To Modern Cryptography : Principles And Protocols (9781584885511)*. Chapman & Hall.

Keck, M. and Sikkink, K. (2014). *Activists beyond Borders*. Cornell University Press.

Kellogg, W. (1987). Mankind's Impact On Climate: The Evolution Of An Awareness. *Climatic Change*, 10(2), Pp.113-136.

Keohane, R. and Nye, J. (1977). *Power and interdependence*. Boston: Little, Brown and Company.

Keohane, R., Haas, P. and Levy, M. (1993). *The Effectiveness of International Environmental Institutions*. Cambridge, MA: MIT Press.

Koh (2017). *Can Blockchain Save Indonesia's Forests?*. [Online] Eco-business. Available At: https://www.Eco-business.com/News/Can-blockchain-save-indonesias-forests/ [Accessed 27 Oct. 2018].

Kollmuss, A., L. Schneider And V. Zhezherin (2015). Has Joint Implementation Reduced Ghg Emissions? Lessons Learned For The Design Of Carbon Market Mechanisms. Sei Working Paper No. 2015-07

Krasner, S. (1982). Structural causes and regime consequences: regimes as intervening variables. *International Organization*, 36(02), p.185.

Kvale, S. (1995). The Social Construction of Validity. *Qualitative Inquiry*, 1(1), pp.19-40.

Lariviere, C. (2018). *Innovate4Climate: Distributed Ledger Technology for Climate Action*. [online] Available at: https://dailyplanet.climate-kic.org/innovate4climate-distributed-ledger-technology-for-climate-action/ [Accessed 15 Oct. 2018].

Lather, P. (1993). Fertile Obsession: Validity After Poststructuralism. *The Sociological Quarterly*, 34(4), pp.673-693.

Latour, B. (1987). Science in action. Cambridge, Mass.: Harvard Univ. Press.

Latour, B. (2004). Politics Of Nature. Cambridge: Harvard University Press.

Law J, 2009, “Seeing Like A Survey” Cultural Sociology 3 239–256

LEDSLAC. (2018). *How Blockchain technology is driving Global Climate Action in Latin America*. [online] Available at: http://ledslac.org/en/2018/07/how-blockchain-technology-is-driving-global-climate-action-in-latin-america/ [Accessed 23 Jan. 2019].

Le Galès, P. (2016). Performance Measurement As A Policy Instrument. *Policy Studies*, 37(6), Pp.508-520.

Lemke, T. (2002). Foucault, Governmentality, and Critique. Rethinking Marxism, 14(3), pp.49-64.

Lidskog, R. and Sundqvist, G. (2015). When Does Science Matter? International Relations Meets Science and Technology Studies. Global Environmental Politics, 15(1), pp.1-20.

Lipson, C. (1984). International Cooperation In Economic And Security Affairs. *World Politics*, 37(01), Pp.1-23.

Litfin, K. (1995). *Ozone discourses*. New York: Columbia University Press.

Lo3 Energy (2018). *The Future Of Energy | Blockchain, Transactive Grids, Microgrids, Energy Trading | Lo3 Stock, Tokens And Information | Lo3 Energy*. [Online] Lo3 Energy. Available At: https://Lo3energy.com/ [Accessed 27 Oct. 2018].

Lockie, Stewart (2014) *Neoliberalism By Design: Changing Modalities Of Market-based Environmental Governance.* In: Lockie, Stewart, Sonnenfeld, David A., And Fisher, Dana R., (Eds.) Routledge International Handbook Of Social And Environmental Change. Routledge International Handbooks . Routledge, London, Uk, Pp. 70-80.

Lövbrand, E. and Stripple, J. (2013). Bringing Governmentality to the Study of Global Climate Governance. Governing the Climate, pp.27-41.

Lovett, G. (2018). *COP23 explores the role of blockchain in climate action*. [online] Climate-KIC. Available at: https://dailyplanet.climate-kic.org/attention-role-blockchain-implementing -paris-agreement/ [Accessed 15 Oct. 2018].

Manning, K. (1997). Authenticity in Constructivist Inquiry: Methodological Considerations Without Prescription. *Qualitative Inquiry*, 3(1), pp.93-115.

March, J. and Olsen, J. (1989). *Rediscovering institutions*. New York, Ny: Free Press.

Marchinski, R. and Behrle, S. (2009). 'The World Bank: Making the Business Case for the Environment' in Biermann, F. and Siebenhüner, B. (2009). Managers of Global Change. 1st ed. MIT Press.

Marke, A. (2018). *Transforming Climate Finance And Green Investment With Blockchains*. 1st Ed. Academic Press.

Mason, M. (2008). The Governance Of Transnational Environmental Harm: Addressing New Modes Of Accountability/Responsibility. Global Environmental Politics, 8(3), Pp.8-24.

Maupin, J. (2017a). *The G20 Countries Should Engage with Blockchain Technologies to Build an Inclusive, Transparent, and Accountable Digital Economy for All*. Policy Area: The Digital Economy. [online] G20 Insights. Available at: http://www.economics-ejournal.org/economics/discussionpapers/2017-48 [Accessed 28 Oct. 2018].

Meadows, D. H., & Club of Rome. (1972). *The Limits to growth: A report for the Club of Rome's project on the predicament of mankind*. New York: Universe Books.

Mearsheimer, J. (1994). The False Promise Of International Institutions. *International Security*, 19(3), P.5.

Microsoft (2018). *Announcing The Confidential Consortium Blockchain Framework For Enterprise Blockchain Networks | Blog | Microsoft Azure*. [Online] Azure.Microsoft.com. Available At: https://Azure.Microsoft.com/En-gb/Blog/Announcing-microsoft-s-coco-framework -for-enterprise-blockchain-networks/ [Accessed 27 Oct. 2018].

Millar, R., Fuglestvedt, J., Friedlingstein, P., Rogelj, J., Grubb, M., Matthews, H., Skeie, R., Forster, P., Frame, D. And Allen, M. (2017). Emission Budgets And Pathways Consistent With Limiting Warming To 1.5 °c. *Nature Geoscience*, 10(10), Pp.741-747.

Miller, P. And Rose, N. (1990). Governing Economic Life. *Economy And Society*, 19(1), Pp.1-31.

Morgenthau, H., *Politics Among Nations: The Struggle For Power And Peace* (New York: Mcgraw-hill, 1985).

Nakamoto, S. (2008). *Bitcoin: A Peer-to-peer Electronic Cash System*. [Online] Available At: https://Bitcoin.org/Bitcoin.Pdf [Accessed 27 Aug. 2018].

Namgyal, T. (2018). *UN looks to blockchain, 'climate coin' to rouse sleepy carbon markets | MLex Market Insight*. [online] Mlexmarketinsight.com. Available at: https://mlexmarketinsight.com/insights-center/editors-picks/energy-and-climate-change/cross-jurisdiction/un-looks-to-blockchain,-climate-coin-to-rouse-sleepy-carbon-markets [Accessed 16 Jan. 2019].

Narayanan, A., Bonneau, J., Felten, E., Miller, A. And Goldfeder, S. (2016). *Bitcoin And Cryptocurrency Technologies*. 1st Ed. Princeton University Press.

Neves-graça, K. (2006). Politics Of Environmentalism And Ecological Knowledge At The Intersection Of Local And Global Processes. Journal Of Ecological Anthropology, 10(1), Pp.19-32.

Neyland, D. (2007). Achieving Transparency: The Visible, Invisible And Divisible In Academic Accountability Networks. *Organization*, 14(4), Pp.499-516.

Nielsen, T. (2016a). From REDD+ forests to green landscapes? Analyzing the emerging integrated landscape approach discourse in the UNFCCC. *Forest Policy and Economics*, 73, pp.177-184.

Nielsen, T. (2016b). *Words Matter in the Woods : Discourses on Deforestation in Global Climate Politics*. PhD. Lund University.

Nielson, D. and Tierney, M. (2003). Delegation to International Organizations: Agency Theory and World Bank Environmental Reform. *International Organization*, 57(02).

Nofer, M., Gomber, P., Hinz, O. And Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering*, 59(3), Pp.183-187.

Nori (2018). *Nori White Paper: A Blockchain-based Marketplace For Removing Carbon Dioxide From The Atmosphere.*. [Online] Nori. Available At: https://nori.com/White-paper [Accessed 27 Oct. 2018].

OECD And IEA (2014). *Co2 Emissions From Transport (% Of Total Fuel Combustion) | Data*. [Online] Data.Worldbank.org. Available At: https://Data.Worldbank.org/Indicator/En.Co2.Tran.Zs [Accessed 27 Oct. 2018].

OECD, UNEP And World Bank (2018). *Synthesis Report: Financing Climate Futures*. [Online] New York, Usa: OECD. Available At: http://www.oecd.org/Environment/Cc/Climate-futures/ [Accessed 29 Oct. 2018].

Okerere, C. And Schroeder, H. (2009). How Can Justice, Development And Climate Change Mitigation Be Reconciled For Developing Countries In A Post-kyoto Settlement? Climate And Development, 1(1), Pp.10-15.

Okereke, C., Bulkeley, H. and Schroeder, H. (2009). Conceptualizing Climate Governance Beyond the International Regime. *Global Environmental Politics*, 9(1), pp.58-78.

O'keeffe, P. (2018). Creating A Governable Reality: Analysing The Use Of Quantification In Shaping Australian Wheat Marketing Policy. *Agriculture And Human Values*, 35(3), Pp.553-567.

Pagiola, S. (2011). Using Pes To Implement Redd. Payments For Environmental Services (PES) *Learning Paper;*No. 2011-1. World Bank, Washington, Dc. World Bank. https://openknowledge.worldbank.org/Handle/10986/17892

Paterson, M. (1997). *Global Warming And Global Politics*. London [U.A.]: Routledge.

Paterson, M. 2009. “Global Governance For Sustainable Capitalism? The Political Economy Of Global Environmental Governance”. In *Governing Sustainability*, Edited By: Adger, W. N.And Jordan, A. 99–122. Cambridge: Cambridge University Press.

Paterson, M. and Stripple, J. (2010). My Space: governing individuals’ carbon emissions. *Environment and Planning D: Society and Space*, 28(2), pp.341-362.

Porter, T. (1996). *Trust In Numbers*. Princeton: Princeton University Press.

Poseidon (2018). *Carbon on Blockchain*. [online] Available at: https://poseidon.eco/ [Accessed 28 Oct. 2018].

Powell, R. (1991). Absolute And Relative Gains In International Relations Theory. *The American Political Science Review*, 85(4), P.1303.

Power, M. (1997). From Risk Society To Audit Society. *Soziale Systeme* 3 (1): 3–21.

Power, M. (2000). The Audit Society – Second Thoughts. *International Journal Of Auditing*4: 111–119.

Power Ledger (2018). *Power Ledger: Energy, Reimagined*. [Online] Power Ledger: Energy, Reimagined. Available At: https://www.Powerledger.Io/ [Accessed 27 Oct. 2018].

Provenance (2018). *From Shore To Plate: Tracking Tuna On The Blockchain | Provenance*. [Online] Provenance. Available At: https://www.Provenance.org/Tracking-tuna-on-the-blockchain [Accessed 27 Oct. 2018].

Purdon, M. (2017). Neoclassical Realism And International Climate Change Politics: Moral Imperative And Political Constraint In International Climate Finance. *Journal Of International Relations And Development*, 20(2), Pp.263-300.

Rayner, S. (2010). How to eat an elephant: a bottom-up approach to climate policy. *Climate Policy*, 10(6), pp.615-621.

Rejeski, D. and Reynolds, L. (2018). *Blockchain Salvation*. [online] Environmental Law Institute. Available at: https://www.eli.org/sites/default/files/eli-pubs/policy-brief-14-web.pdf [Accessed 16 Jan. 2019].

Robertson, M. (2006). The Nature That Capital Can See: Science, State, And Market In The Commodification Of Ecosystem Services. Environment And Planning D: Society And Space, 24(3), Pp.367-387.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F., Lambin, E., Lenton, T., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., de Wit, C., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R., Fabry, V., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology and Society*, 14(2).

Roe, E. (2006). *Narrative policy analysis*. Durham: Duke University Press.

Rose, N. (1993). Government, Authority And Expertise In Advanced Liberalism. *Economy And Society*, 22(3), Pp.283-299.

Rose, N. (1999). Powers of freedom. Cambridge: Cambridge University Press.

Rose, N. and Miller, P. (1992). Political Power Beyond the State: problematics of government. The British Journal of Sociology, 61, pp.271-303.

Sabatier, P. (2010). *Policy change and learning*. Boulder, Colo: Westview Press.

Sabella, A., Irons-Mclean, R. and Yanuzzi, M. (2018). *Orchestrating and automating security for the Internet of Things*. Indianapolis, Indiana: Cisco Press.

Sarant, L. (2018). Clamping down on Bitcoin's thirst for energy. *Nature Middle East*.

Savelyev, A. (2017). Contract Law 2.0: 'smart' Contracts As The Beginning Of The End Of Classic Contract Law. *Information & Communications Technology Law*, 26(2), Pp.116-134.

Scales, I. (2014). Green Consumption, Ecolabelling And Capitalism's Environmental Limits. *Geography Compass*, 8(7), Pp.477-489.

Schmidt, V. (2008). Discursive Institutionalism: The Explanatory Power of Ideas and Discourse. *Annual Review of Political Science*, 11(1), pp.303-326.

Schmidt, V. (2010). Taking ideas and discourse seriously: explaining change through discursive institutionalism as the fourth 'new institutionalism'. *European Political Science Review*, 2(01), p.1.

Schweller, R. and Priess, D. (1997). A Tale of Two Realisms: Expanding the Institutions Debate. *Mershon International Studies Review*, 41(1), p.1.

Scott, J. (1998). *Seeing Like A State*. Yale University Press.

Sinrod (2018). *Still don't understand the blockchain?*. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2018/03/blockchain-bitcoin-explainer-shiller-roubini/ [Accessed 28 Oct. 2018].

Slaughter, A. (2018). *Foreword* in Marke, A. (2018). *Transforming Climate Finance And Green Investment With Blockchains*. 1st Ed. Academic Press.

Smith, J. (1983). Quantitative Versus Qualitative Research: An Attempt to Clarify the Issue. *Educational Researcher*, 12(3), pp.6-13.

Smith, N. (2010). Uneven Development. London: Verso.

Solarcoin (2018). *Solarcoin*. [Online] Solarcoin.org. Available At: https://Solarcoin.org/ [Accessed 27 Oct. 2018].

Soneryd, L. And Uggla, Y. (2015). Green Governmentality And Responsibilization: New Forms Of Governance And Responses To ‘consumer Responsibility’. Environmental Politics, 24(6), Pp.913-931.

Sterling-Folker, J. (2002). Realism and the Constructivist Challenge: Rejecting, Reconstructing, or Rereading. *International Studies Review*, 4(1), pp.73-97.

Stoker, G. (2004). *Transforming Local Governance*. New York, N.Y.: Palgrave Macmillan.

Strathern, M. (2000). The Tyranny Of Transparency. *British Educational Research Journal*, 26(3), Pp.309-321.

Sunstein, C. (2006). *Montreal Versus Kyoto: A Tale Of Two Protocols*. Public Law And Legal Theory Working Papers. [Online] Chicago: University Of Chicago Law School. Available At: https://Chicagounbound.Uchicago.Edu/Cgi/Viewcontent.Cgi?Article=1194&Context=Public_law_and_legal_theory [Accessed 10 Sep. 2018].

Swanson, T. (2015). *Consensus -as-a-service: A Brief Report On The Emergence Of Permissioned, Distributed Ledger Systems*. [Online] Available At:

http://www.Ofnumbers.com/Wp-content/Uploads/2015/04/Permissioned-distributed-ledgers.Pdf [Accessed 24 Oct. 2018].

Swartz, L. (2017). *Blockchain Dreams: Imagining Techno-economic Alternatives After Bitcoin In Another Economy Is Possible*. Cambridge: Polity Press.

Swartz, L. (2018). What Was Bitcoin, What Will It Be? The Techno-economic Imaginaries Of A New Money Technology. Cultural Studies, 32(4), Pp.623-650.

Swyngedouw, E. (2005). Governance Innovation And The Citizen: The Janus Face Of Governance-beyond-the-state. Urban Studies, 42(11), Pp.1991-2006.

Szabo, N. (1997). Formalizing And Securing Relationships On Public Networks. *First Monday*, 2(9).

Tennet (2018). *Blockchain Technology - Tennet*. [Online] Tennet.Eu. Available At: https://www.Tennet.Eu/Our-key-tasks/Innovations/Blockchain-technology/ [Accessed 27 Oct. 2018].

Trombetta, M. (2008). Environmental Security And Climate Change: Analysing The Discourse. *Cambridge Review Of International Affairs*, 21(4), Pp.585-602.

Truby, J. (2018a). Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies. *Energy Research & Social Science*, 44, pp.399-410.

Truby, J. (2018b). Using Bitcoin technology to combat climate change. *Nature Middle East*.

Tsing, A. (2005). Friction: An Ethnography Of Global Connection. Princeton, Nj: Princeton University Press.

Turnhout, E., Neves, K. And De Lijster, E. (2014). 'Measurementality' In Biodiversity Governance: Knowledge, Transparency, And The Intergovernmental Science-policy Platform On Biodiversity And Ecosystem Services (Ipbes). *Environment And Planning A*, 46(3), Pp.581-597.

Turnhout, E., Skutsch, M. And De Koning, J. (2015). Carbon Accounting. Research Handbook On Climate Governance, Pp.366-376.

UN Blockhain (2018). *UN Blockchain*. [Online] UN Blockchain. Available At: https://Un-blockchain.org/ [Accessed 10 Sep. 2018].

UNEP (2016a). *Fintech And Sustainable Development – Assessing The Implications*. Inquiry Report. [Online] UNEP. Available At: http://UNEPinquiry.org/Publication/Fintech-and-sustainable-development-assessing-the-implications/ [Accessed 28 Oct. 2018].

UNEP (2016b). *The Financial System We Need: From Momentum To Transformation*. Inquiry Report. [Online] UNEP. Available At: http://UNEPinquiry.org/Publication/Inquiry-global-report-the-financial-system-we-need/ [Accessed 28 Oct. 2018].

UNFCCC (1998). *Kyoto Protocol To The United Nations Framework Convention On Climate Change*. [Online] Kyoto, Japan: UNFCCC. Available At: https://UNFCCC.Int/Sites/Default/Files/Kpeng.Pdf [Accessed 11 Sep. 2018].

UNFCCC (2003). *The United Nations Framework Convention On Climate Change - Article 1*. [Online] UNFCCC.Int. Available At: http://UNFCCC.Int/Cop4/Conv/Ftconv.Html [Accessed 10 Sep. 2018].

UNFCCC (2015). *Paris Agreement*. [Online] Paris, France: Un. Available At: https://UNFCCC.Int/Sites/Default/Files/English_paris_agreement.Pdf [Accessed 11 Sep. 2018].

UNFCCC (2017). How Blockchain Technology Could Boost Climate Action | UNFCCC. Retrieved From https://UNFCCC.Int/News/How-blockchain-technology-could-boost-climate-action

UNFCCC (2018a). Un Supports Blockchain Technology For Climate Action | UNFCCC. Retrieved From https://UNFCCC.Int/News/Un-supports-blockchain-technology-for-climate-action

UNFCCC (2018b). *Timeline - UNFCCC -- 20 Years Of Effort And Achievement*. [Online] UNFCCC.Int. Available At: http://UNFCCC.Int/Timeline/ [Accessed 10 Sep. 2018].

UNFCCC (2018c). *What Is The Paris Agreement? | UNFCCC*. [Online] Available At: https://UNFCCC.Int/Process-and-meetings/The-paris-agreement/What-is-the-paris-agreement [Accessed 11 Sep. 2018].

UNFCCC (2018d). *Blockchain & Distributed Ledger Technologies to Support Global Climate Action | UNFCCC*. [online] UNFCCC.int. Available at: https://unfccc.int/about-us/partnerships/current-calls-for-partnerships/call-using-distributed-ledger-technologies-including-blockchain-to-support-global-climate-action#eq-5 [Accessed 16 Jan. 2019].

UN PRI (2018). *Responsible Investment And Blockchain*. [Online] Un Pri. Available At: https://www.Unpri.org/Download?Ac=4522 [Accessed 29 Oct. 2018].

Van Rijmenam, M. and Ryan, P. (2018). *Blockchain: Transforming Your Business and Our World*. 1st ed. Routledge.

Vezirgiannidou, S. (2008). The Kyoto Agreement And The Pursuit Of Relative Gains. *Environmental Politics*, 17(1), Pp.40-57.

Victor, D. (2011). *The Collapse Of The Kyoto Protocol And The Struggle To Slow Global Warming*. Princeton: Princeton University Press.

Walker, L. (2017). *How blockchain will help save the environment*. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2017/09/carbon-currency-blockchain-poseidon-ecosphere/ [Accessed 16 Jan. 2019].

Waltz, K. (1990). 'Realist Thought And Neorealist Theory', *Journal Of International Affairs* 44/1, Pp. 21-37.

Weatherley-singh, J. And Gupta, A. (2015). Drivers Of Deforestation And Redd+ Benefit-sharing: A Meta-analysis Of The (Missing) Link. *Environmental Science & Policy*, 54, Pp.97-105.

Weedon, C. (2000). *Feminist Practice & Poststructuralist Theory*. Oxford u.a.: Blackwell.

WEF (2018). *Report: More than 65 Ways Blockchain Technology Can Fix Global Environmental Challenges*. [online] World Economic Forum. Available at: https://www.weforum.org/press/2018/09/report-more-than-65-ways-blockchain-technology-can-fix-global-environmental-challenges/ [Accessed 16 Jan. 2019].

WEF And PwC (2018). *Building Block(Chain)S For A Better Planet*. Fourth Industrial Revolution For The Earth. [Online] Geneva, Switzerland: Wef. Available At: http://www3.Weforum.org/Docs/Wef_building-blockchains.Pdf [Accessed 29 Oct. 2018].

Wodak, R., & Fairclough, N. (1997). Critical Discourse Analysis. In T. A. van Dijk (Ed.), *Discourse as Social Interaction* (pp. 258-284). London: Sage.

World Bank (2017). *Innovate4climate: Finance And Markets Week*. [Online] World Bank. Available At: http://www.Worldbank.org/En/Events/2016/11/16/Innovate4climate-finance-and -markets-week [Accessed 28 Oct. 2018].

World Bank (2018). *Blockchain And Emerging Digital Technologies For Enhancing Post-2020 Climate Markets (English)*. [Online] Washington D.C.: World Bank Group. Available At: http://Documents.Worldbank.org/Curated/En/942981521464296927/Blockchain-and-emerging-digital-technologies-for-enhancing-post-2020-climate-markets [Accessed 27 Aug. 2018].

World Commission on Environment and Development. (1987). *Our Common Future*. Oxford, Univ. Press.

WWF (2018). *Blockchain Tuna Project*. [Online] Wwf.org.Nz. Available At: https://www.Wwf.org.Nz/What_we_do/Marine/Blockchain_tuna_project/ [Accessed 27 Oct. 2018].

Zheng, Z., Xie, S., Dai, H., Chen, X. and Wang, H. (2018). Blockchain challenges and opportunities: a survey. *International Journal of Web and Grid Services*, 14(4), p.352.